



Original Paper

First contribution to the genus *Gymnopilus* (Agaricales, Strophariaceae) in Paraguay

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Abstract

Gymnopilus is characterized by its ferruginous-yellow basidiomata and lamellae, ferruginous spore print, ellipsoidal basidiospores with warty and rough ornamentation, and lacking a germinative pore. Here, novel data on the *Gymnopilus* species of Paraguay is presented, macro and microscopic morphological characteristics, distribution, and ecology are described, and a taxonomic discussion is provided. *Gymnopilus imperialis* is recorded in the Alto Paraná Department, *G. lepidotus* in the Central Department, *G. luteofolius* in the Cordillera Department, *G. peliolepis* in the Paraguari Department, and *G. purpureosquamulosus* in the Central Department and Boquerón, all as new records for Paraguay. Photographs of the fresh basidiomata and some microscopic structures such as basidia and basidiospores are attached.

Key words: Agaricomycetes, fungal diversity, taxonomy.

Resumen

Gymnopilus se caracteriza por poseer basidiomas y laminillas con tonos amarillo ferrugíneos, esporada ferruginosa, basidiosporas elipsoidales con ornamentación verrugosa a rugosa, sin poro germinativo. En el presente trabajo se proporcionan datos novedosos sobre las especies de *Gymnopilus* de Paraguay, se describen sus características morfológicas, su distribución, ecología y se proporciona una discusión en torno a su taxonomía. Se citaron *G. imperialis* para el Departamento Alto Paraná, *G. lepidotus* para el Departamento Central, *G. luteofolius* para el Departamento Cordillera, *G. peliolepis* para el Departamento Paraguari, y *G. purpureosquamulosus* para el Departamento Central y Boquerón, y todas como nuevos reportes para el Paraguay. Además, se ilustran los caracteres microscópicos distintivos. Se anexan fotografías de los basidiomas en fresco y de algunas estructuras microscópicas como basidios y basidiosporas.

Palabras clave: Agaricomycetes, diversidad de hongos, taxonomía.

Introduction

The genus *Gymnopilus* P. Karst. includes more than 200 saprobic species, mainly lignicolous, which is why they represent an important component of the wood mycobiota around the world (Guzmán-Dávalos 2003; Holec 2005; Kirk *et al.* 2008). Based on the pigments it contains and the non-mycorrhizal habit, Kühner (1984) classified

Gymnopilus together with *Galerina* Earle in the Strophariaceae family. Later, Singer (1986) placed it within Cortinariaceae due to the ornamentation and lack of germinal pore of the basidiospores. Currently, according to the results of phylogenetic analysis based on DNA sequences, *Gymnopilus* is not related to any of the two families mentioned above, since it forms an independent clade called

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“Gymnopilae” by Matheny *et al.* (2006) and is currently included in the family Hymenogastraceae (Kirk *et al.* 2008).

Gymnopilus is characterized by its yellow, ferruginous or purple basidiomata, yellow to ferruginous lamellae, central to eccentric stipe, with a partial cortinoid or fibrillose veil, generally fugacious, or as a membranous ring, bitter to farinaceous flesh, ferruginous spore print, basidiospores ellipsoidal with warty to rugose ornamentation, without germinative pore and in most species with dextrinoid walls, presence of subcapitulated cheilocystidia to capitated and hyphae with clamp connections (Horak 1989; Guzmán-Dávalos 2003; Holec 2005). An important ecological character is the lignicolous habit, being able to grow in woods in different degrees of decomposition (Guzmán-Dávalos 2003; Holec 2005) and apparently without having a preference for the substrate (Singer 1951). However, it has been observed that some tropical species are associated with Angiosperms and others with palms, while in temperate zones they are associated with conifers.

In South America *Gymnopilus* has been recorded by Berkeley & Cooke (1876), Saccardo (1887), Patouillard & Gaillard (1888), Singer (1951, 1953b, 1961, 1969, 1975), Singer & Digilio (1951), Dennis (1953, 1961, 1970), Raithelhuber (1974, 1980, 1991, 2004), Talice & Talice (1980), Bononi *et al.* (1984), Lazo (1984), Garrido (1985, 1988), Horak (1989), Pegler (1988, 1990, 1997), Putzke (1994), Valenzuela *et al.* (1994), Sede & López (1999), Cardona *et al.* (2005), Cortez & Coelho (2005), Franco-Molano *et al.* (2005), Wright & Wright (2005), Lechner *et al.* (2006), Drechsler-Santos *et al.* (2007), Karstedt & Stürmer (2008), Wright *et al.* (2008), Lobato *et al.* (2010), Vasco-Palacios & Franco-Molano (2013), Magnago *et al.* (2013), Sequeira (2013), Silva-Junior & Wartchow (2015) and Grassi *et al.* (2016). These authors have cited species for Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador and Uruguay. Nonetheless, records of this genus in Paraguay are scarce: Saccardo (1887), who cited *Flammula sapinea* var. *australis* Kalchbr. and Piris da Motta *et al.* (2015), who cited *G. subtropicus* Hesler for the Paraguari Department. However, *Gymnopilus* presents an important diversity in Paraguay, which is not yet documented. The aim of this work was to describe species of *Gymnopilus* and thus contribute to the registration and knowledge of agaricoid mycobiota of Paraguay.

Materials and Methods

Samples were collected in the Departments Alto Paraná, Boquerón, Central, Cordillera and Paraguari-Paraguay, and analyzed in the Análisis de Recursos Vegetales Laboratory, Mycology lab, Facultad de Ciencias Exactas y Naturales (FACEN), of the Universidad Nacional de Asunción, Paraguay. The macroscopic descriptions were based on fresh material, according to the guidelines proposed by Wright & Albertó (2002) and Lodge *et al.* (2004). The microscopic characteristics were described from the material mounted in 5% KOH and observed in an optical microscope; in addition, 1% floxin, Congo ammoniac red, Melzer reagent and cresyl blue were used, the last one for the metachromatic reaction. The following notations were followed when performing the measurements of the basidiospores: Q = ratio between the length and width of the spores, indicated as a range of variation; n = number of measured spores and N = number of basidiomata (Niveiro *et al.* 2012). The specimens studied were deposited in the herbarium of the Facultad de Ciencias Exactas y Naturales of the Universidad Nacional de Asunción, Paraguay (FACEN).

