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ASCOMYCETES IN *Syagrus coronata* (Mart.) Becc. IN THE RASO DA CATARINA ECOLOGICAL STATION, WITH NEW DISTRIBUTION RECORDS[1]

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Abstract: There is a great need to increase knowledge about the mycobiota associated with the flora of the Caatinga. Among the plant species that occur naturally in the biome, *Syagrus coronata* (Mart.) Becc., popularly known as licurizeiro, is considered one of the main palm trees in the Brazilian semiarid region. Therefore, seeking to identify the ascomycete fungi that develop on its leaves, we carried out two expeditions, one in August 2017 and another in April 2018, to the Raso da Catarina Ecological Station, to collect leaves in different stages of senescence. The material was sent to the UNEB Mycology laboratory for treatment, morphological analysis and identification based on relevant literature. We recorded the presence of thirteen species of fungi growing on the palm leaf structures, seven of which were mitosporic and six meiosporic, according to the reproductive mode. Among the meiosporic individuals, there were lichenized and non-lichenized forms. Regarding the type of colonized leaf substrate, mitosporic species were found only in leaflets, while meiosporic species were present in all leaf portions. In addition, most individuals were found as saprophytes, but saprophytes and mutualistic individuals were also identified. The fungi *Hendersonula australis* Speg. and *Graphis librata* C. Knight, had their first records in Brazil and Bahia, respectively. Furthermore, S. coronata appeared as a new botanical substrate for six ascomycetes. The results of the present study collaborate with the expansion of data on the distribution of Ascomycota. They also raise a discussion about possible factors that influence the establishment of fungal communities in the different leaf portions of the licuri tree and increase the understanding of the ecological importance of this palm for the biodiversity of the Brazilian semiarid region.

Keywords: Biodiversity; Caatinga; Fungi; Palms; Taxonomy.

ASCOMICETOS EM *Syagrus coronata* (Mart.) Becc. NA ESTAÇÃO ECOLÓGICA RASO DA CATARINA, COM NOVOS REGISTROS DE OCORRÊNCIA

Resumo: Há uma grande necessidade de ampliar o conhecimento sobre a micobiota associada à flora da Caatinga. Dentre as espécies vegetais que ocorrem naturalmente no bioma, *Syagrus coronata* (Mart.) Becc., popularmente conhecido como licurizeiro, é considerado uma das principais palmeiras da região semiárida brasileira. Diante disso, buscando identificar os fungos ascomicetos que se desenvolvem em suas folhas, realizamos duas expedições, uma em agosto de 2017 e outra em abril de 2018, à Estação Ecológica Raso da Catarina, para coleta de folhas em diferentes graus de senescência. O material foi encaminhado ao laboratório de Micologia da UNEB para tratamento, análise morfológica e identificação com base em literatura pertinente. Registramos a presença de treze espécies de fungos crescendo nas estruturas foliares da palmeira, das quais sete eram mitospóricas e seis meiospóricas, de acordo com o modo reprodutivo. Dentre os indivíduos meiospóricos, haviam formas liquenizadas e não liquenizadas. Em relação ao tipo de substrato foliar colonizado, as espécies mitospóricas foram encontradas apenas nos folíolos, enquanto as meiospóricas estiveram presentes em todas as porções foliares. Além disso, a maioria dos indivíduos foi encontrados como sapróbios, mas indivíduos fitopatógenos e mutualistas também foram identificados. Os fungos *Hendersonula australis* Speg. e *Graphis librata* C. Knight, tiveram seus primeiros registros no Brasil e na Bahia, respectivamente. Além disso, *S. coronata* se apresentou como novo substrato botânico para seis ascomicetos. Os resultados do presente estudo colaboram com a ampliação dos dados de distribuição dos Ascomycota. Também levantam uma discussão sobre possíveis fatores que influenciam o estabelecimento das comunidades fúngicas nas diferentes porções foliares do licurizeiro e aumentam a compreensão sobre a importância ecológica dessa palmeira para a biodiversidade do semiárido brasileiro.

Palavras-chave: Biodiversidade; Caatinga; Fungos; Palmeiras; Taxonomia.

