

# Diversity of *Ganoderma* spp. and falls of urban trees in Brazil and Colombia

**Keywords:** urban trees, sound pollution, climate changes, wood-degrading fungi, environmental conditions, mushrooms

## Introduction

Urban trees bring several benefits for the wellbeing of the population: for example, they regulate microclimate, provide shade, break the wind, decrease sound pollution, sequester and store carbon, and intercept rain water.<sup>1-4</sup> Constant variables directly interfere with the urban trees, such as water stress, lack of permeable area in the root collar and roots, inadequate pruning, roots cut, mechanical shocks, floods during the rainy season, attacks of insects (termites and beetles) and wood-degrading fungi. Climate changes have triggered more intense phenomena and in the rainy season storms and strong winds are frequent, causing an increase in the occurrences of trees falling because of rotten trunks due to fungi attacks and other xylophagous organisms.<sup>5</sup>

During 2016, up to November 16<sup>th</sup>, 2,907 trees fell, according to the System of Management of Critical Occurrences (SGOC – acronym in Portuguese) of the Municipal Department of Coordination of the Prefecture of São Paulo. Tree falls in densely-populated urban centers are a probable hazard for people, vehicles and properties. *Ganoderma* is a cosmopolitan mushroom genus with 60-80 lacquered species and 30-40 non-lacquered species.<sup>6</sup> It is found in conifer and angiosperm groves in North America and Canada,<sup>7</sup> in China and Europe.<sup>8</sup> Species of the genus occur in eastern Africa,<sup>9</sup> tropical Asia (Imazeki 1939), in Malaysia<sup>10</sup> and in the Neotropics.<sup>11-13</sup> *Ganoderma* species in tropical regions are less well studied and phylogenetic studies have been published only in the last few years (Lima junior et al 2014).<sup>14-21</sup> The tropical regions probably are the origin of this genus once a large number of taxa have been described in the tropics. It is believed that there has been an irradiation from the equatorial regions toward other regions and that environmental condition determined a high biological diversity<sup>22</sup> of these mushrooms.

## Conclusion

Recently the development of next-generation sequencing technologies has enabled sequencing complete genome of the species *G. lucidum*, *G. meredithiae* and *G. applanatum*.<sup>27,28</sup> In two recent PhD thesis,<sup>29,30</sup> eight *Ganoderma* species (*G. australe* (Fr.) Pat., *G. gibbosum* (Blume & T. Nees) Pat., *G. multiplicatum* (Mont.) Pat., *G. orbiformum* (Fr.) Ryvarden, *G. parvulum* complex, *G. perzonatum* Murrill, *G. subamboinense* (Henn.) Bazzalo & Wrigth and *G. stipitatum* (Murrill) Murrill) have been identified infecting ten species of leguminous trees (*Bauhinia purpurea* L., *Caesalpinia ferrea* Mart. ex Tul., *C. peltophoroides* Benth, *Cassia fistula* L., *Leucaena leucocephala* (Lam.) de Wit., *Inga edulis* Mart., *I. vera* Kunth, *Phitecelobium dulce* (Roxb.) Benth, *Poincianella pluviosa* (DC) L.P. Queiroz and Tipuana tipo (Benth) Kuntze) in public streets in cities in tropical and sub-tropical regions, such as São Paulo (Figure 1) (Figure 2), Uberaba and Campo Grande in Brazil, and Cali in Colombia. These studies suggest clear susceptibility of leguminous trees to *Ganoderma* species but there is no fungus-host specificity. Further studies are needed to determine the risk of infected trees to fall down when the fungus is present.