Results and Discussion

Five species of *Gymnopilus* were recorded: *G. imperialis* in the Alto Paraná Department, *G. lepidotus* in the Central Department, *G. luteofolius* in the Cordillera Department, *G. peliopelis* in the Paraguari Department and *G. purpureosquamulosus* in the Central and Boquerón Departments, all as new records for Paraguay.

Gymnopilus imperialis (Speg.) Singer, Lilloa 22: 561 (1951) [1949].

≡ *Pholiota imperialis* Speg., Boletín de la Academia Nacional de Ciencias en Córdoba 11(4): 416 (1889).

Fig. 1

Cespitose to scattered basidiomata. Pileus 8–12 cm in diameter, ovoid when immature, convex, plane-convex to flat; margin entire, wavy, revolute in maturity; surface wet to dry, ochraceous orange, finely velvety when young, turning ferruginous orange, radially fibrillose in mature specimens, not hygrophane. Lamellae adnate to sinuated, ventricose, up to 0.8 cm wide, subdecurrent to decurrent, yellow when young, tobacco color to ferruginous when old, margin entire, concolorous, lamellulae of two lengths. Ferruginous spore print. Context ferruginous orange, does not

change to the touch. Characteristic smell of tobacco, taste not tested. Stipe 6–12 × 0.8–2 cm, cylindrical, widened towards the base, central, hollow, flaring, sulphurous yellow when young, reddish brown when mature, fibrous to fibrillose. Membranous partial veil, sulfurous yellow, later as an apical, evanescent membranous ring that leaves membranous remains to rust-brown fibrils in the stipe. Abundant basal mycelium, yellowish. Spore print dark brown ferruginous.

Basidiospores (6.4–)8.5–9 × 4.4–6.8 μm, Q = 1.26–1.44, Q_s = 1.35, n = 30, N = 2, widely ellipsoid to ellipsoid, apex rounded to acute, strongly verrucose, warts large, without plage, with or without suprahilar depression, golden to ferruginous, dextrinoid, not metachromatic.

Basidia (25–)28–35 × 7–8 μm, clavate, tetrasporic, sterigmata 4.5–6 μm long, amber to ferruginous. Pleurocystidia absent. Cheilocystidia 27.5–38.5 (–40) × 5.5–10 μm, clavate to narrowly utriform, subcapitated to capitated. Subhymenium cellular. Hymenophoral trama subregular, hyphae 4.5–9 (–11.5) μm in diam., thin-walled, yellowish. Pileus trama interwoven, hyphae of 5.5–8.5 (–13.5) μm diam., thin-walled, yellowish. Pileipellis a cutis, prostrate hyphae, some erect to suberect, amber to brownish, septate, thin-walled. Caulocystidia not observed. Clamp connections present in the hyphae of the hymenophoral trama, pileus trama and stipe.

It was found in grassland near plantations of *Pinus elliotti*, during autumn.



Figure 1 – a-f. *Gymnopilus imperialis* – a, b, c. basidiomata when fresh (b. immature basidioma); d. cheilocystidia; e. basidiospores in cotton blue; f. basidiospores in KOH. (leg. M. Campi 027).

The type specimen is from Brazil, also recorded from Argentina, Costa Rica and Jamaica (Spegazzini 1889; Hesler 1969; Guzmán-Dávalos *et al.* 2003). In Brazil it has been cited for the states of São Paulo and Paraná (Spegazzini 1889; Pegler 1997; Capelari *et al.* 2015; BFG 2018).

Examined material: PARAGUAY. ALTO PARANÁ: Refugio Biológico Tati Yupí, 25°22'22.6"S, 54°35'50.5"W, 10.IV.2015, *M. Campi 003346* (FACEN).

This species is grouped within the *spectabilis-imperialis* clade as the basal species, which also includes *G. junonius* (Fr.) P.D. Orton, *G. pampeanus* (Speg.) Singer and *G. spectabilis* (Fr.) Singer, this clade includes robust basidiomata, with thick membranous ring and fibrillose to slightly squamulosus, dark ferruginous colour pileus (Guzmán-Dávalos *et al.* 2003). The species of this clade are very similar to each other, and in many cases have been considered as synonyms or varieties of the same taxon (Guzmán-Dávalos *et al.* 2003).

Gymnopilus pampeanus is a related species, and is differentiated from *G. imperialis* by its cylindrical stipe and adnexed to sinuate-adnate lamellae in the first one, besides *G. pampeanus* appears to be closely associated with *Eucalyptus* forests (Pegler 1983, 1997).

Another closely related species is *G. rugulosus* R. Valenz, Guzmán & J. Castillo. This species is known for the tropical and subtropical regions of the northern hemisphere, shares characters such as robust basidiomata with tuberculated basidiospores; however, it differs from *G. imperialis* by the presence of lageniform, ventricular, non-capitated or subcapitulated pleurocystidia of 21–38 × 5–10 µm (Guzmán-Dávalos & Ovrebo 2001; Cardona *et al.* 2005).

Gymnopilus imperialis was originally described for the south of Brazil (Spegazzini, 1889), and considering the main morphological characters like robust basidiomata, pileus greater than 10 cm in diameter, claviform stipe widened towards the base, membranous ring, basidiospores subglobose to ellipsoidal, tuberculated, and absence of pleurocystidia to be consistent with those observed in the Paraguayan specimen, the material analyzed from Paraguay is identified as *G. imperialis*.

