cryptogamie
Mycologie
2022 • 43 • 1

Taxonomy and phylogenetic analysis reveal one new genus and three new species in *Inonotus s.l.* (Hymenochaetaceae) from Brazil

Vitor Xavier de LIMA, Virton Rodrigo Targino de OLIVEIRA, Nelson Correia de LIMA-JÚNIOR, José Ribamar C. OLIVEIRA-FILHO, Carla SANTOS, Nelson LIMA & Tatiana Baptista GIBERTONI

art. 43 (1) — Published on 21 January 2022
www.cryptogamie.com/mycologie

PUBLICATIONS SCIENTIFIQUES
MUSÉUM NAL HIST NATURELLE

Couverture / *Cover*:
Extraits d'éléments de la Figure 4 / Extracts of the Figure 4

Cryptogamie, Mycologie est indexé dans / Cryptogamie, Mycologie *is indexed in:*
- Biological Abstracts
- Current Contents
- Science Citation Index
- Publications bibliographiques du CNRS (Pascal).

Cryptogamie, Mycologie est distribué en version électronique par / Cryptogamie, Mycologie *is distributed electronically by:*
- BioOne® (http://www.bioone.org/loi/crym)

Cryptogamie, Mycologie est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
Cryptogamie, Mycologie *is a fast track journal published by the Museum Science Press, Paris*

Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publishes:* ***Adansonia, Geodiversitas, Zoosystema, Anthropozoologica, European Journal of Taxonomy, Naturae,*** **Cryptogamie sous-sections** ***Algologie, Bryologie***, ***Comptes Rendus Palevol***.

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél.: 33 (0)1 40 79 48 05 / Fax: 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

ISSN (imprimé / *print*): 0181-1584/ ISSN (électronique / *electronic*): 1776-100

Taxonomy and phylogenetic analysis reveal one new genus and three new species in *Inonotus s.l.* (Hymenochaetaceae) from Brazil

Vitor Xavier de LIMA
Virton Rodrigo Targino de OLIVEIRA
Departamento de Micologia, Centro de Biociências, Universidade Federal de Pernambuco, Av. da Engenharia s/n, Recife, Pernambuco 50740-570 (Brazil)
vitorxlima@gmail.com (corresponding author)

Nelson Correia de LIMA-JÚNIOR
Centro Acadêmico de Vitória CAV, Universidade Federal de Pernambuco (UFPE), Vitória de Santo Antão (Brazil)

José Ribamar C. OLIVEIRA-FILHO
Departamento de Micologia, Centro de Biociências, Universidade Federal de Pernambuco, Av. da Engenharia s/n, Recife, Pernambuco 50740-570 (Brazil)

Carla SANTOS
Nelson LIMA
CEB-Centre of Biological Engineering, Micoteca da Universidade do Minho (MUM), University of Minho, Braga (Portugal)

Tatiana Baptista GIBERTONI
Departamento de Micologia, Centro de Biociências, Universidade Federal de Pernambuco, Av. da Engenharia s/n, Recife, Pernambuco 50740-570 (Brazil)

Submitted on 28 January 2020 | Accepted on 11 June 2021 | Published on 21 January 2022

Lima V. X. de, Oliveira V. R. T. de, Lima-Junior N. C. de, Oliveira-Filho J. R. C., Santos C., Lima N. & Gibertoni T. B. 2022. — Taxonomy and phylogenetic analysis reveal one new genus and three new species in *Inonotus s.l.* (Hymenochaetaceae) from Brazil. *Cryptogamie, Mycologie* 43 (1): 1-21. https://doi.org/10.5252/cryptogamie-mycologie2022v43a1. http://cryptogamie.com/mycologie/43/1

ABSTRACT
During surveys in the Brazilian Amazon, Atlantic Forest and Caatinga, several species of poroid Hymenochaetaceae were collected. Of the collected specimens, ITS and LSU sequences were generated and phylogenetic analyses performed. From morphological and phylogenetic inferences, *Sclerotus* Xavier de Lima, gen. nov. is described based on collections of *Phellinus extensus*, while *Inonotus parvisetus* V.R.T. Oliveira, Xavier de Lima & Gibertoni, sp. nov., *Tropicoporus flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov and *T. nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov. are described as new species. *Sclerotus* gen. nov. is characterized by the strongly ventricose hymenial setae and the black line that is exposed as a dark crust. *Inonotus parvisetum* can be differentiated from similar species of the genus by the smaller tramal setae. *Tropicoporus flabellatus* sp. nov. produces the thinnest basidiomata in the genus, and does not develop a dark crust in the pileus surface, while in *T. nullisetus* sp. nov. hymenial setae is absent. The other specimens clustered within *I. micantissimus* (Rick) Rajchemb., *I. rickii* (Pat.) Reid, *T. linteus* (Berk. & M.A.Curtis) L.W.Zhou & Y.C.Dai, *T. stratificans* G.Coelho & Yurchenko and *T. tropicalis* (M.J.Larsen & Lombard) L.W.Zhou & Y.C.Dai. Here *T. stratificans* is recorded for the first time outside the type locality. Illustrations of the species and keys for *Inonotus sensu lato* are provided.

KEY WORDS
Amazon, Atlantic Forest, Agaricomycetes, Neotropics, Poroid fungi, new genus, new species.

RÉSUMÉ

La taxonomie et l'analyse phylogénétique révèlent un nouveau genre et trois nouvelles espèces dans Inonotus s.l. *(Hymenochaetaceae) du Brésil.*

Au cours de prospections en Amazonie brésilienne, dans la forêt atlantique et la Caatinga, plusieurs espèces de Hymenochaetaceae poroïdes ont été collectées. Des séquences ITS et LSU ont été générées à partir des spécimens collectés et des analyses phylogénétiques ont été effectuées. À partir de déductions morphologiques et phylogénétiques, *Sclerotus* Xavier de Lima, gen. nov. est décrit sur la base de collections de *Phellinus extensus*, tandis qu'*Inonotus parvisetus* V.R.T. Oliveira, Xavier de Lima & Gibertoni, sp. nov., *Tropicoporus flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov et *T. nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov. sont décrites comme de nouvelles espèces. *Sclerotus* gen. nov. est caractérisé par les soies hyméniales fortement ventriculaires et la ligne noire qui est exposée comme une croûte sombre. *Inonotus parvisetum* peut être différencié des espèces similaires du genre par les soies tramales plus petites. *Tropicoporus flabellatus* sp. nov. produit les basidiomes les plus minces du genre et ne développe pas de croûte sombre à la surface du chapeau, tandis que dans *T. nullisetus* sp. nov., les soies hyméniales sont absentes. Les autres spécimens étaient regroupés dans *I. micantissimus* (Rick) Rajchemb., *I. rickii* (Pat.) Reid, *T. linteus* (Berk. & M.A.Curtis) L.W.Zhou & Y.C.Dai, *T. stratificans* G.Coelho & Yurchenko et *T. tropicalis* (M.J.Larsen & Lombard) L.W.Zhou & Y.C.Dai. Ici, *T. stratificans* est enregistré pour la première fois en dehors de la localité type. Des illustrations des espèces et les clés *d'Inonotus s.l.* sont fournies.

MOTS CLÉS
Amazonie,
forêt atlantique,
néotropique,
Agaricomycetes,
Polypores,
genre nouveau,
espèces nouvelles.

INTRODUCTION

The *Inonotus* lineage was better delimited by Wagner & Fischer (2002) based on 28S rDNA phylogenetic analysis and is composed of species with monomitic basidiomata, as well as by several dimitic species that were previously placed in *Phellinus* Quél. (Ryvarden 2004). The dimitic species form a complex of morphologically similar species, known as the *I. inteus* complex, whose taxonomy has received much attention (Tian *et al.* 2013; Vlasák *et al.* 2013; Zhou *et al.* 2016) due to its medicinal importance (Wu *et al.* 2012, 2019). The *I. linteus* complex was segregated from *Inonotus s.s.* into two new genera: *Sanghuangporus* Sheng H. Wu, L.W. Zhou & Y.C. Dai and *Tropicoporus* L.W. Zhou, Y.C. Dai & Shen. H. Wu (Zhou *et al.* 2016). Both genera are characterized by basidiomata with dimitic hyphal system in the tube trama, and a mono-dimitic hyphal system in the context, presence of hymenial setae, and yellowish to brownish thick-walled basidiospores. Most *Tropicoporus* species occur in tropical America, whereas *Sanghuangporus* occurs mostly in the Paleotropics and temperate regions (Zhou *et al.* 2016).

Phellinus extensus (Lév.) Pat. (Hymenochaetaceae), originally described from the French Antilles, is a little-known species characterized by strongly ventricose and very dark, hymenial setae, a unique feature within *Phellinus s.l.* (Larsen & Cobb-Poulle 1990). The affinities of this species remained unknown until phylogenetic analyses were performed by Góes-Neto *et al.* (2002) and later by Decock *et al.* (2006), who placed it among the species of the *I. linteus* complex.

In the present work, both molecular and morphological data were applied to identify three species of *Inonotus* and five species of *Tropicoporus* from the Brazilian Atlantic Forest and Caatinga, of which three are new to science. The results of our phylogenetic inferences also confirmed the affinities of *P. extensus* with species of the *Tropicoporus* and *Shanghuangporus* lineages, forming a basal lineage whose taxonomic status is discussed.

MATERIAL AND METHODS

Morphological analysis

Macroscopic analyses were performed on dried specimens. A drop of 3% KOH was poured over the basidioma to observe possible color (xantochroic) changes. Slides were prepared with 3% KOH for measurements. For basidiospore size, Q = variation in the ratios of basidiospore length/width is provided. Slides were prepared with Melzer's reagent to observe amyloid or dextrinoid reactions of any structures. The absence of reaction with Melzer's reagent is indicated with IKI- (Ryvarden 2004). Presence of cyanophilic reaction was observed on preparations with Lactophenol Cotton Blue (CB+/CB-). Color descriptions are based on the Methuen handbook (Kornerup & Wanscher 1978).

DNA extraction, amplification and sequencing

Fragments from the basidiomata (30-50 mg) were removed and placed in 1.5 ml tubes and stored at -20 °C until DNA extraction. The fragments were ground with liquid nitrogen or homogenized in 2 ml tubes containing 0.17 g of glass beads (425-600 µm) and one ¼ inch ceramic sphere using the FastPrep-24™ 5G Instrument (MP Biomedicals). DNA was extracted using a modified method described in Góes-Neto *et al.* (2005) and Rodrigues *et al.* (2009). PCR amplification of the ITS and LSU regions were performed using the primer pairs ITS1-ITS4 or ITS4-ITS5 and LR0R-LR5, respectively (White *et al.* 1990; Lima-Junior *et al.* 2014). The PCR products were purified either with ExoSAP-IT™ PCR

Product Cleanup Reagent (Thermo Fisher Scientific, United States) or E.Z.N.A.® Cycle-Pure Kit, Omega Bio-tek®, following the manufacturer's recommendations. Samples were Sanger sequenced at the Plataforma Tecnológica de Genômica e Expressão Gênica do Centro de Biociências, UFPE, Brazil, or sent to Stab Vida Lda (Madan Parque, Caparica, Portugal). The cycle sequencing was carried with the same primers of amplification reactions (Moncalvo *et al.* 2000). All obtained sequences were deposited in GenBank (National Center for Biotechnology Information, Bethesda, Maryland, United States).

Phylogenetic analysis

Sequences were assembled and edited with Staden package (Staden *et al.* 1998). For phylogenetic reconstruction, sequences where mostly gathered from published works (Tian *et al.* 2013; Vlasák *et al.* 2013; Wu *et al.* 2015; Coelho *et al.* 2016; Zhou *et al.* 2016), and also BLAST queries with the generated sequences in GenBank were performed to recover similar sequences. Sequence alignments were performed with the online version of MAFFT 7 (Katoh *et al.* 2019) using the default settings, and then manually adjusted in MEGA-X (Kumar *et al.* 2018). Two datasets were compiled: (1) ITS+LSU dataset - 87 specimens of Hymenochaetaceae, with concatenated alignment of ITS region (ITS1, 5.8S and ITS2) and LSU (28S) regions. ITS and LSU DNA sequences from *Trichaptum sector* (Ehrenb.) Kreisel (RP63), one of the closest relatives to Hymenochaetaceae in Hymenochaetales (Zhou *et al.* 2018) were used as outgroup. Due to high divergence in the variable regions of ITS1 and ITS2 in this dataset, regions with ambiguous alignment were manually removed. Also, both ends rich in gaps were trimmed. The final alignment length was 1443 bp. For tree reconstruction the sequences were partitioned in ITS1+ITS2 and 5.8S+28S. (2) ITS dataset – 82 specimens with ITS sequences of the *Inonotus* clade were selected. ITS sequence of *Fulvifomes fastuosus* (Lév.) Bondartseva & S.Herrera (CBS 288.32) was used as outgroup. The alignment was treated as dataset (1). The final alignment length was 746 bp. The alignment was partitioned in ITS1+ITS2 and 5.8S.