ASCOMYCETES EN *Syagrus coronata* (Mart.) Becc. EN LA ESTACIÓN ECOLÓGICA RASO DA CATARINA, CON NUEVOS REGISTROS DE OCURRENCIA

Resumen: Existe una gran necesidad de incrementar el conocimiento sobre la micobiota asociada a la flora de la Caatinga. Entre las especies de plantas que se encuentran naturalmente en el bioma, *Syagrus coronata* (Mart.) Becc., Popularmente conocida como licurizeiro, es considerada una de las principales palmeras del semiárido brasileño. Por ello, buscando identificar los hongos ascomicetos que se desarrollan en sus hojas, realizamos dos expediciones, una en agosto de 2017 y otra en abril de 2018, a la Estação Ecológica Raso da Catarina, para recolectar hojas en diferentes grados de senescencia. El material fue enviado al laboratorio de Micología de la UNEB para su tratamiento, análisis morfológico e identificación en base a la literatura relevante. Se registró la presencia de trece especies de hongos creciendo en las estructuras de la hoja de palma, siete de las cuales eran mitospóricas y seis meiospóricas, según el modo reproductivo. Entre los individuos meiopóricos, había formas liquenizadas y no liquenizadas. En cuanto al tipo de sustrato foliar colonizado, las especies mitospóricas se encontraron solo en folíolos, mientras que las especies meiospóricas estuvieron presentes en todas las porciones foliares. Además, la mayoría de los individuos se encontraron como saprobios, pero también se identificaron individuos fitopatógenos y mutualistas. Los hongos *Hendersonula australis* Speg. y *Graphis librata* C. Knight, tuvieron sus primeros discos en Brasil y Bahía, respectivamente. Además, *S. coronata* apareció como un nuevo sustrato

botánico para seis ascomicetos. Los resultados del presente estudio colaboran con la expansión de los datos de distribución de Ascomycota. También plantean una discusión sobre los posibles factores que influyen en el establecimiento de comunidades de hongos en las diferentes porciones foliares del licurizeiro y aumentan la comprensión de la importancia ecológica de esta palmera para la biodiversidad de la región semiárida brasileña.

Palabras clave: Biodiversidad; Caatinga; Hongos; Palmeras; Taxonomía.

INTRODUCTION

The Caatinga biome represents the largest tropical semiarid ecoregion of South America (Moro et al., 2016), with an area of ca. 844.453 km², which corresponds to 11% of the Brazilian territory and 54% of Northeastern Brazil. Approximately 7% of the Caatinga is protected by conservation units, but only 1% is protected by integral protection conservation units (e.g., parks, biological reserves, and ecological stations) (MMA, 2018). The Raso da Catarina Ecological Station (RCES) is the only integral protection conservation unity in the State of Bahia's Caatinga area. It has an area of 104,844.40 hectares and was created to protect the biome and foster research and environmental education (MMA, 2020).

The fungal diversity in the Caatinga is remarkable (Maia et al., 2015; Gusmão and Maia, 2006). However, research focusing on the mycobiota of RCES is still insipient. Fungi are an essential part of ecosystems working as decomposers, mutualists and pathogens (Schmit and Mueller, 2007). According to Wu et al. (2019), based on studies dependent or not on cultures, the estimated number of fungi is around 12 million (i.e., 11.7 to 13.2) species. Taxonomic mycological studies focusing on identifying and understanding the species of Ascomycota in the region have only intensified starting in 2012 (Vitória et al. 2016b, 2020; Rocha and Vitória, 2020; Fortes et al., 2020).

Funghi is considered one of the largest kingdoms in Eukaryote, with an ever-growing number of accepted species, increasing with every study and fieldwork worldwide (McLaughlin and Spatafora, 2014). Its classification is under continuous revision, primarily due to molecular phylogenetic studies (Wijayawardene et al., 2020). Recently, Wijayawardene et al. (2020) presented an updated classification for Funghi, dividing it into 19 phyla: Aphelidiomycota, Ascomycota, Basidiobolomycota, Basidiomycota, Blastocladiomycota, Calcarisporiellomycota, Caulochytriomycota, Chytridiomycota, Entomophthoromycota, Entorrhizomycota, Glomeromycota,

Kickxellomycota, Monoblepharomycota, Mortierellomycota, Mucoromycota, Neocallimastigomycota, Olpidiomycota, Rozellomycota, and Zoopagomycota.

Ascomycota is the largest phylum, with ca. 6600 species (Wijayawardene et al., 2018). The ascum (also known as “bag”) is characteristic of the group and refers to the structure that contains the sexual endospores known as ascospores (sexual reproduction). Asexual reproduction is done by means of mitosis-generated spores (Webster and Weber, 2007). Regarding habit, they can be parasites (biotrophic or necrotrophic), symbionts, or saprophytes in a wide range of substrates (e.g., soil, water, plant mater, etc.).