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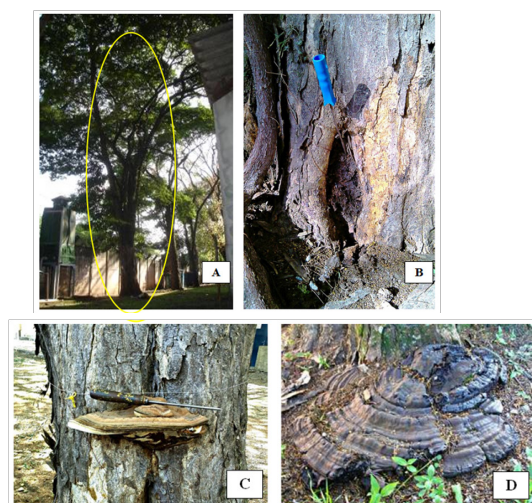
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Ryvarden L<sup>13,23</sup> described 20 lacquered species of *Ganoderma* for several regions of the Neotropics. For Brazil, lacquered and non-lacquered species have been mentioned, including species deemed restricted to Europe, such as *G. lucidum* and *G. applanatum*.<sup>24</sup> In Colombia, the genus has been less studied; however, morphology-based studies mention the existence of *G. australe*, *G. adspersum*, *G. amazonense*, *G. applanatum*, *G. brownie*, *G. chaliceum*, *G. concinnum*, *G. fornicatum*, *G. lucidum*, *G. multiplicatum*, *G. nitidum* and *G. neurosporium*.<sup>13,25,26</sup> The proliferation of the *Ganoderma* species is due to pleomorphic characters dependent of environmental conditions and phase of development. Young *Ganoderma* Basidiomas that are actively growing generally have clearer and brighter colors than specimens several days or weeks old, exposed to repeated periods of rain or drought, covered with dust, attacked by insects or colonized by algae.<sup>6</sup> The genus probably is one of the Polypores fungi group that is taxonomically more confusing; there are over 250 nomenclatural combinations published.<sup>22</sup>



**Figure 1** (A) Tree for suppression. (B) wound with intense decay. (C) Basidioma of *Ganoderma* sp. no boom. (D) Basidioma of *Ganoderma* sp. in the root.



Figure 2 *Ganoderma* sp. Photo AM Gugliotta, 2017.

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## Conflict of interest

Authors declare there is no conflict of interest in publishing the article.

