

New occurrence data of the toxic mushroom *Chlorophyllum molybdites* (Basidiomycota, Agaricaceae) in the Brazilian Amazon region

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ABSTRACT

Chlorophyllum molybdites (Agaricaceae) is a toxic mushroom that occurs in Brazil, mostly in the southern region, where cases of poisoning due to accidental ingestion accumulate. In the Amazon region, the species is little known. Here we report the first confirmed occurrence record for the state of Pará. We expand the geographic distribution of *C. molybdites* and provide a morphological description of the specimens found, contributing to the knowledge of fungal diversity in the Brazilian Amazon region.

KEYWORDS: Agaricales, Amazonian funga, taxonomy, toxic mushroom

Novos dados de ocorrência do cogumelo tóxico *Chlorophyllum molybdites* (Basidiomycota, Agaricaceae) na região amazônica brasileira

RESUMO

Chlorophyllum molybdites (Agaricaceae) é um cogumelo tóxico com ocorrência no Brasil, majoritariamente na Região Sul, onde casos de intoxicação por ingestão acidental se acumulam. Na região amazônica, a espécie é pouco conhecida. Este é o primeiro relato de ocorrência comprovada para o Estado do Pará. Ampliamos a distribuição geográfica de *C. molybdites* e fornecemos uma descrição morfológica dos espécimes encontrados, contribuindo para o conhecimento sobre a diversidade fúngica na região amazônica brasileira.

PALAVRAS-CHAVE: Agaricales, cogumelo tóxico, Funga amazônica, taxonomia

The genus *Chlorophyllum* Masee (Agaricaceae), is monophyletic (Ge *et al.* 2018), distributed in various regions of the planet, and comprises approximately 28 species recognized according to *Index Fungorum* (Cabi 2023). Species of the genus occur in almost all of South America, including Brazil, the country with the highest number of records (Cria 2024), mainly in the south, southeast, and northeast regions. In the north region, there are only records made by Rolf Singer between 1977 and 1978 in Amazonas state deposited in the INPA herbarium (herbarium acronyms as in Thiers 2024), and one record in Rondônia state deposited in RON herbarium (Cria 2024).

Chlorophyllum molybdites (G. Mey.) Masee is considered a toxic mushroom, but, in some regions of the world, after careful cooking, it is edible (Li *et al.* 2021). It often occurs in urban areas and cases of poisoning are known in Brazil (Meijer *et al.* 2007). Records of the species in the Amazon region are rare (Cria 2024), and the lack of knowledge about the diversity

of fungi directly affects distributional and ecological data on the species, including planning of poisoning prevention. Here we report the first confirmed record of *C. molybdites* to the state of Pará, increasing the number of records in the Amazon region.

Specimens of *C. molybdites* were randomly collected between April 2019 and January 2022 in the cities of Santarém and Oriximiná, both in the west of Pará state, Brazil. The climate in the region is hot and humid, with an average annual temperature ranging between 25 and 28 °C, and an average annual rainfall of 2,200 mm, with a rainy season from January to May (monthly average of 231 mm) and a dry season from June to December (monthly average of 61 mm) (Alvares *et al.* 2013).

The specimens were photographed in the field, removed from the ground with the aid of a penknife and packed in paper bags as proposed by Lodge *et al.* (2004). The material was dehydrated in an air circulation oven at 38 °C for 48

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hours and then identified based on macro and microscopic characteristics (basidiospore measurements from dry material rehydrated in 3% KOH or Melzer's reagent) of the basidiome as described by Pegler (1983) and Singer (1986), with reference to Ge *et al.* (2018). Arithmetic means (X_m) of 50 basidiospores (lengths and widths \pm standard deviation) and the mean of E-values (Q) \pm standard deviations are presented. The sample size (n) = total number of basidiospores measured (x) was divided by the number of basidiomes studied (y), as in $n = x/y$ (Largent and Abell-Davis 2011).

The color codes were adopted from the Methuen Handbook of Color (Kornerup and Wanscher 1978). The collected samples were deposited in the fungal collection of the HSTM herbarium at Universidade Federal do Oeste do Pará (<http://hstm.jbrj.gov.br>). The collected specimens occurred on grassy fields in shady urban environments, a habitat that coincides with the that known for the species in other localities, almost always associated with urban and otherwise anthropized environments. The material in this study is described below and agrees with the description by Pegler (1983), Singer (1986) and Ge *et al.* (2018).

Chlorophyllum molybdites (G. Mey.) Masee

Bulletin of Miscellaneous Information of the Royal Botanical Gardens Kew 1898: 136 (1898).

