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Inonotus amazonicus sp. nov., *I. calcitratus* comb. nov. and notes on *Phylloporia* (Hymenochaetaceae, Agaricomycetes) from the Brazilian Amazonia

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ABSTRACT

Inonotus amazonicus is described and illustrated as a new species based on specimens collected in Aripuanã, in the state of Mato Grosso, Brazil, and deposited in herbarium INPA 34 years ago. This species is mainly distinguished from the others in the genus by the abundant, huge tramal setae and the duplex context covered by a persistent adpressed dark brown tomentum. Besides the description of the new species, one new combination is proposed: *I. calcitratus*, *I. luteoumbrinus* and *Phylloporia spathulata* are reported as new to the state of Roraima, *P. chrysita* to the state of Amazonas and *P. pectinata* to the state of Rondônia. Description and illustration of the new species and keys to the species of *Inonotus* and *Phylloporia* known to Brazil are provided.

1. Introduction

Inonotus sensu Wagner and Fischer (2002) has been widely used to accommodate species with pileate, effused-reflexed or resupinate, annual to perennial basidiomata, a monomitic to dimitic hyphal system, presence of hymenial setae and/or setal hyphae, ellipsoid to subglobose and yellowish to brownish basidiospores, negative in Melzer's reagent. Species with similar features but with oblong ellipsoid basidiospores and absence of setae have been placed in *Phylloporia* Murrill (Wagner and Ryvarden 2002; Ryvarden 2004).

Morphologically and molecularly, *Inonotus* and *Phylloporia* are well defined genera (Wagner and Fischer 2001, 2002; Gottlieb et al. 2002; Ryvarden 2005; Martínez 2006; Zhou and Dai 2012) and 17 and four species are found in Brazil, respectively (Gibertoni et al. 2012). Basidiomata of these genera are commonly found on hardwood, causing a white rot, on leaves or on remarkably thin dead branches of living trees (Ryvarden 2004; Dai 2012).

The aim of the present study is to contribute to the knowledge about the diversity of *Inonotus* and *Phylloporia* in Brazil, with new records from the Brazilian Amazonia, and description and illustration of one new species.

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2. Materials and methods

Field trips were undertaken from January 2009 to July 2011 in two reserves in Brazilian Amazonia: Estação Ecológica de Cuniã (8°04′S 63°31′W) and Parque Natural Municipal de Porto Velho (8°45′S 63°54′W) in the state of Rondônia. Additionally, one area in Rondônia (Fazenda Mucuim – 8°22′S 64°07′W) was also visited once. The specimens were deposited in Instituto Nacional de Pesquisas da Amazônia (INPA) and Instituto de Botânica (SP) were also studied (Thiers, continuously updated).

For the identification, specimens were analyzed macro- (shape, colour, hymenial surface) and micro-morphologically (type of hyphal system, basidia, setae and form, size, type of ornamentation and colour of the basidiospores) (Teixeira 1995). Slide preparations with 3–5% KOH, stained with 1% aqueous phloxine, and Melzer's reagent (Ryvarden 1991) were made. Colour designation followed Watling (1969). Newly collected materials were deposited in the herbaria HFSL (Faculdade São Lucas) and URM (Universidade Federal de Pernambuco).

3. Taxonomy

Inonotus amazonicus Gomes-Silva, Ryvarden & Gibertoni, sp. nov. Fig. 1.

MycoBank no.: MB 564298.

This species differs from the other *Inonotus* species by its abundant, huge tramal setae and by the duplex context covered by a persistent adpressed dark brown tomentum.

Type: (designated here) Brazil, Mato Grosso, Aripuanã, on hardwood tree, 24 Apr 1978, leg. M.A. Sousa 458 (holotype, INPA 92004; isotype in URM 83535).

Etymology: "Amazonicus" (Lat.) refers to the type locality.