Among the plant substrates, palms (Arecaceae) have been one of the main focuses of mycological diversity studies (Hyde et al., 1997; Hyde and Fröhlich, 2000; Souza et al., 2008; Vitória et al., 2008, 2011a, b, 2012 a,b, 2014, 2016 a,b, 2019a,b, 2020). Arecaceae is a highly diverse group of tropical plants with considerable cultural, social and economic importance (Zambrana et al., 2007). *Syagrus coronata* (Mart.) Becc. (the licuri palm) is a Neotropical economically relevant palm tree endemic to Brazil and one of the country’s most important species in the semiarid region (Gomes et al., 2018).

An in-depth literature revision of the Ascomycete associated with *S. coronata* highlights the licuri palm’s mycobiota is still poorly studied (Cruz and Gusmão, 2009; Vitória et al., 2016b, 2020; Santos and Vitória, 2017; Rocha and Vitória, 2020; Santos et al., 2016, 2019, 2020; Fortes et al., 2020). Some organs of palm, such as the leaves, can house a highly diverse fungic community (Pinruan et al., 2007). Palm leaves have particular characteristics, with a wide range of sizes, shapes and textures. They are generally constituted of a sheath, petiole, rachis and a divided blade. The leaf-sheath is the broadened portion at the base of the petiole, which wraps around the stipe. The petiole is a stalk that connects the leaf-sheath to the blade, while the rachis is an extension of the petiole where the blade segments are attached. Finally, the leaf-blade represents the laminar and photosynthetic portion of the palm leaf (Sodré, 2005). These structures accumulate organic matter and humidity, which provide the perfect conditions for the establishment and development of microfungi (Drumond, 2007; Oliveira et al., 2015; Castro, 2016).

Thus, the present study aimed to identify and ascomycete fungi that are found growing on the leaves of *S. coronata* in the Raso da Catarina Ecological Station.

MATERIAL AND METHODS

Study area

The study was carried out inside the Raso da Catarina Ecological Station (RCES), located at W 38º44'00" to W 39º29'20" and S 90 9°33'13" to S 9°54'30", extending through the municipalities of Paulo Afonso (8.37%), Rodelas (31.39%) and Jeremoabo (60.24%). The RCES is included in the Caatinga biome, with its vegetation ranging from arboreous to shrubby (Paes and Dias, 2008).

Sampling

Fieldwork was carried out at the RCES in the area inside the municipality of Paulo Afonso during August 2017 and April 2018. During field expeditions, specimens of *S. coronata* colonized by fungi were randomly marked and geotagged. Leaves in different senescence stages (i.e., green leaves, dry leaves still attached to the plant, and dry fallen leaves) were collected from each of the selected specimens for the identification of their mycobiota (Figure 1).

Figure 1 Different senescence stages of the licuri palm (*Syagurus coronata*) leaves collected at the Raso da Catarina Ecological Station (RCES). Photo: Rocha, P.Q.

The plant samples were cut into fragments of 10 to 20 cm long using a machete or pruning shears and divided into leaf-sheath, petiole and leaf-blade to facilitate transport and handling. These fragments were stored in Kraft paper bags and adequately identified (i.e., collector, collector number, geographic coordinates, locality, date, and substrate).

Morphological characterization, identification and storing

The plant samples were studied using two approaches: 1) direct observation of the fungi on the *S. coronata* leaves; 2) observation after the samples were stored in a wet chamber. Fragments of the fungic structures found on the leaves were removed using a hypodermic needle. These samples were mounted on microscope slides using: 1) lactophenol with Cotton Blue to reveal hyaline structures; 2) Melzer (5%) for the amyloid reaction; 3) potassium hydroxide (KOH 10%) to dissolve proteic materials; and 4) water, to allow the observation of the mucilaginous sheath around the spores. Furthermore, we made free-handed longitudinal sections to observe and measure reproductive structures.

The wet chambers were set up using plastic trays, which were appropriately disinfected using 70% ethanol and sodium hypochlorite (2%). The bottom and lateral walls of the trays were covered with damp paper towels soaked with distilled water. Every two days, the trays were had their cover removed to allow them to be resoaked. The plant samples were stored and kept at room temperature for seven days and under a natural light regimen to evaluate fungic growth. After this period, the samples were topographically analyzed under the stereomicroscope (Zeiss Primo Star).

