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ORIGINAL ARTICLE

Conidial fungi associated with leaf litter of red cedar (*Cedrela odorata*) in Belém, Pará (eastern Brazilian Amazon)

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ABSTRACT

The aim of this study was to investigate the species of conidial fungi associated with leaf litter of *Cedrela odorata* (Meliaceae), an endangered red cedar species typical of Amazonian terra-firme forests. Conidial fungi were sampled around *C. odorata* individuals in three forest areas in the municipality of Belém (Pará State, Brazil). A total of 104 species were identified, with 53 new records for the state of Pará, 46 first records for the Brazilian Amazon, including new records for Brazil (*Cordana abramovii*), for South America (*Acarocybiopsis cubitaensis*, *Xylocladium claviforme*) and for the Americas (*Dactylaria biguttulata*). A review of species of conidial fungi reported on *C. odorata* is provided, indicating its distribution in Brazil. For each new record in Brazil, South America and the Americas we present a description, illustrations, geographical distribution and taxonomic comments.

KEYWORDS: Ascomycota, hyphomycetes, Meliaceae, tropical forest

Fungos conidiais associados com o folhedo de cedro vermelho (*Cedrela odorata*) em Belém, Pará (Amazônia Oriental brasileira)

RESUMO

O objetivo deste estudo foi investigar as espécies de fungos conidiais associadas com o folhedo de *Cedrela odorata*, uma espécie de cedro vermelho ameaçada, típica de florestas de terra firme da Amazônia. Fungos conidiais foram amostrados no folhedo ao redor de indivíduos de *C. odorata* em três áreas florestais no município de Belém (PA). Um total de 104 espécies foi identificado, com 53 novos registros para o Estado do Pará e 46 que representam o primeiro registro para a Amazônia brasileira. Dentre estas, foram encontrados novos registros para o Brasil (*Cordana abramovii*), para a América do Sul (*Acarocybiopsis cubitaensis*, *Xylocladium claviforme*) e para as Américas (*Dactylaria biguttulata*). Uma revisão das espécies de fungos conidiais relatadas em *C. odorata* é fornecida, indicando sua distribuição no Brasil. Para cada novo registro no Brasil, América do Sul e Américas apresentamos uma descrição, ilustrações, distribuição geográfica e comentários taxonômicos.

PALAVRAS-CHAVE: Ascomycota, hyphomycetes, Meliaceae, floresta tropical

INTRODUCTION

Conidial fungi are active components in the process of plant decomposition (Dix and Webster 1995). Several studies in Brazil have surveyed the species richness and diversity of these fungi in association with plant debris of several botanical families, revealing a significant number of new species and records for the country (e.g. Forzza *et al*. 2010; Flora do Brasil 2020 em construção 2017; CRIA 2017).

The pioneering studies on conidial fungi in the Brazilian Amazon were by Hennings (1900) and Batista *et al*. (1966). Later contributions increased the knowledge and richness of these organisms in upland and lowland forests (Hernández-Gutiérrez *et al*. 2009; Monteiro *et al*. 2010; Castro *et al*. 2012; Carmo *et al*. 2014).

Cedrela odorata L. (Meliaceae), known as red cedar, is an Amazonian timber species of great economic interest, exploited for the production of noble woods of high commercial value, and is currently threatened by extinction (Albernaz and Avila-

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Pires 2009; IUCN 2017). The distribution of this species in Brazil covers areas of the Amazon, Cerrado and Atlantic Forest biomes (Forzza *et al*. 2010).

Only a few studies have reported on the fungal species associated with *Cedrela* in Brazil, including some conidial fungi and sexual Ascomycetes. Hennings (1902), Gusmão and Grandi (1997) and Viana *et al*. (2012) reported fungi on *C. fissilis* Vell. in the states of São Paulo, Paraná and Ceará, respectively. Batista *et al*. (1964) and Hanada *et al*. (2005) reported *Phyllachora balansae* Speg. and *Pseudobeltrania cedrelae* Henn., respectively, to cause leaf spot in *C. odorata* in the state of Amazonas.

Considering the lack of information on the occurrence of fungi associated with plant species on the verge of extinction in Brazil, and the current conservation status of this tree species of great commercial value, our objective was to study the conidial fungi associated with *C. odorata* in three forest remnants in the highly impacted Belém endemism center, in the eastern Brazilian Amazon. Our aim was to survey the diversity of conidial fungi associated with the leaf litter of *C. odorata*, and to describe and illustrate new records for Brazil.

