



New records of *Ganoderma multiplicatum* (Mont.) Pat. (Polyporales, Basidiomycota) from Colombia and its geographic distribution in South America

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Abstract: *Ganoderma* is a cosmopolitan genus of fungi with species distributed in temperate and tropical regions. Species of *Ganoderma* in living Leguminosae were observed in Park de la Salud in Pance, Cali, Colombia and we record *G. multiplicatum* for the first time from Colombia. A distribution map of this genus in the Neotropical region is presented.

Key words: Ganodermataceae; Leguminosae; taxonomy; Neotropics

The genus *Ganoderma* P. Karst was created by Karsten (1881) to recognize a lacquered and stipitate fungus, *Polyporus lucidus* (Curtis) Fr., the type of the genus (Moncalvo and Ryvarden 1997). *Ganoderma* is well circumscribed by its truncated, ellipsoid basidiospore with apical germinal pore and, double walls structure; the external wall (exosporium) is thin and hyaline, and the internal wall (endosporium) is dark brown and separated with internal crests (Ryvarden 2004). Due to the high phenotypic plasticity found in the basidiomata of this genus and varying concepts of the species, identifying some *Ganoderma* species is confusing and correct geographical distributions are still pending (Moncalvo and Ryvarden 1997). The genus is considered to be cosmopolitan with species distributed in temperate and tropical regions worldwide (Cao and Yuan 2013). In Colombia, *Ganoderma* has not been studied in depth, but morphology-based studies and previous work on the diversity of macrofungi in Colombia included thirteen species of *Ganoderma* (Vasco-Palacios and Franco-Molano 2013). A list of species, locality, voucher and references are presented in Table 1.

Ganoderma multiplicatum (Mont.) Pat. was originally collected in French Guyana on a tree trunk (Moncalvo and Ryvarden 1997). This species has been considered most similar to *G. chalceum* (Corner 1983). However, Ryvarden (2000) considered it a synonym of *G. subamboinense* Henn., but a molecular phylogenetic analysis (ITS region) by Lima et al. (2014) showed that *G. chalceum* and *G. subamboinense* are in different clades, suggesting they are not synonymous. During a search for species of *Ganoderma* in living Leguminosae and in rotten logs in urban and rural areas, we collected a basidiome of *G. multiplicatum* at Park de la salud (03°19'42" N, 076°38'19" W), Cali, Colombia (Table 1). The collection was made according to the methodology of Fidalgo and Bononi (1984). To analyze morphological characters, thin sections of basidiome were prepared and treated with 4% KOH, 1% Phloxine, and Melzer reagent (Ryvarden 2004). Vouchers were deposited at the herbarium of the Botanical Institute of São Paulo (SP) and the herbarium at the Valley University in Colombia (CUVC). DNA analysis (isolation, amplification and sequencing) for ITS region was performed according to protocols used by Raeder and Broda (1985), Moncalvo et al. (1995), Gottlieb et al. (2000). Primers set BMB-CR (5'-GTACACACCGCCGTCG-3') and LRI (5'-GGTTGGTTTCTTTTCCT-3') were used under conditions described by Vilgalys and Hester (1990). Sequences were aligned using BioEdit 7.2.0 (Hall 1999). Best model of nucleotide substitution (HKY+G) was selected by the Akaike criterion in JModelTest version 2.1.3 (Darriba et al. 2012). Maximum parsimony and likelihood was performed using PAUP version 4.0b10 (Swofford 2002). Bayesian analysis was performed using MrBayes 3.04b (Ronquist and Huelsenbeck 2003).

Table 1. Colombian species of *Ganoderma*, locality, voucher and references.