Gymnopilus lepidotus Hesler, Mycologia Memoirs 3: 40 (1969). Fig. 2

Basidiomata cespitose. Pileus 3,5–10 cm diam., hemispheric to convex, margin entire when young, plane-concave with revolute margin at

maturity; wet to dry surface, ferruginous chestnut with vinous tones, becoming clear towards the margin, covered with chestnut scales, erect, abundant in the center, scattered towards the margin. Lamellae subdecurrent, crowded, up to 0.4 cm wide, reddish brown in fresh, ferruginous in dry, margin entire, concolorous, lamellulae of two lengths. Context thin, up to 0.1 cm thick, ferruginous yellow in dry samples, darkens to reddish brown with contact in fresh samples. Smell and taste not tested. Stipe 2–7 cm × 0,4–1 cm, central, cylindrical, widens slightly towards the base, up to 1 cm in diameter, hollow, beige to light brown, fibrillose, striated, reddish to the touch. Partial veil not observed. Basal mycelium whitish to cream, abundant. A reddish pigment dissolves from the pileus when mounted in KOH. Spore print yellow ferruginous to orange ferruginous.

Basidiospores 6–7.5(–8.5) × (4–)4.5–5 µm, Q = 1.5–1.53, Q_x = 1.51, n = 30, N = 2, ellipsoid, amygdaliform, with rounded to subacute apex, without plage, with or without suprahilar depression, thin-walled, warty, warts medium, golden to ochre, dextrinoid, not metachromatic. Basidia 19–24 × 6–7.5 µm, claviform, bi to tetrasporic, sterigmata 4.3–4.5 µm in length, hyaline or with amber-colored content. Pleurocystidia of pseudocystidia type, 21.5–27.5(–43.5) × 6–7.5(–10) µm, utriform to subfusiform, with amber content. Cheilocystidia (15–)18–23 × (6–)8–8.5 µm, lageniform, with obtuse to subcapitate apex, hyaline or with amber content. Subhymenium cellular. Hymenophoral trama subregular, hyphae of 2–4 µm diam., up to 18.5–25.5 µm diam., thin-walled, hyaline or a few with amber content. Pileus trama radial, hyphae of 2.5–4 µm in diam., thin-walled, hyaline or a few with amber color. Pileipellis cutis to trichodermis in the scales, hyphae of 4.5–13 µm in diam., orange to yellowish, prostrate, suberect to erect. Caulocystidia 29.5–32 × 5–5.5 µm, cylindrical, thin-walled, scarce in the apical portion, absent in the rest of the stipe. Clamp connections present in the hyphae of the pileus trama, hymenophoral trama and stipe.

It was found on decomposing trunk, in urban area.

The type is from Florida, United States America (Hesler 1969; Guzmán-Dávalos 2003). In addition it was recorded from Argentina for Misiones Province (Wright & Wright 2005; Lechner *et al.* 2006; Wright *et al.* 2008; Grassi *et al.* 2016), from Colombia (Franco-Molano *et al.* 2005; Vasco-Palacios & Franco-Molano 2013) and

from Mexico for the states of Jalisco and Veracruz (Guzmán-Dávalos 1996).

Examined material: PARAGUAY. CENTRAL: San Lorenzo city, Universidad Nacional de Asunción Campus, 25°20'5,51"S, 57°30'56,95"W, 10.II.2017, Y. Maubet 003783 (FACEN).

Gymnopilus lepidotus is characterized by the brownish-colored pileus with small erect or adherent scales, pleurocystidia and basidioles with granular, golden content, usually very abundant, cheilocystidia and pleurocystidia not capitated and radial pileus trama (Guzmán-Dávalos 1996, 2003).

The size of the pileus is a character that has been discussed: Hesler (1969) and Wright *et al.* (2008) described the pileus as small, 4–8 mm in diam.; later Guzmán-Dávalos (1996, 2003), after reviewing the samples from Florida, stated that the measurements obtained by Hesler (1969) maybe mistaken because, even when dry, the samples reviewed by Hesler presented a bigger pileus, from 6–18(–26) mm in diam. In addition,

some samples from Mexico reached up to 70 mm in diam. As for the pleurocystidia, Hesler (1969) mentioned that they are hyaline, rare and inconspicuous; abundant clavate basidioles with brown content. Guzmán-Dávalos (1996) interprets these basidioles as pleurocystidia of the pseudocystidia type, which coincides with the samples described by Wright *et al.* (2008), who mentioned subpyriform, clavate to subutriform pleurocystidia, 20–22 × 5–6 μm, with ferruginous chestnut content.

Gymnopilus dilepis (Berk. & Broome) Singer is a very similar species to *G. lepidotus*, and probably are synonymous (Guzmán-Dávalos 2003). However, *G. dilepis* has a paleotropical distribution, whereas *G. lepidotus* is an exclusively neotropical species (Guzmán-Dávalos 2003).

The presence of the cheilocystidia, caulocystidia, pleurocystidia of the pseudocystidia type with amber content in the samples from Paraguay are consistent with the microscopic