MATERIAL AND METHODS

We selected three areas in the municipality of Belém (state of Pará, northern Brazil) because they contained *C. odorata* specimens: (a) Bosque Rodrigues Alves Botanical Garden (BRA) (1°25′47″S, 48°27′16″W), an area of upland forest (Ferreira *et al*. 2012); (b) Zoobotanical Park of the Museu Paraense Emílio Goeldi (ZPM) (1°27′14″S, 48°28′31″W), also an upland forest fragment (Ferreira *et al*. 2012); and (c) Environmental Conservation Area (APA) of Combu Island (1°30′40″S, 48°27′35″W), which contains lowland, seasonally flooded forest (Castro *et al*. 2012).

Five individuals of *C. odorata* were selected in each area, and six bimonthly collections were carried out between December 2014 and October 2015. The trees were chosen considering the amount of litter available at their bases. During each collection, litter samples were collected from each individual, consisting of leaflets, rachis, branches and fruits (when available) in the process of decomposition.

Fungi were accessed using an adaptation of the technique of Castañeda-Ruiz *et al*. (2016). Samples were washed in tap water and then incubated in adapted wet chambers consisting of 1L plastic bags lined with moistened paper towel at the bottom. The wet chambers were placed in a polystyrene box (80 L) with 500 ml of water + 2 ml of glycerin and lined with moistened towel paper. Five times a week the styrofoam box was opened for 30 minutes for air circulation. The moisture in the box was maintained by spraying water on the paper towel when needed.

After 72 hours, the samples were analyzed under a stereomicroscope to verify reproductive structures. The examination was repeated for a period of 30–45 days. When present, the structures were removed from the substrate using thin needles and mounted on semi-permanent slides with lactoglycerol (distilled water + lactic acid + glycerin) (Carmo *et al*. 2016) and permanent slides with PVL resin (polyvinyl alcohol + lactophenol) (Trappe and Schenck 1982). Species identification was achieved through morphological analysis and measurement of the microstructures of taxonomic value under an optical microscope with the aid of specialized literature, such as Ellis (1971), Matsushima (1975) and Seifert *et al.* (2011). Illustrations were prepared based on photomicrographs obtained from a DP25 digital camera coupled to an Olympus BX51 optical microscope, equipped with or without a differential interference contrast (DIC) prism.

For each identified species the geographic distribution in Brazil was determined based on CRIA (2017), and for each new species in Brazil a morphological description, illustrations and taxonomic comments are presented. The samples and slides were deposited in the Herbarium João Murça Pires (MG) of the Museu Paraense Emílio Goeldi (MPEG).

The collection of specimens at the Zoobotanical Park, APA of Combu Island and Bosque Rodrigues Alves was authorized by Instituto Chico Mendes de Conservação da Biodiversidade (SISBIO permit #11937) and Secretaria do Municipal do Meio Ambiente – SEMMA/Belém (permit dates 10/12/2014 and 10/07/2015).

RESULTS

We identified 104 species of conidial fungi associated with the litter of *C. odorata* (Table 1). Among these, 53 new records for the state of Pará were found, of which 46 represented new records for the Brazilian Amazon (Table 1). *Cordana abramovii* Seman & Davydkina is a new record for Brazil, while *Acarocybiopsis cubitaensis* J. Mena, A. Hern. Gut. & Mercado and *Xylocladium claviforme* (J.L. Crane & Dumont) Arx are new records for South America. *Dactylaria biguttulata* Goh & K.D. Hyde was registered for the first time in the Americas.

Acarocybiopsis cubitaensis J. Mena, A. Hern. Gut. & Mercado, Mycological Research 103 (8): 1032 (1999)

Figure 1A–C

Synnemata solitary, straight or slightly flexuous, brown to dark brown, 42.5–125 × 10–12.5 µm; composed by an ascending hypha that supports a single conidiogenous cell and descending hyphae formed in the basal part of each conidiogenous cell. Hyphae septate, smooth, brown to dark brown. Conidiogenous cells monoblastic, terminal, discrete, lageniform, with 3–5 percurrent extensions. Conidia acrogenous, solitary, ellipsoid to obovoid, 3-septate, rounded at the apex, median septum with a black band, not constricted at the septa, smooth, brown to dark brown, 25–35 × 22.5–25 µm.