Species	Department/ locality Voucher	Reference
<i>G. adspersum</i> (Schulzer) Donk	Cundinamarca. Loc. n. det. AR0019, AR 0049	Ruiz and Varela (2006)
<i>G. amazonense</i> Weir	Cundinamarca, Zipacón. Ruiz, A. HPUJ 0031	Ruiz and Varela (2006)
	Chocó. Loc. n. det., Torres 131	Guzmán et al. (2004)
	Chocó, Las animas. CO-5788	Setliff and Ryvarden (1983)
<i>G. applanatum</i> (Pers.) Pat.	Caldas, Parque los Nevados. Loc. and Vouch. n. det.	Boekhout and Pulido (1989)
	Dept., Loc. and Vouch. n. det.	Dennis (1970)
	Caldas, Parque los Nevados, COLTB827	Pulido and Boekhout (1989)
	Caquetá, Solano. Vasco-P, A. 529	Vasco-Palacios et al. (2005)
	Caquetá, Peña Rioja. López-Q. 265	Vasco-Palacios et al. (2005)
<i>G. applanatum</i> var. <i>tornatum</i> (Pers.) C.J. Humphrey	Meta, San Juan de Arama, CO-2425	Setliff and Ryvarden (1983)
	Dept., Loc. and Vouch. n. det.	Dennis (1970)
<i>G. australe</i> (Fr.) Pat.	Caquetá, Florencia-El Doncello road. CO-3042	Setliff and Ryvarden (1983)
	Amazonas, La Chorrera. Vasco-P, A. 218	Vasco-Palacios et al. (2005)
	Cundinamarca, Chia city. Pinzón-O, C. HUPN 055, 065, 081, 090, 105, 110, 130, 155, 160, 179 and 190	Pinzón-Osorio and Pinzón-Osorio (2016)
	Chocó. Loc. n. det., Torres 95	Guzmán et al. (2004)
<i>G. brownii</i> (Murrill) Gib.	Chocó. Loc. and Vouch. n. det.	Torres and Hurtado(2003)
<i>G. coffeatum</i> (Berk.) J.S. Furtado	Cundinamarca, Cerro de las Mercedes Guzmán 4639	Guzmán and Varela (1978)
	Boyacá, Chocontá-Agua Clara road. CO-4762	Setliff and Ryvarden (1983)
	Chocó, Quibdó-Itmina road. CO-5680, CO-5683	Setliff and Ryvarden (1983)
<i>G. concinnum</i> Ryvarden	Chocó, Loc. n. det., Guzmán 35321	Guzmán et al. (2004)
	Chocó, Riosucio nat. park. Ryvarden 16840 (O, Holotype, NY, Isotype)	Ryvarden (2004), Ryvarden (2000)
<i>G. chaliceum</i> (Cooke) Steyaert	Vaupés, Tio Barbas, Vaupés River. Holliday PH51 (Holotype, K)	Ryvarden (2004), Ryvarden (2000)
<i>G. fornicatum</i> (Fr.) Pat.	Dept., Loc. and Vouch. n. det.	Dennis (1970)
<i>G. lucidum</i> (Curtis) P. Karst.	Caquetá, Solano. Alvarez 32, López-Q. 51	Vasco-Palacios et al. (2005),
	Caquetá. Loc. n. det., Vouch. n. det.	Franco-Molano et al. (2005)
	Cundinamarca, Colorado. Guzmán 4539	Guzmán and Varela (1978)
	Chocó. Loc. n. det., Guzmán 35407	Guzmán et al. (2004)
	Chocó. Loc. n. det., Vouch. n. det.	Torres and Hurtado(2003)
	Valle del Cauca, Cali city. Guzmán 4473	Guzmán and Varela (1978)
<i>G. nitidum</i> Murrill	Caquetá. Loc. n. det., Vouch. n. det.	Franco-Molano et al. (2005)
	Caquetá, Solano. Vasco-P, A. HUA139	Vasco-Palacios et al. (2005)
<i>G. tornatum</i> (Pers.) Bres.	Cundinamarca, El bosque de Tibabita. CO-14	Setliff and Ryvarden (1983)

Loc. n. det. = local no determinate, Vouch. n. det. = Voucher no determinate, Dept., Loc. and Vouch. n. det. = department, local and voucher no determinate.