(Figure 1)

Description – Pileus medium to large basidiomata with cap varying from 8–12 cm in diameter, ovoid to convex when young, becoming broadly convex to plano-convex when mature, sometimes displaying a small umbo at the center; dry surface, longitudinally striated, initially white (29A1), becoming cream (4A3), covered with brownish, raised or flat scales, concentrated near the center; surface under finely fibrillated scales. Lamellae clustered, white (1A1) turning, greenish to olive green (26D3) when mature, brownish (6E3) when dry. Stipe 11–15 cm long and average 0.92 cm in diameter, white (29A1) to beige (6C2) easily detached from the cap, cylindrical to subcylindrical, widening downwards, base slightly enlarged, finely fibrillated. Ring partially well developed, membranous, whitish upper surface, beige (6C3) to brownish (6E4) undersurface, doubly crowned. Spore print opaque olive green to grayish (30D4). Basidiospores numerous, elongated $7.1\text{--}13.1 \times 6.8\text{--}8.8 \mu\text{m}$ ($X_m = 9.0 \pm 0.9\text{--}10.0 \pm 0.9 \times 6.7 \pm 0.4\text{--}7.4 \pm 0.7 \mu\text{m}$; $Q = 1.2\text{--}1.8$, $n = 50$), some ovoid to medium elliptical ($Q_m = 1.6$) with apicle present in some and thick walls ($0.91\text{--}1.40 \mu\text{m}$), smooth, light olive green, hyaline to dextrinoid, broad truncate with large germ pore. Basidia $19\text{--}22 \times 7\text{--}11 \mu\text{m}$, clavate, hyaline, 4-spored. Pleurocystidia not observed. Pileipellis with terminal elements clavate to subfusiform, $6\text{--}18 \mu\text{m}$. Cheilocystidia $17\text{--}36.1 \times 13.9\text{--}19 \mu\text{m}$, broadly clavate to sphaeropedunculate, hyaline.

Examined material – Brazil, Pará, Santarém. Urban backyard, Santana, MDF 865, HSTMfungi 16327, $02^{\circ}26'857.4''\text{S}$, $054^{\circ}41'15.1''\text{W}$, 08 I 2020; Santana, MDF 866, HSTMfungi 16328, $02^{\circ}25'10.5''\text{S}$, $054^{\circ}44'24.1''\text{W}$, 09 I 2020; Santana, MDF 867, HSTMfungi 16329, $02^{\circ}27'21.8''\text{S}$, $054^{\circ}43'34.3''\text{W}$, 08 IV 2020; Santana, MDF 869, HSTMfungi 16330, $02^{\circ}25'41.2''\text{S}$, $054^{\circ}44'58.2''\text{W}$, 08 I 2022; Curuá-Una hydroelectric power plant, Santana, MDF 864, HSTMfungi 16326, $02^{\circ}48'51.9''\text{S}$, $054^{\circ}17'45.8''\text{W}$, 08 IV 2020; Brazil, Pará, Oriximiná, Monteiro, SCA 1, HSTMfungi 16331, $01^{\circ}45'06.5''\text{S}$, $055^{\circ}50'38.2''\text{W}$, 17 I 2021.

Habit, habitat and known distribution in Brazil – Saprotrophic, scattered to gregarious, terrestrial, growing in the soil in open areas with the presence of grasses, observed in urban areas or in secondary forest areas with anthropic disturbance. So far found in the states of Bahia (Silva and Fortuna 2020), Distrito Federal (Bresadola 1896; Santos 2017), Pará (this study), Paraná (Meijer *et al.* 2006; 2007), Pernambuco (Reid and Eicker 1991), Piauí (Alves *et al.* 2019), Rio de Janeiro (Pegler 1983), Rio Grande do Sul (Rother 2008; Alves *et al.* 2016; Putzke 2017; Timm 2018; 2021), Santa Catarina (Sobestiansky 2005; Neves *et al.* 2013) and São Paulo (Pegler 1997). *SpeciesLink* (Cria 2024) also records the species for the states of Amazonas, Espírito Santo, Maranhão, Minas Gerais, Paraíba, Rio Grande do Norte, Rondônia and Santa Catarina. The species had previously been reported for Pará (Santana *et al.* 2018), however, the species identification was not backed by a full morphological description and no voucher material was referred for further identity confirmation. In this way, this is the first confirmed record of *C. molybdites* in Pará with a complete morphological description and voucher reference (Figure 2).