Material examined: Brazil. Pará: Belém, Parque Zoobotânico do Museu Paraense Emílio Goeldi, on decaying wood of *Cedrela odorata*, 16/X/2015, *R.F. Santos 100* (MG 226161).

Table 1. List of 104 species of conidial fungi recorded on the leaf litter of *Cedrela odorata* in the metropolitan area of Belém (state of Pará, Brazil). Distribution in Brazil indicates the states in which the species was recorded, and is based on CRIA (2017) and data of this study (in bold). New records: ♦American continent; •South America; ▪Brazil; ▲Brazilian Amazon; *Pará state. APA - Environmental Conservation Area of Combu Island; BRA - Bosque Rodrigues Alves Botanical Garden; ZPM - Zoobotanical Park of the Museu Paraense Emílio Goeldi.

Species	APA	BRA	ZPM	Distribution in Brazil
Acarocybiopsis cubitaensis J. Mena, A. Hern. Gut. & Mercado♦▪▲*			x	**PA**
Acrogenospora sphaerocephala (Berk. & Broome) M.B. Ellis	x	x	x	BA, CE, PA
Acumispora verruculosa Heredia, R.F. Castañeda & R.M. Arias	x	x		PA, SP
Anungitea fragilis B. Sutton▲*		x		BA, **PA**
Arthrinium sacchari (Speg.) M.B. Ellis▲*	x	x		**PA**, PE
Beltrania rhombica Penz.	x	x	x	AM, BA, CE, PA, PB, PE, PI, PR, RN, SP, TO
Beltraniella portoricensis (F. Stevens) Piroz. & S.D. Patil	x	x	x	AM, BA, CE, PA, PB, PE, PI, PR, RN, SP
Beltraniopsis esenbeckiae Bat. & J.L. Bezerra▲*		x	x	BA, **PA**, PB, PE
Berkleasmium corticola (P. Karst.) R.T. Moore▲*			x	BA, **PA**
Brachiosphaera tropicalis Nawawi	x			BA, PA
Brachysporiella gayana Bat.			x	AM, BA, CE, PA, PE, PI, SP
Cacumisporium pleuroconidiophorum (Davydkina&Melnik) R.F. Castañeda, Heredia & Iturr.		x	x	BA, PA
Camposporium fusisporum Whitton, McKenzie & K.D. Hyde			x	PA
Campylospora filicladia Nawawi▲*	x			CE, **PA**
Canalisporium caribense (Hol.-Jech. & Mercado) Nawawi & Kuthub.	x	x	x	BA, PA
Canalisporium elegans Nawawi & Kuthub.		x		PA
Canalisporium pulchrum (Hol.-Jech. & Mercado) Nawawi & Kuthub.	x	x	x	PA
Cancellidium applanatum Tubaki	x			AM, BA, PA
Candelabrum brocchiatum Tubaki			x	BA, PA, RN, SP
Chaetendophragmia triangularis Matsush.	x			BA, PA, SP
Chlamydopsis proliferans Hol.-Jech. & R.F. Castañeda▲*			x	BA, **PA**, SP
Chloridium reniforme Matsush.▲*		x		**PA**
Ch. virescens (Pers.) W. Gams & Hol.-Jech.*			x	AM, BA, CE, **PA**, SP
Circinotrichum britannicum P.M. Kirk▲*		x		BA, CE, **PA**
Circinotrichum maculiforme Nees▲*	x	x	x	BA, **PA**, SP
Circinotrichum olivaceum (Speg.) Piroz.▲*			x	BA, CE, **PA**, PB, RN, SP
Circinotrichum papakurae S. Hughes &Piroz.▲*	x			BA, CE, **PA**, PI, SP
Clonostachys rosea (Link) Schroers, Samuels, Seifert & W. Gams		x		BA, PA, PB, PE, RN, SP
Codinaea assamica (Agnihothr.) S. Hughes & W.B. Kendr.	x	x	x	BA, PA, RN
Codinaea fertilis S. Hughes & W.B. Kendr.	x	x	x	BA, CE, PA, PE, PB, PI, SP
Codinaea simplex S. Hughes & W.B. Kendr.	x	x		AM, BA, CE, PA, PB, PE, PI, SP
Coleodictyospora micronesiaca (Matsush.) Matsush.	x			PA
Conioscypha lignicola Höhn.▲*		x		**PA**
Conioscypha varia Shearer			x	BA, PA, RN
Cordana abramovii Seman & Davydkina▪▲*	x			**PA**
Cryptophiale kakombensis Piroz.		x		AM, BA, CE, PA, PE, PI, SP
Cryptophiale udagawae Piroz. & Ichinoe		x	x	AP, BA, CE, PA, PB, PI, RN, SP
Cylindrocladium naviculatum Crous& M.J. Wingf.▲*			x	BA, **PA**
Dactylaria biguttulata Goh & K.D. Hyde♦•▪▲*	x	x		**PA**
Dactylaria candidula (Höhn.) G.C. Bhatt & W.B. Kendr.	x			AM, BA, CE, PA, RN, SP
Dendryphiopsis atra (Corda) S. Hughes▲*			x	BA, **PA**, RN
Dictyochaetopsis polysetosa R.F. Castañeda, Gusmão, Guarro & Saikawa		x		BA, PA, RJ
Dictyosporium digitatum J.L. Chen, C.H. Hwang & Tzean		x		AP, BA, PA
Dictyosporium elegans Corda▲*	x	x	x	BA, CE, **PA**
Dictyosporium musae Photita	x		x	PA

