

Gymnopilus pholiotoides (Agaricales, Basidiomycota), an unexpected new record from an urban area in Brazil

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ABSTRACT – *Gymnopilus pholiotoides* Murrill is discovered for the first time from Brazil. The Brazilian specimen is characterized by the orange tones then yellowish cream color in older basidiomes, pileus surface cracking into areolate appressed squamules when mature, presence of a fragile membranous pendant annulus, basidiospores $(7.1-7.6-9.2 (-9.7) \times 4.6-5.6 \mu\text{m})$, absence of pleurocystidia, and presence of scattered caulocystidia. Description, discussion, drawings, and photographs of the sample are provided. Furthermore, a comparison with the type specimen of *G. pholiotoides* was made.

Keywords: Agaricales, Agaricomycetes, Neotropic, taxonomy

RESUMO – *Gymnopilus pholiotoides* (Agaricales, Basidiomycota), um novo registro inesperado em uma área urbana no Brasil. *Gymnopilus pholiotoides* Murrill é descoberto pela primeira vez para o Brasil. O exemplar brasileiro se caracteriza pela tonalidade alaranjada que muda de cor para creme amarelado nos basidiomas mais velhos, superfície do píleo rompendo em esquamulas adpressas aeroladas nos adultos, presença de um anel membranoso, pendente e frágil, basidiosporos de $(7.1-7.6-9.2 (-9.7) \times 4.6-5.6 \mu\text{m})$, ausência de pleurocistídios e presença de caulocistídios escassos. Apresentam-se aqui a descrição, discussão, desenhos e fotografia da amostra estudada. Também foi comparado com o espécime-tipo de *G. pholiotoides*.

Palavras-chave: Agaricales, Agaricomycetes, Neotrópico, taxonomia

INTRODUCTION

Gymnopilus P. Karst. was originally described from Sweden by Karsten (1879), with *Agaricus picreus* Pers. (Persoon 1798) designated as lectotype (Høiland 1990). The genus has about 200 species (Kirk *et al.* 2008, He *et al.* 2019, Wijayawardene *et al.* 2020). Although it was frequently known as belonging to Cortinariaceae (Singer 1951, Singer 1986), some authors (e.g., Kühner 1984) preferred to include it in Strophariaceae after observed the presence of styrylpyrone, the chemical compound responsible by the yellow pigment of *Gymnopilus*, as well in *Pholiota* (Fr.) P. Kumm. and *Hypholoma* (Fr.) P. Kumm. However, recent molecular studies included the genus in Hymenogastraceae, together with the well-known genera *Galerina* Earle and *Psilocybe* (Fr.) P. Kumm., but with low phylogenetic support (Matheny *et al.* 2015).

Species of *Gymnopilus* are reported worldwide, such as Africa (Pegler 1977, Høiland 1998), Asia (e.g., Kasuya *et al.* 2016, Suwannarach *et al.* 2017, Liu & Bau 2019,

Bashir *et al.* 2020, Thorn *et al.* 2020), Europe (e.g., Høiland 1990, Bon & Roux 2002, Holec 2005, Guzmán-Dávalos *et al.* 2009), North America (Hesler 1969, Guzmán-Dávalos 1994, 1996a, Guzmán-Dávalos & Guzmán 1991, 1995, Thorn *et al.* 2020), and regions of Central (e.g., Guzmán-Dávalos 1996b, Guzmán-Dávalos & Ovrebo 2001) and South America (e.g., Singer & Digilio 1952, Pegler 1997, Cortez & Coelho 2005, Magnago *et al.* 2013, 2015, Silva-Junior & Wartchow 2015).

In Brazil, at least 22 species are known, occurring in the states of Amazonas, Mato Grosso do Sul, Paraíba, Paraná, Rio Grande do Sul, Santa Catarina, and São Paulo (Fabrini & Wartchow 2020). From Northeast Brazil, Magnago *et al.* (2013, 2015) reported *G. purpureosquamulosus* Høil. and *G. subtropicus* Hesler, and Silva-Junior & Wartchow (2015) described *G. purpureograminicola* Silva-Junior & Wartchow from the state of Paraíba.

In this study, we report an interesting species of *Gymnopilus* from an urban area in the State of Pernambuco, Northeast Brazil.