Identification was based on the morphology of reproductive structures, based on relevant literature (Hayward, 1977; Sutton and Dyko, 1989; Sutton, 1980; Barnett and Hunter, 1998; Lu and Hyde, 2000; Cáceres, 2007; Vitória et al., 2008; Joshi et al., 2010; Phillips et al., 2013; Crous et al., 2015). After identification, the analyzed samples were included at MICOLAB-UNEB VIII (Teaching collection, fungarium and fungic cultures collection of the Mycology Laboratory). These materials consist of dried plant fragments with reproductive fungic structures and permanent PVA (polyvinyl alcohol) resin slides.

RESULTS

We identified 13 species of Ascomycota, arranged into 13 genera, nine families, and nine orders (including *Incertae sedis* families) (Table 1). Of the recorded taxa, seven species are mitosporic (i.e., asexual reproductive form), and six are meiosporic (i.e., sexual reproductive form). Of the meiosporic fungi, three were lichenized (i.e., present a mutualistic association with a phycobiont), and three were non-lichenized (i.e., lack a mutualistic association with a phycobiont) (Table 1). Regarding life forms, 61% of the recorded species were saprophytes, 22% were phytopathogens, and 17% were

mutualistic lichens) (Table 1).

Table 1 Taxon distribution and life forms of the Ascomycota observed on the leaves of *S. coronata* in the RCES.

ORDER	FAMILY	TAXA	S/T	LIFE FORM
NON-LICHENIZED MEIOSPORIC FUNGI				
Xylariales	Xylariaceae	***Anthostomella leptospora*** (Sacc.) S.M. Francis	01	**saprophyte**
Botryosphaeriales	Botryosphaeriaceae	***Botryosphaeria*** sp.	01	**saprophyte**
Phyllachorales	Phyllachoraceae	***Camarotella torrendiella*** (Bat.) J.L. Bezerra & N.S. Vitória	02	**phytopathogen**
LICHENIZED MEIOSPORIC FUNGI				
Caliciales	Caliciaceae	***Buellia* sp.**	01	**mutualist**
Ostropales	Graphidaceae	***Graphis librata*** C. Knight	01	**mutualist**
Pyrenulales	Pyrenulaceae	***Pyrenula ochraceoflava*** (Nyl.) R.C. Harris	01	**mutualist**
MITOSPORIC FUNGI				
Pleosporales	Pleosporaceae	***Bipolaris* sp.**	01	**saprophyte**
Pleosporales	Pleosporaceae	***Curvularia* sp.**	01	**saprophyte**
Botryosphaeriales	Botryosphaeriaceae	***Diplodia* sp.**	05	**saprophyte [3]; phytopathogen [2]**
Hypocreales	Nectriaceae	***Fusarium* sp.**	01	**saprophyte**
Botryosphaeriales	*Incertae sedis*	***Hendersonula australis*** Speg.	01	**-**
Botryosphaeriales	Botryosphaeriaceae	***Lasiodiplodia theobromae*** (Pat.) Griffon & Maubl	03	**saprophyte [2]; phytopathogen [1]**
Incertae sedis	*Incertae sedis*	***Wojnowiciella* sp.**	01	**saprophyte**
09*	09*	13*	20*	**-**

S/T (specimens/taxa) – number of specimens per taxa.
*Total number of taxa in each column.

Fungi were observed growing on different *S. coronata* leaf portions and stages of senescence. Seven species were found growing on the leaflets of dry leaves still attached to the plant, while three species were found growing on the leaflets of green leaves. Three species were found growing on the petioles of dry leaves still attached to the plant. Finally, two species were found growing on leaflets of fallen leaves, while a sole species was found growing on the rachis of green leaves. Some species were observed growing on more than one substrate (Table 2).

Table 2 Ascomycetes identified in different parts, senescence stages, and microhabitats of *S. coronata* leaves in the RCES.

SUBSTRATE	SENESCENCE STAGE OF THE LEAF	TAXA
LEAFLETS	Green	***Hendersonula australis***
		Lasiodiplodia theobromae
		***Diplodia* sp.**
		03*
	Dry but still attached to the plant	***Botryosphaeria* sp.**
		***Bipolaris* sp.**
		***Curvularia* sp.**
		***Fusarium* sp.**
		***Wojnowiciella* sp.**
		Lasiodiplodia theobromae
		***Diplodia* sp.**
		07*
	Fallen	***Anthostomella leptospora***
		Lasiodiplodia theobromae
		02*
RACHIS	Green	***Camarotella torrendiella***
		01*
PETIOLE	Dry but still attached to the plant	***Buellia* sp.**
		Graphis librata
		Pyrenula ochraceoflava
		03*

* Total number of taxa in each substrate.