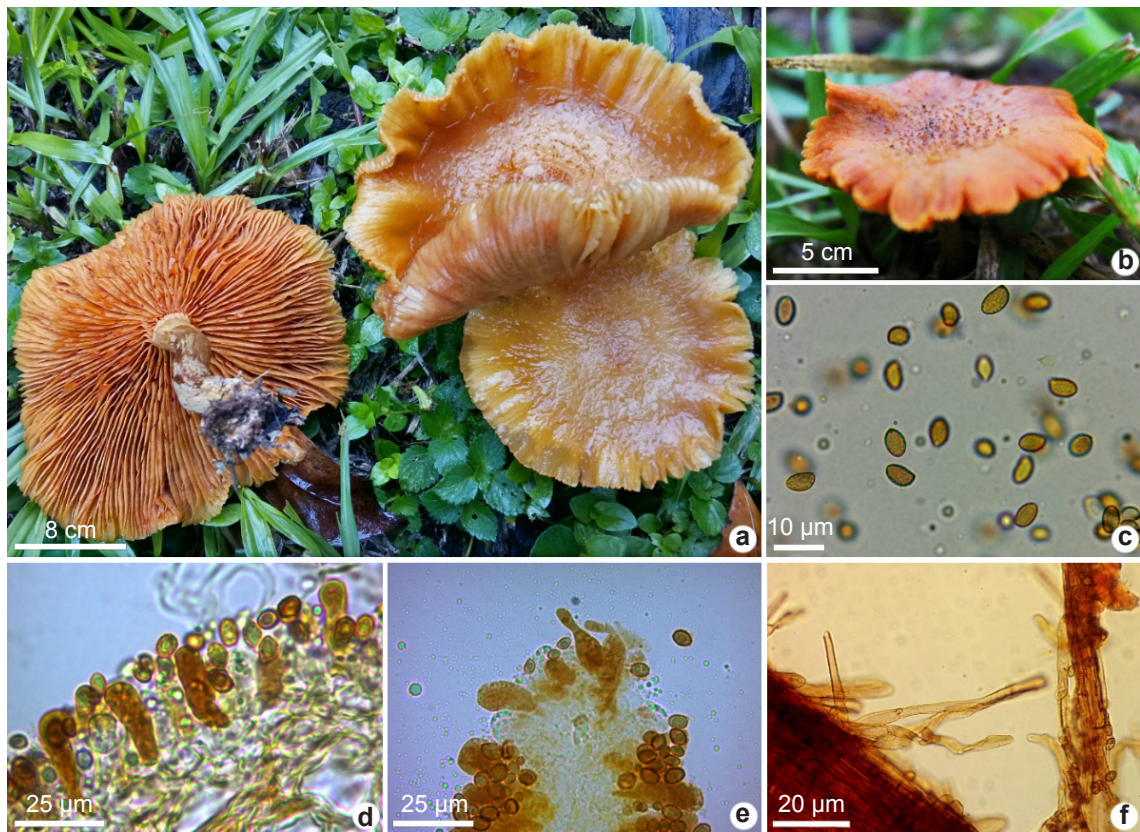


Figure 2 – a-f. *Gymnopilus lepidotus* – a, b. basidiomata (a. basidiomata when fresh; b. detail of the pileus showing scales); c. basidiospores; d. pleurocystidia of pseudocystidia type; e. cheilocystidia; f. caulocystidia. (leg. Y. Maubet 040).

descriptions of Guzmán-Dávalos (1996, 2003). However, the size of the basidioma in the Paraguayan samples are significantly greater than those cited in the literature. The basidiomata collected here were found saturated with rain water, which may have influenced the color of the pileus and the scales. Given that these characters are controversial, we do not believe it to be enough to discard the species, thus we

conclude the specimen studied corresponds to *G. lepidotus*, and this therefore the first record in Paraguay.

Gymnopilus luteofolius (Peck) Singer, Lilloa 22: 260 (1951) [1949].

≡ *Agaricus luteofolius* Peck, Annual Report on the New York State Museum of Natural History 27: 94 (1875).

