

## Mycota (Ascomycota) of *Syagrus coronata* (Mart.) Becc., Raso da Catarina Ecological Station, Brazil: new records

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### Abstract

The Raso da Catarina Ecological Station (ESEC) is a conservation unit of integral protection located in the Caatinga biome, Northeastern Brazil, Bahia, between the cities of Paulo Afonso, Rodelas, and Jeremoabo. Among the botanical species of great relevance in the ESEC region stands out the palm *Syagrus coronata* (Mart.) Becc. (licuri). Currently, there is little information about the mycota that colonizes this host. Thus, this study analyzes the taxonomy of fungi occurring in *S. coronata* at ESEC Raso da Catarina. For that purpose, we conducted eight excursions between May 2014 and January 2015, in which we randomly demarcated and georeferenced 25 *S. coronata* plants. For the survey of the Ascomycota, we collected leaves, bracts, inflorescences, fruits, stem pieces and litter. We morphologically identified twenty-six taxa. Following an extensive literature research, we present dichotomous keys for genera, distribution data, and a checklist of fungi species, of which four are lichenized and 22 non-lichenized (nine anamorph/asexual and 13 teleomorph/sexual). These species belong to 26 genera and 18 families. We report *Syagrus coronata* in this study as a new botanical host for 22 fungi species.

**Keywords:** Caatinga, fungi, palm tree, taxonomy.

## Micota (Ascomycota) de *Syagrus coronata* (Mart.) Becc., Estação Ecológica Raso da Catarina, Brasil: novos registros

### Resumo

A Estação Ecológica Raso da Catarina (ESEC) é uma unidade de conservação de proteção integral localizada no Bioma Caatinga, Nordeste do Brasil, estado da Bahia entre os municípios de Paulo Afonso, Rodelas e Jeremoabo. Dentre as espécies botânicas de grande relevância na região da ESEC destaca-se a palmeira *Syagrus coronata* (Mart.) Becc. (licuri). Na atualidade, são escassas as informações sobre a micota que coloniza esse hospedeiro. Assim, esta pesquisa objetivou realizar um estudo taxonômico dos fungos encontrados em *S. coronata* na ESEC Raso da Catarina. Oito excursões foram realizadas no período de maio/2014 a janeiro/2015 e 25 indivíduos foram demarcados aleatoriamente e georreferenciados. Para o levantamento dos Ascomycota, foram coletados folhas, brácteas, inflorescências, frutos e pedaços de tronco da parte aérea e serrapilheira dos indivíduos. Vinte e seis táxons foram identificados morfológicamente. Chaves dicotômicas para gêneros, dados de distribuição e uma lista de espécies de fungos, sendo quatro liquenizados e 22 não liquenizados (nove anamorfo/assexuais e 13 teleomorfo/sexuais), são apresentados baseados em uma intensa pesquisa de registros de literatura. Essas espécies estão distribuídas em 26 gêneros e 18 famílias. *Syagrus coronata* é documentada, neste estudo, como novo hospedeiro botânico para 22 espécies de fungos estudadas.

**Palavras-chave:** Caatinga, fungos, palmeira, taxonomia.

### Introduction

Caatinga is the predominant type of vegetation in the Brazilian Northeast (Sena 2011). It covers about 11% of the national territory (844,453 Km<sup>2</sup>), present in the states Alagoas, Bahia, Ceará, Maranhão, Pernambuco, Paraíba, Rio Grande do Norte, Piauí, Sergipe and northern Minas Gerais (Ministry of the Environment [MMA] 2012). According to Velloso,

Sampaio & Pareyn (2002), most of the Caatinga biome is characterized by a hot and semiarid climate, with little rainfall. The soils of the semiarid region have a complex spatial distribution, from shallow and rocky, to sandy and deep, presenting a diversity of environments provided by a mosaic of types of vegetation. Velloso *et al.* (2002) suggest that the Caatinga is subdivided into eight ecoregions, among them the Raso da Catarina ecoregion.

Raso da Catarina is an ecoregion located in the center-east of the Caatinga biome, has a narrow and elongated shape, occupying an area of approximately 30,800 km<sup>2</sup> (Paes & Dias 2008). There are five conservation units present: Raso da Catarina Ecological Station (ESEC Raso da Catarina), Serra Negra Biological Reserve, Canudos State Park, Canudos Biological Station and RPPN Fazenda Flor de Lis (Velloso et al. 2002). ESEC Raso da Catarina is located in the state of Bahia, between the municipalities of Paulo Afonso, Rodelas and Jeremoabo, standing out for its biological importance due to the diversity of flora and fauna.

*Syagrus coronata* (Mart.) Becc. is a palm well adapted to the dry and arid regions in the Caatinga biome. It is regionally called ‘licurizeiro’, ‘licuri’, ‘ouricuri’, ‘auricuri’, ‘alicuri’, ‘nicuri’, ‘dicori’, ‘uricuri’, ‘coqueiro dicori’, and ‘coqueiro cabeçudo’ (Drumond, 2007). The species has great socioeconomic importance in naturally occurring areas, especially in semiarid regions, since practically all parts of the plant can be used (Drumond, 2007; Lopes, 2007; Ramalho, 2008).

Several studies in the last decades have addressed mycota associated with Arecaceae, showing high species richness and numerous new species especially anamorphic microfungi and non-lichenized teleomorphs, which, because they are inconspicuous, are poorly studied and practically unknown (Hyde & Fröhlich, 2000; Vitoria et al., 2008, 2011ab, 2012ab, 2014, 2016ab; Santos et al., 2016; Santos & Vitoria, 2017; Vitoria et al., 2019; Santos et al., 2019).

Hyde (1996a), Fröhlich & Hyde (1999) reported how many species of fungi could occur in a single palm, suggesting the ratio palm: fungi of 1:26 and 1:33, respectively, which would directly imply the global number of diversity of fungi that is currently estimated at 12 million (Wu et al. 2019).