Hendersonula australis is reported for Brazil for the first time, while *Graphis*

librata is reported for the State of Bahia for the first time. *Bipolaris* sp., *Buellia* sp., *Fusarium* sp., *G. librata*, *H. australis*, and *Pyrenula ochraceoflava* are recorded colonizing the leaves of *S. coronata* for the first time.

The observed ascomycetes are presented in alphabetical order within the groups: 1) non-lichenized meiosporic fungi; 2) lichenized meiosporic fungi; and 3) mitosporic fungi. We provide a list of examined specimens and data on their geographic distribution. Finally, we present morphological descriptions for all taxa identified to the species rank.

Non-lichenized meiosporic fungi

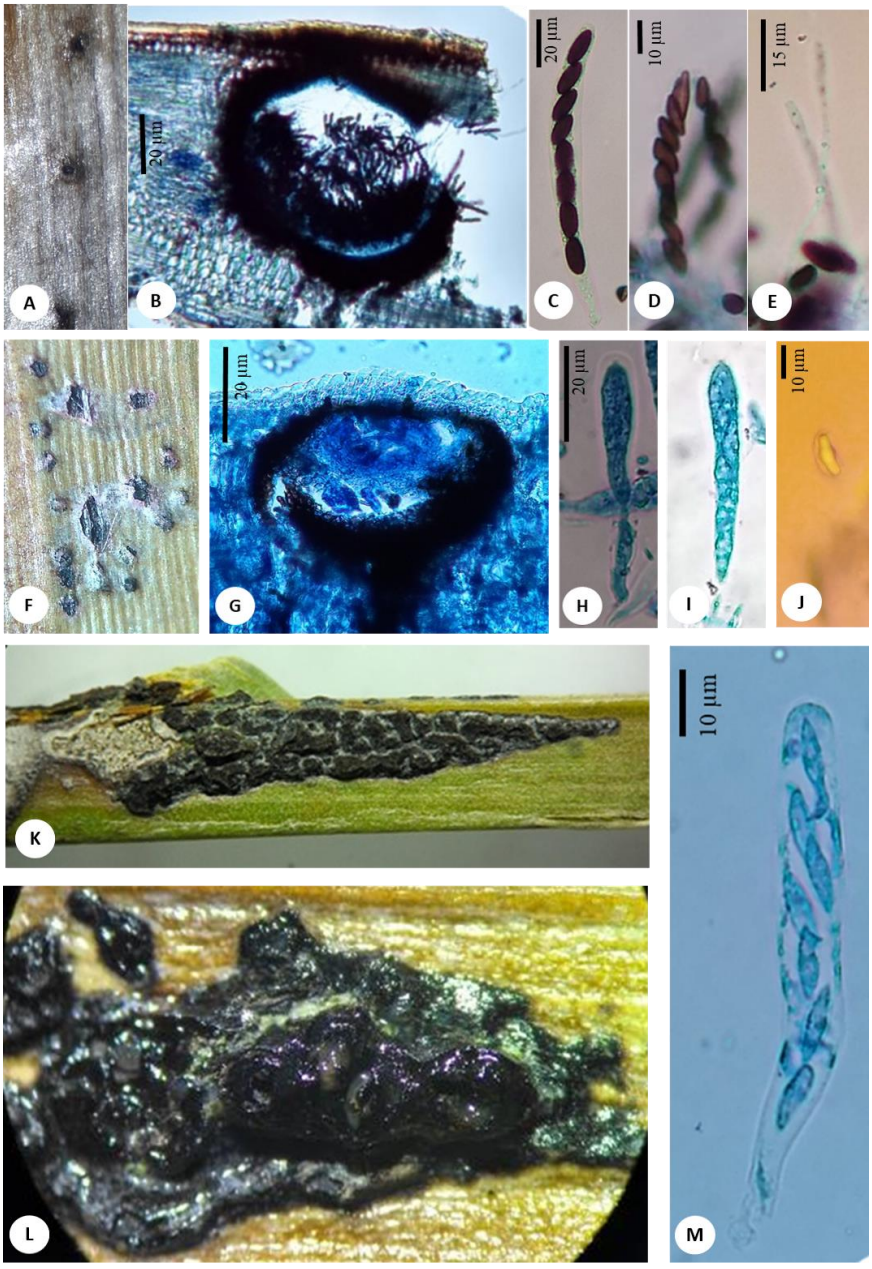

Figure 2. A-E. *Anthostomella leptospora*. **a.** Habit. **b.** Ascoma in longitudinal section. **c-**

d. Asci and ascospores. **e.** Subapical ring. **F-J.** *Botryosphaeria* sp. **f.** Habit. **g.** Ascoma in longitudinal section. **h-i.** Ascum. **j.** Ascospore. **K-M.** *Camarotella torrendiella*. **k-l.** Habit. **m.** Ascum and ascospores.