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Mycol. Fr. 5: 74, 1889.

≡ *Polyporus multiplicatus* Mont., Ann. Sci. Nat. Bot. Ser. 4, 1: 128, 1854.

Figures 1–9.

This species presents basidiomata 14 × 10 × 3 cm, dimidiate to sessile perennial, margin whitish, lobulate, shiny laccate surface, pale light brown to reddish brown, pores angular to round, 4–6 per mm, pore surface creamy to ochraceous; cuticle formed by clavate hyphal ends, strongly amyloid in the apical part, with a few protuberances and basidiospores 8.4 × 5.8 μm.

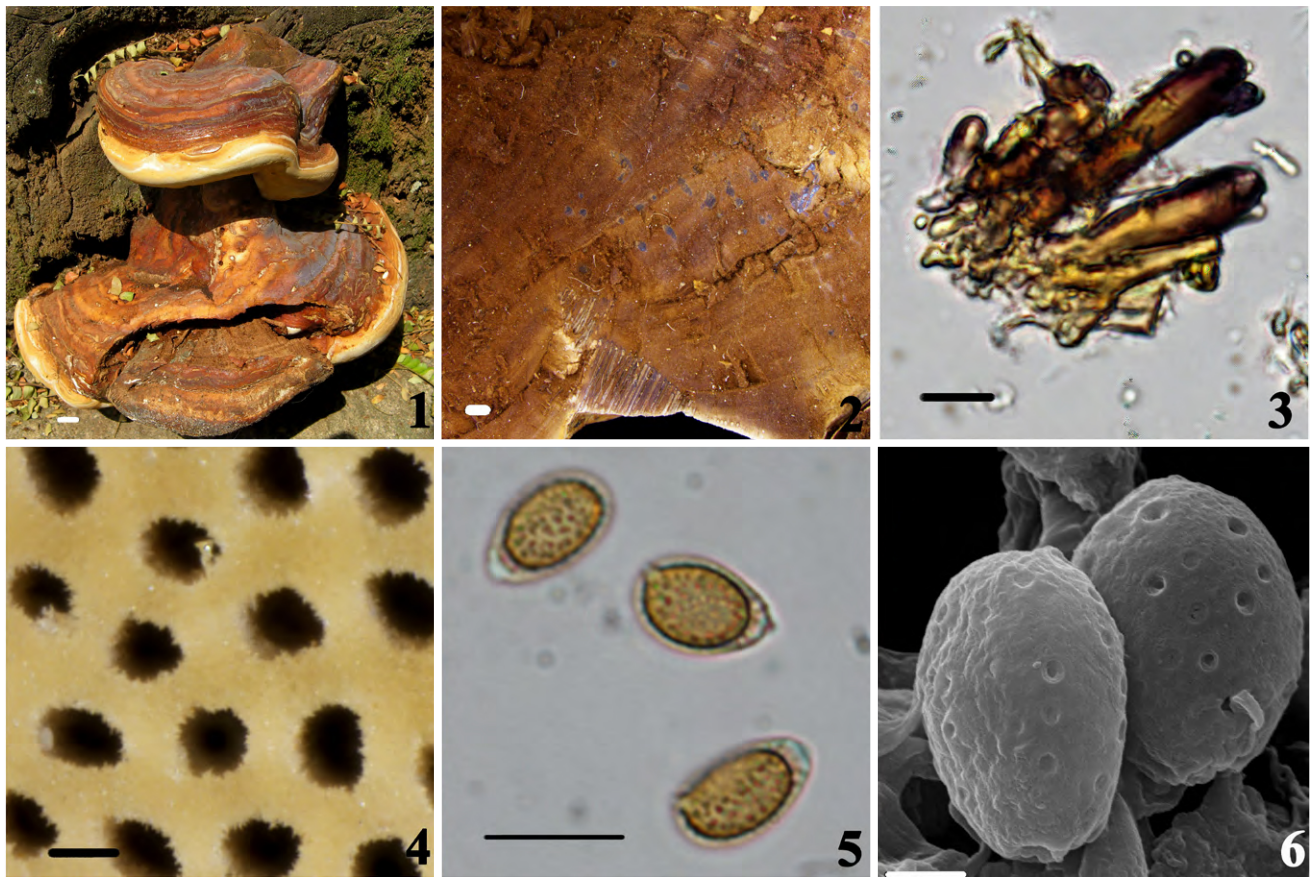
Specimen examined: Colombia: Cali, Dept. Valle, Park de la Salud, Pance, 05.I.2013. A.C. Bolaños and G. Aguilár (CUVC60077).