Endophytic, phytopathogenic, saprobic, mutualist, and symbiont fungi inhabit palm trees, in which species of the phylum Ascomycota predominate. This phylum corresponds to the largest group in the Fungi kingdom, containing approximately sixty-six thousand genera, as estimated in the Outline of Ascomycota: 2017 (Wijayawardene et al., 2018).

Brazil is a country rich in palm species, some of which are of great social and economic importance for the northeast region. An example is *S. coronata*, called “the semiarid green gold”. Currently, the mycota of this host is little known.

Thus, this research carried out a taxonomic study of the fungi found in *S. coronata* at ESEC Raso da Catarina, Paulo Afonso, Bahia, Brazil, presenting dichotomous keys, geographic distribution and a list of morphologically characterized species.

## Materials and Methods

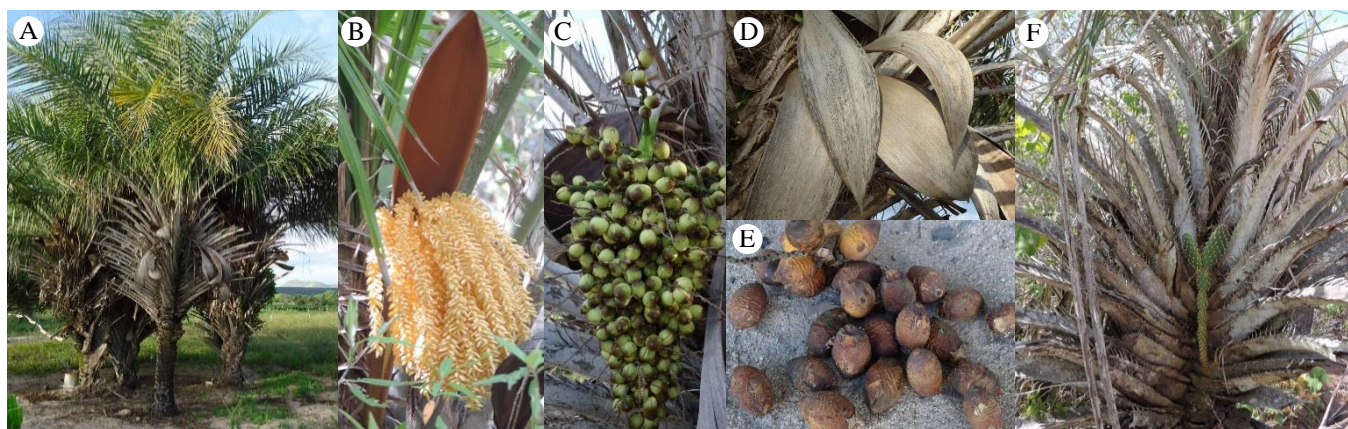
### Study Area

The research was carried out at the Raso da Catarina Ecological Station (ESEC), located in northeastern Bahia State, between parallels 9°33' S and 9°54' S and meridians 39°29' W and 38°44' W, on the left bank of the Vaza Barris River, and on the right bank of the São Francisco River (Paes & Dias 2008). The study area is approximately 473 km away from Salvador city, capital of the state.

### Material collection

We conducted eight excursions between May 2014 and January 2015. During the collections, we randomly demarcated and georeferenced 25 *S. coronata* plants (in flowering and fruiting) in five areas of ESEC, with a minimum distance of 100 m between plants. For the survey of the Ascomycota, we collected leaves, bracts (spathe), inflorescences, fruits, and stem pieces from shoots and litter (Figure 1).

The botanical material was fractionated, with the aid of puncturing materials, in fragments of 10 to 20 cm in length and subsequently packed in 2 kg Kraft paper bags, identified with the following data: location, date, substrate, geographical coordinate, collector and collection number.



**Figure 1.** Material collected from *Syagrus coronata* to survey the Ascomycota. A: *S. coronata* in its natural environment; B: Inflorescence; C: Fruit bunch; D: Bracts; E: Ripe fruits; F: Petioles arranged in a crown. Photos: Fortes, N.G.S. and Santos, M.A.L.

### Morphological characterization, identification and preservation

Wet chambers were mounted on plastic trays, properly cleaned with 70% alcohol and 2% sodium hypochlorite. The bottom and walls of the containers were covered with moistened paper towels. Every two days, the trays were opened to spray distilled water in order to maintain humidity. The plant material was stored for seven days, at room temperature and under natural light, to assess fungal growth. Subsequently, the topographic analysis of the material was performed in a stereomicroscope.

The fragments of the fungal structures were removed with the aid of a fine-tipped needle (type insulin) and mounted between slide and cover slip, using the following reagents: lactophenol with the addition of blue cotton dye to show hyaline structures; Melzer 5% for diagnosis of the amyloid reaction at the apex of the asci and lichenic structures; 10% potassium hydroxide (KOH) for dissolving protein material and water, as a means of assembly for visualizing the mucilaginous sheath, when present, around the structures. In addition, the preparation of the vertical sections of the ascomas and stems were carried out with the aid of razor blades and performed freehand to observe the reproductive structures.

We analyzed the samples at the Science Laboratory of the State University of Bahia - UNEB, Campus VIII, Paulo Afonso-BA. We identified fungi based on the morphology of the reproductive structures according to the relevant bibliography. Relevant (Arx & Müller 1954; Müller & Arx

1962; Ellis 1971, 1976; Luttrell 1973; Barnett & Hunter 1998; Fröhlich & Hyde 2000; Taylor *et al.* 2003; Cáceres 2007). After identification, we deposited the analyzed material in the URM Herbarium of the Federal University of Pernambuco (UFPE), in Recife city, and in the MICOLAB UNEB-VIII of the State University of Bahia (UNEB), in Paulo Afonso city.

We divided the fungi of this study into three major groups, namely: anamorphs, non-lichenized teleomorphs, and lichenized teleomorphs. We distributed the taxa in alphabetical order, presenting dichotomous keys for genera, distribution and material examined. Nomenclature and authors follow the online databases Species Fungorum (<http://www.speciesfungorum.org/Names/Names.asp>) and Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>).