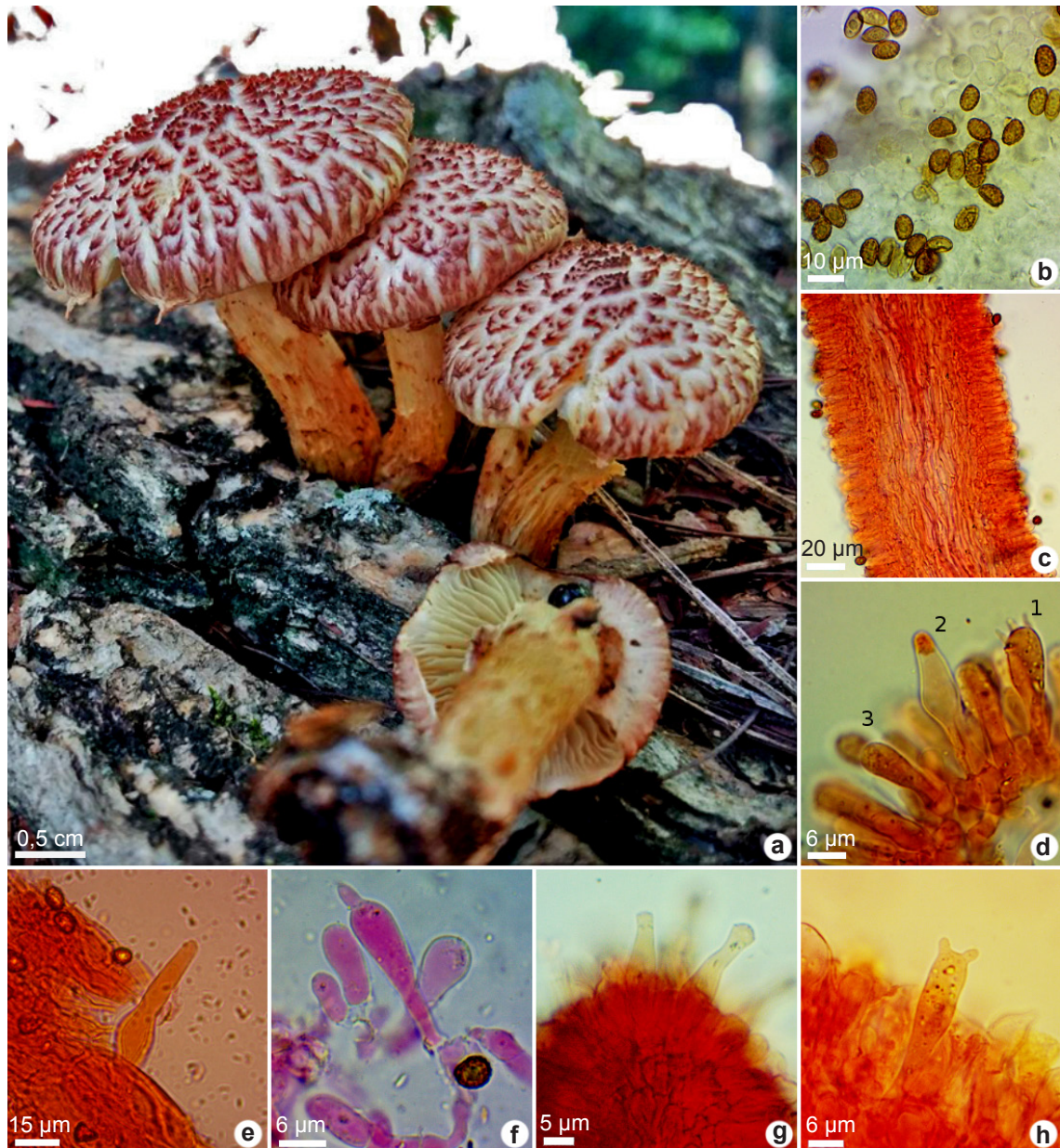


Figure 3 – a-h. *Gymnopilus luteofolius* – a. basidiomata; b. basidiospores; c. hymenophoral trama; d1. basidium; d2. pleurocystidium; d3. basidiole; e. pileocystidium; f. pleurocystidium with rostrate apex; g. cheilocystidia; h. basidia. (leg. M. Campi 128).

≡ *Pholiota luteofolius* (Peck) Sacc., Sylloge Fungorum 5: 756 (1887). Fig. 3

Basidiomata cespitose. Pileus 1.1–2.3 cm in diam., hemispheric to plane-convex; margin entire to rimose when fresh, involute when young, appendiculate when mature, dry surface, whitish to cream color, covered by fibrillose scales, erect, suberect to prostrate, reddish to purple, permanent, distributed more or less evenly over the surface of the pileus, which in dry turns dark brown on a yellowish to ocher surface. Lamellae close, ventricose, up to 0.3 cm wide, with a decurrent tooth, cream to yellowish in fresh, chestnut golden when dry. Margin entire, concolorous, lamellulae of two lengths. Context whitish in fresh, yellowish in dry. Smell and taste not tested. Stipe 2,3–3,5 × 0,5–0,8 cm, central, cylindrical, uniform to slightly widened towards the base, hollow, flexuous, fibrillose to squamous, scales brown, insert to the substrate. Partial veil remains as yellowish membranous remains at the top of the stipe, evanescent. Spore print ferruginous chestnut.

Basidiospores de $7.3\text{--}9.7 \times 5\text{--}7.2 \mu\text{m}$, $Q = 1.4\text{--}1.5$, $Q_x = 1.45$, $n = 30$, $N = 2$, ellipsoidal, amygdaliform, without plage, with suprahilar depression, thin-walled, warty, warts medium, golden to reddish brown, not dextrinoid, not metachromatic. Basidia $21.5\text{--}27.2 \times 6.9\text{--}9.4 \mu\text{m}$, claviform, bi and tetrasporic, $3.2\text{--}4.7 \mu\text{m}$ long sterigmata, present in the margin and the edge of the lamellae, hyaline. Basidioles $16.2\text{--}28.3 \times 5.9\text{--}7.6 \mu\text{m}$, thin-walled, hyaline. Pleurocystidia $24\text{--}35 \times 6.3\text{--}8.3 \mu\text{m}$, fusiform with rostrate apex, thin-walled, hyaline. Cheilocystidia of $21\text{--}34.6 \times 4.2\text{--}7.6 \mu\text{m}$, lageniform, apex obtuse to subcapitated, hyaline. Subhymenium ramose inflated. Hymenophoral trama subregular, hyphae of $2.6\text{--}7.5 \mu\text{m}$ in diam., thin-walled. Pileus trama interwoven, hyphae of $12.6\text{--}24.8 \mu\text{m}$ in diam., thin-walled, loosely arranged, hyaline, towards the surface of the pileus the hyphae present a refringent content, $3.9\text{--}8.8 \mu\text{m}$. Pilleipellis a cutis to a trichoderm in the scales, with hyphae of $7.5\text{--}18.5 \mu\text{m}$ in diam., hyaline to chestnut with embedded pigment, erect to form scales, thin-walled, sometimes thickened. Pileocystidia $46\text{--}97 \times 14\text{--}24 \mu\text{m}$, pyriform to fusiform, occasional, septate, thin-walled, hyaline. Caulocystidia not observed. Clamp connections present in the hyphae of the pileipellis, pileus trama, hymenophoral trama and stipe.

It was found in rotting trunk, in urban area.

It's distributed in Argentina and some states of the United States of America (Singer 1953b; Hesler 1969).

Examined material: PARAGUAY. CORDILLERA: Atyra City, Los Agüero country house, $25^{\circ}20'45.2''\text{S}$, $57^{\circ}11'19.0''\text{W}$, 12.XI.2016, *M. Campi 128* (FACEN).

This species is characterized by a dark reddish to reddish brown colour on the surface of the pileus when young, turning pinkish red or yellowish red to yellowish; red to vinous context that shifts to yellowish, and the clavate to ventricose caulocystidia disposed in clusters, in addition the species has fusoid to ventricose pleurocystidia and ventricose cheilocystidia with capitate to non-capitate apex (Hesler 1969). The studied samples do not present dextrinoid basidiospores, which differs from the observations of Hesler (1969). Singer (1969) noted that the dextrinoid reaction could be lost in herbarium samples and it is very difficult to observe. Because the fresh material was not studied for the Paraguayan material, it is inconclusive whether or not the basidiospores are dextrinoid.

Gymnopilus peliolepis (Speg.) Singer, Lilloa 22: 561 (1951) [1949].

≡ *Pholiota peliolepis* Speg., Boletín de la Academia Nacional de Ciencias en Córdoba 23(3–4): 394 (1919) [1949]. Fig. 4

Basidiomata cespitose. Pileus of 2.5–7.5 cm in diam., convex to plane-convex, margin entire, involute; surface yellowish chestnut, wet to dry, covered with erect to flattened scales, pyramidal, purple, evenly distributed when young, diminish towards the margins until disappearing in mature samples, not hygrophanous. Lamellae close, ventricose, up to 0.4 cm wide, decurrent to subdecurrent, yellow in fresh, with uneven color, ferruginous orange, with purple shades on the edge when dry, margin entire, lamellulae of three lengths. Context thin, up to 0.8 cm thick, whitish, does not change color with touch. Smell and taste not tested. Stipe 2–3 × 0.2–0.6 cm, central, cylindrical, widens slightly towards the base, up to 0.66 cm diam., flexuous, fibrillose, hollow, light yellow to light brown, stains with ferruginous color towards the base. Partial veil forms a fibrillose ring in the upper part of the stipe, fleeting. Basal mycelium cottony, whitish, adhering to the substrate. Spore print ferruginous chestnut.