Table 1. Continued

Species	APA	BRA	ZPM	Distribution in Brazil
Dinemasporium lanatum Nag Raj & R.F. Castañeda	x	x		AM, BA, PA, RN,
Diplocladiella scalaroides G. Arnaud		x	x	BA, PA
Ellisembia adscendens (Berk.) Subram.	x	x	x	BA, CE, PA, PB, PE, PI, RN, SP
Ellisembia bambusae (M.B. Ellis) W.P. Wu▲*			x	BA, **PA**
Ellisembia minigelatinosa (Matsush.) W.P. Wu		x		BA, PA, RN
Ellisembia vaga (Nees & T. Nees) Subram.▲*	x	x	x	BA, **PA**, RN
Exserticlava triseptata (Matsush.) S. Hughes	x	x		AM, BA, PA, PB
Gonytrichum macrocladum (Sacc.) S. Hughes▲*	x	x	x	BA, **PA**, PE, SP
Gyrothrix circinata (Berk. & M.A. Curtis) S. Hughes▲*		x	x	BA, CE, **PA**, PE, PR, RN, SP
Gyrothrix podosperma (Corda) Rabenh.▲*	x	x	x	BA, CE, **PA**, PR, SP
Hansfordia pulvinata (Berk. & M.A. Curtis) S. Hughes*	x			AM, BA, **PA**
Helicomyces roseus Link	x	x		BA, PA, PB, RS
Helicosporium aureum (Corda) Linder▲*		x	x	BA, CE, **PA**
Helicosporium pannosum (Berk. & M.A. Curtis) R.T. Moore	x			BA, PA, SP
Helicosporium griseum Berk. & M.A. Curtis▲*			x	BA, **PA**, PE, SP
Helicosporium guianense Linder▲*	x		x	BA, **PA**
Helicosporium virescens (Pers.) Sivan.			x	BA, PA, PE, RN
Hermatomyces sphaericus (Sacc.) S. Hughes▲*	x	x	x	BA, **PA**
Idriella cubensis R.F. Castañeda & G.R.W. Arnold▲*	x	x	x	**PA**
Idriella lunata P.E. Nelson & S. Wilh.▲*	x		x	BA, **PA**, PE, PI
Junewangia globulosa (Tóth) W.A. Baker & Morgan-Jones▲*	x			BA, **PA**, PB, PE, RN
Lauriomyces sakaeratensis Somrith., Kosol & E.B.G. Jones		x		AM, BA, PA
Mariannaea elegans (Corda) Samson		x		BA, PA, SP
Megacapitula villosa J.L. Chen &Tzean▲*			x	**PA**
Melanocephala triseptata (Shearer, J.L. Crane & M.A. Mill.) S. Hughes▲*	x	x	x	BA, **PA**
Menisporopsis pirozynskii Varghese & V.G. Rao			x	AP, BA, PA, RN, SP
Menisporopsis theobromae S. Hughes	x	x	x	AP, BA, CE, PA, PB, PE, PI, RN, SP
Monodictys paradoxa (Corda) S. Hughes	x	x	x	PA
Monotosporella palmicola Yanna & K.D. Hyde	x			PA
Myrothecium setiramosum R.F. Castañeda▲*	x	x		BA, **PA**
Nigrospora sphaerica (Sacc.) E.W. Mason*	x		x	AM, AL, **PA**, PE, RJ, SP
Paliphora intermedia Alcorn		x		AM, BA, PA, PI
Periconia cookie E.W. Mason & M.B. Ellis▲*		x		BA, CE, GO, MA, **PA**, PE, PI, RN, SP
Peyronelina glomerulata P.J. Fisher, J. Webster & D.F. Kane▲*			x	**PA**, PE
Phaeocandelabrum elegans (R.F. Castañeda) R.F. Castañeda, Heredia & Saikawa▲*			x	BA, CE, **PA**
Phaeoisaria clematidis (Fuckel) S. Hughes	x	x	x	BA, CE, PA, PE, RN, SP
Phaeoisaria triseptata Hol.-Jech.▲*		x		BA, CE, **PA**
Physalidiella elegans (LuppiMosca) Rulamort	x			BA, PA, SP
Piricauda cochinensis (Subram.) M.B. Ellis	x			BA, PA, PB
Pithomyces chartarum (Berk. & M.A. Curtis) M.B. Ellis*			x	AM, BA, **PA**, PE, PI, RN, SP
Polyschema amoenum R.F. Castañeda, Iturr. & Minter			x	PA
Repetophragma fasciatum (R.F. Castañeda) R.F. Castañeda, Gusmão & Saikawa▲*	x	x		BA, **PA**
Repetophragma filiferum (Piroz.) R.F. Castañeda, Gusmão & Heredia	x		x	PA, PE, SP
Rhexoacrodictys erecta (Ellis &Everh.) W.A. Baker & Morgan-Jones	x			BA, PA, PB, RN, SP
Solosympodiella clavata Matsush.▲*		x		BA, **PA**
Speiropsis pedatospora Tubaki▲*	x			BA, **PA**
Speiropsis scopiformis Kuthub. & Nawawi	x	x		AP, BA, CE, PA, PI, SP