MATERIAL AND METHODS

The specimen was collected from rotten wood in a residence located in the district of Iputinga that has an area with about 434 ha in the municipality of Recife, capital of the State of Pernambuco (Machado *et al.* 2017). The methodology of morphological analysis followed Silva-Junior & Wartchow (2015). The shape of the basidiospores follows Bas (1969). Color codes followed Online Auction Color (2004). For DNA extraction and ITS rDNA amplification, the methodology summarized by Silva-Filho *et al.* (2018) was used. The material is deposited at JPB (Thiers, continuously updated).

RESULTS

Gymnopilus pholiotoides Murrill, Mycologia 5(1): 24. 1913. $\equiv$ *Flammula pholiotoides* (Murrill) Murrill, Mycologia 5(1): 36. 1913.

(Figs. 1–3)

Pileus 29–72 mm diam., plane-convex to plane, surface smooth with small punctuations when young then areolate cracking into small plates with appressed squamulose appearance, orange-brown (OAC 775), then predominantly yellowish cream (paler than OAC 857–858); context 7 mm

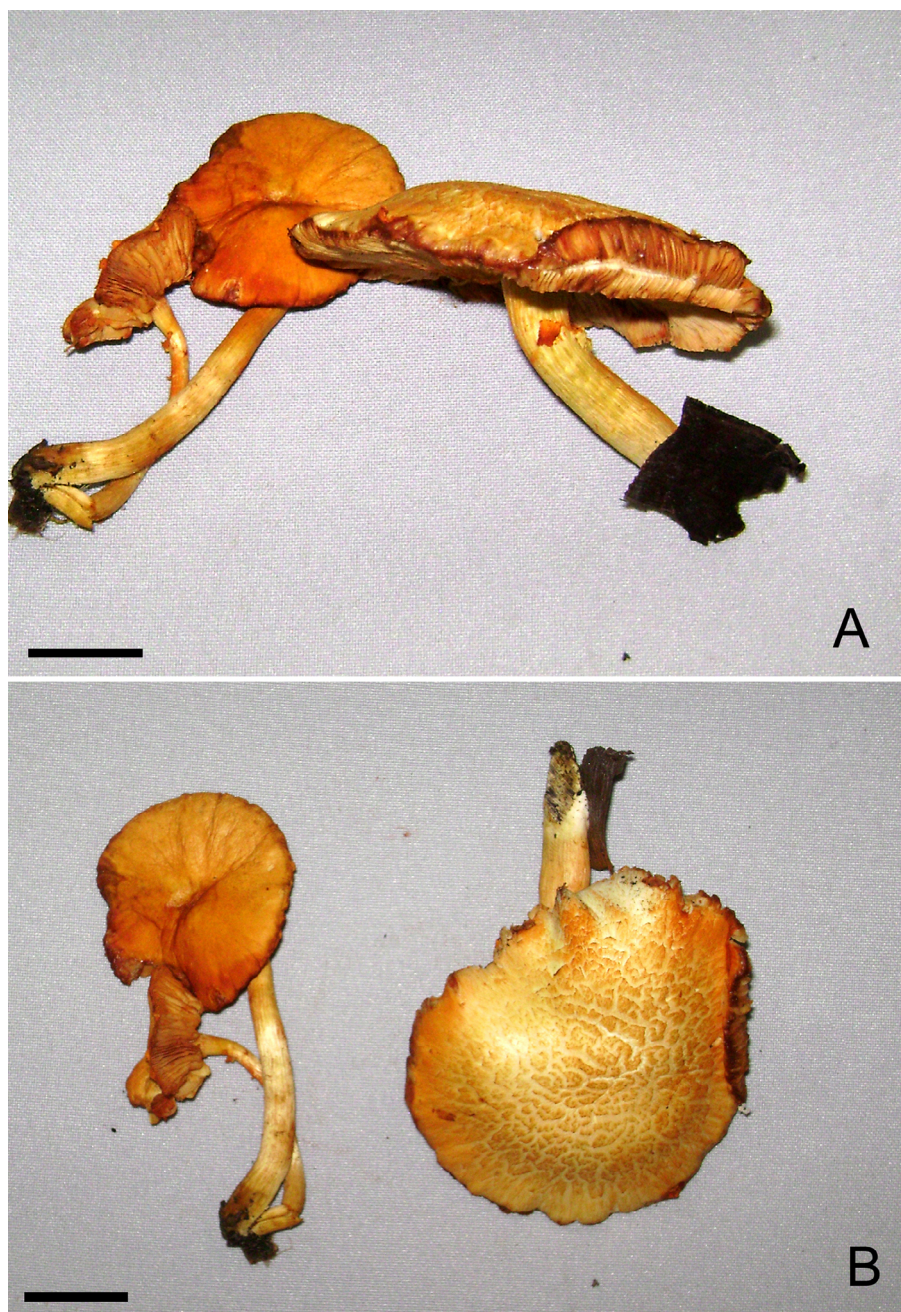


Figura 1. *Gymnopilus pholiotoides*. **A.** Basidiomes observed in side-view. **B.** Basidiomes showing pileus surface. Bars = 20 mm.