Basidiospores $7.8\text{--}9.2\text{--}(9.8) \times 4.9\text{--}6.0 \mu\text{m}$, $Q = 1.56\text{--}1.64$, $Q_x = 1.60$, $n = 30$, $N = 2$, ellipsoid, with rounded to subacute apex, thin-walled, with or without plage, with or without suprahilar depression, verrucose, warts medium, ferruginous golden, dextrinoid, non-metachromatic. Basidia $14.5\text{--}18 \times 5\text{--}6 \mu\text{m}$, clavate, tetrasporic, sterigmata $3.5\text{--}4$

μm long, hyaline. Cheilocystidia $11\text{--}28 \times 4.5\text{--}8.5$ μm , lageniform, capitate, hyaline or with chestnut content. Subhymenium cellular. Hymenophoral trama subregular, hyphae of $3\text{--}12.5$ (-15) μm , hyaline, thin-walled. Pileus trama composed of intertwined hyphae of $3\text{--}14.5$ μm in diameter, hyaline, thin-walled. Thrombopleurous hyphae of $4.5\text{--}9.5$ μm in diam., with yellowish refringent content, abundant. Pileipellis a cutis to trichoderm in the scales, with hyphae of $6.5\text{--}11.5$ (-13.5) μm diam., prostrate, suberect to erect, golden to brown. Pileocystidia

not observed. Caulocystidia not observed. Clamp connections present in the hyphae of the pileus trama, hymenophore trama and stipe when mounted in KOH. A yellowish pigment dissolves.

It was found on decaying trunk of the palm native to south America, *Acrocomia aculeata*, during summer.

It's known for Argentina, Brazil and Florida, USA according to Hesler (1969), Farr (1973), Raitelhuber (1988, 1991, 2000, 2004), Singer (1951, 1953a) and Singer & Digilio (1951).

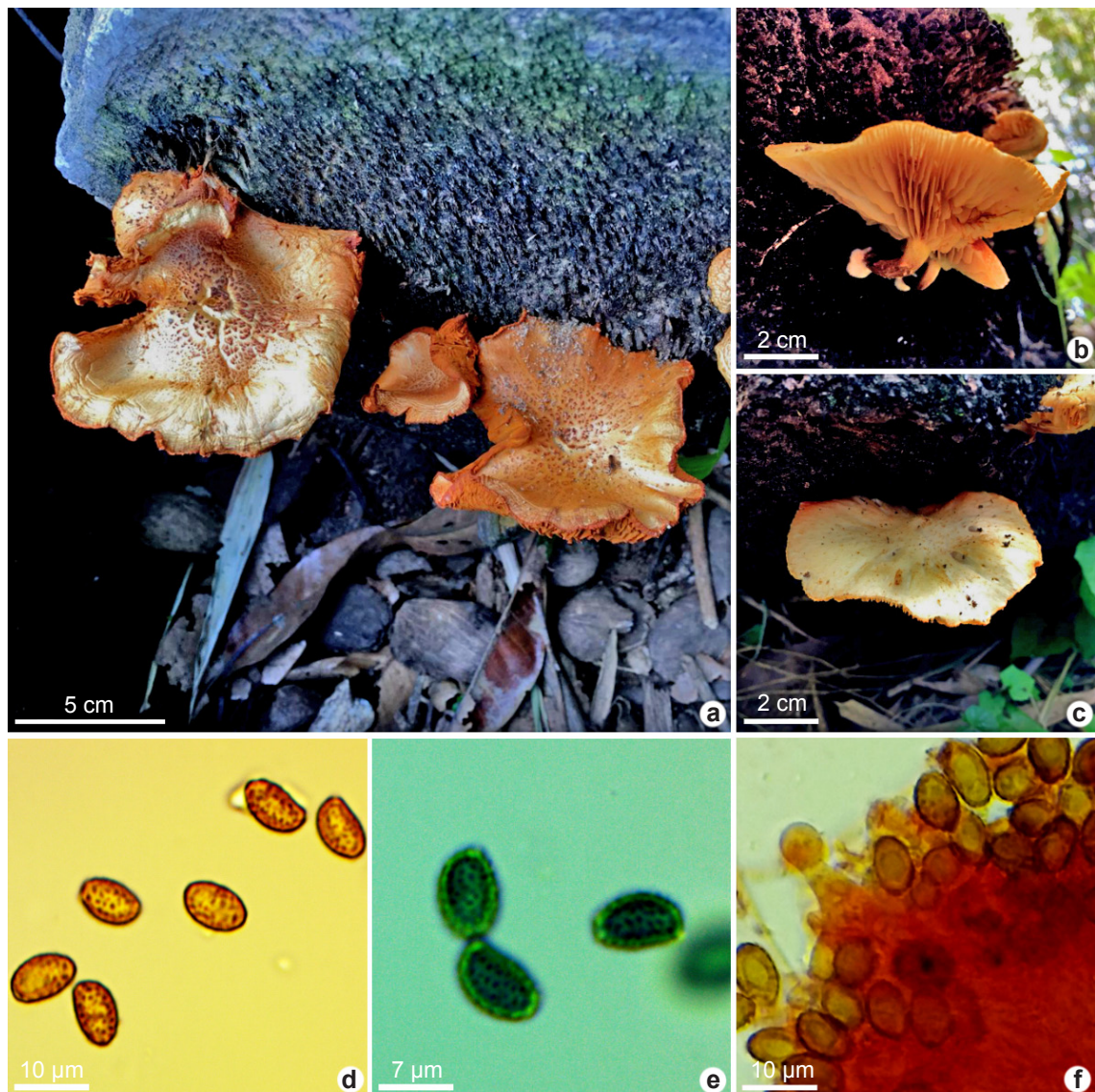


Figure 4 – a-f. *Gymnopilus peliolepis* – a, b, c. basidiomata (b. pileus in lateral view showing stipe insertion; c. pileus showing surface configuration); d. basidiospores in KOH; e. basidiospores in cotton blue showing ornamentation; f. cheilocystidium. (leg. C. Mancuello 013).