Basidiomata annual, pileate, sessile to slightly dimidiate, semicircular, up to 9 cm long and 5 cm wide from base to edge and 1.5 cm thick at base, dense when dry; *pileus* dull, velutine and soft, deep fulvous (12), cigar brown (16) to snuff brown (17), sulcate, covered with a persistent adpressed layer of tomentum, up to 0.5 mm thick, a black thin zone present between the tomentum and the distinctly fulvous (12) to cinnamon (10) dense context; *margin* rather sharp and undulating in the largest specimens; *pore surface* cigar brown (16) to snuff brown (17), pores round, 7–10 per mm, invisible to the naked eye; *tubes* concolorous with pore surface, dense, up to 1 cm long and a distinct thin dark line present between tubes and the dense, fulvous (12) to cinnamon (10) context, up to 3 mm thick at the base.

Hyphal system monomitic, generative hyphae, hyaline, simple-septate, in the trama pale yellow, 3–7 μm in diam., in the context rusty brown and almost solid to very thick-walled, 4–8 μm in diam; *tramal setae* 30–120 × 10–35 μm, abundant in trama and dissepiments, acute slightly widened in the middle part, tapering towards the base, dark brown, and thick-walled, arising from a simple septum; *hymenial setae* absent; *basidia* not seen in the type specimen; *basidiospores* subglobose, pale yellow in 3% KOH, smooth, thin-walled, negative, but almost hyaline in Melzer's reagent, 5–5.5 × 4–4.5 μm.

Distribution and ecology: Known only from the state of Mato Grosso, Brazil. The species has been reported on hardwood tree.

Other specimen examined: Brazil, State of Mato Grosso, Aripuanã, 24 Apr 1978, leg. M.A. Sousa 471 (INPA 85338, as *Inonotus* sp.).

Taxonomic remarks: This is a remarkable species with its abundant, huge tramal setae and the duplex context covered by a persistent adpressed dark brown tomentum. The zone between the context and the tubes is thinner and slightly paler than the black zone between the context and the tomentum. It reminds one of the zones seen above the tubes in the common and widespread *Bjerkandera adusta* (Fr.) P. Karst. and it seems to be related to *I. pseudoglomeratus* Ryvarden, species known only from Venezuela and Belize and as growing on unknown hardwood tree (Ryvarden 2004), which however has a glabrous pileus, and much longer and slender setal hyphae besides hymenial setae. *Inonotus compositus* Han C. Wang is similar to *I. amazonicus* by sharing pileate basidiomata, a monomitic hyphal structure, presence of tramal seate and absence of hymenial setae, and yellowish basidiospores. However, the former has homogeneous context, larger pores (2–3 per mm) and ellipsoid basidiospores (Dai 2010).

Inonotus calcitratus (Berk. & M.A. Curtis) Gomes-Silva & Gibertoni, comb. nov.

MycoBank no.: MB 564574.

Basionym: *Polyporus calcitratus* Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 314 (1868) [1869].

Description see *Phellinus calcitratus* (Berk. & M.A. Curtis) Ryvarden by Ryvarden (2004).

Distribution and ecology: American species known from the West Indies and South America (Ryvarden 2004). In Brazil, it is reported for the states of Amazonas, Bahia, Pará, Pernambuco, Rio Grande do Sul and Rondônia (Gibertoni et al. 2012, as *Phellinus calcitratus*). The species has been reported on hardwood tree.

Specimens examined: Brazil, State of Rondônia, Porto Velho, Fazenda Mucuim, 31 Jul 2007, leg. A.C. Gomes-Silva et al. 99 (URM 82895); Estação Ecológica de Cuniã, 20 Aug 2010, leg. A.C. Gomes-Silva et al. 3039 (URM 83103); Parque Natural Municipal de Porto Velho, 21 Aug 2010, leg. A.C. Gomes-Silva et al. 3043 (URM 83118).

