



A new occurrence of *Mucor nidicola* (Madden, Stchigel, Guarro, Sutton & Starks) (Mucorales, Mucoromycota) in the Upland Rainforest of the Brazilian Northeast and first report as a saprobe in soil

Diogo Xavier Lima, Thalline Rafaella Leite Cordeiro, Catarina Letícia Ferreira de Lima, Carlos Alberto Fragoso de Souza, André Luiz Cabral Monteiro de Azevedo Santiago, Cristina Maria Souza-Motta

Graduate Program in Biology of Fungi, Department of Mycology, Federal University of Pernambuco, Av. Professor Nelson Chaves, s/n, 50670-420, Recife, PE, Brazil.

Corresponding author: Diogo Xavier Lima, diogo_xavier00@hotmail.com

Abstract

Mucor nidicola, a mucoralean fungus, was isolated for the first time from a wasp nest in Massachusetts, USA, and then reported in the state of Paraná, Brazil, as an entomopathogenic fungus collected from insects in strawberry crops. This work reports the first occurrence of *M. nidicola* from soil in the Brazilian Northeast. This species is distinguished from other species by producing erect, unbranched, and once-branched sporangiophores, globose to subglobose columellae, and mostly ellipsoidal sporangiospores, but with some irregular and varying in size and shape.

Keywords

ITS rDNA; Mucoromyceta; taxonomy.

Academic editor: Roger Fagner Ribeiro Melo | Received 6 December 2019 | Accepted 29 January 2020 | Published 14 February 2020

Citation: Lima DX, Cordeiro TRL, Lima CLF, Souza CLF, Santiago ALCMA, Souza-Motta CM (2020) A new occurrence of *Mucor nidicola* (Madden, Stchigel, Guarro, Sutton & Starks) (Mucorales, Mucoromycota) in the Upland Rainforest of the Brazilian Northeast and first report as a saprobe in soil. Check List 16 (1): 163–167. <https://doi.org/10.15560/16.1.163>

Introduction

Brazilian Upland Rainforests are in elevated areas that range from 500 to 1100 m in altitude and belong to the Atlantic Forest domain. These areas are within the semi-arid region of northeast Brazil, but due to the altitude, they show moderate temperatures and high moisture in comparison to the surrounding caatinga vegetation (Tabarelli and Santos 2004), factors which favor the high biodiversity of these forests (Myers et al. 2000; Ribeiro et al. 2008). Surveys on the diversity of mucoralean fungi in Brazilian Upland Rainforests have reported several

taxa of *Mucor*, including four new species (Guo Jie Li et al. 2016; de Souza et al. 2018; Lima et al. 2018).

The genus *Mucor*, proposed by Fresenius (1850), comprises the largest number of species within the order Mucorales Fr., which in turn belongs to the subphylum Mucoromycotina Benny and the phylum Mucoromycota Doweld (Spatafora et al. 2016). The species of this genus are characterized by the production of unbranched and/or branched sporangiophores, as well as globose, unapophysate sporangia with deliquescent or persistent walls (Benny 2013). According to Wijayawardene (2018), nearly 60 species of *Mucor* are accepted, albeit

the exact number of valid taxa is unknown (Gherbawy et al. 2010).

Mucor nidicola has only been reported as an entomopathogenic fungus in the USA, South Korea, and Brazil (Madden et al. 2012; Ahn et al. 2016; Nguyen et al. 2016; Poitevin et al. 2018) and as an endophyte of banana rachises in Colombia (Méndez-Castillo et al. 2017). Here we present a description of *M. nidicola* isolated from soil samples in an Upland Rainforest area located in the state of Pernambuco, Brazil. This is the first report of this species in soil as well as in the Brazilian Northeast.

Methods

The soil samples were collected in October 2018 in the city of Garanhuns (Fig. 1), which is in the state of Pernambuco, Brazil. For isolation, 5 mg of soil were added to Petri dishes containing wheat germ agar medium (Benny 2008) amended with chloramphenicol (80 mg/L). Plates were incubated on the laboratory at 25 °C for 7 days in alternate periods of light and dark. Fungal biomass was obtained for genomic DNA extraction as described by Góes-Neto et al. (2005). The primer pairs ITS1/ITS4 (White et al. 1990) were used to amplify the ITS region of rDNA. A polymerase chain reaction was conducted as described by Oliveira et al. (2014). The final amplicons were purified with the Invitrogen™ PureLink™ PCR

Purification Kit and sequenced. The newly obtained sequence was deposited in GenBank. The specimen was identified by the observation of the macroscopic (coloration, appearance, and diameter of the colonies) and microscopic (microstructures) characteristics, according to the description of Madden et al. (2012).