Bayesian Inference (BI) was performed in MrBayes 3.2 (Ronquist *et al*. 2012). For each partition the best evolutionary model was selected using JModelTest implemented in MEGA-X (Kumar *et al.* 2018). The best models were chosen based on the Bayesian Information Criterion scores. For the ITS + LSU dataset, the chosen models were GTR + G for the ITS1 + ITS2 partition, and K2 + G + I for 5.8S+28S. For the ITS dataset, the chosen models were K2 + G + I for the ITS1 + ITS2 partition, and K2 for 5.8S. Initially, one million generations were performed and additional generations were computed until the average standard deviation of split frequencies reached bellow 0.01 (Ronquist et al. 2012). A burn-in of 25% the initial trees was used before computing the consensus tree. Maximum Likelihood (ML) analyses were performed with MEGA-X (Kumar *et al.* 2018), and bootstrap support values calculated with 1000 resamplings.

Table 1. — Newly sequenced specimens for this study.

		GenBank accession no.	
	Voucher	**ITS**	**LSU**
Inonotus micantissimus	URM90186	MG576057	MG576125
I. parvisetus sp. nov.	URM94334	MT908374	MT906640
I. parvisetus sp. nov. holotype	URM94335	MT908372	MT906638
I. rickii	URM94336	MT908373	MT906639
I. rickii	URM94337	–	MT906641
Phellinus extensus	URM89390	MN795108	MN812244
P. extensus	URM87072	MN795109	MN812245
P. extensus	URM89663	MN795110	MN812246
P. extensus	URM89538	MN795111	MN812247
Tropicoporus flabellatus sp. nov. holotype	URM94338	MT908376	MT906643
T. flabellatus sp. nov.	JB7	MT925653	MT925654
T. linteus	URM84512	MN795115	MN812251
T. linteus	URM85603	MN795116	MN812252
T. linteus	URM94051	–	MN812255
T. linteus	URM94072	MN795122	MN812256
T. linteus	URM94076	MN795123	MN812257
T. linteus	URM94048	–	MN812262
T. linteus	URM93764	–	MN812263
T. linteus	URM93771	–	MN812264
T. linteus	URM94047	–	MN812265
T. nullisetus sp. nov.	URM94074	MN795117	MN812253
T. nullisetus sp. nov.	URM94075	MN795118	MN812254
T. nullisetus sp. nov. holotype	URM94073	MN795129	MN812261
T. stratificans	URM94063	MN795124	MN812266
T. tropicalis	URM89677	MN795112	MN812248
T. tropicalis	URM94077	MN795113	MN812249
T. tropicalis	URM94071	MN795114	MN812250
T. tropicalis	URM94055	MN795119	–
T. tropicalis	URM94070	MN795120	–
T. tropicalis	URM93800	MN795121	–
T. tropicalis	URM93777	MN795125	MN812258
T. tropicalis	URM93753	MN795126	-
T. tropicalis	URM94069	MN795127	MN812259
T. tropicalis	URM94078	MN795128	MN812260

RESULTS

Phylogenetic analysis

The generated sequences are presented in Table 1 and all sequences used for phylogenetic reconstruction are presented in Supplementary Material 1. The resulting tree from the BI and ML analyses were similar, thus only the ML tree is shown with both bootstrap (BT) and posterior probabilities (PP) values at the nodes (Figs 1; 2).

The phylogeny of Hymenochaetaceae inferred from the ITS+LSU dataset recovered the *Inonotus s.l.* clade, composed by the *Inonotus s.s.*, *Sanghuangporus* and *Tropicoporus* lineages and the *Phellinus extensus* clade, all with statistical support (BT ≥ 86%; PP ≥ 0.99). The *P. extensus* clade is sister to the *Sanghuangporus* and *Tropicoporus* lineages. One set of the studied specimens nested within the *Tropicoporus* lineage is placed as sister to *T. dependens* (Murrill) L.W. Zhou, Y.C. Dai & Vlasák and *T. guanacastensis* L.W. Zhou, Y.C. Dai & Vlasák, and another studied specimen groups within the *T. tropicalis s.l.* clade. Other group of studied specimens clustered within the *Inonotus s.s.* lineage, forming a distinct clade sister to *I. griseus* L.W. Zhou, *I. henanensis* Juan Li &

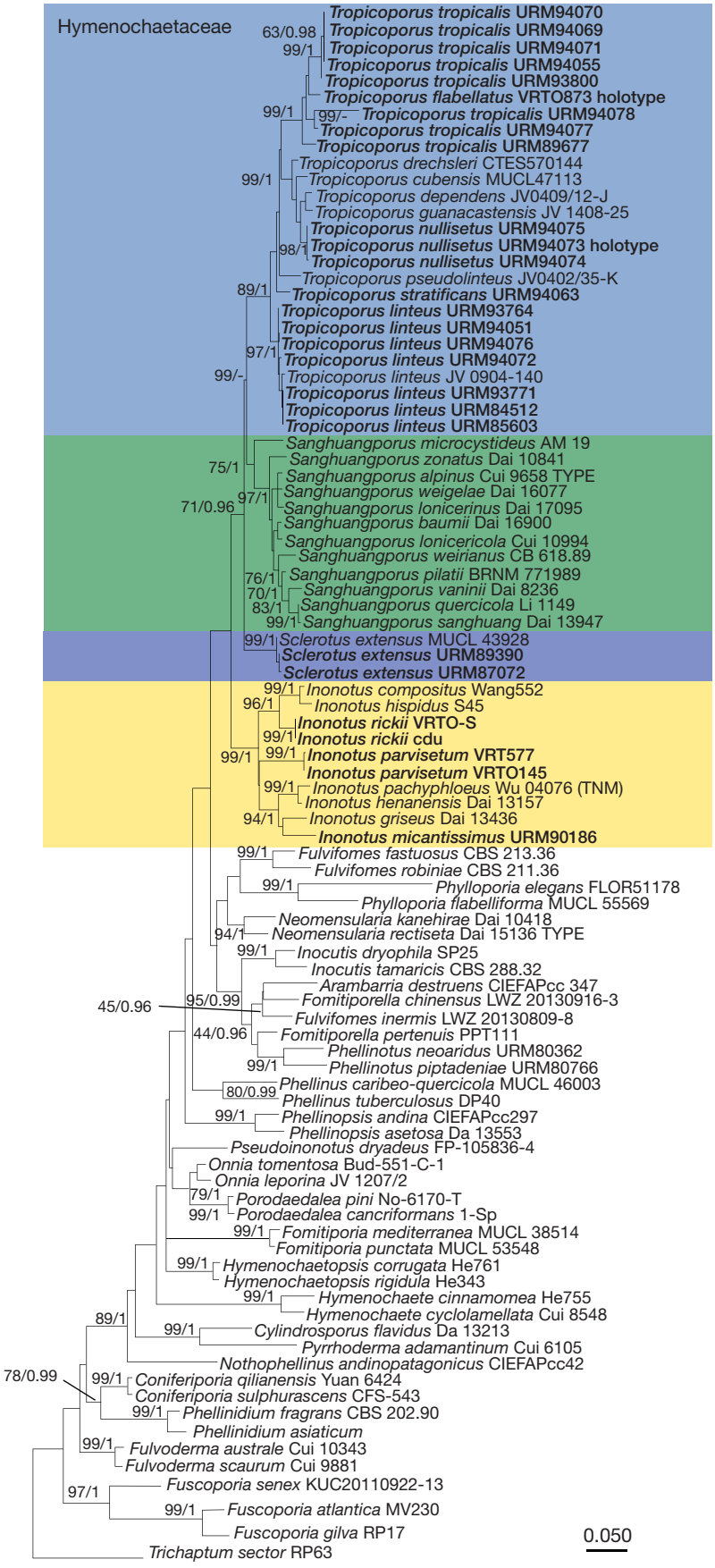

FIG. 1. — Phylogeny of Hymenochaetaceae, with focus on *Inonotus* clade, inferred from ITS and LSU sequences. Topology is from ML analysis, with BT/PP [...]

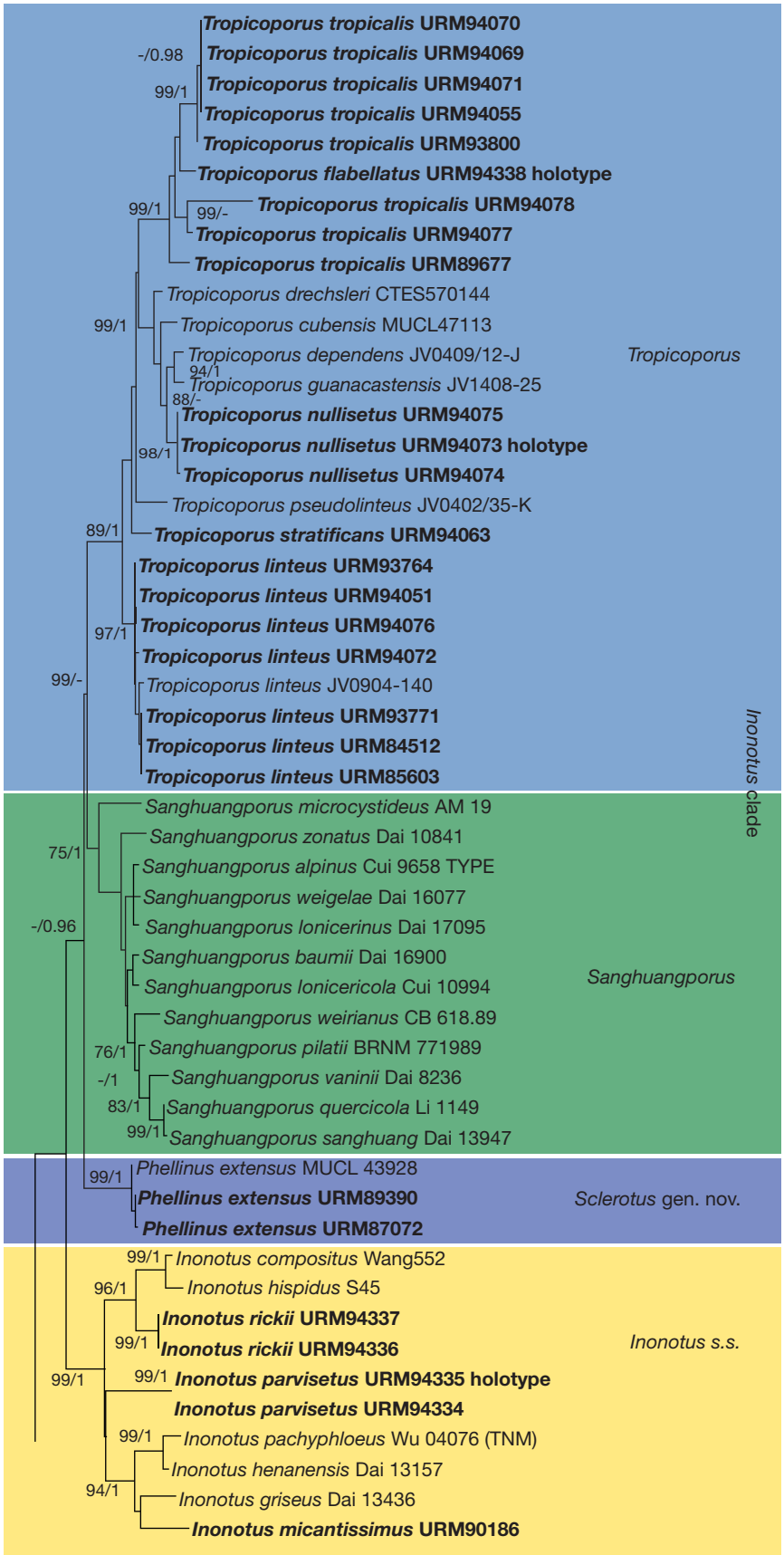

FIG. 1 (continuation). — [...] values at the nodes. Only BT above 75% and/or PP above 0.95 are shown. Newly generated sequences are in **boldface**.