Taxonomic remarks: Wagner and Fischer (2002) proposed the segregation of *Phellinus* s.l. in smaller genera based in morphological and molecular characters and included in *Inonotus* species with annual to perennial, resupinate, effused-reflexed and pileate basidiomata, a monomitic to dimic hyphal system, hymenial or hyphoid setae, and ellipsoid, globose and pigmented (yellowish to brownish) basidiospores. *Phe. calcitratus*, by presenting hymenial setae (5–8 μm width), and globose to subglobose, yellowish brown basidiospores (5–6 × 4.5–5 μm), is thus transferred to *Inonotus*. The combination of *P. calcitratus* in *Fulvifomes calcitratus* (Berk. & M.A. Curtis) Murrill in 1915 is currently not accepted (www.mycobank.org; www.indexfungorum.org) because this genus accommodates species without setae (Wagner and Fischer 2002).

Inonotus luteoumbrinus (Romell) Ryvarden [as '*luteo-umbrinus*'], Syn. Fung. (Oslo) 21: 79 (2005).

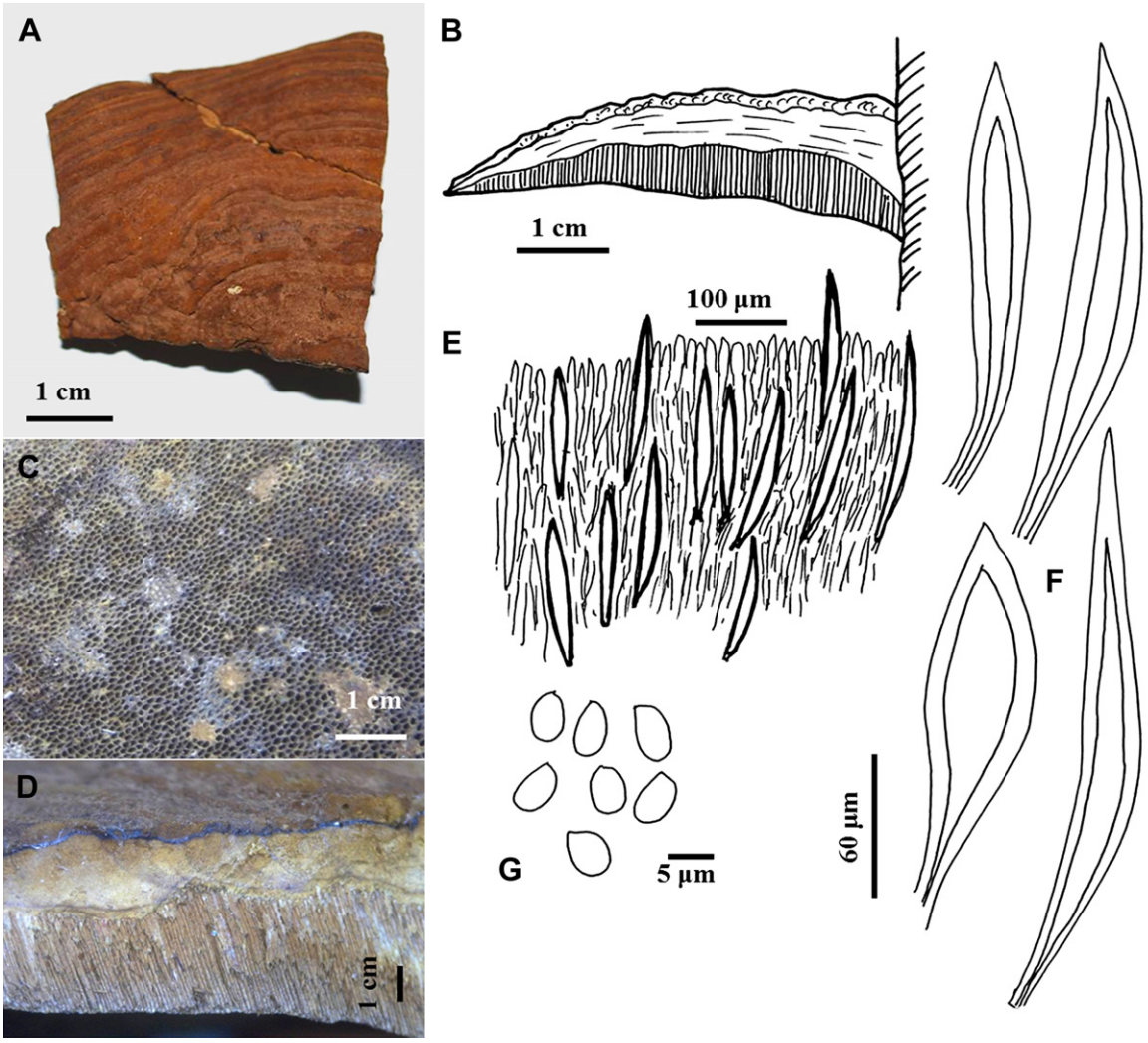

Fig. 1 – *Inonotus amazonicus* (all from holotype). A: basidioma. B, D: section through the basidiomata. C: pore surface. E: section though dissepiments showing the tramal setae. F: tramal setae. G: basidiospores. Photos by A.C. Gomes-Silva and drawings by L. Ryvarden.

Basionym: *Phaeoporus luteoumbrinus* Romell, K. svenska Vetensk-Akad. Handl., ser. 3 26: 27 (1901).

Description: In Ryvarden (2005).

Distribution and ecology: American species known from Brazil to Louisiana and Texas in United States, but apparently rare (Ryvarden 2004). In Brazil, it is reported for the states of Acre, Bahia, Mato Grosso, Pernambuco, Tocantins and Santa Catarina (Gibertoni et al. 2012). It is a new record to state of Roraima. The species has been reported on hardwood tree.