1. *Anthostomella leptospora* (Sacc.) S.M. Francis, Mycol. Pap. 139: 24 (1975). Figure 2. A-E

Description: Ascoma perithecial (Figure 2. A-B), 100 × 85 µm in longitudinal, immersed, solitary, visible on the surface as black dots with a central ostiole, outer wall thick, black, inner wall thin, hyaline, peridium 45 µm wide, clipeum 60 µm long, central, black. Asci (Figure 2. C-D) (67.5–)75–87.5 × (5–)7.5 µm, clavate, subpetiolate, unitunicate, monostichous, 8-spored, with a subapical ring I+, discoid (Figure 2. E). Paraphyses 2.5 µm wide, hyaline, septate, unbranched. Ascospores (Figure 2. C-D) 10–12.5(–15) × 5–7.5 µm, cylindric to ellipsoid, smooth, hyaline to olivaceous when young, becoming dark brown when mature, with a longitudinal germinative slit, straight, as long as the spore, mucilaginous sheath not seen, dwarf cell absent.

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo de *S. coronata* em serrapilheira, 30.08.2017, *col*. P. Q. Rocha, 09°39’ 05.1” S and 038° 29’ 07.7” W, 611 m (MICOLAB-UNEB VIII 0141).

Distribution: Australia, Brazil, Brunei, France, Southern Africa, Thailand, UK, Venezuela, and Zambia (Francis, 1975; Lu and Hyde, 2000).

Substrates: Arecaceae: *Borassus* sp., *Calamus* spp., *Elaeis* sp., *Phoenix* sp., *Pinanga* sp., and *S. coronata* (rachis); Cyperaceae: *Cladium* spp., and *Lepidosperma* sp.; Poaceae: *Olyra* sp.; Cupressaceae: *Sequoia* sp. (Lu and Hyde, 2000; Vitória et al., 2016b; Santos et al., 2016; Mendes and Urben, 2020; SMML, 2020; Species Link, 2020).

***2. Botryosphaeria* sp.** Figure 2. F-K

Consulted literature: Phillips et al. (2013)

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, 30.08.2017, *col*. P. Q. Rocha, 09°39’ 05.1” S 038° 29’ 07.7” W, 611 m (MICOLAB-UNEB VIII 0142).

Distribution: Over 30 countries, including Brazil (Species Link, 2020; SMML, 2020)

Substrates: 134 plant species (SMML, 2020), plus *S. coronata* (leaflets and spathe) (Vitória et al., 2016b).

3. Camarotella torrendiella (Bat.) J.L. Bezerra & Vitória, in Vitoria, Bezerra, Gramacho & Luz, Tropical Plant Pathology 33 (4): 297 (2008) Figure 2. L-N

Description: Ascigerous stromata with a flat base, black, carbonaceous, subcircular, asperous, initially isolated, posteriorly becoming confluent, forming more or less parallel lines of verrucae, hardly detachable from the leaves. Stromatic tissue 150 µm thick, black. Perithecia 140 × 200 µm in longitudinal section. Asci 70–105 × (15–)17.5(–22.5) µm, clavate, bitunicate, subpedicellate, I-, 8-spored, polistichous. Paraphyses 2.5 µm wide, hyaline, unbranched, septate. Ascospores 17.5–20(–22.5) × 5–7.5 µm, fusiform, smooth, 2-celled, 3-septate, hyaline, mucilaginous sheath present, dwarf cell absent.

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em raque verde de *S. coronata* (causando necrose de aspecto verrugoso), 11.04.2018, *col*. P.Q. Rocha, 09°39’03.6” S 038° 29’07.5” W, 602 m (MICOLAB-UNEB VIII 0143). Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em raque verde de *S. coronata*, 11.04.2018, *col*. P.Q. Rocha 09° 39’05.9” S 038° 29’07.7” W, 602 m (MICOLAB-UNEB VIII 0144).

Distribution: Endemic to Brazil (Acre, Alagoas, Amapá, Amazonas, Bahia, Ceará, Espírito Santo, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Norte, and Sergipe) (Species Link, 2020; Mendes and Urben, 2020).