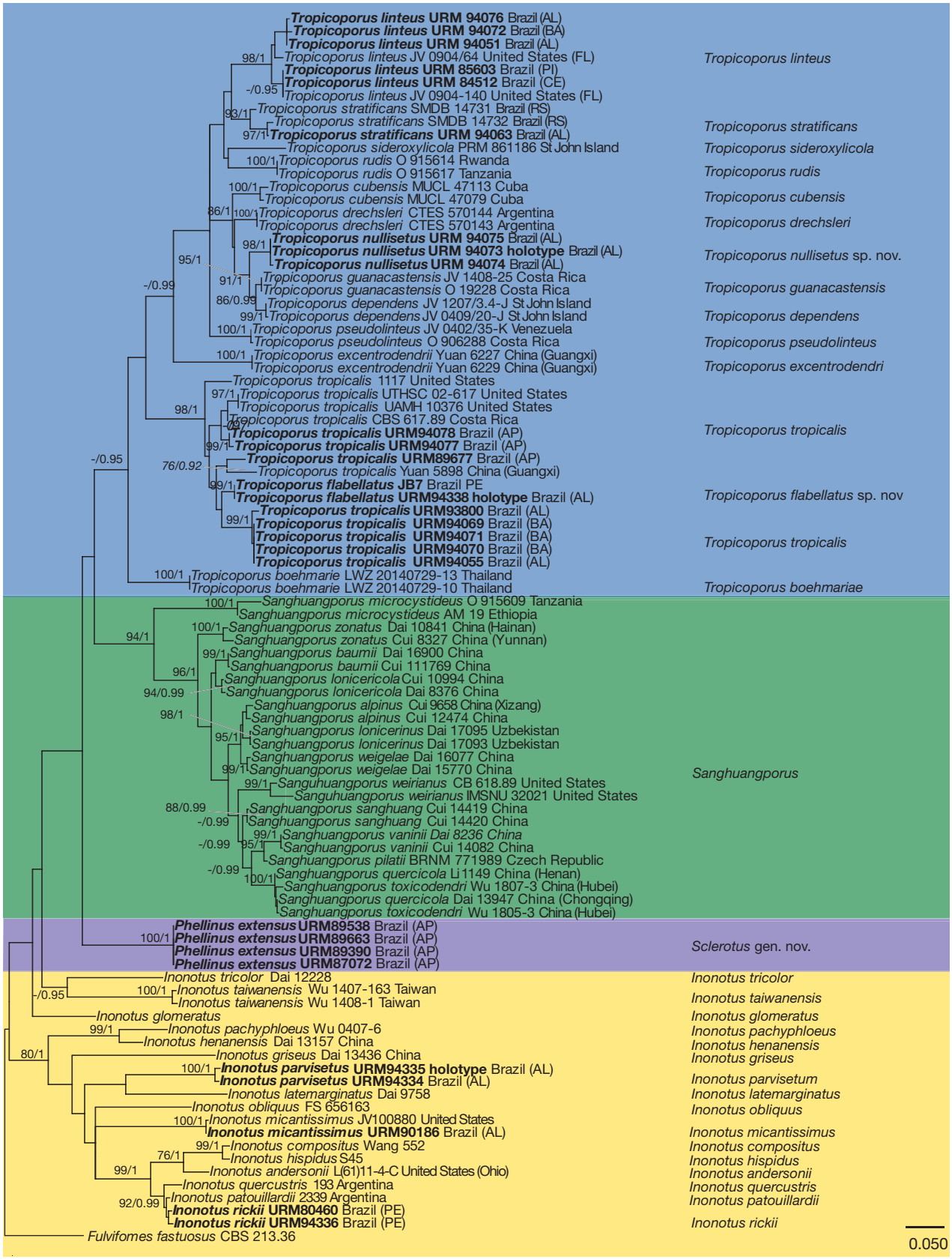

FIG. 2. — Phylogeny of *Inonotus* clade from ITS sequences. Topology is from ML analysis, with BT/PP values at the nodes. Only BT above 75% and/or PP above 0.95 are shown. Newly generated sequences are in boldface.

Y.C. Dai, *I. micantissimus* (Rick) Rajchenb. and *I. pachyphloeus* (Pat.) T. Wagner & M. Fisch.

The tree generated from the ITS dataset is shown in Figure 2. In this tree, *Sanghuangporus*, *P. extensus* and *Tropicoporus* were also recovered. The *P. extensus* clade is placed as sister to *Sanghuangporus* and *Tropicoporus*. The three lineages are also strongly supported; however, *Tropicoporus* had lower support from BT of the ML tree (57%). The *Inonotus s.s.* does not form a monophyletic group in this tree, similar to the ITS tree generated by Zhou *et al.* (2016). A set of studied specimens nesting within the *Tropicoporus* lineage form a new strongly supported clade in both analyses (BT = 99%; PP = 1.0), sister to *T. dependens* and *T. guanacastensis*, and other specimens are placed within *T. tropicalis* lineage. In the *Inonotus s.s.* lineage, another set of the studied specimens clustered as sister to *I. latemarginatus* Y.C. Dai. The remaining studied specimens clustered with *I. micantissimus*, *I. rickii* (Pat.) D.A.Reid, *T. linteus* (Berk. & M.A.Curtis) L.W.Zhou & Y.C.Dai, *T. stratificans* G.Coelho & Yurchenko and *T. tropicalis* (M.J.Larsen & Lombard) L.W.Zhou & Y.C.Dai with strong support.

The set of specimens forming new clades in the *Inonotus s.s.* and *Tropicoporus* lineage are morphologically distinct from the other described species of both genera. Also, the *P. extensus* specimens form a new clade within the *Inonotus s.l.* lineage. Based on morphological and molecular evidences, we thus suggest the recognition of a new genus, *Sclerotus* Xavier de Lima, gen. nov., three new species, *I. parvisetus* V.R.T. Oliveira, Xavier de Lima & Gibertoni, sp. nov., *T. flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov. and *T. nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov. and one synonymization.

Taxonomy

Family Hymenochaetaceae Imazeki & Toki
Genus *Inonotus* P.Karst.

Inonotus micantissimus (Rick) Rajchemb.

Nordic Journal of Botany 7 (5): 565 (Rajchenberg 1987).

Phellinus macrosporus Gibertoni & Ryvarden, *Synopsis Fungorum* 18: 51 (2004).

Specimens examined. — **Argentina**, Missiones, Iguazu National Park, III.1982, L. Ryvarden (O[O919343]) — **Brazil**. Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 09°15'29.0"S, 36°25'52.0"W, 614 m, 3.VII.2017, V. Xavier de Lima PPT6, (URM[URM90186]); 3.VI.2017, V. Xavier de Lima PPT132, (URM[URM91180]); Bahia State, Salvador, on *Nectandra* sp., III.1944, J. Rick, (PACA-Fungi[20691, holo-]); Pernambuco State, Recife, Parque Estadual Dois Irmãos, XI.2001, *Phellinus macrosporus* (URM[URM77582, holo-]); Rio Grande do Sul State, Santa Maria, Cerrito, VI.1984, G. Coelho (O[O919342]); Parque Pinhal, VI.1992, G. Coelho (O[O919346]); Santa Maria, IX.1995, G. Coelho (O[O919344]); São Paulo State, Cananéia, llha do Cardoso, II.1987, D. Pegler, K. Hjortstam & L. Ryvarden (O[O910345; O919341]); Costa Rica, Puntaneras, La Amistad Pacifico, Estación Biológica Las Tablas, Finca Cafrosa, IX.2000, L. Ryvarden (O[O506129]); Dominican Republic, Cordillera Central, La Veja, Rreserva Científica Ebano Verde, II.1998, P. Perdomo (O[O906277]); United States of America, Virgin Islands, St. John Island, IX.2004, C. Vlaskova (O[O919340]); Florida, Miami, Mathesons Hammock, VIII.2010, J. Vlasák (O[O505347]).

Remarks

The recently collected specimens (URM90186 and URM91180) are identical to the holotype of *I. micantissimus* (Fig. 3A-D). The large tramal setae (Fig. 3B) and large subglobose basidiospores (Fig. 3D) make this a very distinctive species in Hymenochaetaceae. The type of *P. macrosporus* was also analyzed, and our observations agree with Gibertoni *et al.* (2004). The species is characterized by the resupinate basidiomata, 7-8 pores/mm, presence of tramal and hymenial setae, globose, hyaline basidiospores, 6.2-12.4 µm in diam. Basidiospores are very similar in both types, being slightly larger in *I. micantissimus*. The current basidiospore measures from the type of *I. micantissimus* (10-13 × 8-10) were slightly different from those reported by previous works (Rajchenberg 1987; Ryvarden 2004: 10-13 × 8-12 µm). Basidiospore size and color seem to be a weak taxonomic character to distinguish these two species from each other, since their size overlap and the differences in the L (1.83 µm) and W (2.59 µm) averages among the species are in the range of the basidiospore variation within each species. Additionally, basidiospore color varies even in the same specimen. Thus, the synonymization of *P. macrosporus* to *I. micantissimus* is proposed.

Inonotus parvisetus
V.R.T. Oliveira, Xavier de Lima & Gibertoni, sp. nov.

This species is characterized by the pileate basidioma, narrow tramal setae, absence of hymenial setae, pores 6-8/mm and basidiospores 4.5-5 µm long.

MycoBank number. — MB 837431.

Holotype. — **Brazil**. Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 09°15'27.0"S, 36°24'44.0"W, 515 m, 19.VII.2018, V.R.T. Oliveira, (URM[URM94334]).

Additional specimen examined. — **Brazil**. Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 09°15'27.0"S, 36°24'44.0"W, 515m, 14.V.2019, V.R.T. Oliveira, (URM[94335]).

Etymology. — From parvus (Latin) meaning "small". Referring to the smaller tramal setae in comparison to similar species of the genus.

Habitat and distribution. — Tropical, ombrophilous broadleaf forest.

Description

Basidioma perennial, pileate (Fig. 4A-B), sessile, broadly attached to dimidiate, solitary to imbricate, convex to triquetrous in section, 2.3-6.7 cm wide, 2.1-4 cm long, 1.1-2.7 cm thick at the base, hard, light. Pileus surface firstly tomentose, yellowish-brown, but forming a hard, darker to black crust of agglutinated hyphae with age, concentrically sulcated, cracking radially in older parts. Margin obtuse. Pore surface (Fig. 4C) dark brown, pores round, 6-8/mm; margin sterile, yellow to brownish-yellow. Context golden-brown,