## Results and Discussion

### Anamorphs

Anamorphic or mitosporic fungi, that is, with asexual reproduction according to mycology references. This session shows fungi that produce conidia (asexual/mitotic spores) in solitary conidiophores, aggregated conidiophores (synnemata), and conidiophores inside conidiomata (pycnidia).

Identification key for the anamorphic genera of this study (Figure 2.A-U)

1. Conidia helicoid .....	2
1'. Conidia of other types .....	3
2. Conidia hyaline or shiny, with hygroscopic filaments .....	<i>Neohelicomyces</i>
2'. Conidia brown or pale, nonhygroscopic filaments .....	<i>Helicoma</i>
3. Conidia aseptate .....	4
3'. Conidia septate at maturity .....	6
4. Conidiophores basauxic .....	<i>Endocalyx</i>
4'. Conidiophores acroauxic .....	5
5. Conidia solitary, dry, and hyaline .....	<i>Phaeoisaria</i>
5'. Conidia aggregated into sticky heads or dry chains brown to blackish .....	<i>Stachybotrys</i>
6. Conidia bicelular .....	<i>Harzia</i>
6'. Conidia multicelular .....	7
7. Conidia of two types: a spiny; b smooth, with irregularly lobed edges .....	<i>Spegazzinia</i>
7'. Conidia of only one type .....	8
8. Conidia branched into chains, with constricted septa .....	<i>Latorua</i>
8'. Conidia solitary, with 4 columns of cells, ending at the apex with setous appendages .....	<i>Tetraploa</i>

### 1. *Endocalyx melanoxanthus* (Berk. & Broome) Petch

Bibliography consulted: Ellis (1971), Vitoria *et al.* (2011b).

Distribution: Known distribution in Argentina, Australia, Brazil, China, Cuba, Philippines, Ghana, Hawaii, Hong Kong, Jamaica, Japan, Malaysia, Myanmar, Mexico, New Guinea, New Zealand, Pakistan, Sierra Leone, Seychelles, Singapore, Thailand, Taiwan, the United States, and Venezuela, colonizing hosts of the genera *Acrocomia* Mart., *Archontophoenix* H.Wendl. & Drude, *Arenga* Labill., *Borassus* L., *Chrysalidocarpus* Becc., *Cocos* L., *Coffea* L., *Dracaena* Vand. ex L., *Elaeis* Jacq., *Euterpe* Mart., *Licuala* Wurm.

*Livistona* R.Br., *Nannorrhops* H.Wendl., *Oncosperma* Blume, *Phoenix*, *Ravenala* Adans., *Ripogonum* J.R.Forst. & G.Forst., *Roystonea*, *Sabal*, *Satakentia* H.E.Moore, *Serenoa* Hook.f., *Shorea* Roxb. ex C.F.Gaertn., *Smilax* L., *Trachycarpus* H.Wendl., *Washingtonia* H. Wendl., and *Wodyetia* Irvine (Farr & Rossman, 2019). In Brazil, there are records of these specimens on the palms *Acrocomia intumescens* Drude and *E. oleracea*, for Pernambuco State, and *E. dulis*, for Bahia State (Vitoria *et al.*, 2011b).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S.*

*coronata* bract, 01.15.2015, col. N.G.S. Fortes, 09°49'82" S and 038°28'99" W, 537 m. (URM 91144 and MICOLAB UNEB-VIII 0006).

**2. *Harzia palmara*** (Cooke) D.W. Li & N.P. Schultes, in Schultes, Murtishi & Li

Bibliography consulted: Ellis (1976), Chen and Tzean (2009), Schultes *et al.* (2017).

Distribution: The genus is cosmopolitan, with diverse habitats: in association with plants, litter, seeds, soil, and manure. Known distribution in Canada, China, India, Ghana, Malaysia, Nepal, Nigeria, Papua New Guinea, Pakistan, Somalia, Taiwan, the United States, and Venezuela. In Brazil, there are records of this genus on *Musa paradisiaca* L. (Federal District), *Sorghum bicolor* (L.) Moench, and *Vigna unguiculata* (L.) Walp. (Pernambuco) (Farr & Rossman, 2019; Mendes & Urben, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* inflorescence, 06.10.2014, col. N.G.S. Fortes, 09°39'58" S and 38°28'46" W, 588 m; on *S. coronata* leaflet, 01.15.2015, col. N.G.S. Fortes, 09°49'82" S and 038°28'99" W, 537 m. (MICOLAB UNEB-VIII 0028).

**3. *Helicoma microscopicum*** (Ellis) Linder

Bibliography consulted: Zhao *et al.* (2007).

Distribution: Known distribution in China, colonizing decaying palm leaves, and in the USA (New Jersey), on *Alnus serrulata* (Aiton) Willd. (Farr & Rossman, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet collected from the litter, 01.15.2015, col. N.G.S. Fortes, 09°49'82" S and 38°28'99" W, 537 m. (MICOLAB UNEB-VIII 0025).

**4. *Latorua caligans*** (Bat. & H.P. Upadhyay) Crous

Bibliography consulted: Ellis (1971), Crous *et al.* (2015).