Table 1. Continued

Species	APA	BRA	ZPM	Distribution in Brazil
Sporidesmium tropicale M.B. Ellis▲*	x	x	x	BA, CE, **PA**, PB
Stachybotrys kampalensis Hansf.▲*		x		BA, **PA**
Stachybotrys longispora Matsush.▲*			x	BA, CE, **PA**
Tetraploa aristata Berk. & Broome	x			BA, PA, PE, RN, SP
Thozetella cristata Piroz. & Hodges	x	x		BA, CE, PA, PE, PI, PR, RN, SP
Triadelphia uniseptata (Berk. & Broome) P.M. Kirk▲*		x		**PA**, RS
Vanakripa fasciata R.F. Castañeda, M. Stadler & Decock		x		PA
Vermiculariopsiella cubensis (R.F. Castañeda) Nawawi, Kuthub. & B. Sutton▲*		x		BA, **PA**, SP
Wiesneriomyces laurinus (Tassi) P.M. Kirk	x	x	x	BA, CE, PA, PB, PE, PI, PR, RN, SP
Xylocladium claviforme (J.L. Crane & Dumont) Arx▪■▲*			x	**PA**
Zygosporium echinosporum Bunting & E.W. Mason*	x			AP, BA, **PA**, PE
Zygosporium gibbum (Sacc., M. Rousseau & E. Bommer) S. Hughes*	x			AM, BA, CE, **PA**, PE, PI, RN
Zygosporium masonii S. Hughes*	x	x	x	AP, AM, BA, **PA**, PE, RN, SP
Total = 104	58	59	56	

Known distribution: America [Brazil (this study), Cuba (Mena-Portales *et al.* 1999)].