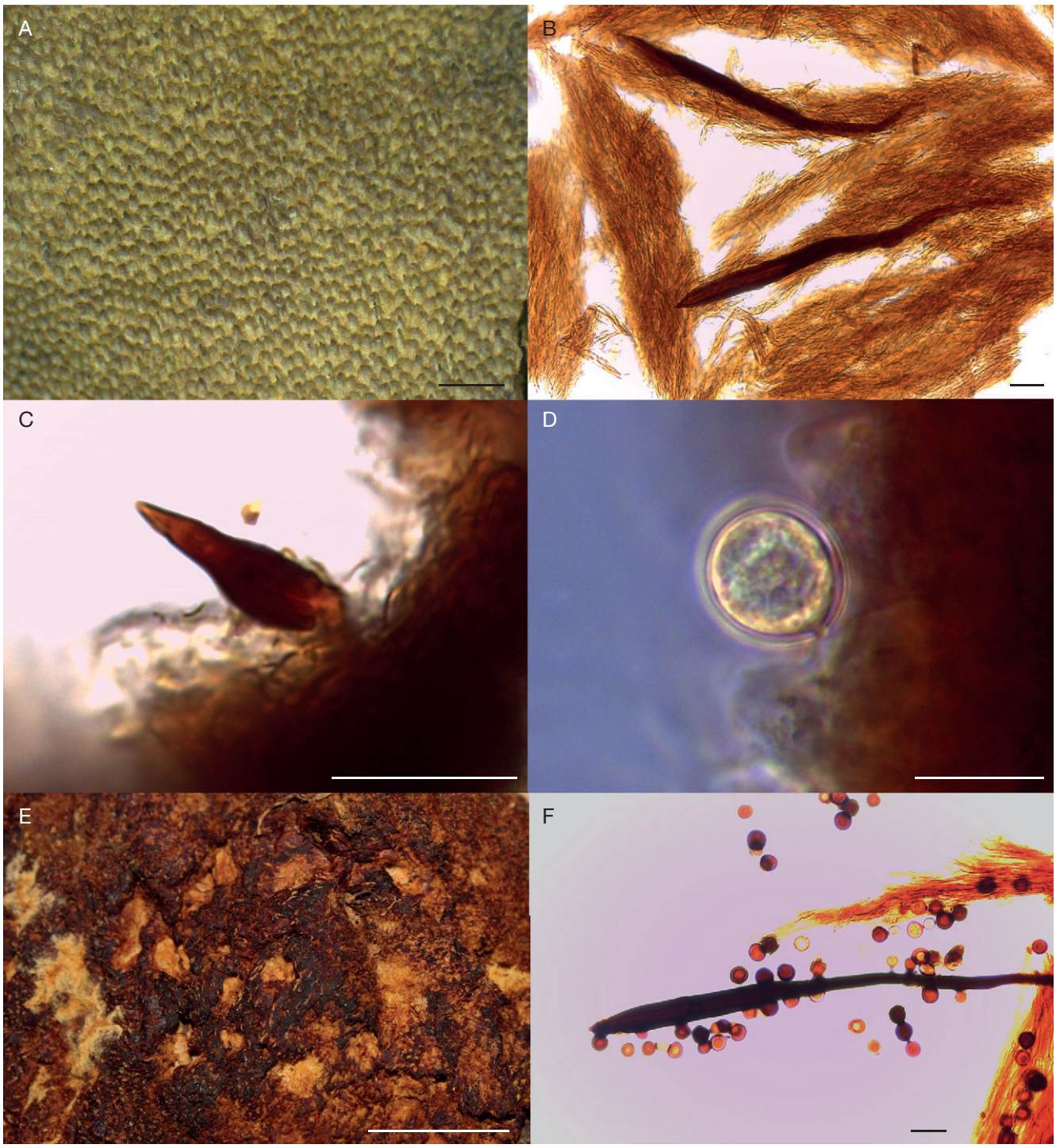

Fig. 3. — *Inonotus micantissimus* (Rick) Rajchemb. (URM90186): **A**, pore surface; **B**, tramal setae; **C**, hymenial setae; **D**, basidiospores. *I. rickii* (Pat.) Reid (URM94336): **E**, aspect of the anamorphous stage; **F**, tramal setae and chlamydospores. All preparations in 3% KOH. Scale bars: A, 1 mm; B, C, F, 20 µm; E, 1 cm.

duplex, with a thin black line near the pilear surface. Tubes concolorous with the context, tube layers (up to four layers in the holotype) separated by a thin layer of context, old tubes filled with concolorous to whitish mycelia. Context and tubes turning black in KOH 3%, drying out as dark spot. Hyphal system in the context monomitic, generative hyphae simple and mostly regularly septate, sparingly branched, hyaline, yellow, golden yellow in water and rusty brown in KOH, mostly thick-walled with wide to narrow lumen, rarely hyaline and thin-walled, 3-5.5 µm in diameter; black line (Fig. 4D) composed by dark reddish-brown, more densely agglutinated and intertwined hyphae; below the line, hyphae grow parallel to the pilear surface, near the tube they grow downwards to form the tube trama, and above the line, hyphae concolorous

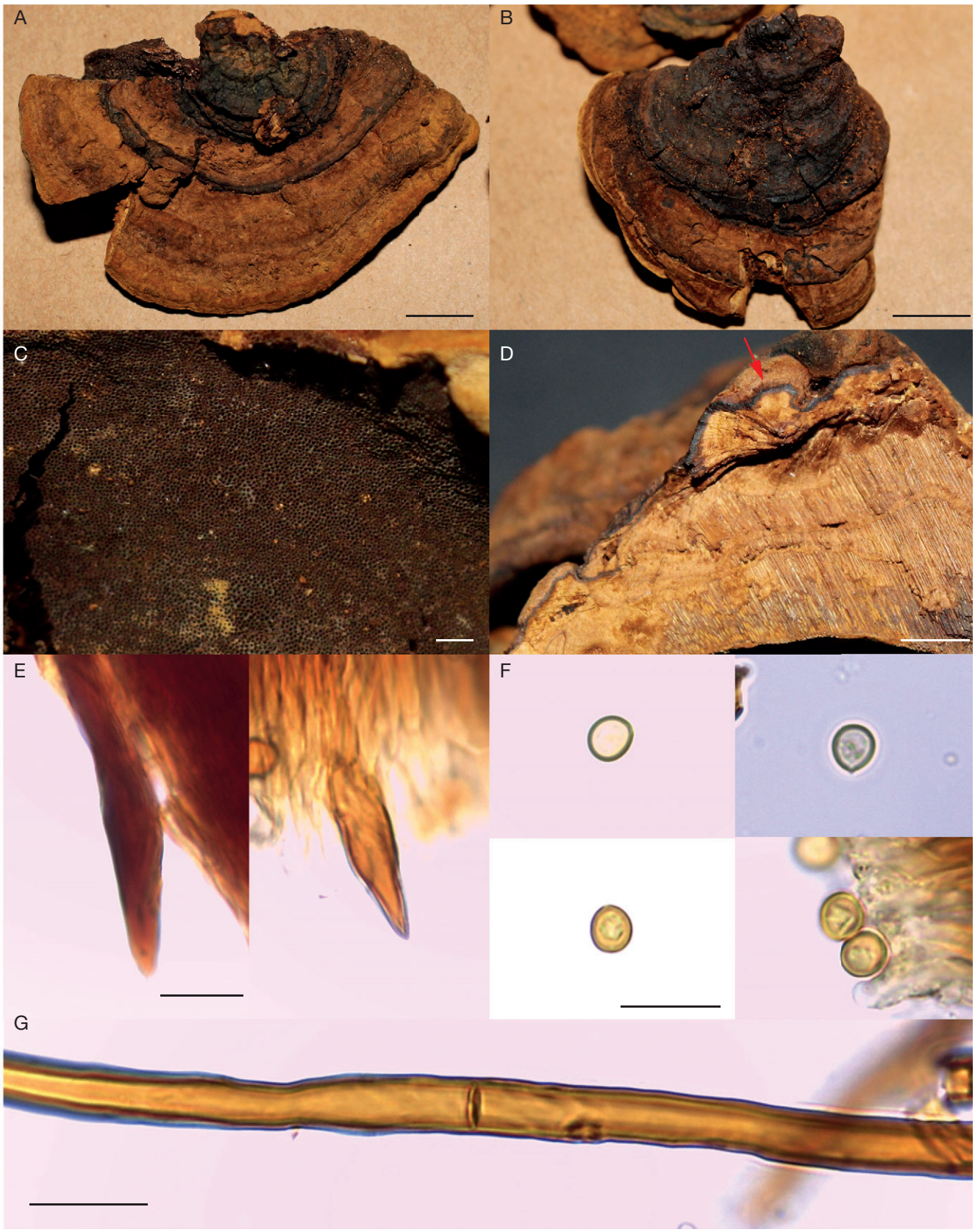

FIG. 4. — *Inonotus parvisetus* V.R.T. Oliveira, Xavier de Lima, Gibertoni, sp. nov. (URM94334): **A**, **B**, dried basidiomata of the holotype; **C**, pore surface; **D**, longitudinal section of the dried basidioma, **red arrow** pointing the black line in the context; **E**, tramal setae; **F**, basidiospores; **G**, generative hyphae of the context. All preparations in 3% KOH. Scale bars: A, B, 1 cm; C, 1 mm; D, 5 mm; E-G, 10 µm.

or slightly darker, growing upwards to compose the tomentum. Tomentum dense, hyphae straight, thick-walled with a wide lumen, yellow to dark yellow in water, rusty brown in KOH 3%, 3.4-5.5 µm diameter, ends obtuse, mostly broken and agglutinated in older parts of the pileus. Tube trama monomitic, hyphae grown straight perpendicular to the pilear surface, generative hyphae hyaline to yellow, thin to slightly thick-walled, 2.5-4 µm in diameter. Tramal setae (Fig. 4E) abundant to rare in the holotype, brownish yellow in water, dark rusty-brown in KOH 3%, more frequent near pore mouths, often protruding out of dissepiment, 45-80 × 6-8.5 µm. Basidia not observed. Basidiospores (Fig. 4F) subglobose, 4-5.5 × 4-5 µm (Q = 1-1.1), thick-walled, smooth, pale yellow in water and golden yellow to rusty brown in 3% KOH, CB-, IKI-.

Remarks

Macroscopically, this species is very similar to other pileate species of *Inonotus s.l.* found in the region. However, the presence of monomitic tube trama, tramal setae and subglobose basidiospores readily places this species in *Inonotus s.s.* Regarding species recorded in Brazil, it is similar to *I. amazonicus* Gibertoni & Ryvarden, *I. brasiliensis* Xavier de Lima & Ryvarden and *I. patouillardii* (Rick) Imazeki by the presence of tramal setae and absence of hymenial setae. *Inonotus amazonicus* has wider tramal setae (10-35 µm); *I. brasiliensis* is annual, pileus surface yellowish and has larger tramal setae (up to 120 × 15); *I. patouillardii* has wider pores (3-4/mm) and is usually recorded as parasitic (Gottlieb *et al.* 2002).

Inonotus rickii (Pat.) Reid

Kew Bulletin 12 (1): 141 (1957).

Specimens examined. — **Brazil**. Pernambuco State, Recife City, on living *Clitoria fairchildiana* (Fabaceae), 8°3'11.91"S, 34°53'2.53"W, 4.V.2019, V. R. T. Oliveira, (URM[URM94336]); on living *Delinix regia* (Fabaceae), 8°2'46.89"S, 34°56'37.40"W, 16.VIII.2019, V.R.T. Oliveira, (URM[URM943377]).

Remarks

The specimens analyzed were recorded as parasitic of urban trees. Both specimens were found in the anamorphous stage (*Ptychogaster cubensis* Pat.) on Fabaceae (*Clitoria fairchildiana*, native species, and *Delonix regia*, exotic) (Fig. 3E-F). In the ITS phylogeny, *I. rickii* is closely related to *I. patouillardii* (Fig. 2), the latter being differentiated by minor and questionable morphological features (Gottlieb *et al.*, 2002). They may represent the same species, however, sequencing either the type material or material from the type locality is desirable to confirm this hypothesis.

Sclerotus Xavier de Lima, gen. nov.

Type species. — *Sclerotus extensus* (Lév.) Xavier de Lima

MycoBank number. — MB833801.

Etymology. — Scler-,(Greek) hard; otus (Greek) ear.

Substrate. — Dead angiosperm.

Description

Basidioma perennial, pileate, resupinate to effused-reflexed, hard; pilear surface, when present, initially finely tomentose, but tomentum soon wearing away exposing the black line in the context like a hard crust or cuticle, narrowly sulcated, covering all pileus surface. In section, basidioma applanate, context dark brown; crust glossy, thick. Hyphal system dimitic in context and tube trama. Generative hyphae simple septate. Hyphae darkening in 3% KOH. Hymenial setae present, strongly ventricose, dark, with a narrow lumen. Basidiospores ellipsoid to subglobose, pale yellow, slightly thick-walled, IKI-, CB-. On dead angiosperm.

Remarks

This genus differs from other poroid Hymenochaetaceae by the combination of the presence of strongly ventricose and dark hymenial setae and a thick black line that is exposed after the tomentum wears away (Fig. 5). The dimitic nature of tube trama and context, the pigmented thick-walled basidiospores and presence of hymenial setae makes this genus morphologically similar to *Phellinus s.s.*, but it can be differentiated by the unique hymenial setae. This genus, so far, is represented by a single tropical species, *S. extensus*.

Sclerotus extensus (Lév.) Xavier de Lima, comb. nov.

Polyporus extensus Lév. Annales des Sciences Naturelles Botanique 5: 129 (1846).

MycoBank number. — MB 833802.

Examined specimens. — **Brazil**, Amapá State, Porto Grande, National Forest of Amapá, X.2014, A. M. Soares, (URM[URM89663]), as *Phellinus extensus* (Lév.) Pat.; II.2014, A. M. Soares, (URM[URM89390]), as *Fomitiporia punctata* (Pilát) Murrill; II.2014, A. M. Soares, (URM[URM87072]), as *Phellinus extensus* (Lév.) Pat.; X.2014, A. M. Soares, (URM[URM89538]), as *Inonotus calcitratus* (Berk. & M. A. Curtis) Gomes-Silva & Gibertoni. Pará State, Portel, National Forest of Caxiaunã, VIII.2013, A. M. Soares, (URM[URM87073]). Pernambuco State, Igarassu, Ecological Refuge Charles Darwin, IX.2000, T. B. Gibertoni, (URM[URM77595]), as *Phellinus extensus*. — **France**, Guadeloupe, Duchassaing, as *Fomes extensus* Lév., (URM[URM6750]).

Genus *Tropicoporus* L.W.Zhou, Y.C.Dai & Sheng H.Wu

Tropicoporus flabellatus V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov.