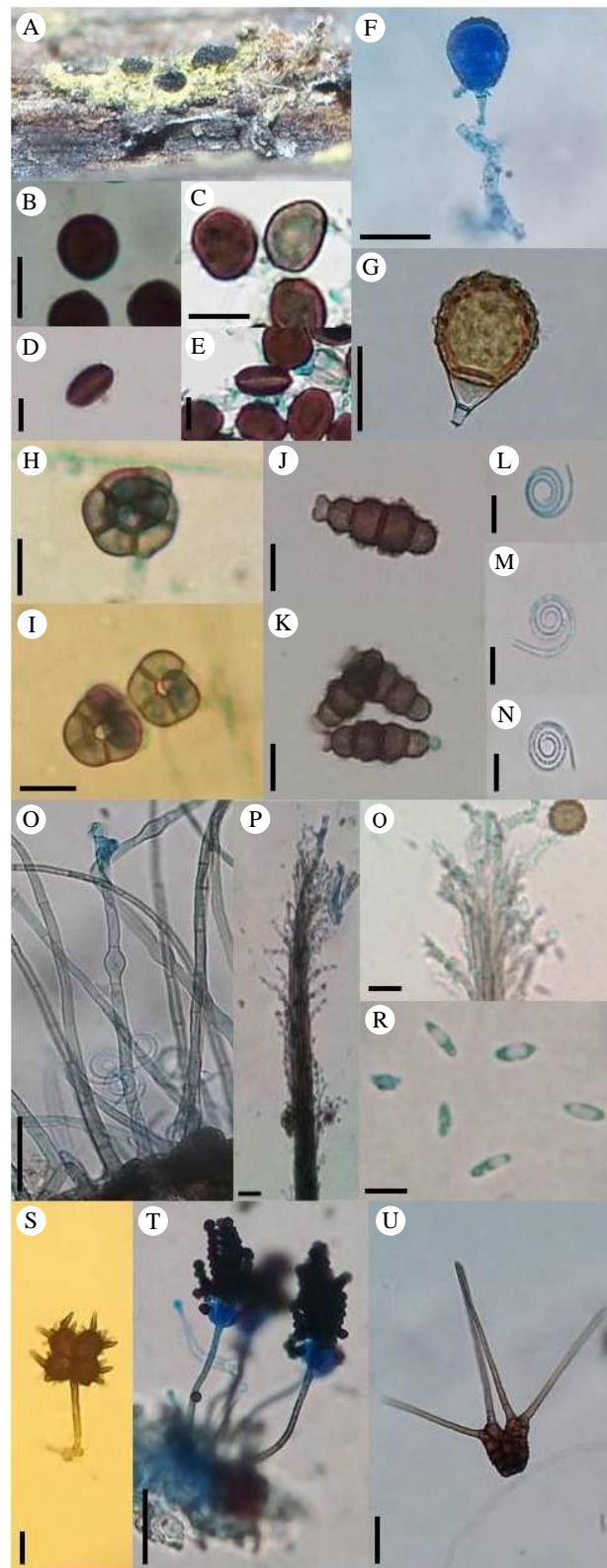
Distribution: Commonly occurring in the soil, with known distribution in Australia, India, Nigeria, and Brazil (in the states of Pernambuco and Sergipe). There are no records of *L. caligans* in other Brazilian states (Farr & Rossman, 2019; Mendes & Urben, 2019; Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet, 01.15.2015, col. N.G.S. Fortes, 09°49'82" S and 038°28'99" W, 537 m. (URM 91146).

**5. *Neohelicomyces pallidus*** (Cesati) Y.Z. Lu & K.D. Hyde

Bibliography consulted: Goos (1989), Zhao *et al.* (2007), Cruz *et al.* (2009), Lu *et al.* (2018).

Distribution: Known distribution in China (Guangdong, Hebei, Liaoning, Tibet), Czech Republic, Italy, Japan, and the USA (Massachusetts), on decaying wood. National databases do not contain information on the occurrence of *N. pallidus* (Lu *et al.*, 2018; Specieslink, 2019; Farr & Rossman, 2019; Mendes & Urben, 2019). Therefore, this is the first record of the species in Brazil.



**Figure 2.** Anamorphic fungi. A-E: *Endocalyx melanoxanthus*; F-G: *Harzia palmara*; H-I: *Helicoma microscopicum*; J-K: *Latorua caligans*; L-O: *Neohelicomyces pallidus*; P-R: *Phaeoisaria pseudoclematidis*; S: *Spegazzinia* sp.; T: *Stachybotrys echinatus*; U: *Tetraploa aristata*. (B-C= 10 µm, D-E= 7,5 µm, F= 30 µm, G= 20 µm H-I= 7 µm, J-K= 10 µm, L-N = 10 µm, O = 20 µm, P= 30 µm, Q= 15 µm, R = 7,5 µm, S= 10 µm, T= 30 µm, U= 30 µm).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet collected from the litter, 06.10.2014, col. N.G.S. Fortes, 09°40'10'' S and 38°27'87'' W, 531 m. (MICOLAB UNEB-VIII 0022).

#### 6. *Phaeoisaria pseudoclematidis* D.Q. Dai & K.D. Hyde

Bibliography consulted: Ellis (1971), Liu *et al.* (2015).

Distribution: The genus is cosmopolitan. Known distribution in Thailand only, with bamboo (*Bambusa* sp.) as host. This is the second record of this species in the world, with *S. coronata* as a new host for science (Liu *et al.*, 2015; Farr & Rossman, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet, 01.15.2015, col. N.G.S. Fortes, 09°49'82'' S and 038°28'99'' W, 537 m. (URM 91148 and MICOLAB UNEB-VIII 0030).

#### 7. *Spegazzinia* sp.

Bibliography consulted: Ellis (1971).

Distribution: The genus is cosmopolitan, with diverse habitats (Farr & Rossman, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* bract, 01.15.2015, col. N.G.S. Fortes, 09°49'81'' S and 038°28'98'' W, 533 m. (MICOLAB UNEB-VIII 0021).

#### 8. *Stachybotrys echinatus* (Rivolta) G. Sm.

Bibliography consulted: Wang *et al.* (2015).

Distribution: Known distribution in China, Honduras, Hong Kong, India, England, Japan, Malaysia, Kenya, Pakistan, Poland, Taiwan, and the USA (Farr & Rossman, 2019). In Brazil, there are records of this species on decaying leaves of *Miconia cabussu* Hoehne (location not informed), *Senna alata* (L.) Roxb., and *Ruellia incompta* (Nees) Lindau (Bahia) (Mendes & Urben, 2019; Barbosa *et al.*, 2008).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* inflorescence, 06.10.2014, col. N.G.S. Fortes, 09°40'10'' S and 038°27'87'' W, 531 m. (MICOLAB UNEB-VIII 0031).

#### 9. *Tetraploa aristata* Berk. & Broome

Bibliography consulted: Ellis (1971), Tanaka *et al.* (2009).