Specimens examined: Brazil, Acre, loc. n. det., 8 Oct 1980, leg. B. Lowy et al. 544 (INPA 100449, as *Polyporus* sp.); Roraima, Alto Alegre, 18 Jun 1986, leg. K.F. Rodrigues et al. 1029 (INPA 143387); Caracaraí, BR 174, Km 335, 17 Nov 1977, leg. I.J. Araújo et al. 552 (INPA 77535, as *Phellinus fastuosus*); Ilha de Maracá, 16 May 1986, leg. B. Lowy et al. s.n (INPA 144628, as *Polyporus* sp.); Mato Grosso, Aripuanã, 23 Apr 1978, leg. M.A. Sousa 438 (INPA 91949, as *Inonotus* sp.).

Taxonomic remarks: This species differs from the others of the genus by the olivaceous basidiospores in KOH and the thin cuticle below a thin tomentum.

3.1. *Key to species of* Inonotus *known from Brazil*

1. Basidiomata resupinate to nodulose 2
1. Basidiomata pileate or effused reflexed 4
2. Hymenial setae and setal hyphae absent; basidiospores rusty brown *I. venezuelicus* Ryvarden (see Ryvarden 2005)
2. Hymenial setae and/or setal hyphae present; basidiospores yellowish brown 3
3. Hymenial setae and setal hyphae present; pore surface dark, 5–7 per mm; basidiospores globose to subglobose, 10–13 × 8–12 µm, in the largest dimension *I. micantissimus* (Rick) Rajchenb. (see Ryvarden 2005)
3. Hymenial setae present and setal hyphae absent; pore surface reddish, 7–9 per mm; basidiospores ellipsoid to oval, 3–4.5 × 2.5–4 µm *I. tropicalis* (M.J. Larsen & Lombard) T. Wagner & M. Fisch. (see Wagner and Fischer 2002)
4. Setal hyphae present in the dissepiments 5
4. Setal hyphae absent in the dissepiments 10
5. Upper surface azonate; chlamydospores usually present in the context *I. rickii* (Pat.) D.A. Reid (see Ryvarden 2005)