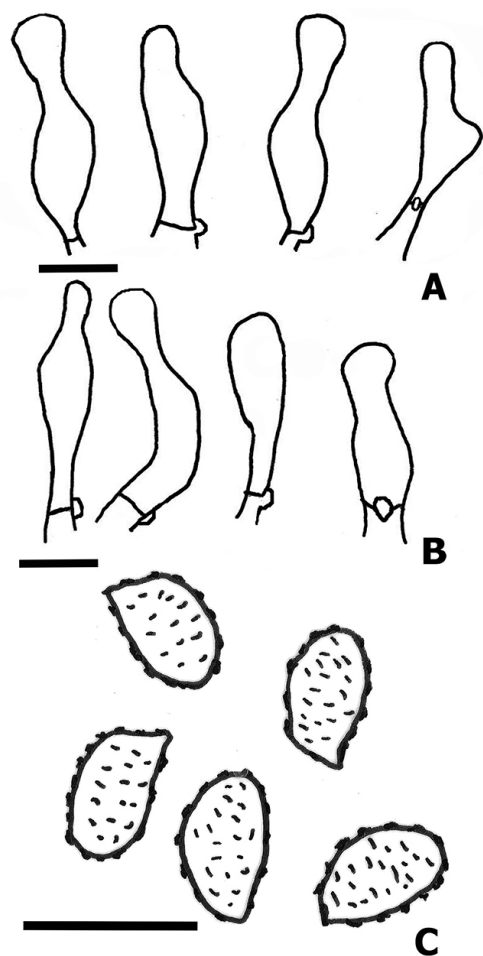


Figura 2. *Gymnopilus pholiotoides*. A. caulocystidia; B. cheilocystidia; C. basidiospores. Bars = 10 μ m.



Figure 3. Basidiospores of *Gymnopilus pholiotoides* with KOH 3%. Bars = 10 μ m.

thick at the disk, pale yellow (paler than OAC 857–848), unchanging, exposed among some of the areolate plates of the pileus surface. Lamellae adnexed-sinuate, beige (OAC 712–713) in young basidiomes, then ferruginous (OAC 716–718) when mature, subcrowded, up to 5 mm broad, edge entire, concolorous; lamellulae common, with diverse lengths. Stipe 45–66 $\times$ 4–7.5 mm, central to very slightly eccentric, equal to very slightly tapered at the apex; surface longitudinally fibrillose, dark yellow (OAC 852–853) to yellow-beige (OAC 803), unchanging on bruising or handling; annulus near the apex, thin, membranous, fragile, pendant.

Basidiospores (7.1–) 7.6–9.2 (–9.7) $\times$ 4.6–5.6 μ m (L = 8.4 μ m; W = 5.1 μ m; Q = 1.45–1.90, Qm = 1.63); ellipsoid to frequently elongate, apex sub attenuate to obtuse, walls slightly thickened, ornamented, verrucose, warts small to medium (less than 1 μ m high), germ pore absent, yellowish brown in KOH 3% and Melzer's reagent (non-dextrinoid). Basidia 19–28 $\times$ 5–8 μ m, clavate, hyaline; with 4 sterigmata, 3–4.5 μ m long. Subhymenium ramose, with

thin-walled hyaline hyphae. Cheilocystidia 16.3–20.4 $\times$ 4.6–6.6 μ m, infrequent, clavate, utriform or lageniform, apex obtuse to subcapitate, thin-walled, hyaline. Pleurocystidia not found, probably absent. Lamellae trama regular, with hyphae thin-walled, hyaline. Pileus trama interwoven, with hyphae 7.5–15 μ m wide, thin-walled, yellowish. Pileipellis a cutis, with hyphae 3.6–13.3 μ m wide, thin-walled, pigment encrusted, yellowish. Caulocystidia 14.3–20.9 $\times$ 5.1–7.1 μ m, lageniform, apex obtuse to subcapitate, thin-walled, hyaline. Clamp connections present.

Material examined: BRAZIL, PERNAMBUCO, Recife, Iputinga, Rua Conselheiro Silveira de Souza 1181, residência da família Escobar, 26.I.2011, I.H. Escobar s.n. (JPB 64088).