## References

- Shigo AL. Tree decay: an expanded concept. Washington: USDA, Agriculture Forest Service; 1979.
- Nowak DJ, Crane DE. Carbon storage and sequestration of urban trees in the USA. *Environmental Pollution* 2002;116(3):381–389.
- SVMA. *Manual Técnico de Arborização Urbana*. Prefeitura de São Paulo; 2015. 124 p.
- Pradella DZA, Silva JWF, Nisi TCC. *Arborização Urbana*. 1st ed. São Paulo: SMA/CEA; 2015.
- Brazolin S. Biodeterioração, anatomia do lenho e análise de risco de queda de árvores de tipuana, *Tipuana tipu* (Benth.) O. Kuntze, nos passeios públicos da cidade de São Paulo, SP. Tese de Doutorado, Piracicaba: Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo; 2009. 265 p.
- Moncalvo JM. Systematics of *Ganoderma*. In: Flood J, Bridge PD, editors. *Ganoderma diseases of perennial crops*. CAB International, Wallingford, UK; 2000. p. 23–45.
- Gilbertson RL, Ryvarden L. North American Polypores. Part 1. Fungiflora, Oslo; 1986.
- Ryvarden L. Can we trust morphology in *Ganoderma*? In: Buchanan RK, Hseu RS, editors. *Ganoderma: systematics, phytopathology and pharmacology*. Proceedings of Contributed Symposium 59A, B, 5th International Mycological Congress, Vancouver, Taipei: National Taiwan University; 1995. p. 19–24.
- Ryvarden L, Johansen I. *A preliminary polypore flora of east Africa*. Fungiflora, Oslo; 1980. 636 p.
- Corner EJH. Ad Polyporaceas I. *Amauroderma* and *Ganoderma*. *Beiheft Nova Hedwigia* 1983;75:1–182.
- Donk MA. Revision der Niederländischen Homobasidiomycetae-Aphylloraceae II. *Med Bot Mus. Rijksuniv Utrecht*. 1933;9:1–27.
- Furtado JS. Relation of micro structures to the taxonomy of the Ganodermoideae (Polyporaceae) with special reference to the structure of the cover of the pileus surface. *Mycologia*. 1965;57:588–611.
- Ryvarden L. Neotropical Polypores: Part I. Introduction, *Ganodermataceae & Hymenochaetaceae*. *Synopsis Fungorum*. 2004;19:1–227.
- Flores JA, Barnes CW, Ordoñez ME. *Ganoderma podocarpense* sp. nov. *Persoonia*. 2017;39:299.
- Zothanzama J, Blanchette H, Barnes CW. *Ganoderma mizoramense* sp. nov. *Persoonia*. 2017;38:327.
- Coetzee MPA, Marincowitz, S, Muthelo VG, et al. *Ganoderma* species, including new taxa associated with root rot of the iconic *Jacaranda mimosifolia* in Pretoria, South Africa. *IMA Fungus*. 2015;6(1):249–256.
- Xing JH, Song J, Decock C, Cui BK. Morphological characters and phylogenetic analysis reveal a new species within the *Ganoderma lucidum* complex from South Africa. *Phytotaxa*. 2016;266(2):115–124.
- Cao Y, Yuan HS. *Ganoderma mutabile* sp. nov. From south western China based on morphological and molecular data. *Mycol Progress*. 2011;12(1):121–126.
- Torres-Torres MG, Guzmán-Dávalos L, Gugliotta AM. *Ganoderma viviamercedianum* sp. nov. and related species *G. perzonatum*. *Mycotaxon*. 2008;105:447–454.
- Kinge TR, Mih AM. *Ganoderma ryvardenense* sp. nov. Associated with basal stem rot (BSR) disease of oil palm in Cameroon. *Mycosphere*. 2011;179–187.
- Douanla-Meli C, Langer E. *Ganoderma carocalcareus* sp. nov., with crumbly-friable context parasite to saprobe on *Anthocleista nobilis* and its phylogenetic relationship in *G. resinaceum* group. *Mycological Progress*. 2009;8(3):145–155.
- Moncalvo JM, Wang HF, Hseu RS. Phylogenetic relationship in *Ganoderma* inferred from the Internal Transcribed Spacers and 25S Ribosomal DNA sequences. *Mycologia*. 1995;87(2):223–238.
- Ryvarden L. Studies in Neotropical polypores 2: a preliminary key to neotropical species of *Ganoderma* with a laccate pileus. *Mycologia*. 2000;92:180–191.
- Gugliotta AM, Abrahão MC, Gibertoni TB. *Polyporales* in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro; 2013.
- Vasco-Palacios AM, Franco-Molano AE. Diversity of Colombian Macrofungi (*Ascomycota-Basidiomycota*). *Mycotaxon*. 2013;121:499.
- Bolaños AC. Diversidade do gênero *Ganoderma* Karst. (Ganodermataceae) e atividade enzimática de espécies que ocorrem em leguminosas. Tese de Doutorado, São Paulo: Instituto de Botânica, Secretaria do Meio Ambiente; 2016. 145 p.
- Wang XC, Shao J, Liu C. The complete mitochondrial genome of the medicinal fungus *Ganoderma applanatum* (Polyporales, Basidiomycota). *Mitochondrial DNA*. 2016;27(4):2813–2814.
- Wang XC, Wu K, Chen H, et al. The complete mitochondrial genome of the white-rot fungus *Ganoderma meredithiae* (Polyporales, Basidiomycota). *Mitochondrial DNA*. 2016;27(6):4197–4198.
- Bolaños AC, Bononi VL, Gugliotta AM, et al. New records of *Ganoderma multiplicatum* (Mont.) Pat. (Polyporales, Basidiomycota) from Colombia and its geographic distribution in South America. *Check list of the Biodiversity data*. 2016;12(4):1–7.
- Quimio-Silva LO. Avaliação da decomposição por fungos *Ganoderma* spp (Polyporales, Basidiomycota) em sementes de *Poincianella pluviosa* LP (queiroz) da arborização urbana da cidade de São Paulo. Tese de Doutorado, São Paulo: Instituto de Botânica, Secretaria do Meio Ambiente; 2017.