Distribution: Known distribution in South Africa, Germany, Australia, Barbados, Bolivia, China, Cuba, Fiji, Ghana, the Virgin Islands, India, Italy, Hong Kong, Jamaica, Malaysia, Mexico, Myanmar, Papua New Guinea, Pakistan, Peru, Puerto Rico, Kenya, the United Kingdom, Dominican Republic, Sierra Leone, Thailand, Uganda, the USA, and Venezuela (Farr & Rossman, 2019). In Brazil, there are records for the states of Bahia, Pará, Paraíba, Pernambuco, Rio Grande do Norte, Santa Catarina, and São Paulo (Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* inflorescence, 01.15.2015, col. N.G.S. Fortes, 09°49'82'' S and 038°28'99'' W, 537 m; on *S. coronata* leaflet collected from the litter, 01.15.2015, col. N.G.S. Fortes, 09°49'82'' S and 038°28'99'' W, 537 m. (URM 91163 and MICOLAB UNEB-VIII 0033).

#### Teleomorphs

Fungi with sexual reproduction by meiotic spores formed inside the asci. The same as teleomorphic or meiosporic fungi, that is, with sexual reproduction. This section shows fungi that produce ascospores (sexual spores or meiospores) in perithecium-like, thyriothecium-like, and cleistothecium-like ascomata.

#### Teleomorphs Non-lichenized

Fungi that do not associate with algae and/or cyanobacteria through lichenization.

Identification key for the non-lichenized teleomorphic genera of this study (Figura 3.A-Z)

1. Asci unitunicate or prototunicate .....	2
1'. Asci bitunicate .....	12
2. Asci prototunicate .....	3
2'. Asci unitunicate .....	4
3. Cleistothecium surrounded by Hülle cells; reddishbrown ascospores.....	<i>Emericella</i>
3'. Cleistothecium pale yellow, shiny; hyaline ascospores .....	<i>Eurotium</i>
4. Asci with an I <sup>+</sup> subapical ring.....	5
4'. Asci with an I subapical ring or without visible apical structure .....	8
5. Ascomata lenticular; filiform ascospores, with 1 median septum .....	<i>Oxydothis</i>
5'. Ascomata not as above; unicellular ascospores .....	6
6. Ascospores hyaline, with a layered mucilaginous sheath; occasionally brown at maturity and with a germinative tube.....	<i>Capsulospora</i>
6'. Ascospores brown at maturity, with a nonlayered mucilaginous sheath .....	7
7. Ascospores with germinative tube, brown ascospores and occasionally with a dwarf cell .....	<i>Anthostomella</i>
7'. Ascospores without germinative tube, with a pale median band .....	<i>Fasciatispora</i>
8. Ascomata stromatic .....	9
8'. Ascomata of other types.....	10

9. Asci 8-spored; hyaline, ellipsoid ascospores surrounded by a mucilaginous sheath..... *Camarotella*  
 9'. Asci multispored; hyaline or pale ascospores, allantoid, surrounded by a mucilaginous sheath ..... *Diatrypella*  
 10. Ascomata lenticular, semi-immersed under a blackish clypeus ..... *Linocarpon*  
 10'. Ascomata not as above.....11  
 11. Perithecium oval or globular, deeply immersed under a slightly raised or flattened clypeus ..... *Neolinocarpon*  
 11'. Perithecium almost or totally glabrous, with long neck; limoniform, apiculate, and smooth ascospores..... *Melanospora*  
 12. Thyriotheceum linear, with epidermoid texture wall ..... *Aulographum*  
 12'. Perithecium Immersed; brown, bicellular ascospores ..... *Didymosphaeria*

**1. *Anthostomella palmaria*** B.S Lu & K.D Hyde

Bibliography consulted: Lu and Hyde (2000).

Distribution: Known distribution in the United States (Hawaii), Thailand, and Brazil (Bahia), colonizing the palms *Cocos* sp., *Licuala longicalyca* Furtado, and *S. coronata* (Lu & Hyde, 2000; Farr & Rossman, 2019; Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on the rachis of *S. coronata* leaves collected from the litter, 05.07.2014, col. N.G.S. Fortes, 09°39'44.9" S and 038°28'01.9" W, 591 m. (URM 91149 and MICOLAB UNEB-VIII 0076).

**2. *Aulographum* sp.**

Bibliography consulted: The specimen is congeneric to *Aulographum*; we identified it based on the study by Sierra (2006).

Distribution: *Aulographum* species have a wide distribution, occurring as saprobes on plant remains (Farr & Rossman, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* bract, 07.14.2014, col. N.G.S. Fortes, 09°39'58" S and 038°28'04" W, 588 m. (URM 91152 and MICOLAB UNEB-VIII 0015).

**3. *Camarotella torrendiella*** (Batista) Bezerra & Vitoria

Bibliography consulted: Vitoria et al. (2008).

Distribution: In Brazil, there are records for the states of Alagoas, Amapá, Amazonas, Bahia, Ceará, Espírito Santo, Pará, Paraíba, Pernambuco, Rio Grande do Norte, Rio de Janeiro, and Sergipe, on the palms *Allagoptera brevicalyx* M. Moraes, *Attalea funifera* Mart. ex Spreng., *Bactris* sp., *B. pickelli* Burret, *B. ferruginea* Burret, *C. nucifera*, *Syagrus botryophora* (Mart.) Mart., *S. coronata*, *S. picrophylla* Barb. Rodr., *S. microphylla* Burret, *S. petraeae* (Mart.) Becc., *S. schizophylla* (Mart.) Glassman, *S. vagans* (Bondar) A.D. Hawkes, and *S. wedemannii* Burret (Vitoria, 2010; Farr & Rossman, 2019; Specieslink, 2019; Mendes and Urben, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet, 09.02.2014, col. N.G.S. Fortes, 09°39'39" S and 038°27'44" W, 557 m. (URM 91165 and MICOLAB UNEB-VIII 0020).

**4. *Capsulospora brunneispora*** K.D. Hyde

Bibliography consulted: Hyde (1996b), Hyde & Fröhlich (2000).