Habit and habitat: On a dead royal palm trunk at Managua, Cuba (Murrill 1913); and in pair on an unidentified log in an urban area at Recife, Brazil (this work).

Note: The molecular analysis was unsuccessful due to contamination of the sample (A.G.S. Silva-Filho, pers. comm.).

DISCUSSION

Basing in key differences, as the appressed areolate fibrillose squamules on pileus resulted by the cracking surface, the non-dextrinoid basidiospores, interwoven pileus trama, the absence of pleurocystidia, and presence of membranous pendant veil led to consider our specimens as *G. pholiotoides* (Hesler 1969). Besides our collection is also characterized by the orange tones in young basidiome then yellowish cream in older, presence of cheilocystidia, and scattered caulocystidia. The most evident differences between our specimens and the original description of this species are the paler pileus (instead ochraceous), the adnexed-sinuate lamellae (instead short-decurrent), the presence of a more fragile pendant annulus in our material (although it is definitely membranous), and the smaller cheilocystidia.

Hesler (1969) putatively described *Gymnopilus* subgen. *Annulati* Hesler to accommodate all species with veil forming a membranous to densely fibrillose persistent annulus, classification followed by Guzmán-Dávalos (1995). Nevertheless, later studies by Guzmán-Dávalos *et al.* (2003) found that this subgeneric treatment was not supported by phylogenetic analyses. Since our material bears a small detachable membranous annulus in fresh basidiomes (more visible in young basidiome), we used the key for the species of this subgenus proposed by Hesler (1969) for identification. Otherwise, it does not coincide with any of the species of the other subgenus, *Gymnopilus* subgen. *Gymnopilus*, characterized by the presence of arachnoid veil or absence of it (Hesler 1969).

In Hesler's key (1969), we found *G. pholiotoides* from Cuba as the most similar species. Although it is described as having ochraceous pileus, short decurrent lamellae, and with the presence of thicker and more persistent annulus, the study of the type by Hesler (1969) referred similar basidiospore size, $7-9.5 \times 4.5-5.5 \mu\text{m}$, pileus cracking into fibrillose appressed scales, the absence of pleurocystidia, and ventricose bearing a neck and often capitate cheilocystidia, measuring $24-38 \times 4-7 \mu\text{m}$. The protologue by Murrill (1913: 24-25) reported somewhat smaller pileus (30 mm in diam.) and also the thick persistent annulus, at least in young basidiomes. Pegler (1987b) also studied the type and referred a fragmented collection but found basidiospores $7-9.5 \times 4.6-5.2 \mu\text{m}$ ($L = 8.7 \pm 0.4 \mu\text{m}$; $W = 5 \pm 0.3 \mu\text{m}$; $Q_m = 1.70$) and utriform to narrowly lageniform cheilocystidia, $20-30 \times 6-7.5 \mu\text{m}$.

We considered that the differences mentioned are not enough to separate our specimen from *G. pholiotoides*. Furthermore, we checked the type of *G. pholiotoides* (Earle 527, NY). As already stated by Pegler (1987b), it is in very bad conditions, with only few fragments of stipe, context (apparently), and very few lamellae. So, one of the differences with the Brazilian's specimen, "the lamellae short-decurrent" in this species, could not be

confirmed. The only structure that could be observed was the basidiospores. The type has two types of basidiospores: 1) $8-9.6 \times 5.2-6.4 \mu\text{m}$, $Q = 1.45-1.60$ (-1.70), ellipsoid, verrucose, possibly the normal ones, and 2) $9-11 \times 5.5-6 \mu\text{m}$, $Q = 1.63-2.00$, elongate, subfusiform, with finer warts, in general looking somewhat amorphous or different to the normal ones.

Pegler (1987b) also reviewed *G. chrysotrichoides* Murrill from Cuba, suspecting to be the same species of *G. pholiotoides* basing in the glabrous pileus surface and concluded that the areolate surface of *G. pholiotoides* was due to dry conditions during collection since both species are found in the same place and on coconut log. In addition, he described basidiospores $7-10 \times 4.6-6 \mu\text{m}$ ($L = 8.7 \pm 0.5 \mu\text{m}$; $W = 5.5 \pm 0.3 \mu\text{m}$; $Q_m = 1.60$). On the other hand, Hesler (1969) immediately separated *G. chrysotrichoides* in his key basing on the dextrinoid basidiospores, $7.5-10 \times 5-6 \mu\text{m}$, and the absence of clamp connections. Later type studies by Guzmán-Dávalos (2003) revealed larger basidiospores, $8-11.2$ (12) $\times$ ($5.2-$) $5.6-7.2$ (-8) μm , in the type specimen of *G. chrysotrichoides* and pileus with purplish to reddish-brown scales, for that reason she synonymized it with *G. palmicola* Murrill and considered independent of *G. pholiotoides*.