Additional specimens examined: Brazil. São Paulo, SP417797, SP417778, SP417780; French Guyana K123639 lectotype.

In the Neotropical region, *Ganoderma multiplicatum* was cited in Venezuela (Ryvarden 2004) and in Brazil it has been mentioned from Alagoas (Torres-Torres et al. 2012), Amazonas, Para and Rondônia (Gomes-Silva and

Gibertoni 2009; Torres-Torres et al. 2012), Mato Grosso do Sul (Quevedo et al. 2012), Paraíba (Lima et al. 2014), Rio de Janeiro (Torres-Torres et al. 2012), Roraima (Gomes-Silva et al. 2011), São Paulo (Gugliotta et al. 2011; Torres-Torres et al. 2012), Santa Catarina (Loguercio-Leite et al. 2005; Drechsler-Santos et al. 2008; Baltazar and Gibertoni 2009), and Sergipe (Torres-Torres et al. 2012). In Argentina, this species has been reported from Tucumán, Corrientes and Chaco (Gottlieb and Wright 1999). A list of localities, substrates and vouchers can be found in Table 2.

This is the first record of the species from Colombia and contributes to the list of *Ganoderma* species from Colombia and the Neotropics. The type material of *G. multiplicatum*, from French Guyana, is in Kew herbarium (K), and it consists of a basidiome fragment. Nevertheless, it allowed for the identification of our Colombian specimen. Although originally described from South America, *G. multiplicatum* was subsequently found in Africa and Asia (Steyaert 1980; Zhao 1989), including India (Bhosle et al. 2010) and Taiwan (Wang



Figures 1–6. *Ganoderma multiplicatum*. **1.** Basidiome. **2.** Context. **3.** Cuticle cell. **4.** Pores. **5–6.** Basidiospores. Scale bar 1 = 2 cm, 2 = 1 mm, (3–5) = 10 μm , 4 = 100 μm , 6 = 2 μm .

Table 2. Geographic distribution, ecosystem, substrate and references where *Ganoderma multiplicatum* has been found in America.