Examined material: PARAGUAY. PARAGUARÍ: Quiindy city, 25°54'26.9"S, 57°15'56.1"W, 11.XII.2016, C. Mancuello 004314 (FACEN).

Gymnopilus peliolepis is characterized by its whitish-yellowish pileus, covered by fibrillose scales from bright red to dark purple, basidiospores with small to medium warts, absence of pleurocystidia and caulocystidia and being associated with decomposed hardwood (Singer 1951).

A morphologically related species is *G. purpureosquamulosus*, which Høiland (1998) proposes to differentiate specimens collected in Africa and Asia. Subsequently, Guzmán-Dávalos *et al.* (2008) recorded this species in Central America (Panama) and Europe. Previously it had been determined as *G. palmicola* Murrill or as *G. peliolepis*; thus *G. peliolepis* would currently be restricted to neotropical regions. Høiland (1998) differentiates *G. purpureosquamulosus* by its slightly thinner basidiospores ($8.25 \times 5.2 \mu\text{m}$) and ventricose cheilocystidia with prostrate apex, rounded to globose, but not markedly capitated, as seen in *G. peliolepis*. *Gymnopilus palmicola* is differentiated by its larger basidiospores ($8\text{--}12 \times 5.6\text{--}7.2 \mu\text{m}$) with larger warts (Guzmán-Dávalos *et al.* 2008).

From the type specimen of Brazil, Guzmán-Dávalos *et al.* (2008), described two types of basidiospore shape: from the spore print of $6\text{--}8 \times 4.4\text{--}5.2 \mu\text{m}$, ellipsoidal, with medium warts, and from the basidioma, $6.4\text{--}7.2 \times 4\text{--}4.8 \mu\text{m}$, ellipsoidal to oblong, with very small warts, almost asperulated. Singer (1951) and Hesler (1969) described verrucose basidiospores for this species. The basidiospores of the studied material are $7.2\text{--}9.2 \times 4.9\text{--}6 \mu\text{m}$, which is somewhat wider than those described by Guzmán-Dávalos *et al.* (2008). Singer (1951) described spores with verrucose ornamentation, which is consistent with the basidiospores presented.

An important character to consider of *G. aculeatus* (Bres. & Roum.) Singer is the habit. *Gymnopilus aculeatus* has been found on dead trunks of palms and orchids (Singer 1951). The same is described for *G. palmicola*, which is always related to palms. On the other hand, *G. purpureosquamulosus* grows both on decaying wood (Høiland 1998; Guzmán-Dávalos *et al.* 2008) and on living palms (Guzmán-Dávalos *et al.* 2008), and *G. peliolepis* is restricted to decaying wood (Singer 1951). However, more studies are necessary to determine the substrate specificity of these species.

Gymnopilus purpureosquamulosus Høil., Mycotaxon 69: 82 (1998). Fig. 5

Basidiomata cespitose. Pileus of 2–9 cm diam., hemispherical, convex to plano-convex at maturity, margin entire to crenate when young, smooth to wavy; wet to dry surface, bright yellow when young, ferruginous chestnut when mature, covered with erect, triangular, permanent scales, evenly distributed or grouped in the center and diminishing towards the margins, in dry samples the margin scales become appressed, reddish, ferruginous chestnut to violet when fresh, purple when dry. Lamellae close, ventricose, up to 0.5 cm wide, sinuated to shortly decurrent, concolour to the surface of the pileus in fresh, orange ferruginous when dry, margin entire, wavy, concolor, lamellulae of three lengths. Context yellowish up to 0.4 cm thick. Smell inappreciable, taste not bitter. Stipe 2–7 × 0.4–1 cm, central, cylindrical, widens slightly towards the base, hollow, flexuous, fibrillose, whitish to yellowish when fresh, stains to reddish brown to the touch. Partial veil leaves fibrillose remnants of ferruginous tonalities in the upper part of the stipe, fleeting. Basal mycelium whitish, abundant. Spore print ferruginous.

Basidiospores ($5.9\text{--}6.5\text{--}8 \times 4\text{--}5.5 \mu\text{m}$; $Q = 1.46\text{--}1.51$, $Q_x = 1.48$, $n = 30$, $N = 3$, ellipsoid, amygdaliform, with subacute apex, without plage, with or without suprahilar depression, thin-walled, finely verrucose, warts small, golden to reddish brown, dextrinoid, not metachromatic. Basidia $20\text{--}30 \times 6\text{--}9 \mu\text{m}$, clavate, tetrasporic, sterigmata $3\text{--}5.5 \mu\text{m}$ long, hyaline or with yellow-brown cytoplasmic content. Basidiole ($16.5\text{--}17.5\text{--}35$ (-40) × ($4\text{--}5\text{--}9.5 \mu\text{m}$, thin-walled, hyaline or mostly with golden-brown content. Pleurocystidia of the pseudocystidia type of $16.5\text{--}28$ (-35) × $5\text{--}9.5 \mu\text{m}$, fusiform, hyaline or with uniform or irregular orange or golden brown content. Cheilocystidia ($12\text{--}16\text{--}27.5 \times 5\text{--}9 \mu\text{m}$, lageniform with obtuse to subcapitated apex, hyaline or with golden brown coloration. Subhymenium ramose-inflated. Hymenophoral trama interwoven, hyphae $5\text{--}14$ (-16) μm in diam., thin-walled. Pileus trama interwoven, with hyphae of ($4\text{--}5\text{--}15$ (-17.5) μm diam., thin-walled, widening towards the superficial layers. Pileipellis a cutis to trichoderm in the scales, with hyphae of $4.5\text{--}14.5$ (-17.5) μm in diam., prostrate to suberect or erect when they form the scales, thickened walls, golden brown, with pigment embedded in its walls. Pileocystidia not observed. Caulocystidia ($38\text{--}47\text{--}74.5 \times 5.5\text{--}14.5$ (-15.5) μm , cylindrical, in erect to recurved tufts, towards the tip

of the stipe, scarce to absent in some samples. Clamp connections present in the hyphae of the pileipellis, pileus trama, hymenophoral trama and stipe. When mounting in KOH a yellowish pigment dissolves.