This species is characterized by the thin flabelliform basidioma, presence of hymenial setae, pores 7-9/mm and basidiospores 4.5-5 µm long.

MycoBank number. — MB 837432.

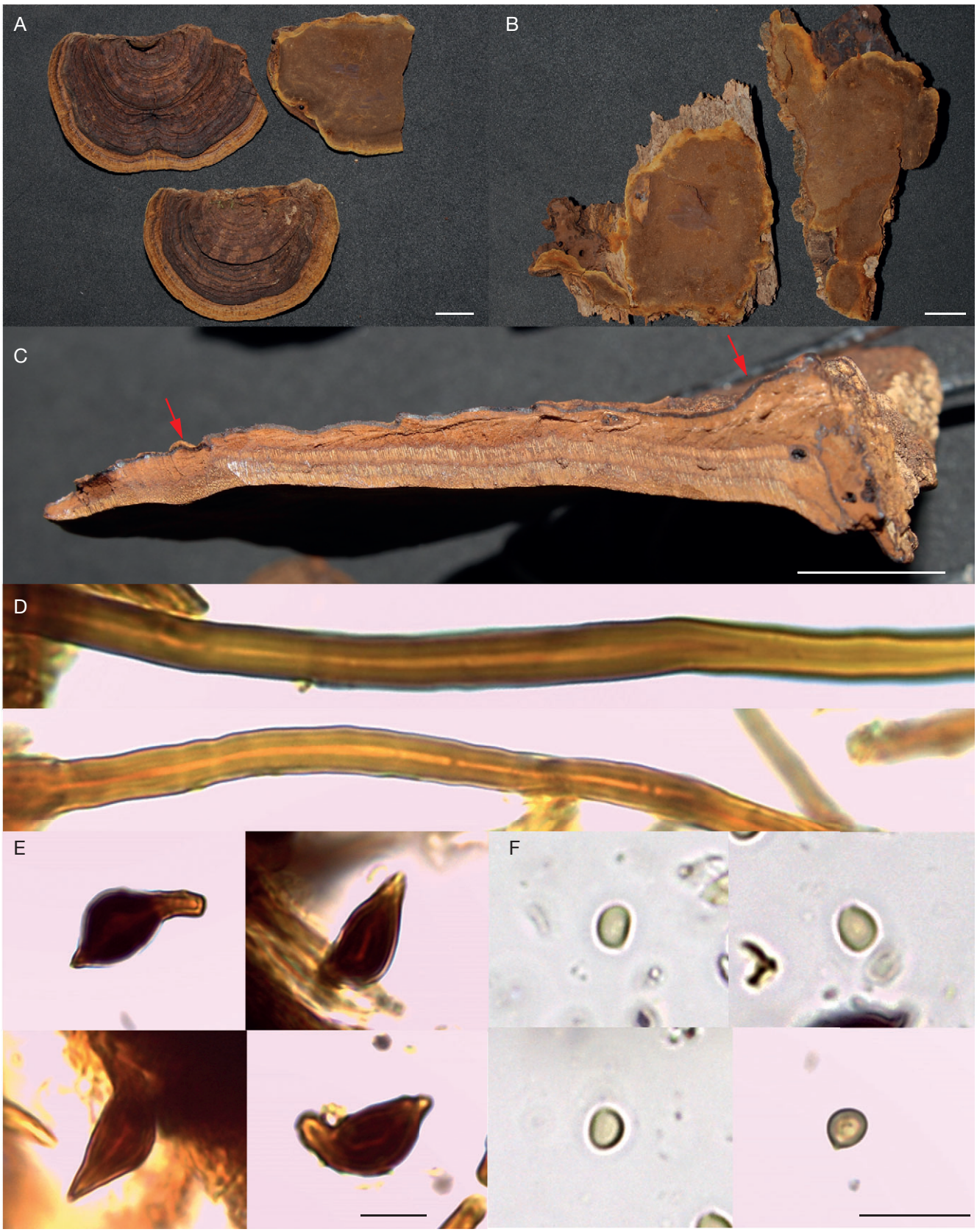

FIG. 5. — *Sclerotus extensus* (Lév.) Xavier de Lima: **A**, dried basidiomata of URM87072; **B**, dried basidiomata of URM89390; **C**, longitudinal section of the dried basidioma of URM89538, **red arrows** pointing the black line in the context; **D**, skeletal of the context in 3% KOH; **E**, hymenial setae (URM89538) in 3% KOH; **F**, basidiospores (URM89538) in 3% KOH. Scale bars: A-C, 1 cm; D-F, 10 µm.

Holotype. — **Brazil**, Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 9°15'00.7"S, 36°25'38.3"W, 758m, 25.VII.2019 V. R. T. Oliveira, (URM[URM94338]).

Additional specimens examined. — **Brazil**, Pernambuco State, Recife, Recife's Botanical Garden, on dead wood, 17.VI.2016, J. R. C. Oliveira-Filho, as *Inonotus* cf. *pseudoradiatus* (URM[JB7])

Etymology. — "*Flabellum*" (Latin) meaning "small fan". Referring to shape of the basidioma.

Habitat and distribution. — Tropical, ombrophilous broad-leaf forest.

Description

Basidioma (Fig. 6A) perennial, pileate, sessile, dimidiate, solitary to imbricate, applanate to slightly convex in section (Fig. 6B), 2.9-3.5 cm wide, 2.1-2.8 cm long, 0.5-0.9 cm thick at the base, hard, twisting when dry. Pileus surface radially folded, often with projections; initially velutinate, but soon wearing in narrow black and brown concentric zones. Margin acute. Pore surface (Fig. 6C) dark brown to brownish-yellow near the margin, pores round, 7-9/mm; margin sterile, brownish-yellow. Context 0.3-0.5 cm thick at the base, golden-brown, duplex, with a thin black line near the pilear surface. Tubes golden-brown, slightly darker than the context, indistinctly stratified (up to three layers in the holotype), old tubes filled with concolorous mycelia. Context and tubes turning immediately purplish-black in contact with KOH 3%, drying out remaining as a dark spot. Hyphal system in the context monomitic, generative hyphae simple and mostly regularly septate, sparingly branched, hyaline, yellow, golden yellow in water and rusty brown in KOH, mostly thick-walled with wide to narrow lumen, rarely hyaline and thin-walled, 3-5.5 µm in diameter, wall up to 1.5 µm thick; black line is composed by dark reddish-brown, more densely agglutinated and intertwined hyphae (Fig. 6H); below the line, hyphae grow parallel to the pilear surface, near the tube they grow downwards to form the tube trama, and above the line, hyphae concolorous or slightly darker, growing upwards to compose the tomentum. Tomentum hyphae straight, thick-walled with a wide lumen, yellow to dark yellow in water, rusty brown in KOH 3%, 3-5.5 µm diameter, richly septate, ends obtuse or clavate, mostly broken (Fig. 6I). Tube trama dimitic, hyphae growing straight, perpendicular to the pilear surface, generative hyphae hyaline to yellow, thin to slightly thick-walled, 2.5-4 µm in diameter, skeletal hyphae (Fig. 6G) golden yellow in water, brownish-yellow in 3% KOH, thick-walled with a narrow lumen, wall up to 2 µm thinning out towards the apex, unbranched, 3.5-4.5 µm in diameter. Hymenial setae (Fig. 6D) rare in the holotype, 10-20 × 6-8.5 µm brownish yellow in water, dark rusty-brown in KOH 3%, originating in the trama, near pore mouths, projecting inside the tube or immersed in the trama. Cystidiole not observed. Basidia tetrasterigmate, subglobose, 7-9 × 5-6 µm. Basidiospores (Fig. 6E) ellipsoid with a flattened side, 4.5-5 × 3.5-4 µm (Q = 1.12-1.42), thick-walled, smooth, pale yellow in water and golden yellow in 3% KOH, CB-, IKI-.

Remarks

The thin and small basidiomata, and the small pores characterize this species. Although perennial, the formation of a dark crust was not observed in older parts of the pileus surface. The other known neotropical pileate *Tropicoporus* with small pores is *T. guanacastensis* (7-8/mm, Zhou *et al.* 2016). However, *T. guanacastensis* produce harder and thicker basidiomata, and a crust in the upper surface that cracks with age. Although pileate, *T. flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov. is placed within the *T. tropicalis* clade, which is composed by resupinate species, making it readily distinguishable from this species

Tropicoporus linteus

(Berk. & M.A.Curtis) L.W.Zhou & Y.C.Dai

Fungal Diversity 77: 344 (2015).

Specimens examined. — **Brazil**, Alagoas State, Quebrangulo, Biological Reserve of Pedra Talhada, on dead wood, 09°14'02.3"S, 36°25'10.2"W, 876 m, 13.V.2019, V. R. T. Oliveira, (URM[URM94051]); 09°14'09.9"S, 36°25'09.6"W, 860 m, 12.VII. 2019, V. R. T. Oliveira, (URM[URM94076]); 09°15'29.0"S, 36°25'52.0"W, 614 m, 07.II.2019, V. R. T. Oliveira, (URM[URM93764]); 09°15'29.0"S, 36°25'52.0"W, 614 m, 18.VII.2019, V. R. T. Oliveira, (URM[URM94048]). 09°15'29.0"S, 36°25'52.0"W, 614 m, 07.II.2019, V. R. T. Oliveira, (URM[URM93771]); Bahia State, Itamarajú, Historical and Natural Park of Monte Pascoal, on dead wood, 16°53'35.5"S, 39°24'36.7"W, 429 m, 27.V.2019, R. L. M. Alvarenga, (URM[URM94072]). Ceará State, Crato City, FLONA do Araripe, on dead wood, 7°20'23"S, 39°25'58"W, 21.I.2013, C. R. S. Lira, (URM[URM84512]). Piauí State, Caracol, Natural Park of Serra das Confusões, on dead wood, 9°13'22"S, 43°29'23"W, 13.III.2012, C. R. S. Lira, (URM[URM85603]).

Remarks

Ryvarden (2004) described *T. linteus* (as *Phellinus linteus*) without mentioning a black line in the context. However, Dai & Xu (1998) examined the holotype and indicated the presence of a black line between the context and the superficial tomentum, similar to what was observed in our specimens (Fig. 7). Dai & Xu (1998) also mentioned that the hyphae from context and the trama swell in KOH, but it was not observed in our specimens. It is morphologically very similar to other species of the genus, but differs from other known Brazilian *Tropicoporus* mostly by the pileate basidiomata, absence of binding-like hyphae in the context and presence of setae.

Tropicoporus nullisetus

Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov.

This species is characterized by the pileate basidioma, 4-5 pores/mm, lack setae, and basidiospores 5-5.5 µm long.

MycoBank number. — MB 834098.

Holotype. — **Brazil**. Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 9°15'00.7"S, 36°25'38.3"W, 758m, 12.X.2018, V. Xavier de Lima, (URM[URM94073]).