Country Department/state, locality Voucher	Ecosystem, substrate	Reference
Argentina		
Corrientes, Corrientes city, BACF 34461	On <i>Schinopsis</i> sp. stump	Gottlieb and Wright (1999)
Corrientes, Mbucuruyá, Sta Teresa Station, BAFC 24414	Tipuana tipu	Gottlieb and Wright (1999)
Corrientes, Cosme Dept. BAFC 24416	Buried wood	Gottlieb and Wright (1999)
Chaco, Charata	N.d.*	Gottlieb and Wright (1999)
Tucuman, Tucuman city, BAFC 34390	On stump	Gottlieb and Wright (1999)
Tucuman, La Cocha Dept., Monte Grande, Lil.8846	N.d.*	Gottlieb and Wright (1999)
Brazil		
Alagoas, Maceió Ibama Reserve. Maziero, R. s.n. SP250605	N.d.*	Torres-Torres et al. (2012)
Amazonas, Santa Laura, Madeira River. U.S. dept. Agric. Path. Myc. Coll. 66859, s.d. RLS.55.K.25	N.d.*	Steyaert (1980)
Amazonas, Manaus. M.A. Sousa 151.INPA74707	N.d.*	Gomes-Silva and Gilbertoni (2009), Torres-Torres et al. (2012)
Amazonas, Manaus. M.A. Sousa 249.INPA74533	N.d.*	Gomez-Silva et al. (2011)
Amazonas, Barcelos, Serra de Aracá, E.S.S. et al. 294. INPA 153737	N.d.*	Gomez-Silva et al. (2011)
Mato Grosso do Sul, Campo grande, mata do prosa. J.R. Quevedo & A.K.M. Oliveira 11SP	Living trees	Quevedo et al. (2012)
Para, Melgaço, scientific station Ferreira penna. T.B. Gilbertoni URM 79280, URM79281, URM79282, URM79283	N.d.*	Gomes-Silva et al. (2011)
Rio de Janeiro, mata da Tijuca. J.S. Furtado s.n. SP91404	N.d.*	Torres-Torres et al. (2012)
Paraíba, Mataracá, Mineradora Millenium. URM83346	N.d.*	Lima et al. (2014)
Rondônia, Jaru, right margin of Jaru river. Capelari & Maziero, 693. SP211484	N.d.*	Gomes-Silva et al. (2011); Torres-Torres et al. (2012)
Rondônia, Loc. n. det., R.D. Goos et al. 1673. INPA125007	N.d.*	Gomes-Silva et al. (2011)
Rondônia, Porto Velho, municipal natural park de Porto Velho. A.C. Gómez-Silva 646. URM81081.	N.d.*	Gomes-Silva et al. (2011), Lima et al. (2014)
Roraima, Boa vista, M.A. Jesús 882, INPA186187	N.d.*	Gómez-Silva et al. (2011)

Continued

Table 1. Continued.

Country Department/state, locality Voucher	Ecosystem, substrate	Reference
Santa Catarina, Loc. n. det.	N.d.*	Drechsler-Santos et al. (2008), Baltazar and Gibertoni (2009),
Santa Catarina, Florianópolis, Leite & Folle. (FLOR10841). As G. subamboinense.	N.d.*	Loguercio-Leite et al. (2005), Drechsler-Santos et al. (2008), Baltazar and Gibertoni (2009)
Santa Catarina, Florianópolis. Folle & Willerding. (FLOR10859). As G. subamboinense	N.d.*	Loguercio-Leite et al. (2005)
São Paulo, Parque Estadual Fontes do Ipiranga. Campacci 12(SP)	N.d.*	Gugliotta et al. (2011), Torres-Torres et al. (2012)
São Paulo, Parque do estado, Botanical Institute. B. Skovortzov s.n. SP10746	On Wood	Torres-Torres et al. (2012)
Sergipe, Ecological station Santa Isabel. R.H. Marino s.n. SP375895	N.d.*	Torres-Torres et al. (2012)
Colombia		
Cali, Parque de la Salud. A.C. Bolaños & G. Aguilar 294. CUV60077	<i>Caesalpinia pelthophoroides</i>	This work
French Guiana		
Isla Principe, Loc. n. det., Crypt. Guyan. 357	On trunk	Steyaert (1980); Moncalvo and Ryvarden (1997)
Venezuela		
Loc. n. det.	N.d.*	Ryvarden (2004)

N.d.* = no data, Loc. n. det. = local no determinate.