Comments: *Acarocybiopsis cubitaensis* was proposed by Mena-Portales *et al.* (1999) and remains the single species of a monotypic genus; it is characterized by a synnema consisting of ascending hyphae that support the conidiogenic cell from which descending hyphae originate, which extend towards the substrate. Conidiogenesis is monoblastic and the conidiogenous cells have percurrent extensions producing ellipsoid to obovoid, 3-septate, brown conidia. Seifert *et al.* (2011) suggested that *Manoharachariomyces lignicola* N.K. Rao, D.K. Agarwal & Kunwar (Rao *et al.* 2005) would be congeneric with *Acarocybiopsis*, but would represent a different species because it has 2-3, strongly interlaced hyphae arising from the base of the conidiogenous cell, forming a synnema. The hyphae and conidia of *M. lignicola* are smaller (up to 110 × 3.5–4.5 µm and 28–36 × 16–18.5 µm respectively) than those found in *A. cubitaensis*. A careful analysis of the *M. lignicola* holotype is necessary for a new combination to be proposed. The morphological characteristics of the specimens studied are in agreement with the description of the holotype (Mena-Portales *et al.* 1999), however the measurements found in the Brazilian material were smaller than those described for the synnemata (42.5–125 × 10–12.5 µm vs. 50–300 × 12–20 µm) and conidia [25–35 × 22.5–25 µm vs. (35.5–) 38–46 × (18.5) 21.5–26 µm]. It should be noted that this is the first time that *A. cubitaensis* has been collected outside the type locality. This represents the first record of this species for South America.

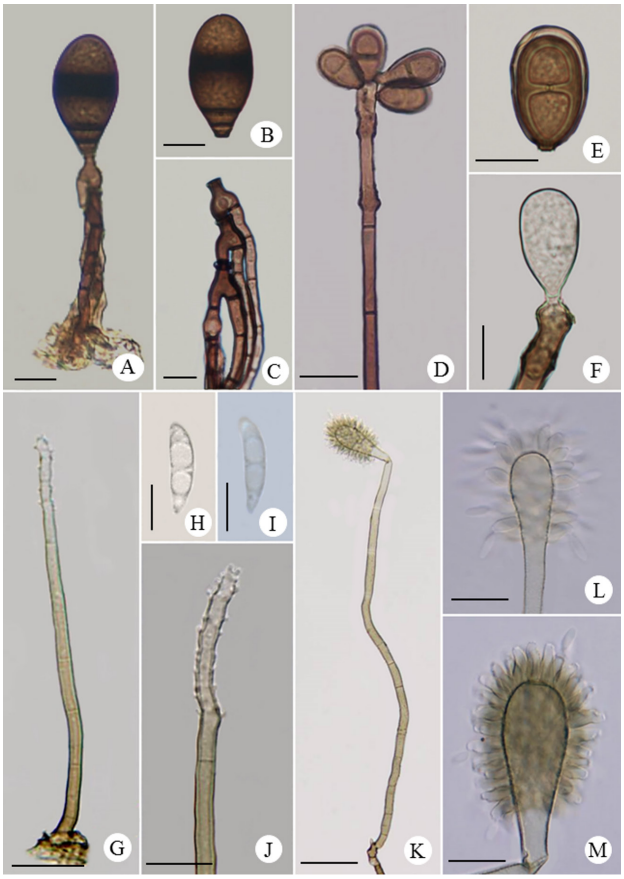

Figure 1. A-C. *Acarocybiopsis cubitaensis:* A. Synnema, B. Conidium, C. Detail of conidiogenous cells; D-F. *Cordana abramovii*: D. Conidiophore and conidia, E. Conidium, F. Conidiogenous cell and young conidium; G-J. *Dactylaria biguttulata*: G. Conidiophore, H-I. Conidium, J. Detail of conidiogenous cell; K-M. *Xylocladium claviforme*: K. Conidiophore, L. Vesicle and conidia, M. Detail of vesicle. Bars: 10 µm (A-C, E-F, H-J, L-M), 20 µm (D,G), 50 µm (K). This figure is in color in the electronic version.

Cordana abramovii Seman & Davydkina, Novosti Sistematiki Nizshikh Rastenii 20: 115 (1983)

Figure 1D–F

Conidiophores macronematous, mononematous, simple, erect, straight or slightly flexuous, septate, thick walled, smooth, dark brown, paler towards the apex, 225–325 × 7.5–8.5 µm. Conidiogenous cells polyblastic, integrated, terminal and intercalary, usually swelling, 7.5–10 µm wide, denticulate. Conidia acropleurogenous, solitary, pyriform to obovoid, 1-distoseptate, with a septal pore, thick walled, smooth, brown to dark brown, 20–30 × 15–17.5 µm, truncated base.

Material examined: Brazil. Pará: Belém, Combu Island, on decaying wood of *Cedrela odorata*, 18/X/2014, *R.F. Santos 89* (MG 226165).