The species is characterized by having medium to large, robust, agaricoid basidiomes, with evident plate-shaped scales, with olive-green basidiospores, thick-walled, ellipsoid to amygdaliform, with a truncated apex. The samples from this study corroborate this description, although, at microscopical level, both lower and slightly higher Q values were reported for the basidiospores ($Q = 1.3$, Pegler 1983; Alves *et al.* 2016; $Q = 1.5$, Bijeesh *et al.* 2017).

Although it appears to be edible in some regions of Mexico (Villarreal and Perez-Moreno 1989), there is consensus that *C. molybdites* is a toxic mushroom responsible for many poisoning incidents in different parts of the world (Berger and Guss 2005; Meijer *et al.* 2007; Yamada *et al.* 2012). However, there are also reports of edibility in some cultures around the world for *C. molybdites* after undergoing cooking processes (Li *et al.* 2021), possibly due to its morphology that is easily confused with edible species of *Lepiota* (Pers.) Gray and *Macrolepiota* Singer (Vellinga 2002; 2003).

In Brazil, the largest distribution of *C. molybdites* is in the Atlantic Rainforest (Cria 2024), a region where cases



Figure 1. *Chlorophyllum molybdites*. **A** – Morphological development of the basidiome; **B** – Lamellae with greenish coloration and detail of the ring; **C** – Aspect of gregarious growth indicating formation of the fairy circle; **D** – Detail of pileus; **E** – Cheilocystidia; **F** – Basidia; **G** – Olive green spore print; **H** – Basidiospores. Scale = 1 cm (A,B,D); 10 µm (E,F,H).

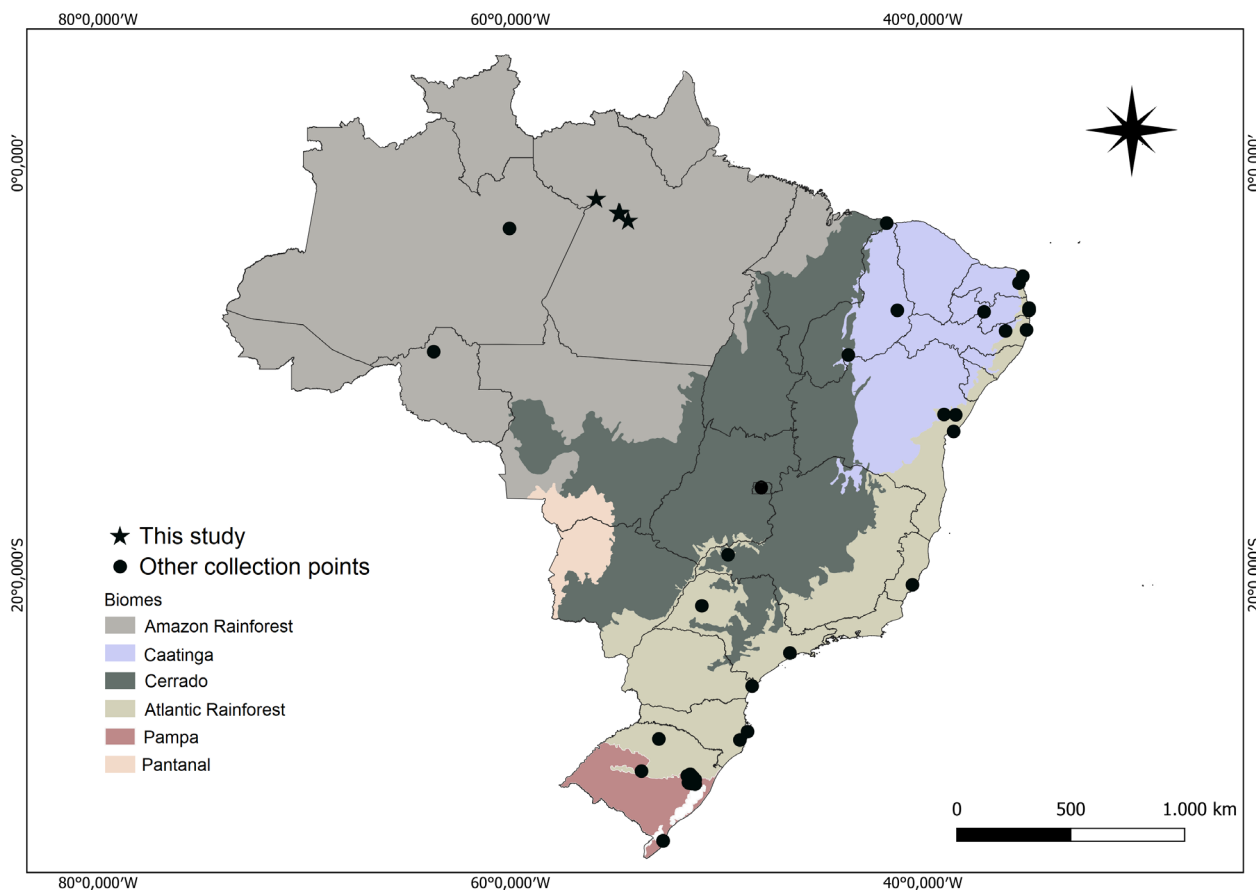


Figure 2. Distribution of *Chlorophyllum molybdites* in Brazil according to Species Link and literature data.