Results

Material examined. BRAZIL• Pernambuco, Garanhuns; 08°56'013"S, 036°27'640"W; 774 m a.s.l.; 10 Oct. 2018, leg. Diogo Xavier Lima (D.X. Lima URM 8170); habitat: soil; GenBank accession no. MN646273.

Distribution. Brazil, Colombia, USA, and South Korea.

Identification. *Mucor nidicola* (Madden, Stchigel, Guarro, Sutton & Starks), International Journal of Systematic and Evolutionary Microbiology 62: 1710–1714. 2012. Figure 2A–H.

Colonies light yellow to brownish (MP 114C), reverse yellow (MP 114D), growing rapidly on MEA (9 cm in diameter after 4 days at 25 °C). Sporangioophores erect, 10–15 µm in diameter, unbranched or once-branched. Sporangia smooth-walled, yellowish to brownish, globose, 30–70 µm in diameter, with wall deliquescent but persistent in young sporangia. Columellae smooth-walled, hyaline, globose to subglobose 5–40 × 20–45

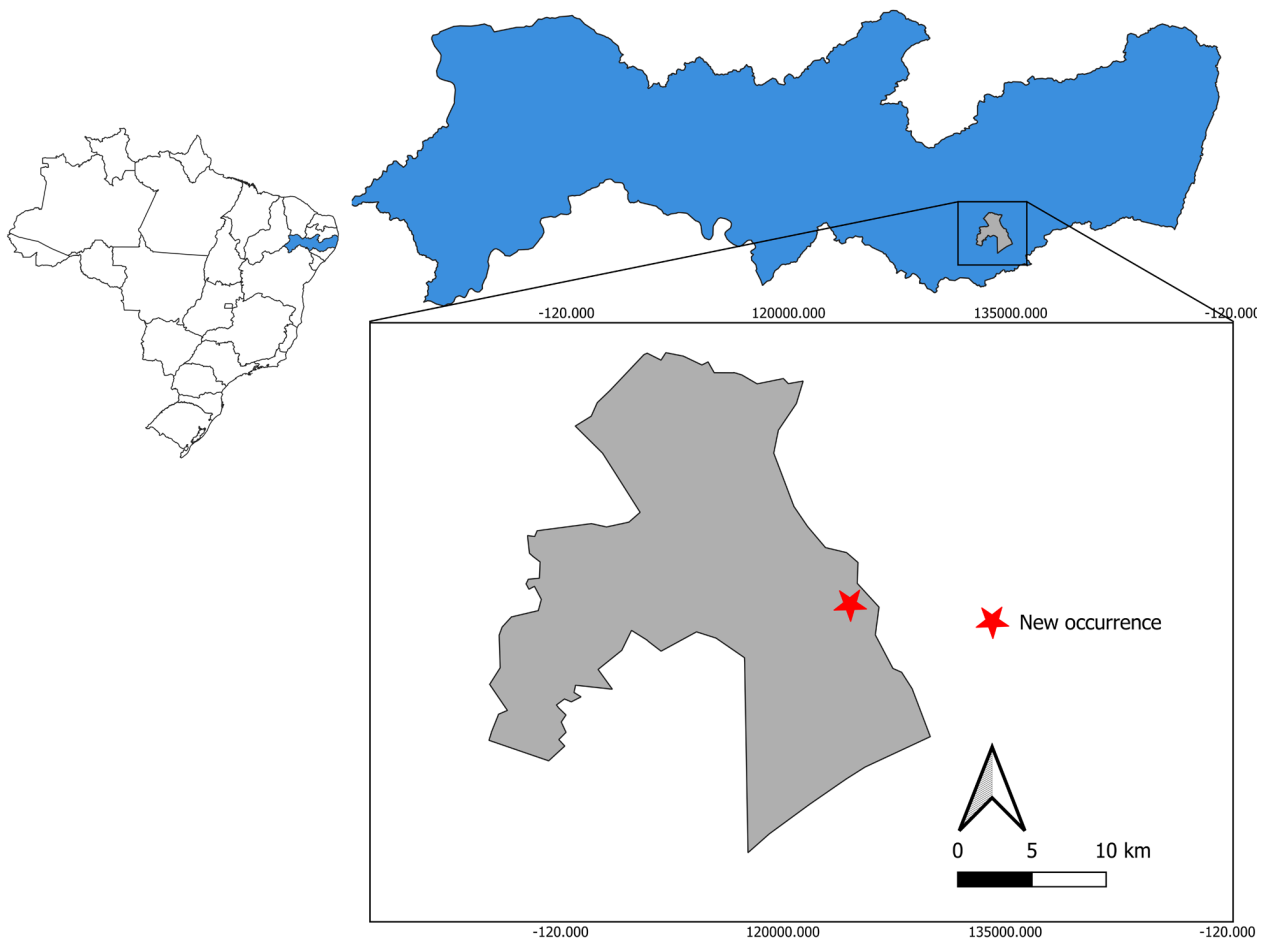


Figure 1. The location in Garanhuns city, where *Mucor nidicola* URM 8170 was found.