Distribution: Known distribution in Australia, Brazil, Brunei, Ecuador, Hong Kong, and Malaysia, colonizing the hosts

*Archontophoenix alexandrae* (F.Muell.) H.Wendl. & Drude, *Calamus australis* Mart., *Calamus conirostris* Becc., *C. nucifera*, *M. flexuosa*, *Phoenix hanceana* Kunth (Arecaceae), and *Pandanus tectorius* Parkinson (Pandanaaceae) (Farr & Rossman, 2019; Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* bract, 07.14.2014, col. N.G.S. Fortes, 09°39'58" S and 038°28'04" W, 588 m; on *S. coronata* bract collected from the litter, 07.14.2014, col. N.G.S. Fortes, 09°39'25" S and 038°29'28" W, 625 m. (URM 91153 and MICOLAB UNEB-VIII 0049).

**5. *Diatrypella caryotae*** R.K. Verma

Bibliography consulted: Verma (1996).

Distribution: Known distribution in India, colonizing the palm *Caryotae urens* L. This is the first record of this species in Brazil, with *S. coronata* as a new host for science (Verma, 1996).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole, 05.07.2014, col. N.G.S. Fortes, 09°48'45" S and 038°29'32" W, 700 m. (MICOLAB UNEB-VIII 0043).

**6. *Didymosphaeria* sp.**

Bibliography consulted: Lu and Hyde (2000).

Distribution: Genus whose species live in tropical regions (Farr & Rossman, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* bract, 05.07.2014, col. N.G.S. Fortes, 09°48'45" S and 38°29'32" W, 700 m. (MICOLAB UNEB-VIII 0065).

**7. *Emericella* sp.**

Bibliography consulted: Malloch and Cain (1972).

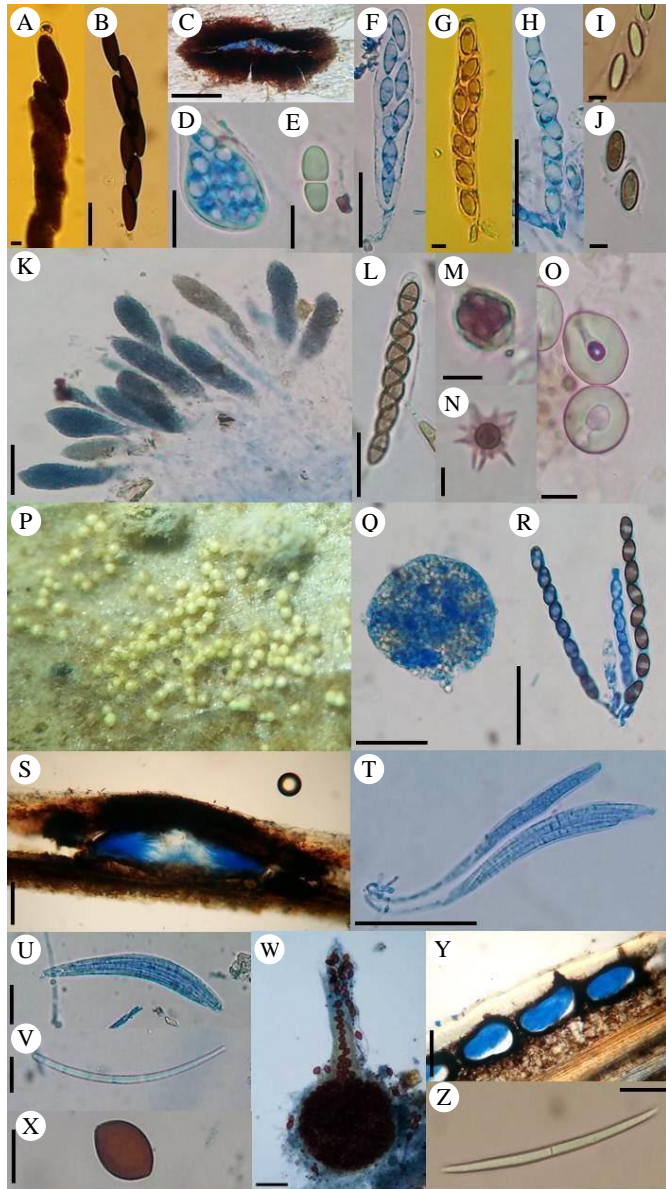
Distribution: The genus is cosmopolitan, with species in association with plants and in the soil (Farr & Rossman, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaf rachis, 01.15.2015, col. N.G.S. Fortes, 09°49'82" S and 038°28'99" W, 537 m. (MICOLAB UNEB-VIII 0027).

**8. *Eurotium* sp.**

Bibliography consulted: Hubka et al. (2013).

Distribution: The representatives of this group have a wide distribution in nature, being referred to as xerophiles or halophiles. Reports show that these individuals significantly impact the economy due to their capacity to degrade stored grains, cereals, textile products, herbarium materials, leather articles, among others (Hubka *et al.*, 2013).



**Figure 3.** Non-lichenized Teleomorphic Fungi A-B: *Anthostomella palmaria*; C-E: *Aulographum* sp.; F: *Camarotella torrendiella*; G-J: *Capsulospora brunneispora*; K: *Diatrypella caryotae*; L: *Didymosphaeria* sp.; M-O: *Emericella* sp.; P-Q: *Eurotium* sp.; R: *Fasciatispora petrakii*; S-T: *Linocarpon* sp.; U-V: *Neolinocarpon attaleae*; W-X: *Melanospora zamiae*; Y-Z: *Oxydothis* sp. (A-B= 5 µm, C= 75 µm, D= 15 µm, E= 10 µm, F= 50 µm, G= 4 µm, H= 50 µm, I-J= 7,5, K= 30 µm, L= 30 µm, M= 10 µm, N= 5 µm, O= 20 µm, Q= 40 µm, R= 40 µm, S= 180 µm, T= 50 µm, U= 20 µm, V= 30 µm, W= 10 µm, X= 75 µm, Y= 50 µm, Z= 25 µm).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet,

01.15.2015, col. N.G.S. Fortes, 09°49'81'' S and 38°28'98'' W, 533 m; on *S. coronata* leaflet, 01.15.2015, col. N.G.S. Fortes, 09°49'82'' S and 38°28'99'' W, 537 m. (MICOLAB UNEB-VIII 0026).