of poisoning due to accidental ingestion of the species are reported (Meijer *et al.* 2007). To avoid similar cases in the Amazon of Pará, it is necessary to increase knowledge about the biodiversity of fungi, especially in areas that have not yet been explored, and carry out scientific outreach and accident prevention actions considering toxic species.

In this sense, education and scientific outreach actions aimed at the knowledge of mushroom species, especially those occurring locally and regionally, are necessary to improve conservation strategies, prevent accidents due to ingestion of toxic and poisonous species, and contribute to reducing the disparity in perception of fungi (Silva and Gouw 2021; Ferreira and Lima 2022). We highlight the importance of the dissemination of science to the public in a clear and accessible way, aiming at understanding fungal biodiversity and preventing intoxications.

This study expands the geographic distribution of *C. molybdites* to the state of Pará, in the eastern Brazilian Amazon, prompting further research and the implementation of scientific outreach actions, especially considering the growing popularity of non-conventional edible fungi and the risk of accidental ingestion of toxic species.

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REFERENCES

- Alvares, C.A.; Stape, J.L.; Sentelhas, P.C.; Gonçalves, J.L.M.; Sparovek, G. 2013. Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22: 711-728.
- Alves, M.H.; Oliveira, C.M.; Coelho, N.C. 2019. First record of *Chlorophyllum molybdites* (G. Mey.) Masee (Basidiomycota, Agaricaceae) from Piauí state, Brazil. *Check List* 15: 695-699.
- Alves, R.P.; Menezes, G.C.A.; Oliveira, E.D.; Victoria, F.C.; Pereira, A.B.; Albuquerque, M.P. 2016. *Chlorophyllum* Masee e *Macrolepiota* Singer (Agaricaceae) em área do bioma Pampa, Rio Grande do Sul, Brasil. *Neotropical Biology and Conservation* 11: 141-152.
- Berger, K.J.; Guss, D.A. 2005. Mycotoxins revisited: Part II. *The Journal of Emergency Medicine* 28: 175-183.
- Bresadola, G. 1896. Fungi Brasilienses lecti a cl. Dr. Alfredo Möller. *Hedwigia* 35: 276-302.