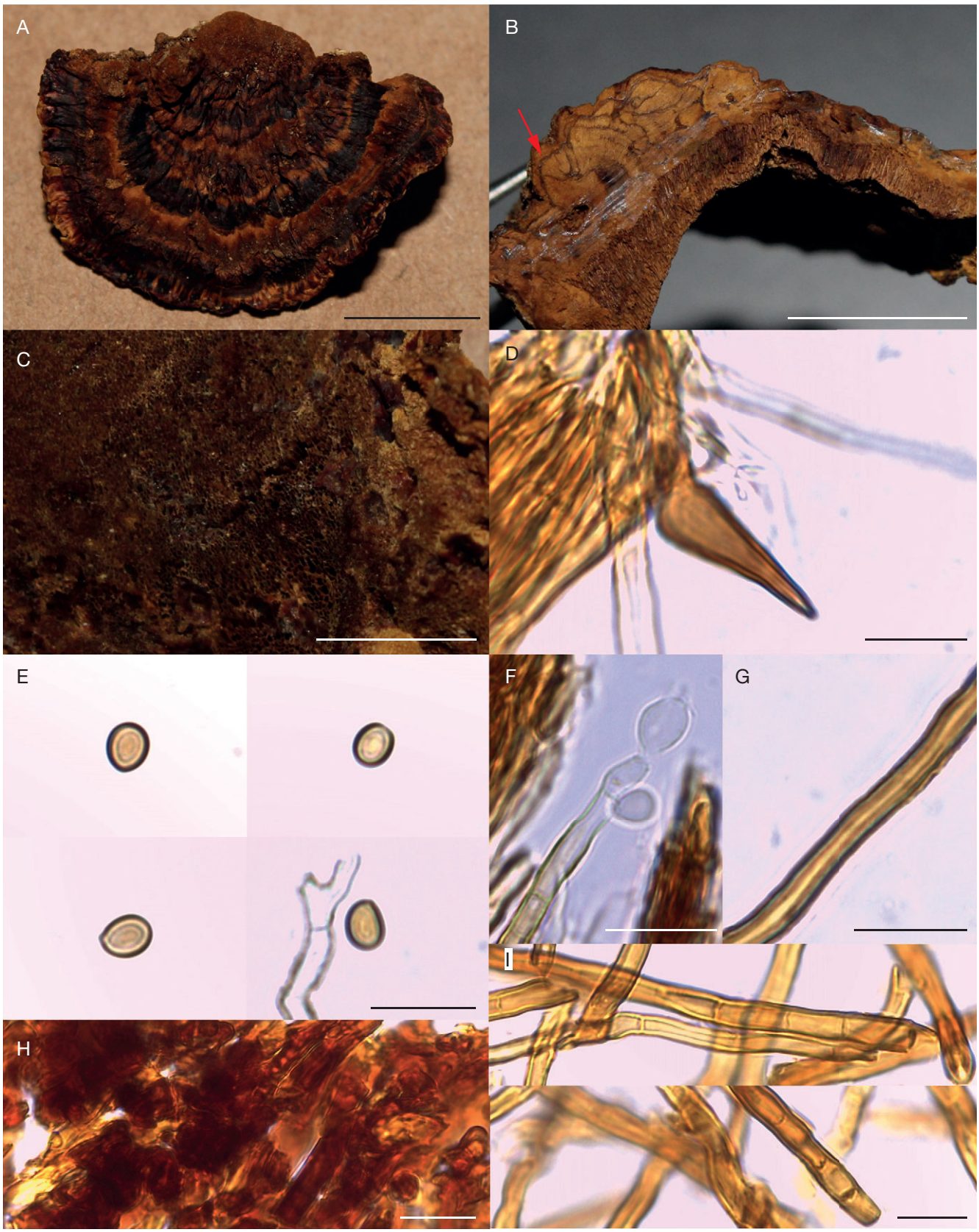

FIG. 6. — *Tropicoporus flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov. (URM94338): **A**, dried basidiomata; **B**, longitudinal section, **red arrow** pointing to the black line in the context; **C**, pore surface; **D**, hymenial setae; **E**, basidiospores; **F**, generative hypha with basidia at the end; **G**, skeletal hypha of the tube trama; **H**, hyphae of the black line in the context; **I**, hyphae of the tomentum. All preparations in 3% KOH. Scale bars: A, B, 1cm; C, 5 mm; D-I, 10 µm

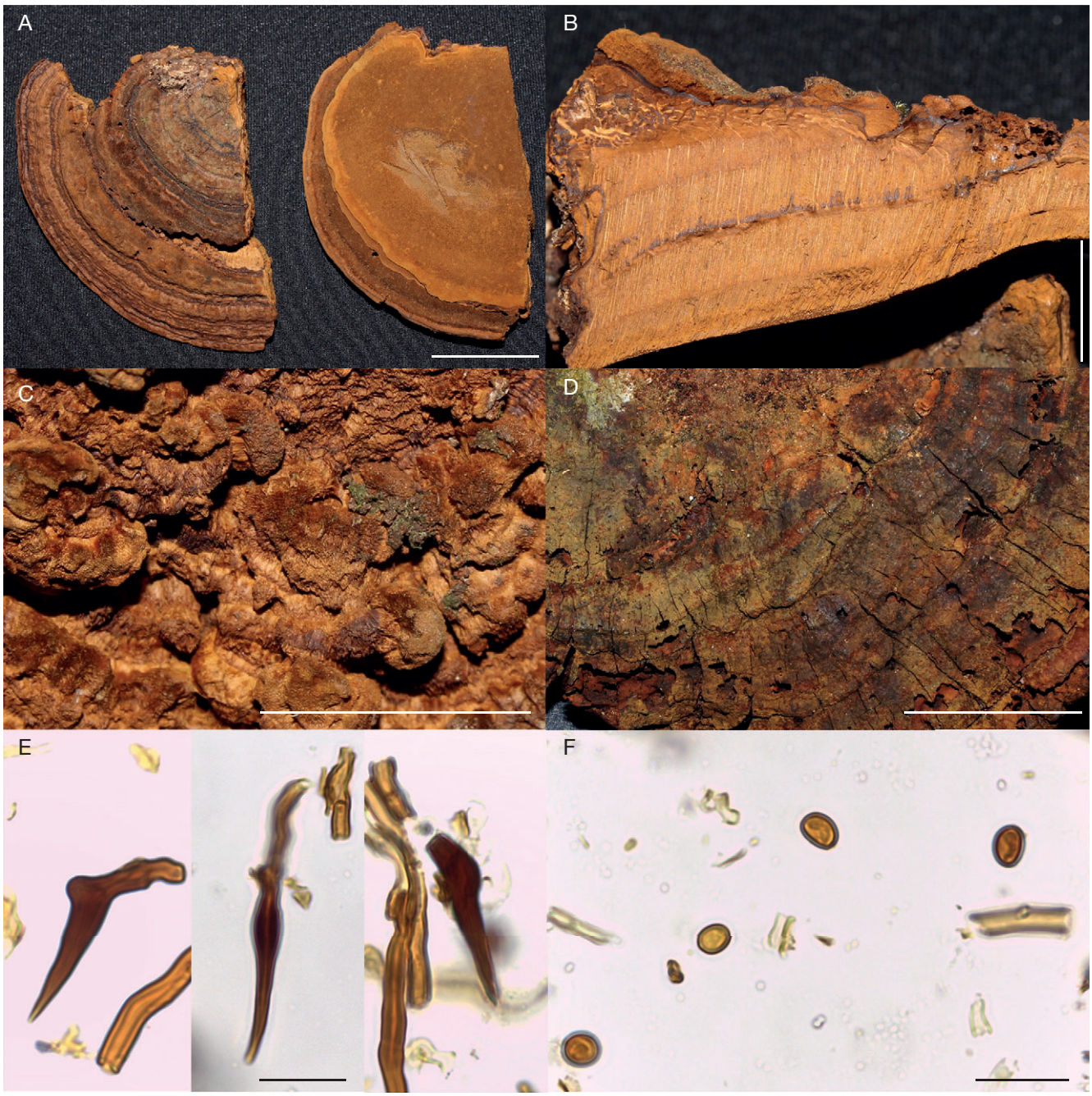

Fig. 7. — *Tropicoporus linteus* (Berk. & M.A.Curtis) L.W.Zhou & Y.C.Dai: **A**, dried basidiomata of URM84512; **B**, longitudinal section of URM84512, black line below the tomentum; **C**, pileus surface of URM94076; **D**, pileus surface of URM94048; **E**, hymenial setae of URM84512 in 3% KOH; **F**, basidiospores of URM84512 in 3% KOH; Scale bars: A, 2cm; B-D, 1 cm; E, F, 10 µm.

Additional specimens examined. — **Brazil**, Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 09°15'29.0"S, W 36°25'52.0"W, 614 m, 18.VII.2018, V. R. T. Oliveira, (URM[URM94074]); 09°15'32.6"S, 36°25'12.6"W, 590 m, 02.II.2019, V. R. T. Oliveira, (URM[URM94075]).

Etymology. — From "*nullum*" (Latin) meaning "absent". Referring to the lack of setae.

Habitat and distribution. — Tropical, ombrophilous broadleaf forest.

Description

Basidioma (Fig. 8A-B) perennial, pileate, sessile, broadly attached, solitary to imbricate, applanate to triquetrous in section (Fig. 8C), 3.5-10.5 cm wide, 3.5-7.0 cm long, 2.0-3.5 cm thick at the base, woody hard and light. Pileus surface firstly velutinate, yellowish-brown, but soon forming a hard, darker to black crust of agglutinated hyphae, concentrically sulcated, cracking radially in older parts. Margin obtuse to acute, entire, where tomentum may be persistent, yellowish-brown. Pore surface

Fig. 8. — *Tropicoporus nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov. Holotype (URM94073): **A**, **B**, basidioma *in situ*; **C**, longitudinal section and the black line bellow the tomentum; **D**, pore surface; **E**, origin and end of a skeletal hyphae from the tube trama in 3% KOH; **F**, basidiospores in 3% KOH; **G**, cystidioles in CB; **H**, basidiospores in water. Scale bars: A, B, 5 cm; C, 1 cm; D, 5 mm; E-H, 10 µm.

dark golden brown, glancing, with a sterile zone at the pileus margin, up to 3 mm wide, pores round, (3-)4-5/mm (Fig. 8D). Context 0.7-1.2 cm thick at the base, azonate, duplex, with a black line near the pilear surface dividing the upper tomentum, from the lower golden-brown context. Tubes concolorous with the lower context, indistinctly stratified (up to five layers in the holotype), new tubes slightly brighter than older ones, old tubes filled with golden brown mycelia. All structures turning immediately black in KOH 3%, dark reddish when drying out. Hyphal system in the context monomitic, generative hyphae simple and mostly regularly septate, sparingly branched, yellow, golden yellow in water and rusty brown in KOH, mostly thick-walled with wide to narrow lumen, rarely hyaline and thin-walled, 2.5-5.5 µm in diameter, wall up to 1.5 µm thick; black line composed by darker, densely agglutinated hyphae. Below the line, hyphae grow downwards until it differentiates +into the tube trama, and above the line, hyphae concolorous or slightly darker, growing upwards composing the tomentum, or agglutinated, forming a dark crust in older parts; tomentum hyphae straight, thick-walled but with a wide lumen, yellow to dark yellow in water, rusty brown in 3% KOH, 2-5 µm diameter, septate, ends obtuse or clavate, mostly broken. Tube trama dimitic, generative hyphae yellow, thin to slightly thick-walled, 2.5-3 µm in diameter, skeletal hyphae (Fig. 8E) growing perpendicular to the pilear surface, golden yellow (in water) to brownish-yellow (in 3% KOH), thick-walled with a narrow lumen, wall up to 2 µm thinning out towards the apex, unbranched, 3.5-4.5 µm in diameter. Cystidioles frequent, lageniform with a narrow and long or shorter and round apex, or cylindrical with an obtuse or acuminating tip, 14-18 × 5-8 µm (Fig. 8G). Basidia not observed. Basidiospores ellipsoid with a flattened side, 5-5.5 × 4-4.5 µm (Q = 1.11-1.37), thick-walled, smooth, pale yellow (in water) and golden yellow to dark rusty brown (in 3% KOH), color variation can be observed in the same basidioma, CB-, IKI- (Fig. 8F, H).

Remarks

Except for the absence of hymenial setae, this species is morphologically very similar to other neotropical *Tropicoporus* with pileate basidiomata. However, *T. dependens* and *T. sideroxycola* (Vlasák & Y.C. Dai) L.W. Zhou, Y.C. Dai & Vlasák have binding-like hyphae (Zhou *et al.* 2016); *T. guanacastensis* has smaller pores (7-8/mm) (Zhou *et al.* 2016); *T. cubensis* (Y.C.Dai, Decock & L.W. Zhou) L.W.Zhou & Y.C.Dai have slightly smaller pores (5-6/mm) and basidiospores (4-5 × 3-4 µm); and *T. drechsleri* Salvador-Montoya & Popoff seems restricted to *Cordia americana* (L.) Gottshling & J.E. Mill. (Salvador-Montoya *et al.* 2018). In the holotype, cystidioles are abundant, but hard to observe in the other analyzed specimens.

Tropicoporus stratificans G.Coelho & Yurchenko

Phytotaxa 245 (2): 147 (2016).

Specimen examined. — **Brazil**, Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 09°14'57.7"S, 36°25'39.7"W, 724 m, 14.VII.2019, V. R. T. Oliveira, (URM[URM94063]).

Remarks

The specimens from Northeast (URM94063) (Fig. 9E-H) and Southern Brazil (SMDB14731 and SMDB14732) clustered with good support in the ITS tree (PP = 1, bootstrap = 93%). Our collection differs from the original description and holotype illustrations mostly by the somewhat lanceolate setae (however dimensions are identical), and the presence of abundant rhomboid crystals immersed in the tube trama. The stratified basidioma, tendency to form elongated pores in vertical parts and the velutinate margin make *T. stratificans* a distinct species in the region.