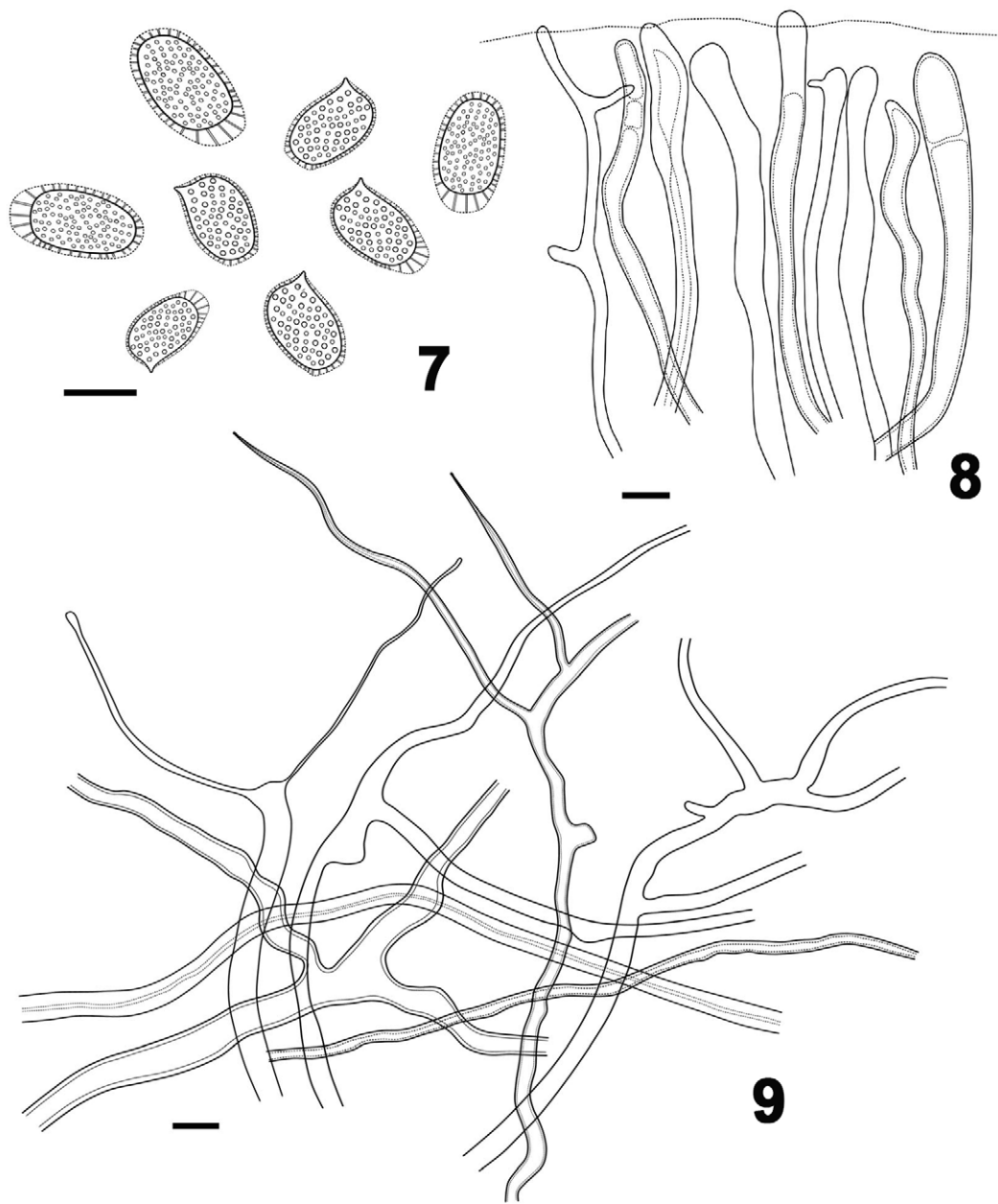


Figure 7–9. *Ganoderma multiplicatum*. 7. Basidiospores. 8. Cuticle cells. 9. Skeletal hyphae. Scale bar = 5 μm.