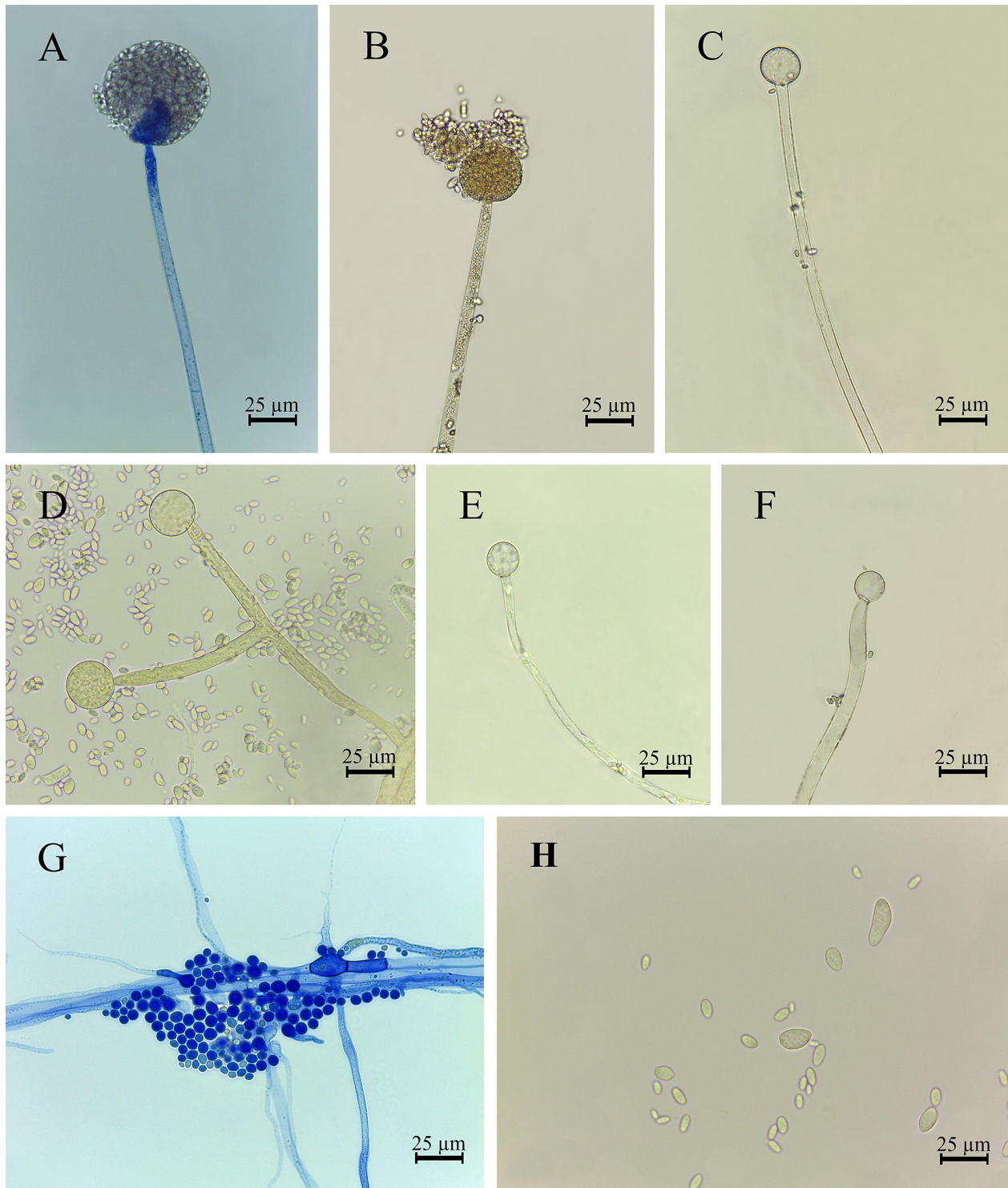


Figure 2. *Mucor nidicola*. **A, B.** Unbranched sporangiophore with sporangium. **C, E, F.** Unbranched sporangiophores and columella. **D.** Sporangiophores branched once. **G.** Chlamydospores. **H.** Sporangiospores.

μm . Collar evident. Sporangiospores mostly ellipsoidal, $3\text{--}10 \times 2\text{--}6 \mu\text{m}$, some irregularly shaped, $12\text{--}20 \times 5\text{--}12 \mu\text{m}$, light greyish, smooth-walled. Chlamydospores globose or barrel-shaped, thick-walled zygosporegia not observed. Probably heterothallic.

Discussion

The specimen studied was isolated from soil. This same species was found in a wasp nest, mushroom flies, guts

of soldier fly larvae, insects in strawberry crops, and endophytic in bananas (Madden et al. 2012; Ahn et al. 2016; Nguyen et al. 2016; Méndez-Castillo et al. 2017; Poitevin et al. 2018). The morphological characteristics of *M. nidicola* URM 8170 show close similarity to the original description by Madden et al. (2012), although we observed a few variations in relation to the size of the ellipsoid sporangiospores, which are much bigger than those of the holotype ($3\text{--}10 \times 2\text{--}6 \mu\text{m}$); we have found irregular sporangiospores up to $20 \times 12 \mu\text{m}$ in size. The

color of colonies is slightly different than described by Madden et al. (2012) as orange to greyish-orange, whereas our strain is yellow to brownish. However, we do not consider these differences enough to characterize a new variety. In BLASTn analysis our strain sequence MN646273 (URM 8170) showed 99.33% identity with *M. nidicola* JF299215 (CBS 130359)