Known distribution: Africa [Seychelles (Zelski *et al*. 2014)], America [Brazil (this study), Costa Rica, Nicaragua (Delgado and Koukol 2016),Mexico (Heredia-Abarca *et al*. 2006), Peru (Zelski *et al*. 2014), USA (Raja *et al*. 2007)], Asia [Brunei, Philippines (Cai *et al*. 2003), India (Heredia-Abarca *et al*. 2006), Russia, Thailand (Zelski *et al*. 2014)], Oceania [New Zealand (Heredia-Abarca *et al*. 2006)].

Comments: *Cordana* was described by Preuss (1851) and typified by *C. pauciseptata* Preuss. This genus has simple, macronematous conidiophores with polyblastic, sympodial conidiogenous cells that are terminal or intercalary, usually inflated, with cylindrical denticles that form 0–1-septate, brown to light brown conidia, with schizolytic secession (Seifert *et al*. 2011; Hernández-Restrepo *et al*. 2014). Currently, 19 species of *Cordana* are included in Cordanaceae (Cordanales, Sordariomycetes), which can be found as saprobes or phytopathogens (Hernández-Restrepo *et al*. 2014; Zelski *et al*. 2014). Most of these species are known only from the type locality, with the exception of *C. abramovii*, *C. musae* (Zimm.) Höhn. and *C. terrestris* (Timonin) M. Hern.-Rest., Gené & Guarro, which present wide distributions (Farr and Rossman 2017). In Brazil, *C. ellipsoidea* de Hoog (Bahia, Pará), *C. musae* (Bahia, Pará, Piauí), *C. pauciseptata* (Bahia) and *C. terrestris* (Bahia) were recorded (CRIA 2017). *Cordana abramovii* was found in basidiomata of a Polyporales and in decomposing wood of *Beilschmiedia tarairi* (A. Cunn.) Kirk, (Lauraceae), with conidiophores measuring up to 1000 µm and conidia of 27–31 × 15–15.5 µm (Seman and Davydkina 1983). Morphologically, the Brazilian specimens are consistent with the description of the holotype, except for the smaller conidiophores (225–325 vs. 250–1000 µm). This species is widely distributed in temperate and tropical areas, this being the first record for Brazil.

Dactylaria biguttulata Goh & K.D. Hyde, Fungal Diversity 3: 64 (1999)

Figure 1G–J

Conidiophores macronematous, mononematous, simple, erect, straight or slightly flexuous, septate, smooth, brown, paler towards the apex, 92.5–137.5 × 3–3.5 µm. Conidiogenous cells polyblastic, integrated, terminal, denticulate, subhyaline to very pale brown. Conidia acropleurogenous, ellipsoid, 1-septate, slightly curved, obtuse to subobtuse at the apex, with a guttule in each cell, smooth, hyaline, 10–12 × 3–4 µm.

Material examined: Brazil. Pará: Belém, Jardim Botânico Bosque Rodrigues Alves, on decaying fruit of *C. odorata*, 28/IV/2015, *R.F. Santos 32* (MG 226166); Combu Island, on decaying wood of *C. odorata*, 10/VI/2015, *R.F. Santos 49* (MG 226667).

Known distribution: America [Brazil (this study)], Asia [China (Goh and Hyde 1999)].

Comments: *Dactylaria* was proposed by Saccardo (1880) with *D. purpurella* (Sacc.) Sacc. as the type species. This genus is characterized by simple or rarely branched, hyaline or brown conidiophores with polyblastic, sympodial, denticulate conidiogenous cells, with unicellular to multiseptate, hyaline or brown conidia with schizolytic secession (Seifert *et al*. 2011). Worldwide, 87 species are currently accepted, distributed in temperate and tropical areas (Goh and Hyde 1997; Paulus *et al*. 2003; Mycobank 2017). In Brazil, 20 species have been recorded in the Amazon, Caatinga and Atlantic Forest biomes, with *D. candidula* (Höhn.) G.C. Bhatt & W.B. Kendr. the most common species (CRIA 2017). *Dactylaria biguttulata* was described by Goh and Hyde (1999) on submerged wood. According to Goh and Hyde (1999) the conidia of *D. biguttulata* can be compared to those of *D. longidentata* Cazau, Aramb. & Cabello in terms of the presence of guttule and conidial morphology. However, the conidia of *D. longidentata* are predominantly unicellular and smaller (8–11 × 2–3 vs. 10–13 × 3.5–4.5 µm) (Cazau *et al*. 1990). This is the first report of the species for the terrestrial environment and for the Americas.