**9. *Fasciatispora petrakii*** (Mhaskar & V.G. Rao) K.D. Hyde  
Bibliography consulted: Hyde (1995).

Distribution: Known distribution in Australia, Brunei, China, Philippines, Florida (USA), India, Hong Kong, Java, Malaysia, Papua New Guinea, Singapore, and Thailand, colonizing hosts of the family Arecaceae, belonging to the following genera: *Archontophoenix*, *Butia* (Becc.) Becc., *Calamus* L., *Cocos*, *Cyrtostachys* Blume, *Daemonorops* Blume ex Schult.f., *Elaeis*, *Euterpe*, *Licuala*, *Livistona*, *Mauritia* L.f., *Metroxylon* Rottb., *Oncosperma*, *Phoenix*, *Sabal*, *Syagrus*, *Trachycarpus* H.Wendl., and *Wallichia* (Farr & Rossman, 2019). In Brazil, there are records of these specimens on *Butia* sp. (Federal District), *E. oleifera* (Bahia and Pernambuco), *Elaeis guineensis*, *M. flexuosa*, and *S. botryophora* (Pernambuco) (Mendes & Urben, 2019; Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* bract, 07.14.2014, col. N.G.S. Fortes, 09°39'58'' S and 038°28'04'' W, 588 m. (URM 91154 and MICOLAB UNEB-VIII 0002).

#### 10. *Linocarpon* sp.

Bibliography consulted: Hyde (1997).

Distribution: Group whose species live mostly in tropical regions of Oceania (Farr & Rossman, 2019). Currently, this genus comprises 43 valid epithets (Species Fungorum, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole collected from the litter, 07.14.2014, col. N.G.S. Fortes, 09°47'18'' S and 038°29'31'' W, 685 m. (MICOLAB UNEB-VIII 0010).

#### 11. *Melanospora zamiae* Corda

Bibliography consulted: Cannon and Hawksworth (1982).

Distribution: This fungus is very widespread in the tropics and in warm temperate regions, frequently occurring on rotting vegetation or in association with animal waste. It has known distribution in Germany, Egypt, the USA (California, Florida, Illinois, and New York), Ghana, India, England, Israel, Libya, Tanzania, and Venezuela (Farr & Rossman, 2019). In Brazil, there are records of these specimens on goat droppings, in Recife city, Pernambuco State (Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* leaflet, 01.15.2015, col. N.G.S. Fortes, 09°49'82'' S and 038°28'99'' W, 537 m. (MICOLAB UNEB-VIII 0041).

**12. *Neolinocarpon attaleae*** N.S. Vitoria & J.L. Bezerra

Bibliography consulted: Vitoria et al. (2013).

Distribution: Vitoria et al. (2013) were the first authors to describe and illustrate this species, which colonized the palm *A. funifera* in Bahia State.

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole, 09.02.2014, col. N.G.S. Fortes, 09°39'39" S and 038°27'44" W, 557 m.

**13. *Oxydothis* sp.**

Bibliography consulted: Hyde and Frohlich (2000).

Distribution: Its representatives occur in nature as saprobes, endophytes, or parasites, on leaves or petioles, usually causing deep and dark lesions. The literature refers to members of the

families Arecaceae, Poaceae, Liliaceae, and Pandanaceae as their hosts. Currently, this genus comprises 79 valid epithets (Species Fungorum, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole, 05.07.2014, col. N.G.S. Fortes, 09°48'45" S and 038°29'32" W, 700 m; on *S. coronata* petiole collected from the litter, 10.21.2014, col. N.G.S. Fortes, 09°38'16" S and 038°29'26" W, 595 m. (URM 91158 and MICOLAB UNEB-VIII 0007).

*Teleomorphs Lichenized*

Fungi that associate with algae and/or cyanobacteria through lichenization.

Identification key for the lichenized teleomorphic genera of this study (Figura 4.A-J)

- 1. Thallus crustose, grayishwhite .....2
- 1'. Thallus crustose, yellowish-white; verruciform, solitary or gregarious apothecium, with the same color as the thallus; asci twospore, bitunicate ..... *Pertusaria*
- 2. Ascospores ellipsoid to fusiform, macrocephalic with transverse septa ..... *Arthonia*
- 2'. Ascospores muriform with transverse and longitudinal septa .....3
- 3. Ascospores hyaline to pale yellow, smooth with lumina ..... *Cryptothecia*
- 3'. Ascospores hyaline, smooth with mucilaginous sheath..... *Polymeridium*

**1. *Coniocarpon cinnabarinum*** DC.

Bibliography consulted: Cáceres (2007).

Distribution: In Brazil, there are records for the states of Alagoas, Pernambuco, Rio Grande do Sul, Rondônia, São Paulo, and Sergipe (Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole collected from the litter, 10.21.2014, col. N.G.S. Fortes, 09°38'16" S and 038°29'26" W, 595 m; on *S. coronata* petiole, 10.21.2014, col. N.G.S. Fortes, 09°39'02" S and 038°28'52" W, 602 m. (MICOLAB UNEB-VIII 0067).

**2. *Cryptothecia* sp.**

Bibliography consulted: Cáceres (2007).

Distribution: In Brazil, there are records of this genus in the states of Amapá, Amazonas, Federal District, Goiás, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, Santa Catarina, São Paulo, and Sergipe (Specieslink, 2019).

Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole, 10.21.2014, col. N.G.S. Fortes, 09°38'02" S and 038°29'26" W, 599 m. (MICOLAB UNEB-VIII 0071).

**3. *Pertusaria carneola*** (Eschw.) Müll. Arg.

Bibliography consulted: Cáceres (2007).

Distribution: In Brazil, there are records for the states of Pernambuco, Piauí, Rio Grande do Sul, and Sergipe (Specieslink, 2019)

Material examined: Brazil. Bahia: Raso da Catarina Ecological

Station (ESEC), Paulo Afonso city, on *S. coronata* stem collected from the litter, 09.02.2014, col. N.G.S. Fortes, 09°37'39" S and 038°29'27" W, 596 m; on *S. coronata* petiole, 05.07.2014, col. N.G.S. Fortes, 09°40'02" S and 038°27'56" W, 567 m. (MICOLAB UNEB-VIII 0140).