5. Upper surface zonate; chlamydospores absent in the context 6
6. Hymenial setae present; basidiospores subglobose, pale rusty brown, <5 μm *I. portoricensis* (Overh.) Baltazar & Gibertoni [see Ryvarden 2004, as *Phellinus portoricensis* (Overh.) O. Fidalgo]
6. Hymenial setae absent; basidiospores subglobose to ellipsoid, hyaline to pale yellow, >5 μm long 7
7. Pileus with a distinct umbo, pileal surface glabrous and concentrically sulcate *I. pseudoglomeratus* Ryvarden (see Ryvarden 2005)
7. Pileus without umbo, pileal surface finely tomentose or velutineous to glabrous with age, but then even 8
8. Context duplex; pores 7–10 per mm; basidiospores subglobose *Inonotus amazonicus*
8. Context homogeneous; pores 3–4 per mm; basidiospores ovoid to ellipsoid 9
9. Hymenial setae rare, 15–21 × 5–9 μm; basidiospores (5.5–) 6–8 μm in the largest dimension *I. patouillardii* (Rick) Imazeki (see Ryvarden 2005)
9. Hymenial setae frequent, 15–40 × 6–14 μm; basidiospores 5–6(–6.5) μm in the largest dimension *I. radiatus* (Sowerby) P. Karst.
10. Hymenial setae present 11
10. Hymenial setae absent 14
11. Hymenial setae hooked *I. fulvomelleus* Murrill (see Ryvarden 2005)
11. Hymenial setae straight 12
12. Pore surface greyish brown to umber brown, pores 8–10 per mm; basidiospores globose to subglobose, pale yellowish brown, 5–6 × 4.5–5 μm *Inonotus calcitratus* (see Ryvarden 2004, as *P. calcitratus*)
12. Pore surface of different colour, pores <8 per mm; basidiospores ellipsoid to oblong ellipsoid, hyaline, 4–5 × 3–3.5 μm 13
13. Hymenial setae 10–14 μm wide; pore surface dark rusty brown, pores 3–5 per mm *I. pseudoradiatus* (Pat.) Ryvarden (see Ryvarden 2005)
13. Hymenial setae 4–7 μm wide; pore surface yellow, pores 5–6 per mm *I. xanthoporus* Ryvarden (see Ryvarden 2005)
14. Pores 7–8 per mm; basidiospores globose to subglobose, olivaceous brown *I. luteoumbrinus*
14. Pores <7 per mm; basidiospores oblong ellipsoid, different colour 15
15. Pores 4–6 per mm; basidiospores hyaline to pale yellow, 4–5(–6) × 3–4.5 μm *I. splitbergeri* (Mont.) Ryvarden (see Ryvarden 2005)
15. Pores 3–4 per mm; basidiospores rusty to umber brown, 5–7 × 4–5 μm *I. jamaicensis* (Murrill) A.M. Gottlieb et al. (see Ryvarden 2005).

Phylloporia chrysites (Berk.) Ryvarden, Norw. Jl Bot. 19: 235 (1972).

Basionym: *Polyporus chrysites* Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 233 (1856).

Description: In Wagner and Ryvarden (2002) and Ryvarden (2004).

Distribution and ecology: Species known from Florida and south to Brazil (Ryvarden 2004). In Brazil, reported in the states of Acre, Bahia, Pará, Paraíba, Paraná, Pernambuco, Rio Grande do Norte, Rondônia, Santa Catarina and São Paulo (Gibertoni et al. 2012). It is a new record to state of Amazonas. The species has been reported on living trees or hardwood.

Specimens examined: Brazil, Amazonas: Manaus, Distrito Agropecuário – ZF3, 3 Oct 1985, leg. K.F. Rodrigues & D.C. Daly 754 (INPA 137041); Campus do INPA, 14 May 1979, leg. M.A. Sousa 612 [INPA 85611, as *Phellinus ribis* (Schumach.) Quél.]; loc. n. det., 13 Mar 1974, leg. G.T. Prance et al. 20488 (INPA 44466, as *Phellinus ribis*); Rondônia, Porto Velho, Estação Ecológica de Cuniã, 11 Jan 2011, leg. A.C. Gomes-Silva et al. 2116 (URM 83102); Jarú, loc. n. det., 15 Oct 1986, leg. M. Capelari & R. Maziero 1149 (SP 211480).

