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## Amazonian bird's nest fungi (Basidiomycota): Current knowledge and novelties on *Cyathus* species

Thiago Accioly <sup>a</sup>, Rhudson H.S.F. Cruz <sup>a,\*</sup>, Nathalia M. Assis <sup>a</sup>, Noemia K. Ishikawa <sup>b</sup>, Kentaro Hosaka <sup>c</sup>, María P. Martín <sup>d</sup>, Iuri G. Baseia <sup>e</sup>

<sup>a</sup> Programa de Pós-Graduação em Sistemática e Evolução, Universidade Federal do Rio Grande do Norte, Centro de Biociências, Campus Universitário, Natal, 59072-970, Brazil

<sup>b</sup> Coordenação de Biodiversidade, Instituto Nacional de Pesquisas da Amazônia (INPA), Av. André Araújo, 2.936, Petrópolis, Manaus, 69060-001, Brazil

<sup>c</sup> Department of Botany, National Museum of Nature and Science (TNS), 4-1-1 Amakubo, Tsukuba, Ibaraki, 305-0005, Japan

<sup>d</sup> Departamento de Micología, Real Jardín Botánico, RJB-CSIC, Plaza de Murillo 2, Madrid, 28014, Spain

<sup>e</sup> Departamento de Botânica e Zoologia, Universidade Federal do Rio Grande do Norte, Centro de Biociências, Campus Universitário, Natal, 59072-970, Brazil

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### ABSTRACT

The genus *Cyathus* is historically subsampled in the Amazon Forest, which is a potential source of striking taxonomic richness. In this paper, a checklist of Amazonian *Cyathus* species with detailed descriptions, illustrations and comments of five uncommon species are given. A new species named *C. albinus* is proposed with morphological and molecular data, being mainly characterized by a light color hirsute exoperidium contrasting with a dark brown emplacement and basidiospores ovoid to elliptical. Three other species, *C. amazonicus*, *C. earlei* and *C. triplex*, are recorded for the first time from their localities. Also, polyphyly is detected into *striatum* infra-generic group after the addition of tropical species, but a subclade containing Amazonian species was highly supported.

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### 1. Introduction

There is evidences that tropical forests have great diversity and richness of fungal species (Cannon & Hawksworth, 1995; Hawksworth & Rossman, 1997), and studies focusing in diverse and combined sources of biological information revealed that integrative taxonomy is, in many cases, a powerful tool to reveal new taxa (Henkel, Smith, & Aime, 2010; Silva, Cabral, Marinho, Ishikawa, & Baseia, 2013; Cabral et al., 2014a,b), further expanding the estimates of fungal diversity in these regions.

The phyto-physiognomies that compose the mosaic of biomes forming the Amazonian domain (Coutinho, 2006) extends over nine South American countries (Brazil, Peru, Colombia, Venezuela, Equator, Bolivia, British Guiana, Suriname, and French Guiana). It forms what is known as the Panamazon (Martini, 2002), defining the Amazon not by geopolitical, but by biogeomorphological factors, indeed facilitating the elaboration and implementation of

measures for the effective conservation of biodiversity (Fig. 1).

In Central Amazon, rapid habitat degradation, disorderly growth of cities and the shortage of best defined land policies combined climatic changes is leading to accelerated biodiversity loss. Because of that scientific community recognizes the urgency in learning about biodiversity in this kind of megadiverse area, before the current species become extinct due to human action (Baseia et al., 2016; Fearnside, 2006; Fearnside & Graça, 2009; IBGE, 2013; Luizão & Vasconcelos, 2002; Marques & Pinheiro, 2011; Mueller, Bills, & Foster, 2004; Nelson, Ferreira, Silva, & Kawasaki, 1990; Prance, Rodrigues, & Silva, 1990; Ribeiro et al., 1999; Silva, Rylands, & Fonseca, 2005).