Substrates: Arecaceae: *Cocos nucifera* L., *Allagoptera brevicalyx* M. Moraes*, Bactris ferruginea* Burret*,* and *S. coronata* (leaflet); Malvaceae: *Theobroma cacao* L. (Santos et al., 2016; Santos and Vitória, 2017; Vitória et al., 2020; Species Link, 2020; Mendes and Urben, 2020; SMML, 2020).

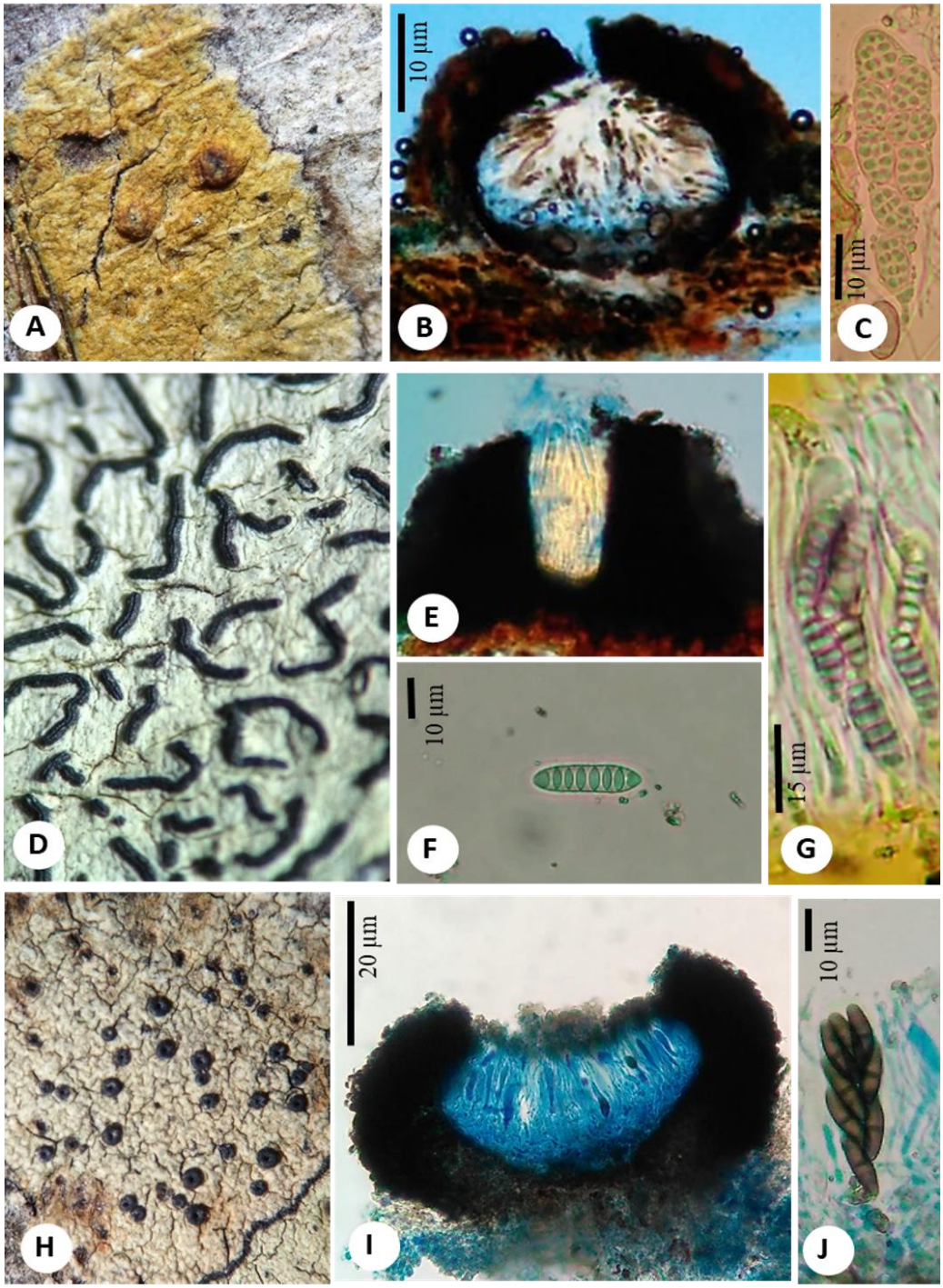

Figure 3. A-B. *Pyrenula ochraceoflava* **a.** Habit. **b.** Ascoma in longitudinal section. **c.** Ascum and ascospores. **D-G**. *Graphis librata*. **d.** Habit. **e.** Ascoma in longitudinal section. **f.** Ascospores **g.** Ascum and ascospores. **H-J.** *Buellia* sp. **h.** Habit. **i.** Ascoma in longitudinal section. **j.** Ascospores.