Tropicoporus tropicalis (M.J.Larsen & Lombard) L.W.Zhou & Y.C.Dai

Fungal Diversity 77: 345 (2015)

Specimens examined. — **Brazil**, Alagoas State, Quebrangulo City, REBIO de Pedra Talhada, on dead wood, 09°15'23.0"S, 36°24'47.0"W, 542 m, 14.V.2019, V. R. T. Oliveira, (URM[URM93800]); 09°15'23.0"S, 36°24'47.0"W, 542 m, 14.V.2019, V. R. T. Oliveira, (URM[URM94055]); S 09°15'29.0" and W 36°25'52.0", 614 m, 14.VII.2019, V. R. T. Oliveira, (URM[URM93777]); 09°15'21.0"S, 36°24'47.0"W, 534 m, 14.VII.2019, V. R. T. Oliveira, (URM[URM93753]); 9°15'00.7"S, 36°25'38.3"W, 758m, 19.IX.2018, V. Xavier de Lima, (URM[URM94078]). Amapá State, Porto Grande, FLONA de Amapá, 01°23'07'N, 51°39'28"W, 158 m, II.2014, A. M. Soares, (URM[URM89677]). Bahia State, Itamarajú, PARNAH do Monte Pascoal, on dead wood, 16°53'33.8"S, 39°24'37.8"W, 408 m, 25.V.2019, R. L. M. Alvarenga, (URM[URM94070]); 16°53'33.8"S, 39°24'37.8"W, 408 m, 26.V.2019, R. L. M. Alvarenga, (URM[URM94071]); 16°53'33.8"S, 39°24'37.8"W, 408 m, 08.VIII.2018, V. Xavier de Lima, (URM[URM94069]); Pernambuco State, Olinda, 7º Grupo de Artilharia de Campanha (GAC), on dead wood, 08°00'05"S, 34°51'51"W, 16.VI.2018, V. R. T. Oliveira, (URM[URM[94077]).

Remarks

The most commonly found species of genus in the studied areas (Fig. 9A-D). The abundance of setae is highly variable among specimens, and often it is necessary to observe more than one microscopical preparation to detect their presence. The small pores (7-10/mm) and basidiospores (3-3.5 × 2-2.5 µm), and the presence of setae in the dissepiments or immersed in the trama distinguish this species from other resupinate poroid Hymenochaetaceae in the region.

DISCUSSION

The *Inonotus* clade in tropical America was studied by several authors and several neotropical species were included (Tian *et al.* 2013; Vlasák *et al.* 2013; Zhou *et al.* 2016). However, only one study included specimens from Brazil (Coelho *et al.* 2016). To date, *T. dependens*, *T. linteus*, *T. pseudolinteus* (Vlasák & Y.C. Dai) L.W. Zhou, Y.C. Dai & Vlasák, *T. stratificans* and *T. tropicalis* were recorded in Brazil (http://splink.cria.org.br). The sampling effort in North and Northeast Brazil revealed that *T. tropicalis* is the most common species in the region. The species of *Tropicoporus* with pile-

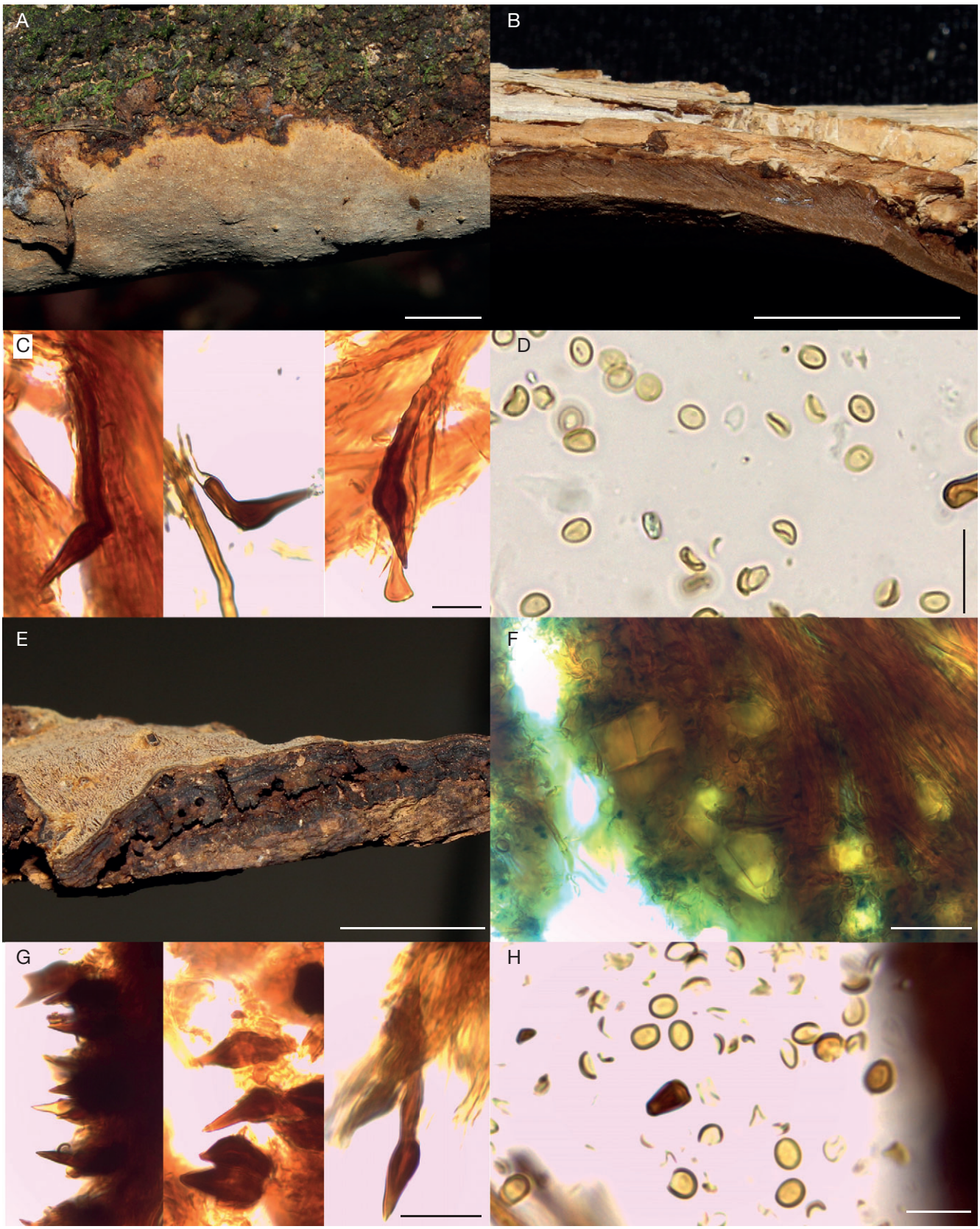

FIG. 9. — *Tropicoporus tropicalis* (M.J.Larsen & Lombard) L.W.Zhou & Y.C.Dai and *T. stratificans* G.Coelho & Yurchenko*:* **A**, *T. tropicalis* basidioma of URM94078 *in situ*; **B**, vertical section of URM94078; **C**, setae of URM94078 in 3% KOH; **D**, basidiospores of URM94078 in 3% KOH; **E**, dried *T. stratificans* basidioma of URM94063; **F**, tube trama of URM94063 in CB, immersed rhomboid crystals; **G**, hymenial setae of URM94063 in 3% KOH; **H**, basidiospores of URM94063 in 3% KOH. Scale bars: A, B, 5 cm; C, 1 cm; D, 5 mm;

Key to *Inonotus s.l.*

1. Hyphal system monomitic throughout; setal hyphae present or absent ..... *Inonotus* P.Karst.
— Hyphal system dimitic in the tube; setal hyphae absent 2

2. Context and tube trama dimitic; hymenial setae strongly ventricose and dark; dark line present, soon exposed as a dark crust ..... *Sclerotus* Xavier de Lima, gen. nov.
— Context mono-dimitic; tube trama dimitic; dark line in the context present or absent, if present, bellow the mat/tomentum; hymeniael setae variable, rarely absent ..... *Sanghuangporus*/*Tropicoporus*

Key to the neotropical species of *Tropicoporus*

1. Basidioma resupinate 2
— Basidioma pileate 3

2. Basidioma, thick, stratified; pores 5-7/mm; basidiospores 4-5 µm long ..... *T. stratificans* G.Coelho & Yurchenko
— Basidioma thin, effused; pores 7-10/mm; basidiospores 3-4 µm long ..... *T. tropicalis* (M.J.Larsen & Lombard) L.W.Zhou & Y.C.Dai

3. Hymenial setae absent ..... *T. nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov.
— Hymenial setae present, scanty to abundant 4

4. Biding-like hyphae present in the context and tube trama 5
— Biding-like hyphae absent 6

5. Basidiospores 4-5 µm long; pores 5-7/mm ..... *T. dependens* (Murrill) L.W.Zhou, Y.C.Dai & Vlasák
— Basidiospores 6-7 µm long; pores 2-3/mm ..... *T. sideroxylicola* (Vlasák & Y.C.Dai) L.W.Zhou, Y.C.Dai & Vlasák

6. Pores 7-9/mm; setae 10-25 µm long 7
— Pores ≤ 7/mm; setae 16-43 µm long, mostly > 20 µm long 8

7. Basidiomata up to 4 cm thick at base, forming a dark crust on the pileus ..... *T. guanacastensis* L.W. Zhou, Y.C. Dai & Vlasák
— Basidiomata thin, up to 0.9 cm thick at base, not forming a dark crust ..... *T. flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov.

8. In seasonally dry subtropical forest; on *Cordia americana* ..... *T. drechsleri* Salvador-Montoya & Popoff
— Tropical and subtropical; host various 9

9. Pores 4-5/mm ..... *T. pseudolinteus* (Vlasák & Y.C. Dai) L.W. Zhou, Y.C. Dai & Vlasák
— Pores 5-7/mm 10

10. Black line absent in the context; setae 27-43 long ..... *T. cubensis* (Y.C.Dai, Decock & L.W.Zhou) L.W.Zhou & Y.C.Dai
— Black line present in the context; setae 22-30 long ..... *T. linteus* (Berk. & M.A.Curtis) L.W.Zhou & Y.C.Dai

ate basidiomata found in the study areas were *T. flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov., *T. linteus* and *T. nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov., the first and the latter described here as new to science. One specimen clustered with the recently described *T. stratificans*, originally collected in the state of Rio Grande do Sul, with subtropical climate in southern Brazil, expanding thus the knowledge about the geographical distribution of this species. All other species with resupinate basidioma clustered in the *T. tropicalis* clade. This clade is characterized by perennial, resupinate basidiomata with small pores. However, the placement of *T. flabellatus* V.R.T. Oliveira, J.R.C. Oliveira-Filho, Xavier de Lima & Gibertoni, sp. nov. within this lineage confirms that what is being identified as *T. tropicalis* is actually a complex of morphologically similar species.

An important feature for species and genera recognition among Hymenochaetaceae is the presence of hymenial setae. When analyzing microscopical preparations of specimens of *Tropicoporus* found in Brazil, we noted that the abundance of setae in a single species is highly variable. Some specimens of *T. linteus* and *T. tropicalis* have hymenial setae densely covering the tube wall. However, in other specimens, setae are scarce, usually immersed in the tube trama and difficult to observe. Tian *et al.* (2013) remarked the occurrence of setae in the dissepiments as a distinctive characteristic of *T. cubensis*, but

Key to *Inonotus* in Brazil

1. Any kind of setae absent 2
— Setae present in hymenium or/and in tube trama 8

2. Resupinate species 3
— Pileate species 4

3. Pores 3-4/mm ..... *I. venezuelicus* Ryvarden
— Pores 7-8/mm ..... *I. costaricensis* Ryvarden

4. Pores 7-8/mm ..... *I. luteoumbrinus* (Romell) Ryvarden
— Pores 1-6/mm 5

5. Pores irregular, 1-3/mm ..... *I. dentatus* Decock & Ryvarden
— Pores regular, round to angular 6

6. Basidiospores 7-8 x 6-7 µm ..... *I. neotropicus* Ryvarden
— Basidiospores up to 6 µm in longest dimension 7

7. Pore surface yellow to rusty brown; basidiospores hyaline to pale yellow ..... *I. splitgerberi* (Mont.) Ryvarden
— Pore surface dull purplish brown; basidiospores rusty brown ..... *I. porrectus* Murrill

8. Tramal setae present; hymenial absent or present 9
— Tramal setae absent; hymenial present 19

9. Hymenial setae absent 10
— Hymenial setae present 13

10. Pores 3-4/mm ..... *I. patouillardii* (Rick) Imazeki
— Pores 7-10/mm 11

11. Tramal setae 6-8 µm wide ..... *I. parvisetus* V.R.T. Oliveira, Xavier de Lima & Gibertoni, sp. nov.
— Tramal setae wider, up to 35 µm 12

12. Basidioma applanate to slightly convex, brown ..... *I. amazonicus* Gibertoni & Ryvarden
— Basidioma trequitreous, yellowish ..... *I. brasiliensis* Xavier de Lima & Ryvarden

13. Pileate species 14
— Resupinate species 17

14. Tramal setae branched ..... *I. cuticularis* (Bull.) P. Karst.
— Tramal setae unbranched 15

15. Pores 8-10/mm ..... *I. portoricensis* (Overh.) Baltazar & Gibertoni
— Pores 2-6/mm 16

16. Pores 2-3/mm; basidiospores 6-8.5 µm long ..... *I. rickii* (Pat.) Reid
— Pores 4-6/mm; basidiospores 5-6 µm long ..... *I. pseudoglomeratus* Ryvarden

17. Basidiospores 7-8 µm long ..... *I. adnatus* Ryvarden
— Basidiospores 8.5-13 µm long 18

18. Basidiospores 8.5-11.5 µm long, hymenial setae 33-45 µm long ..... *I. multisetifer* Abrahão & Gugliotta
— Basidiospores 10-13 µm long, hymenial setae 20-32 µm long ..... *I. micantissimus* (Rick) Rajchemb.