Taxonomic remarks: *Phylloporia chrysites* is recognized by the basidiomata with a thick, velvety, spongy, easily-compressed tomentum, tiny pores (6–8 per mm) and small basidiospores (2.5–3.5 μm in diam.). It is related to *Phellinus weberiana* (Sacc.) Ryvarden, which has a zonate, dark brown pileus and larger basidiospores, 3–4.5 × 2.5–3.5 μm (Wagner and Fischer 2002). *Phylloporia frutica* (Berk. & Curt.) Ryvarden is another similar species, but it differs by the duplex context and larger pores, 2–4 per mm (Ryvarden 2004).

Phylloporia pectinata (Klotzsch) Ryvarden, Syn. Fung. (Oslo) 5: 196 (1991).

Basionym: *Polyporus pectinatus* Klotzsch, Linnaea 8: 485 (1833).

Description: In Wagner and Ryvarden (2002) and Ryvarden (2004).

Distribution and ecology: Pantropical and widespread (Ryvarden 2004). In Brazil, it was reported in the states of Amazonas, Bahia, Mato Grosso, Pará, Paraná, Pernambuco, Rio Grande do Norte, Rio Grande do Sul, Rio de Janeiro, Roraima, São Paulo, Santa Catarina (Gibertoni et al. 2012). It is a new record to state of Rondônia. The species has been reported on hardwood tree.

Specimens examined: Brazil, State of Amazonas, Manaus, Campus INPA, 13 Jun 1979, leg. M.A. Sousa 625 (INPA 84112); State of Rondônia, Porto Velho, Estação Ecológica de Cuniã, on hardwood, 11 Feb 2011, leg. A.C. Gomes-Silva et al. 2149, 2109, 2091 (URM 83112, URM 83041, URM 83042); 11 Mar 2011, leg. A.C. Gomes-Silva et al. 882 (URM 83043).

Taxonomic remarks: This species is characterized by the upper surface with numerous sulcate zones, yellow-brown pore surface, tiny pores (8–10 per mm), small and subglobose basidiospores [3–3.5(–4) × 3 μm]. It is related to *Phylloporia ephedrae* (Woron.) Parmasto, a Central Asian species with larger pores (6–7 per mm) (Wagner and Ryvarden 2002).

Phylloporia spathulata (Hook.) Ryvarden, Syn. Fung. (Oslo) 5: 196 (1991).

Basionym: *Boletus spathulatus* Hook., in Kunth, Synopsis Plantarum, Quas in Itinere ad Plagam Aequinoctialem Orbis Novi, Collegerunt Al. de Humboldt et Am. Bonpland (Paris) 1: 9 (1822).

Description: In Wagner and Ryvarden (2002) and Ryvarden (2004).

Distribution and ecology: Pantropical (Ryvarden 2004). In Brazil, it was reported in the states of Amazonas, Bahia, Minas Gerais, Pará, Paraíba, Paraná, Rio Grande do Sul, Rondônia, Santa Catarina and São Paulo (Gibertoni et al. 2012). It is a new record to state of Roraima. The species has been reported as inhabiting in ground of forest.