**4. *Polymeridium* sp.**

Bibliography consulted: Cáceres (2007).

Distribution: In Brazil, there are records of this genus in the states of Bahia, Ceará, Espírito Santo, Minas Gerais, Pernambuco, Piauí, Rio Grande do Sul, Rondônia, and Sergipe (Specieslink, 2019).

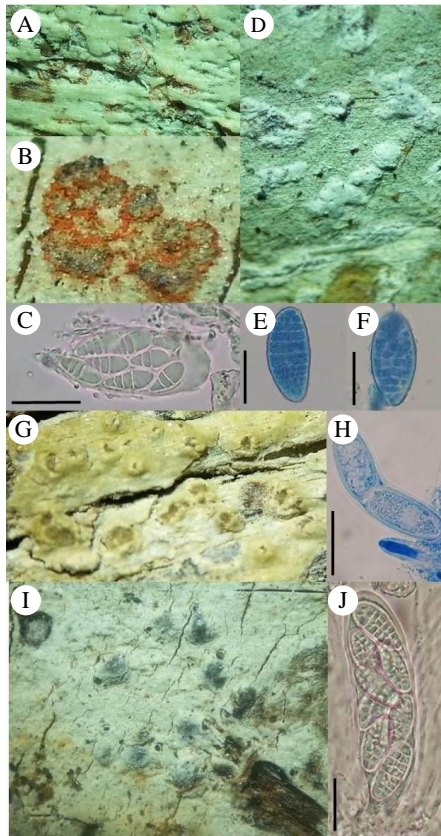
Material examined: Brazil. Bahia: Raso da Catarina Ecological Station (ESEC), Paulo Afonso city, on *S. coronata* petiole, 10.21.2014, col. N.G.S. Fortes, 09°39'02" S and 038°28'52" W, 602 m; on *S. coronata* petiole collected from the litter, 10.21.2014, col. N.G.S. Fortes, 09°38'16" S and 038°29'26" W, 595 m; on *S. coronata* petiole collected from the litter, 07.14.2014, col. N.G.S. Fortes, 09°40'06" S and 038°27'47" W, 536 m. (MICOLAB UNEB-VIII 0069).

*S. coronata* occurs naturally in the Brazilian semiarid region and, although it is not an endangered species, its disordered and intensive use makes this host vulnerable (Silva et al., 2006).

The knowledge about the mycota of the palm *S. coronata* in the Caatinga biome is limited, being restricted to publications of a taxonomic nature of Cruz et al. (2009), that described and illustrated three species of Ascomycota: *Piricauda cochinchensis* (Subram.) M.B. Ellis, *Helicosporium virescens* (Pers.) Sivan. and *Repetophragma filiferum* (Piroz.) R.F. Castañeda, Gusmão and Heredia, found in the



municipalities of Senhor do Bonfim and Campo Formoso (Bahia); Santos *et al.* (2016) with 12 cataloged species, collected in Paulo Afonso, Juá-Bahia; Vitoria *et al.* (2016) with Checklist of 25 taxa from expeditions carried out at ESEC Raso da Catarina and Paulo Afonso in the Juá and Bogó-Bahia villages; Santos and Vitoria (2017) with seven descriptions of fungi found in Água Branca-Alagoas; Santos *et al.* (2019a) with a new record for the American continent collected in Paulo Afonso, Juá-Bahia and Santos *et al.* (2019b) presenting 20 lichenized and non-lichenized Ascomycota species collected in Paulo Afonso (Juá and Bogó villages) and Nova Glória (Brejo do Burgo and Serrota villages).



**Figure 4.** Lichenized Teleomorphic Fungi. A-C: *Coniocarpon cinnabarinum*; D-F: *Cryptothecia* sp.; G-H: *Pertusaria carneola*; I-J: *Polymeridium* sp. (C= 30 µm, E-F= 20 µm, H= 60 µm, J= 20 µm).

Currently, according to publications reporting studies on the *S. coronata* mycota, the occurrence record is less than 100 identified species. Thus, the new records presented in this research expand not only the information about *S. coronata* mycota collected at ESEC Raso da Catarina, but also enriches Brazilian mycology.

The number of fungal species on Arecaceae is usually large. Hyde (1996a) suggested for this family the palm:fungi ratio of 1:26, higher than the ratio of 1:6, generally accepted for other plants. Fröhlich and Hyde (1999) estimated 1:33 the palm: fungus ratio for the tropics. According to Pinruan *et al.* (2007), the morphology of palms may influence fungal colonization. In the present study, anamorphic (asexual) fungi occurred mostly on leaflets, while teleomorphic (sexual) fungi

occurred on the petiole and leaf rachis. For Pinruan *et al.* (2007), palm parts exposed to different microhabitat conditions and substrate nutrient availability show differences in fungal populations. Palm stems and petioles provide a substrate rich in cellulose and lignin, and only fungi with the necessary enzymes can use it. Palm leaves favor anamorphic (asexual) species that colonize quickly, and dry after nutrient depletion.

Considering the information from publications and online databases such as SpeciesLink (2019), Embrapa - Fungi Reported in Plants in Brazil (Mendes & Urben, 2019), and Fungal databases - Fungus-Host Distributions (Farr & Rossman, 2019), the results obtained in this study considerably increase the knowledge about the richness of fungal species sheltered by *S. coronata*, because this study reports *S. coronata* as a new substrate for 22 identified Ascomycota species.

## Conclusion

The information we provided about the Ascomycota on *S. coronata* expands the knowledge about the taxonomy, geographic distribution, and ecology of the mycota in the Caatinga biome. In addition, it highlights the importance of this host for the native fungal community, suggesting the continuation of research. Future studies must focus on biological diversity, registration of new species, and the existing relationships between these organisms and the plant, with a view to developing biodiversity conservation strategies.

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