19. Hymenial setae hooked 20
— Hymenial setae straight 21

20. Pileus surface strigose; setae 30-55 µm long ..... *I. fulvomelleus* Murrill
— Pileus surface tomentose to glabrous; setae 14-35 µm long ..... *I. radiatus* (Sowerby) P. Karst.

21. Pileus surface adpressed velutinate; pore surface rusty brown ..... *I. pseudoradiatus* (Pat.) Ryvarden
— Pileus surface scrupose; pore surface yellow ..... *I. xanthoporus* Ryvarden

this feature was observed in all analyzed species of *Tropicoporus*, not only *T. cubensis*. An exception in *Tropicoporus* is the new species described herein, *T. nullisetus* Xavier de Lima, V.R.T. Oliveira & Gibertoni, sp. nov., which has no hymenial setae.

Sclerotus extensus is considered to be a pantropical species (Ryvarden & Johansen 1980; Ryvarden 2004), but it was originally described from Guadeloupe and to date only sequences from Brazilian and French Guiana Amazon are available for this species. *Sclerotus extensus* is described as distinctly pileate (Ryvarden & Johansen 1980; Ryvarden 2004) as it is seen in URM6750 from Guadeloupe and in the type NY730655 (type not located in PC). However, resupinate and effused-reflexed specimens clustered with pileate specimens in our phylogeny (Fig. 2). The macromorphological plasticity of this species was not accounted for, which probably caused misidentification of several resupinate and effused-reflexed specimens.

Inonotus s.s. differentiates from other species in the *Inonotus s.l.* lineage by the monomitic hyphal system in the context and tube trama. Few specimens were found during the surveys and they represents *I. micantissimus*, *I. rickii* and *I. parvisetus* V.R.T. Oliveira, Xavier de Lima & Gibertoni, sp. nov. Several species of *Inonotus* were recorded from Brazil, but most of them lack sequenced molecular markers. Due to the complexity of morphological differentiation among species of the *Inonotus s.l.* lineage, revision of exsiccate and molecular analyses in the light of recent discoveries are necessary to reveal the true diversity of the genus in Brazil.

Acknowledgements

The authors would like to thank the Herbário Pe. Camille Torrend (URM) for the loan of the exsiccates, the Programa de Pós Graduação em Biologia de Fungos (UFPE, Brazil), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq: SISBIOTA 563342/2010-2, PPBio Semi-Árido 457476/2012-5, PROTAX 562106/2010-3, Universal 472792/2011-3, PQ 307601/2015-3 e 302941/2019-3, ICMBio 421241/2017-9), Coordenação de Aperfeiçoamento de Pesquisa e Ensino Superior (CAPES: Capes-SIU 008/13, CAPES/PRINT 88887.311892/2018-00) and Fundação de Amparo à Ciência e Tecnologia do Estado de Pernambuco (FACEPE: ATP-0021-2.03/18, APQ-0788-2.03/12, APQ 0003-2.03/18)) for the financial support. and post-doctorate scholarship of VXL. We also would like to thank Nordesta Reforestation & Education for the support in the field work performed at the Biological Reserve of Pedra Talhada. This study was also partially supported by the Portuguese Foundation for Science and Technology (FCT) under the scope of the strategic funding of the UID/BIO/04469/2019 unit and the BioTecNorte operation (NORTE-01-0145-FEDER-000004) funded by the European Regional Development Fund under the scope of Norte2020-Programa Operacional Regional do Norte. The reviewers are also acknowledged for their valuable contributions.

REFERENCES

Coelho G., Silveira A. O., Antonelli Z. I. & Yurchenko E. 2016. — *Tropicoporus stratificans* sp. nov. (Hymenochaetales, Basidiomycota) from southern Brazil. *Phytotaxa* 245 (2): 144-152. https://doi.org/10.11646/phytotaxa/245.2.5

Dai Y. C. & Xu M. Q. 1998. — Studies on the medicinal polypore, *Phellinus baumii*, and its kin, *P. linteus*. *Mycotaxon* 67: 191-200.

Decock C., Figueroa S. H., Robledo G. & Castillo G. 2006. — *Phellinus caribaeo-quercicolus* sp. nov., parasitic on *Quercus cubana*: taxonomy and preliminary phylogenetic reationships. *Mycologia* 98(2): 265-274. https://doi.org/10.1080/15572536.2006.11832699.

Gibertoni T. B., Ryvarden L. & Cavalcanti M. A. Q. — 2004. Studies in neotropical polypores 18 New species from Brazil. *Synopsis Fungorum* 18: 44–56.

Góes-Neto A., Loguercio-Leite C. & Guerrero R. T. 2002. — Molecular phylogeny of tropical Hymenochaetales (Basidiomycota). *Mycotaxon* 84: 337-354.

Goés-Neto A., Loguercio-Leite C. & Guerrero R. T. 2005. — DNA extraction from frozen field-collected and dehydrated herbarium fungal basidiomata: performance of SDS and CTAB-based methods. *Biotemas* 18: 19-32.

Gottlieb A. M., Jorge E. W. & Moncalvo J. M. 2002. — Inonotus sl in Argentina – morphology, cultural characters and molecular analyses. *Mycological Progress* 1.3: 299-313.

Katoh K., Rozewicki J. & Yamada K. D. 2019. — MAFFT online service: multiple sequence alignment, interactive sequence choice and visualization. *Briefings in Bioinformatics* 20(4): 1160-1166. https://doi.org/10.1093/bib/bbx108.

Kornerup A. & Wanscher J. H. 1978. — Methuen handbook of colour. Eyre Methuen: 1-248.

Kumar S., Stecher G., Li M., Knyaz C. & Tamura K. 2018. — MEGA X: Molecular Evolutionary Genetics Analysis across computing platforms. *Molecular Biology and Evolution* 35:1547-1549. https://doi:10.1093/molbev/msy096.

Larsen M. J. & Cobb-Poulle L. A. 1990. — *Phellinus* (Hymenochaetaceae) – A survey of the world taxa. Synopsis Fungorum 3. Oslo, *Fungiflora*.

Lima-Júnior N., Gibertoni T. B. & Malosso E. 2014. — Delimitation of some neotropical laccate *Ganoderma* (Ganodermataceae): molecular phylogeny and morphology. *Revista de Biología Tropical* 62: 1197-1208.

Moncalvo J. M., Lutzoni F. M., Rehner A. S., Johnson J. & Vilgalys R. 2000. — Phylogenetic relationships of agaric fungi based on nuclear large subunit ribosomal DNA sequences. *Systematic Biology* 49: 278-305.

Rajchenberg M. 1987. — Type studies of Polyporaceae (Aphyllophorales) described by J. Rick. *Nordic Journal of Botany* 7: 553-568.

Reid D. A. 1957. — New or interesting records of Australasian Basidiomycetes. III. *Kew Bulletin* 12 (1): 127-143. https://doi.org/10.2307/4109115

Rodrigues P., Venâncio A., Kozakiewicz Z. & Lima N. 2009. — A polyphasic approach to the identification of aflatoxigenic and non-aflatoxigenic strains of *Aspergillus* section *Flavi* isolated from Portuguese almonds. *International Journal of Food Microbiology* 129: 187-193. https://doi:10.1016/j.ijfoodmicro.2008.11.023.

Ronquist F., Teslenko M., Van Der Mark P., Ayres D. L., Darling A., Höhna S., Larget B., Liu L., Suchard M. A. & Huelsenbeck J. P. 2012. — MrBayes 3.2: Efficient Bayesian Phylogenetic Inference and Model Choice Across a Large Model Space. *Systematic Biology* 61: 539-542. https://doi.org/10.1093/sysbio/sys029.

Ryvarden L. 2004. — *Neotropical polypores Part 1. Introduction, Ganodermataceae & Hymenochaetaceae*. Synopsis Fungorum 19. Fungiflora, Oslo, 228 p.

Ryvarden L. & Johansen I. 1980. — A preliminary polypore flora of East Africa. Fungiflora, Oslo, 636 p.

Salvador-Montoya C. A., Costa-Rezende D. H., Ferreira-Lopes V., Borba-Silva M. A. & Popoff O. F. 2018. — *Tropicoporus drechsleri* (Hymenochaetales, Basidiomycota), a new species in the "*Inonotus linteus*" complex from northern Argentina. *Phytotaxa* 338 (1): 75-89. https://doi: 10.11646/phytotaxa.338.1.6.

Staden R., Beal K. F. & Bonfield J. K. 1998. — The Staden Package. Computer Methods in Molecular Biology. *Bioinformatics Methods and Protocols* 132: 115-130.

Tian X. M., Yu H. Y., Zhou L. W., Decock C., Valsák J. & Dai Y. C. 2013. — Phylogeny and taxonomy of the *Inonotus linteus* complex. *Fungal Diversity* 58: 159-169. https://doi: 10.1007/s13225-012-0202-9.

Vlasák J., Li H.J., Zhou L. W. & Dai Y. C. 2013. — A futher study on *Inonotus linteus* complex (Hymenochaetales, Basidiomycota) in tropical America. *Phytotaxa* 124 (1): 25-36.

Wagner T. & Fischer M. 2002. — Proceedings towards a natural classification of the worldwide taxa. *Phellinus s.l.* and *Inonotus s.l.*, and phylogenetic relationship of allied taxa. *Mycologia* 94 (6): 998-1016. https://doi.org/10.1080/15572536.2003.11833156.

White T. J., Bruns T., Lee S. & Taylor J. W. 1990. — Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics, *in* Innis M. A., Gelfand D. H., Sninsky J. J., White T. J., *PCR Protocols, a Guide to Methods and Applications*. *Academic Press*, New York, 315-322.

Wu F., Qin W. M., Euatrakool O. & Zhou L. W. 2015. — *Tropicoporus boehmeriae sp. nov.* (Hymenochaetaceae, Basidiomycota) from Thailand, a new member of the *Inonotus linteus* complex. *Phytotaxa* 231 (1): 73-80.

Wu F., Zhou L. W., Yang Z. L., Bau T., Li T. H. & Dai Y. C. 2019. — Resource diversity of Chinese macrofungi: edible, medicinal and poisonous species. *Fungal Diversity* 98: 1-76.

Wu S. H., Dai Y. C., Hattori T., Yu T. W., Wang D. M., Parmasto E., Chang H. Y. & Shih S. Y. 2012. — Species clarification for the medicinally valuable 'sanghuang' mushroom. *Botanical Studies* 53: 135-149.

Zhou L. W., Vlasák J., Decock C., Assefa A., Stenlid J., Abate D., Wu S. H. & Dai Y. C. 2015. — Global diversity and taxonomy of the *Inonotus linteus* complex (Hymenochaetales, Basidiomycota): *Sanghuangporus* gen. nov., *Tropicoporus excentrodendri* and *T. guanacastensis* gen. et spp. nov., and 17 new combinations. *Fungal Diversity* 77: 335-347. https://doi.org/10.1007/s13225-015-0335-8

Zhou L. W., Wang X. W., Vlasák J. & Ren G. J. 2018. — Resolution of phylogenetic position of Nigrofomitaceae within Hymenochaetales (Basidiomycota) and Nigrofomes sinomelanoporus sp. nov. (Nigrofomitaceae) from China. *MycoKeys* 29: 1-13.

Submitted on 28 January 2020;
accepted on 11 June 2021;
published on 21 January 2022.