Specimens examined: Brazil, State of Amazonas, Humaitá, loc. n. det., on soil, 3 Dec 1996, leg. G.T. Prance & J.F. Ramos 3584 (INPA 19157, as *Coltricia* sp.); Jutaí, loc. n. det., 26 Oct 1986, leg. E.S.S. Silva et al. 866 (INPA 154981); Manaus, Distrito Agropecuário – ZF3, on soil, 2 Oct 1985, leg. K.F. Rodrigues & D.C. Daly 719 (INPA 137008); SE de Manaus, 2 Oct 1985, leg. G. Guzman & V.L.R. Bononi s.n. (SP 193562, as *Polyporus* sp.); Campus do INPA, 1980, leg. V.L.R. Bononi 294, 777 (SP 211856, SP 211865); loc. n. det., 19 Oct 1976, leg. G.T. Prance et al. 23927 [INPA 63311, as *Coltricia cinnamomea* (Jacq.) Murrill]; State of Pará, Cachoeira da Porteira: loc. n. det., 26 Jun 1980, leg. V.L.R. Bononi 677, 739, 876 (SP 178100, SP 193984, SP 194249); Aug 1980, leg. V.L.R. Bononi s.n. (SP 193437, 193442, as *Amauroderma rude* (Berk.) Torrend); Oriximiná, loc. n. det., 19 Jun 1980, leg. V.L.R. Bononi 455 [INPA 103493, as *Phellinus gilvus* (Schwein.) Pat.]; 23 Jun 1980, leg. V.L.R. Bononi 558 (INPA 103563, as *Polyporus* sp.); 28 Jun 1980, leg. V.L.R. Bononi 677 (INPA 103632, as *Phellinus* sp.); Jun 1980, leg. V.L.R. Bononi s.n. (SP 193906, SP 214710, as *Coltricia* sp.); Tucuruí, Rio Tocantins, May 1978, leg. M.G. Silva s.n. (INPA 85126); State of Rondônia, Jarú, Margem direita do rio Jarú, on soil, Jan 1987, leg. M. Capelari & R. Maziero 1078 [SP 211677, as *Coltricia spathulata* (Hook.) Murrill]; Porto Velho, Parque Natural Municipal de Porto Velho, 2 Feb 2010, leg. A.C. Gomes-Silva et al. 1004 (URM 82865); 20 Jun 2009, leg. A.C. Gomes-Silva & E.B.A. Souza 765 (URM 81086); Estação Ecológica de Cuniã, 11 Mar 2010, leg. A.C. Gomes-Silva et al. 805 (URM 83049); State of Roraima, loc. n. det., 26 Feb 1971, leg. G.T. Prance et al. 10710 (INPA 29062).

Taxonomic remarks: The species is characterized by the stipitate basidiomata, small pores (7–9 per mm) and golden-yellow basidiospores, 3–4 × 2–3 μm. According to Wagner and Ryvarden (2002), the stipitate basidiomata with a thin dark zone below the adpressed tomentum both on the pileus and the stipe should be good characteristics for separation from the other species. *Phylloporia veracrucis* (Sacc.) Ryvarden is related to *Phylloporia spathulata*, but differs by the larger basidiospores, 4–4.5 × 3–3.5 μm (Ryvarden 2004).

3.2. *Key to species of* Phylloporia *known from Brazil*

1 Basidiomata stipitate, on soil *Phylloporia spathulata*

1* Basidiomata resupinate to sessile, on living trees or hardwood. 2

2 Basidiomata dense and perennial with distinct skeletal hyphae *Phylloporia pectinata*

2* Basidiomata soft and fragile, annual and only with generative hyphae 3

3 Pores angular, 2–4 per mm; basidiospores ellipsoid to subglobose, pale yellow, 3–4.5 × 2.5–3 μm *Phylloporia frutica* (see Ryvarden 2004)

3* Pores round, 6–8 per mm; basidiospores subglobose, pale yellowish brown, 2.5–3.5 μm *Phylloporia chrysita*.

4. Discussion

Up to now, 17 species of *Inonotus* and four of *Phylloporia* have been recorded from Brazil (Gibertoni et al. 2012). Two of them [*I. tabacinus* (Mont.) G. Cunn. and *I. porrectus* Murrill] have not been included in the work because these species were recently transferred to *Hymenochaete porioides* T. Wagner & M. Fisch. and *Inocutis porrecta* (Murrill) Baltazar, respectively, based on molecular and/or morphology analysis (Wagner and Fischer 2002; Baltazar et al. 2010).

After revision of fungal collections in INPA and SP, one new species, *I. amazonicus*, collected 34 years ago, was discovered in INPA, which demonstrates the importance of accessibility and re-evaluation of dried fungal collections.

Besides the new species, new records were found and one new combination (*I. calcitratus*) was proposed based on material collected during the field trips and deposited in the herbaria. *Inonotus luteoumbrinus* and *Phylloporia spathulata* are new to the state of Roraima, *P. chrysita* to the state of Amazonas and *P. pectinata* to the state of Rondônia. Thus, 16 species of *Inonotus* and four species of *Phylloporia* are known from Brazil so far.

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