It was found in decaying wood or trunks, urban area, found during spring and summer.

The species have pantropical distribution. Zimbabwe (Høiland 1998), Nigeria, Italy, Switzerland, Panama (Guzmán-Dávalos *et al.* 2003), India (Acharya *et al.* 2017) and Brazil (Neves *et al.* 2013).

Examined material: PARAGUAY. CENTRAL: San Lorenzo City, Universidad Nacional de Asunción University Campus, 25°20'11,62"S, 57°30'51,98"W, 2.XI.2016, *M. Campi* 003774 (FACEN). BOQUERON DEPARTMENT, Montanía country house, 21°57'30.8"S, 60°11'15.6"W, 6.I.2016, *Y. Maubet* 026 (FACEN).

Gymnopilus purpureosquamulosus is characterized by having the pileus covered with pointed and erect scales in the center, adpressed towards the margin, reddish, lilac, reddish brown when fresh, and purple when dry, ellipsoidal

to oblong basidiospores, with subacute apex, the cheilocystidia of varied forms, lageniform, utriform, cylindrical to fusiform, with claviform, rounded to globose apex. (Høiland 1998; Guzmán-Dávalos *et al.* 2008; Acharya *et al.* 2017).

Høiland (1998) indicates that *G. peliolepis* (Speg.) is similar to *G. purpureosquamulosus*; however, it differs in that the former has smaller basidiospores and less capitated cheilocystidia. Another morphologically similar species is *G. dilepis*, although it has smaller basidiospores than those found in *G. purpureosquamulosus* (Høiland 1998). In the description of the type specimen, the scales are adpressed in the center, while Guzmán-Dávalos *et al.* (2008) mention that the scales are erect in the center and adpressed towards the margin.

There is some confusion between *G. purpureosquamulosus* and *G. chrysopellus* Singer & Digilio (1951). *Gymnopilus chrysopellus* was described by Berkeley & Curtis (1869) as *Agaricus (Flammula) chrysopellus* from Cuba. These authors



Figure 5 – a-f. *Gymnopilus purpureosquamulosus* – a, b, c. basidiomata (c. pileus showing lamellae); d. basidiospores in KOH; e. basidiospores in cotton blue; f. cheilocystidia. (leg. *M. Campi* 121).

describe “Pileo umbilicato adpresse tomentoso, quandoque depresso margine subsulcato...”. Subsequently, Murrill (1913) proposes the combination of this species to *Gymnopilus*, adding the characters of the spores. However, neither of the two mentioned authors described the coloration of the pileus and the scales. Singer & Digilio (1951) describe in detail *G. chrysopellus* based on material from Argentina, Brazil, Peru, Martinique, Guyana, Cuba and USA, noting that it is a common species throughout tropical and subtropical America. These authors provide a description with characters similar to those described by Høiland (1998) for *G. purpureosquamulosus*. Singer & Digilio (1951) describe the pileus surface as having a “yellow background, with erect scales, concolorous with the surface, gradually becoming deep orange to ferrugineous.” Moreover, Hesler (1969) described *G. chrysopellus* with a golden yellow surface, tomentose, sometime with appressed fibrils. Høiland (1998) when describing a *G. purpureosquamulosus* does not compare it with the Singer & Digilio descriptions of *G. chrysopellus*. Considering this, we could currently restrict *G. chrysopellus* to the specimens with the pileus surface fibrillose, golden yellow, without orange ferruginous scales, leaving the latter as a distinctive character for *G. purpureosquamulosus*. To know the identity of the specimens studied by Singer & Digilio (1951), is necessary to re-study them, in order to know with certainty the distribution of these two conflictive species. The morphological differences between the material studied in Paraguay and that recorded in the bibliography of the type specimen and additional materials of *G. purpureosquamulosus* are: (a) erect scales in the center agreeing with the description of Guzmán *et al.* (2008), but differing from the adpressed scales described by Høiland (1998) for the type specimen, and (b) hyphae of the pileipellis with pigment embedded in bands cited by Høiland (1998) and Guzmán *et al.* (2008); however, Acharya *et al.* (2017) did not describe this character for Indian materials. Based on the characters presented by the cited authors, we conclude that the material studied corresponds to *G. purpureosquamulosus*, cited for the first time in Paraguay.

Conclusion

Spegazzini (1919) recorded in Paraguay two species as *Flammula picrea* (Pers.) P. Kumm. and *Flammula sapinea* (Fr.) P. Kumm. Later, Flecha & Niveiro (2019) suggested that this two records

were synonyms of *Gymnopilus* based on the data available in Mycobank and Index Fungorum Databases; however, they did not analysed the samples from Spegazzini to confirm that they belong to the genus, hence we can not confirm the presence of *Gymnopilus* in the previous records made by Spegazzini in Paraguay. Flecha & Niveiro (2019) also mention the species *Gymnopilus earlei* Murrill recorded by Gullón (2011), which represents a photographic record since there is not a physical record of the sample, therefor this is also an unconfirmed record. After a long hiatus in the study of Funga in general, and of *Gymnopilus* in particular for Paraguay, this study represent the first contribution towards the description of *Gymnopilus* in the country, nevertheless a broader sampling and the inclusion of molecular data are necessary to complement the knowledge of *Gymnopilus* in Paraguay and in the region.

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