Gymnopilus subpenetrans Murrill was considered by Pegler (1987b) as similar to *G. pholiotoides* and *G. chrysotrichoides* (see above) because they were collected in the same day and in the same log, and the microscopic features were identical. However, Hesler (1969) synonymized *G. subpenetrans* under *G. geminellus* (Peck) Murrill. Murrill (1913: 20) protologued *G. subpenetrans* with ferruginous-orange pileus, sinuate with long decurrent tooth lamellae, and basidiospores $8-10 \times 4-5 \mu\text{m}$, but no mention of any velar ornamentation in the stipe. Hesler's (1969: 51) description of *G. geminellus*, based on specimens from Michigan, New York (holotype of *G. geminellus*), and Cuba (holotype of *G. subpenetrans*), reported yellowish red subfibrillose or glabrous pileus, emarginated lamellae, subconcolorous stipe, white fugacious veil, dextrinoid, $7-8.5$ (-9) $\times$ $4.5-5$ (-5.5) μm basidiospores, and presence of pleurocystidia. Thus, this complex of species requires more attention in the future.

Other tropical American species share some characteristics with *G. pholiotoides*, such as the pileus surface, size and characteristics of the basidiospores, and attachment of the lamellae in the stipe. Since these taxa have been mentioned in some works (e.g., Hesler 1969, Pegler 1987b, 1997, Cortez & Coelho 2005), they need some attention as follow.

Gymnopilus armillatus Murrill and *G. praefloccosus* Murrill are somewhat similar to *G. pholiotoides*, according to Hesler's (1969) key, because they have non-dextrinoid basidiospores, but differ mostly in the characteristics of the pileus surface, cystidia, and basidiospores size. The first species also has somewhat smooth pileus, but

slightly longer basidiospores, 8–10 × 4.5–6 µm, presence of pleurocystidia, longer cheilocystidia 18–34 × 3–8 µm, and presence of pileocystidia; and *G. praefloccosus* readily differs in the smaller pileus, 20–30 mm diam., with surface having conic floccose warts, and presence of pleurocystidia (Hesler 1969).

Gymnopilus earlei Murrill from Jamaica differs in the basidiomes with pale yellow to pale ferruginous pileus ranging 30–100 mm in diam. with fibrillose to floccose-squamose surface, fugacious arachnoid yellow veil, slightly smaller basidiospores, 6–8.5 × 4–4.5(–5) µm, presence of pleurocystidia, and caulocystidia none (Hesler 1969).

Gymnopilus areolatus Murrill, *G. aureobrunneus* (Berk. & M.A. Curtis) Murrill, and *G. chrysopellus* (Berk. & M.A. Curtis) Murrill are other common neotropical species similar to *G. pholiotoides* due the non-dextrinoid basidiospores, which are quickly characterized by the smaller basidiospores (6–7 × 4–4.5 µm, 5.5–7.5 × 4–5 µm, and 5.5–7.5 × 3.8–4.7 µm, respectively) and the absence of membranous veil in the stipe (Berkeley & Curtis 1868, Murrill 1913, Pegler 1987a, 1987b) or with fibrillose veil (Hesler 1969). Regarding to *G. chrysopellus*, Singer & Digilio (1952: 370) referred larger basidiospores, 6–9.5 (–10.3) × 4–6 µm, but ‘generally 6–7.5 × 4–4.8 µm’ and variously attached lamellae, from adnate to adnate-sinuate or adnate-decurrent in many specimens analyzed by them. In our opinion, the basidiospores size reported by Singer & Digilio (1952) is too large for the species, as already concluded by Hesler (1969).

The European *G. sapineus* (Fr.) Maire also present medium size pileus, up to 65 mm diam., sometimes ranging to 80 or 90 mm in diam., absence of pleurocystidia, and somewhat similar basidiospores size, 7–9.5 (–10) × 4–5.5 µm. However, *G. sapineus* differs at least in the darker (tawny then rusty brown) pileus with floccose-squamulose to fibrillose-tomentose, tomentose to tomentose-scaly surface, and scanty (according to Hesler 1969) to absent veil (Høiland 1990, Bon & Roux 2002, Holec 2005).

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