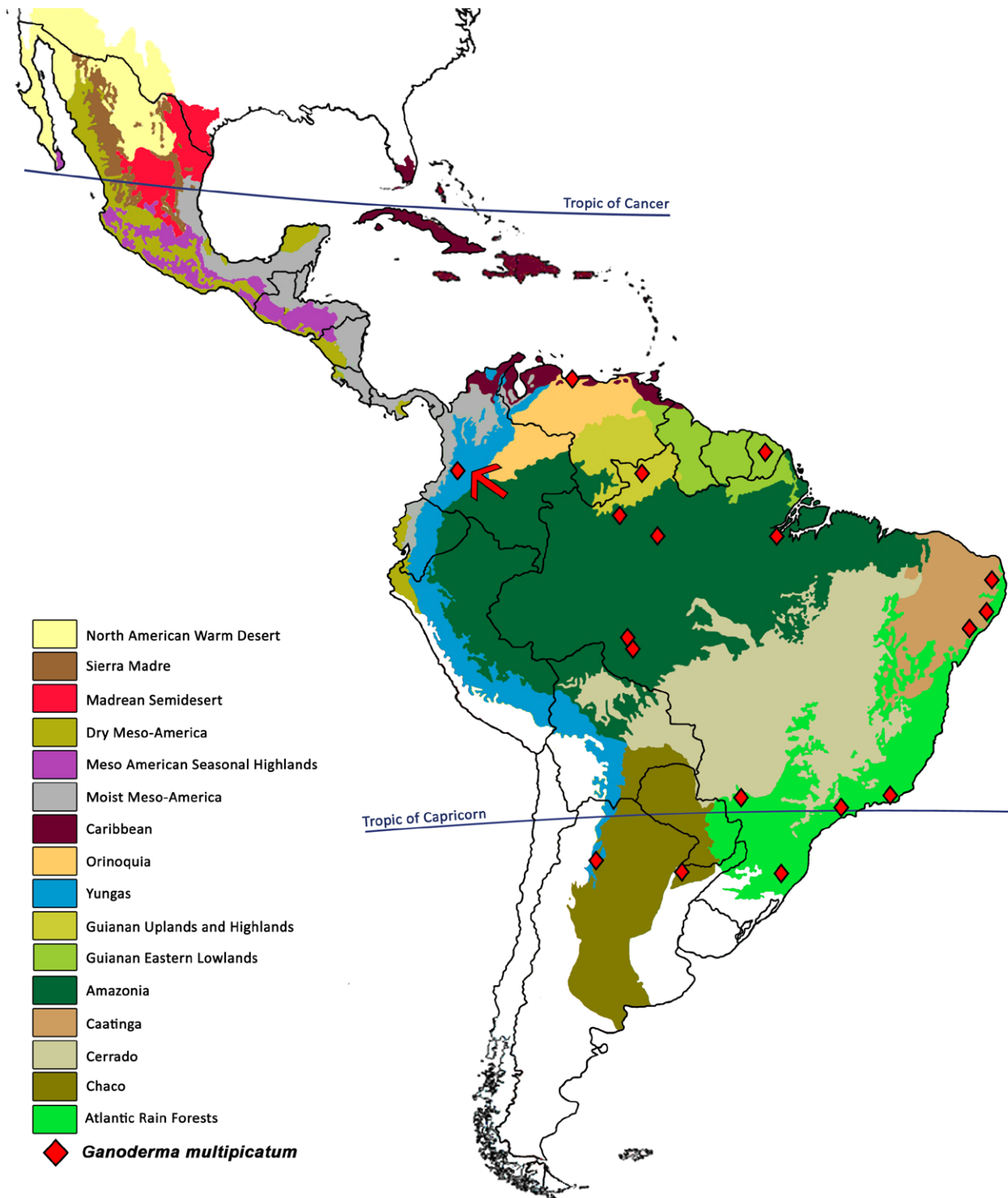


Figure 10. Geographical distribution map of *Ganoderma multiplicatum* from Colombia and South America. (Source map: Robledo et al. 2016).

and Wu 2007). The distribution of *G. multiplicatum* in the Neotropics is shown in Figure 10.