*Cyathus* Haller : Pers. is a genus of gasteroid fungi that is characterized by having small-sized (ca. 5–15 mm high) basidiomata with a cup or inverted-bell shape at maturity, with small discoid packets (peridioles) inside. Due to its similarities to bird's eggs in a nest, the genus is commonly called "bird's nest fungi" (Brodie, 1975). Although the genus is treated in a few different families depending on the authors, phylogenetic studies indicate the bird's nest fungi (including *Cyathus*, *Crucibulum* Tul. & C. Tul., *Nidula* V.S. White, *Nidularia* Fr. and *Mycocalia* J.T. Palmer) form a clade with the

\* Corresponding author.

E-mail address: [rhudsoncruz@yahoo.com.br](mailto:rhudsoncruz@yahoo.com.br) (R.H.S.F. Cruz).



Fig. 1. Amazonian domain boundaries (Panamazon) according to Martini (2002) and collection sites.

genus *Cystoderma* Fayod, which is tightly clustered with a core Agaricaceae Chevall., including *Agaricus* L., *Lepiota* P. Browne and *Lycoperdon* Pers. (Matheny et al., 2006). There are only limited numbers of studies, but the genus is subdivided into three infra-generic groupings by molecular methods (Zhao, Jeewon, Desjardin, Soyong, & Hyde, 2007, 2008).

*Cyathus* species occur in many Brazilian morphoclimatic domains (Barbosa, Cruz, Calonge, & Baseia, 2014; Baseia & Milanez, 2001; Berkeley & Cooke, 1876; Coutinho, 2006; Cruz, 2013; Cruz & Baseia, 2014; Cruz, Barbosa, & Baseia, 2012a,b; Sotão et al., 2009; Trierveiler-Pereira, Gomes-Silva, & Baseia, 2009), and it is the second most represented gasteroid genus in Amazonian Forest, with eight reported species by far (Table 1). On the other hand, the Caatingas domain, a semi-arid portion of Brazil with much greater hydric stress in comparison to the Amazonian domain, has twice the number of reported species, according to the first and the only

study in this area (Cruz, 2013). Arguably, it potentially means that taxonomic richness of the genus in the Amazonian domain remains quite underestimated, since high humidity is one of the main factors for the occurrence of fruit bodies of these gasteroid fungi (Brodie, 1975). The main reason for this discrepancy may be the scarcity of specialists and funding at the Amazon Forest.

In order to assess the still neglected taxonomic richness in the Amazonian domain, this work aimed to increase knowledge about the genus *Cyathus* in the Brazilian portion of this domain by describing a new species and providing new distribution data of known species.

## 2. Materials and methods

Specimens were collected during field expeditions in forested areas of Central Amazon at Manaus and Manacapuru cities,

Table 1

*Cyathus* species referred to the Amazon Forest and their geopolitical distribution within the morphoclimatic domain.

Species	Distribution	Reference
<i>Cyathus amazonicus</i>	Brazil (RO) <sup>c</sup>	Trierveiler-Pereira et al., 2009
<i>Cyathus berkeleyanus</i>	Brazil (PA) <sup>a</sup>	Sotão et al., 2009
<i>Cyathus helenae</i> H.J. Brodie	Brazil (PA) <sup>a</sup>	Sotão et al., 2009
<i>Cyathus limbatus</i>	Brazil (AM) <sup>a</sup>	Berkeley & Cooke, 1876
	British Guiana	Brodie & Dennis, 1954
<i>Cyathus morelensis</i> C.L. Gómez & Pérez-Silva	Brazil (AM) <sup>a</sup>	Cruz, Lima, Braga-Neto, & Baseia, 2012b
<i>Cyathus stercoreus</i> (Schwein.) De Toni	Brazil (PA) <sup>a</sup>	Sotão et al., 2009
<i>Cyathus striatus</i>	Colombia <sup>a</sup>	Vasco-Palacios, Franco-Molano, López-Quintero, & Boekhout, 2005
	Brazil (PA) <sup>b</sup>	Sotão et al., 2009
<i>Cyathus triplex</i>	British Guiana <sup>a</sup>	Brodie & Dennis, 1954
	Brazil (PA) <sup>b</sup>	Sotão et al., 2009

<sup>a</sup> Refers to first record from the Amazonian domain.

<sup>b</sup> First record from the Brazilian Amazon.

<sup>c</sup> Description of new species. For the Brazilian samples: AM – Amazonas, RO – Rondônia, PA – Pará.

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