- CABI Bioscience. 2022. The CABI Bioscience and CBS Database of Fungal Names. (<http://www.indexfungorum.org/Names/Names.asp>). Accessed on 09 Dec 2023.
- Cria. 2024. SpeciesLink. (<http://splink.cria.org.br>). Accessed on 25 Mar 2024.
- Ferreira, L.D.; Lima, R.A. 2022. Cegueira micológica em uma escola pública no município de Humaitá-AM. *Revista de Ensino, Educação e Ciências Humanas* 23: 433–437.
- Ge, Z.W.; Jacobs, A.; Vellinga, E.C.; Sysouphanthong, P.; Walt, R.; Lavorato, C.; Yang, Z.L. 2018. A multi-gene phylogeny of *Chlorophyllum* (Agaricaceae, Basidiomycota): new species, new combination and infrageneric classification. *MycKeys* 32: 65–90.
- Kornerup, A.; Wanscher, J.H. 1978. *Methuen Handbook of Colour*, 3th ed., Eyre Methuen, London, 224p.
- Largent, D.L.; Abell-Davis, S.E. 2011. Observation on *Inocephalus virescens* comb. nov. and *Alboleptonia stylophora* from northeastern Queensland. *Mycotaxon* 116: 231–245.
- Li, H.; Tian, Y.; Menolli Jr, N.; Ye, L.; Karunaratna, S.C.; Perez-Moreno, J.; et al. 2021. Reviewing the world's edible mushroom species: A new evidence-based classification system. *Comprehensive Reviews in Food Science and Food Safety* 20: 1982–2014.
- Lodge, D.J.; Ammirati, J.F.; O'Dell, T.E.; Mueller, G.M. 2004. Collecting and describing macrofungi. In: Mueller, G.M.; Bills, G.F.; Foster, M.S. (Ed.). *Biodiversity of Fungi: Inventory and Monitoring Methods*. Elsevier Academic Press, Oxford, 777p.
- Meijer, A.A.R. 2006. Preliminary list of the macromycetes from the Brazilian state of Paraná. *Boletim do Museu Botânico Municipal* 68: 1–55.
- Meijer, A.A.R.; Amazonas, M.A.L.A.; Rubio, G.B.G.; Curial, R.M. 2007. Incidences of poisonings due *Chlorophyllum molybdites* in the state of Paraná, Brazil. *Brazilian Archives of Biology and Technology* 50: 479–488.
- Neves, M.A.; Baseia, I.G.; Drechsler-Santos, E.R.; Góes-Neto, A. 2013. Guide to the common fungi of the semiarid region of Brazil. TECC Editora, Florianópolis, 144p.
- Pegler, D.N. 1983. Agaric flora of the Lesser Antilles. *Kew Bulletin Additional Series* 9: 1–668.
- Pegler, D.N. 1997. *The Agarics of São Paulo: An Account of the Agaricoid Fungi (Holobasidiomycetes) of São Paulo State, Brazil*. Royal Botanic Garden, Kew, 68p.
- Putzke, J.; Putzke, MTL. 2017. *Cogumelos-Fungos Agaricales no Brasil*. Famílias Agaricaceae, Amanitaceae, Bolbitaceae, Entolomataceae, Coprinaceae/Psathyrellaceae, Crepidotaceae e Hygrophoraceae. São Gabriel, 521p.
- Reid, D.A.; Eicker, A. 1991. A comprehensive account of *Chlorophyllum molybdites*. *Botânica Bulletin Academia Sinica* 32: 317–334.
- Rother, M.S.; Silveira, R.M.B. 2008. Família Agaricaceae (Agaricales, Basidiomycota) no Parque Estadual de Itapuá, Viamão, Rio Grande do Sul, Brasil. *Revista Brasileira de Biociências* 6: 259–268.
- Santana, M.D.F.; Couceiro, D.M.; Couceiro, S.R.M. 2018. Macrofungi of the Floresta Nacional do Tapajós. (<https://fieldguides.fieldmuseum.org/pt-br/guias/guia/996>). Accessed on 15 Mar 2024.
- Santos, F. 2017. *Manual de Cogumelos Comestíveis no Distrito Federal*. Ipanema, Brasília, 46p.
- Silva, A.C.; Gouw, A.M.S. 2021. Percepções e conhecimentos dos estudantes sobre fungos. *Scientia Plena* 17: 1–10. doi: [org/10.14808/sci.plena.2021.064401](https://doi.org/10.14808/sci.plena.2021.064401)
- Silva, L.; Fortuna, J. 2020. Macrofungos encontrados no Campus X da Universidade do Estado da Bahia. *Enciclopédia biosfera*, 17: 312–327.
- Singer, R. 1986. *The Agaricales in Modern Taxonomy*, 4th ed. Koeltz Scientific Books, Stuttgart, 981p.
- Sobestiansky, G. 2005. Contribution to a Macromycete survey of the states of Rio Grande do Sul and Santa Catarina in Brazil. *Brazilian Archives of Biology and Technology* 48: 437–457.
- Timm, J.M. 2018. *Primavera FUNGI: Guia de fungos do Sul do Brasil*, 1st ed. Via Sapiens, Porto Alegre, 500p.
- Timm, J.M. 2021. *Primavera Fungi: Guia de fungos do Sul do Brasil*, 2nd ed. Via Sapiens, Porto Alegre, 500p.
- Thiers, B. 2024. [continuously updated] Index herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. (<http://sweetgum.nybg.org/science/ih/>). Accessed on 12 Jun 2024.
- Vellinga, E.C. 2002. New combinations in *Chlorophyllum*. *Mycotaxon* 83: 415–417.
- Vellinga E.C. 2003. Notes on *Chlorophyllum* and *Macrolepiota* (Agaricaceae) in Australia. *Australian Systematic Botany* 16: 361–370.
- Villarreal, L.; Perez-Moreno, J. 1989. Los hongos comestibles silvestres de México, un enfoque integral. *Micología Neotropical Aplicada* 2: 77–114.
- Yamada, M.; Tokumitsu, N.; Saikawa, Y.; Nakata, M.; Asano, J.; Miyairi, K.; et al. 2012. Molybdophyllysin, a toxic metalloendopeptidase from the tropical toadstool, *Chlorophyllum molybdites*. *Bioorganic & Medicinal Chemistry* 20: 6583–6588.

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