In our phylogenetic analysis, the Colombian sample as was found to be *G. multiplicatum*, with high statistical support (Bootstrap: MP: 80%, ML: 82%, BPP: 0.9), using the ITS region and including 26 additional sequences from GenBank. According to Lima et al. (2014), and in this analysis, *G. chalceum* and *G. subamboinense* were recovered in different clades (Figure 11).

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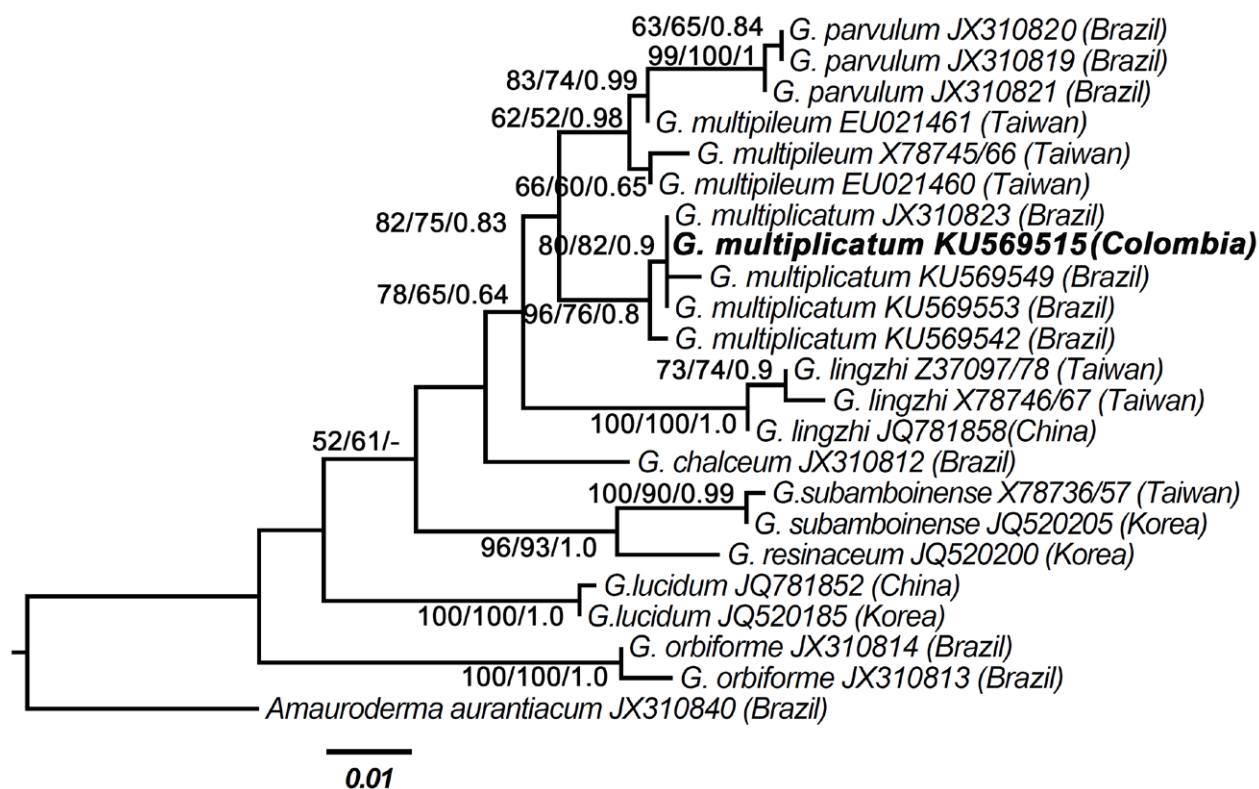


Figure 11. ITS tree and reconstruction of the phylogenetic ITS of the sequence of *G. multiplicatum*. Statistical support nodes include the maximum parsimony bootstrap, maximum likelihood and Bayesian respectively.

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