We report the first occurrence of *M. nidicola* in north-eastern Brazil and its first report as saprobe, isolated specifically from soil of a Brazilian Upland Rainforest area, contributing to the knowledge of the geographical distribution of mucoralean fungi.

Acknowledgements

This manuscript was financed by the “Integrated Network for the Taxonomy of Plants and Fungi” (MCT/CNPq/MEC/CAPES/FNDCT – Transversal project/FAPs No. 47/2010 – National Biodiversity Research System – SISBIOTA BRAZIL), “Mucoromycotina from Atlantic Forest in the semiarid region of Pernambuco” (CNPq – Universal Application – 458391/2014-0), “URM Herbarium: characterization and availability of the collection as a source of microbiological resources” (FACEPE – APQ – 0143-2.12/15) and “Diversity of Mucoromycotina in the different ecosystems of the Atlantic Forest of Pernambuco” (FACEPE – First Projects Program PPP/FACEPE/CNPq – APQ – 0842-2.12/14). We also thank the Fundação de Amparo à Ciência e Tecnologia do Estado de Pernambuco and Conselho Nacional de Desenvolvimento Científico e Tecnológico for the scholarships respectively awarded to Diogo Xavier Lima and to André L. C. M. de A. Santiago.

Authors' Contributions

TRLC and CLFL collected the material; CAFS performed the specified methodology; DXL and CSM wrote the text; ALCMAS and DXL identified the species.

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