Xylocladium claviforme (J.L. Crane & Dumont) Arx, Proceedings van de Koninklijke Nederlandse Akademie van Wetenschappen Section C 85: 27 (1982)

Figure 1K–M

Conidiophores macronematous, mononematous, simple or branched, straight or slightly flexuous, septate, verrucose, brown, paler towards the apex, 320–600 × 8–10 µm, apex enlarged forming a vesicle; clavate vesicle, pale brown, 25–35 × 12–15 µm. Conidiogenous cells polyblastic, discrete, sympodial, ellipsoid, pale brown, cicatrized, formed in the vesicle. Secession rhexolytic. Conidia acrogenous, solitary, unicellular, fusiform to ellipsoid, obtuse at the apex, truncated at the base, smooth, subhyaline, 6–8 × 2.5–3 µm.

Material examined: Brazil. Pará: Belém, Parque Zoobotânico do Museu Paraense Emílio Goeldi, on decaying wood of *Cedrela odorata*, 10/VI/2015, *R.F. Santos 77* (MG 226170).

Known distribution: America [Brazil (this study), Cuba, Mexico (Heredia *et al*. 2004), Jamaica (Crane and Dumont 1975)].

Comments: *Xylocladium* was proposed by Engler and Prantl (1900) and typified by *X. clautriavii* (Pat.) P. Syd. ex Lindau. This genus is included in the Graphostromataceae (Xylariales) and is characterized by the presence of macronematous conidiophores, usually forming a vesicle clavate at the apex, where cicatrized, sympodial conidiogenous cells produce unicellular, hyaline conidia with rhexolytic secession (Seifert *et al*. 2011; Wendt *et al*. 2018). *Xylocladium claviforme* was first described as *Masoniomyces claviformis* J.L. Crane & Dumont by Crane and Dumont (1975), on rotting wood, and later transferred to the genus *Xylocladium* by Arx (1982). In *X. claviforme* the conidiogenous cells have flattened scars at the point of origin of the conidia, whereas *X. clautriavii* has conidiogenous cells with 3–4 protruding scars, in addition to smaller conidia (5–6 × 3 µm) (Saccardo and Trotter 1913). The Brazilian material presented larger conidia (6–8 × 2.5–3 vs. 4–7 × 2 µm) than those described by Crane and Dumont (1975) and Heredia *et al*. (2004). This is the first record of this species for South America.

DISCUSSION

This is the first study dealing with conidial fungi associated with decomposing leaf litter of *Cedrela odorata* in Brazil. Until now, only a leaf spot was registered in this tree species, caused by *Pseudobeltrania cedrelae* (Hanada *et al*. 2005). This agent of leaf spot was not found in the present study.

Among the listed species, 51 species have already been found in Pará state and other Brazilian states, on several substrates. Previous records of conidial fungi in the state of Pará were known for the localities of Capitão-Poço (Pfenning 1997), Melgaço (Hernández-Gutiérrez *et al*. 2009; Monteiro *et al*. 2010; Hernández-Gutiérrez 2013), Santa Bárbara (CRIA 2017) and Belém (Rodrigues 1994; Castro *et al*. 2011; 2012; CRIA 2017). Our results increase the known number of conidial fungi species in Pará to 383, being the state of northern Brazil with the highest known diversity of this group.

Accordingly, our results increase the known diversity of conidial fungi in the municipality of Belém. In APA Combu Island there was an increment from 253 known species (Rodrigues 1994; Castro *et al*. 2011; 2012; CRIA 2017) to 278 species. This was the second record of conidial fungi in the Zoobotanical Park of Museu Goeldi, after the pioneering study by Paul C. Hennings in the early 1900s (Batista *et al*. 1966). This was the first record of conidial fungi for Bosque Rodrigues Alves Botanical Garden.

Among the new records found, *Acarocybiopsis cubitaensis*, *D. biguttulata* and *X. claviforme* have so far been recorded only in tropical environments, while *C. abramovii* presents a wide distribution, with records in several countries of temperate and tropical regions.

CONCLUSIONS

This study contributed to the knowledge about conidial fungi associated with *Cedrela odorata*, and to the expansion of the geographic distribution of several conidial fungi in the tropical region, including 46 new additions for the Brazilian Amazon, and new records for South America and the American continent. Our data evidences the need to expand collection efforts in less explored areas in the Brazilian Amazon.

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