***1. Buellia* sp.** Figure 3. A-C

Consulted literature: Joshi et al. (2010)

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em pecíolo de *S. coronata*, 11.04.2018, *col*. P.Q. Rocha, 09° 39'05.9" S 038° 29'07.7" W, 602 m (MICOLAB-UNEB VIII 0145).
Distribution: Cosmopolitan (Joshi et al., 2010).

Substrates: Rocks, wood, plant debris, over bryophytes and other lichens, and over the bark or stems of Betulaceae: *Alnus* sp.; Ulmaceae: *Zelkova* sp.*;* Asparagaceae: *Agave sisalana* Perrine*;* Bixaceae: *Bixa orellana* L.; Rubiaceae: *Gardenia jasminoides* Ellis; Cyperaceae: *Phyllostachys bambusoides* Castillonis; Salicaceae: *Populus tremuloides* Michx. (Joshi et al., 2010; SMML, 2020); and *S. coronata* (this study).

2. Graphis librata C. Knight, Trans. Proc. NZ Inst. 16: 404 (1884) Figure 3. D-G
Description: Thallus crustose, greenish-grey, KOH+ pale yellow, continuous, with occasional fissures, opaque. Lirella 85 × 57.5 µm in longitudinal section, black, elevated, branched. Asci 62.5–87.5 × 10–15 µm, clavate, bitunicate, subpedicellate, I-, 8-spored, polistichous. Paraphyses 1.25–2.5 µm wide, septate, hyaline. Ascospores 1.75–22.5(–25) × 5 µm, fusiform, smooth, apexes round, (5–7–)8-septate, lumina lens-shaped, hyaline, I+ violet, mucilaginous sheath present, dwarf cell absent.

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em pecíolo de *S. coronata*, 11.04.2018, *col*. P.Q. Rocha, 09° 39'05.9" S 038° 29'07.7" W, 602 m (MICOLAB-UNEB VIII 0146).
Distribution: Australia, Brazil (Bahia, Paraná, Piauí, Rio Grande do Sul, São Paulo, and Sergipe), Dominica, and New Zeland (Kantvilas, 1990; Species Link, 2020; present study).

Substrates: Nothofagaceae: *Nothofagus* sp.; Atherospermataceae: *Doryphora* sp.; Fabaceae: *Coriaria* sp.; Betulaceae: *Alnus* sp.*;* Salicaceae: *Salix* sp.; Rosaceae: *Crataegus* sp., *Prunus* sp.; Rutaceae: *Melicope* sp.; Oleaceae: *Ligustrum* sp. (Hayward, 1977; Kantvilas, 1990); and *S. coronata* (present study).

3. Pyrenula ochraceoflava (Nyl.) R.C. Harris, Mem. Bot de NY. Gdn 49: 96 (1989) Figure 3. H-J

Description: Thallus crustose, yellow, continuous, KOH+ red. Ascoma 180–200 × 240–270 µm in longitudinal section, erumpent, covered by the thallus, ostiole apical.

Asci 62.5–87.5 ×17.5–30 µm, clavate, bitunicate, pedicellate, sessile, 8-spored, polistichous. Paraphyses 1.35 µm wide, hyaline, septate. Ascospores 17.5–25 × 10–15 µm, smooth, ellipsoid, I-, hyaline when young, becoming olivaceous when mature, mucilaginous sheath absent, dwarf cell absent.

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em pecíolo de *S. coronata*, 11.04.2018, *col*. P.Q. Rocha, 09° 39'05.9" S 038° 29'07.7" W, 602 m (MICOLAB-UNEB VIII 0147).

Distribution: Mainly Pantropical, in Brazil recorded for the States of Alagoas, Bahia, Pernambuco, and Sergipe (Cáceres, 2007; Species Link, 2020).

Host: Arecaceae: *Cocos nucifera* L. (Makhija and Adawadkar, 2001), and *S.coronata* (present study); Rhizophoraceae: *Rhizophora* sp. (Logesh, 2012); Euphorbiaceae: *Excoecaria agallocha* L. (Logesh et al., 2013).

Mitosporic fungi

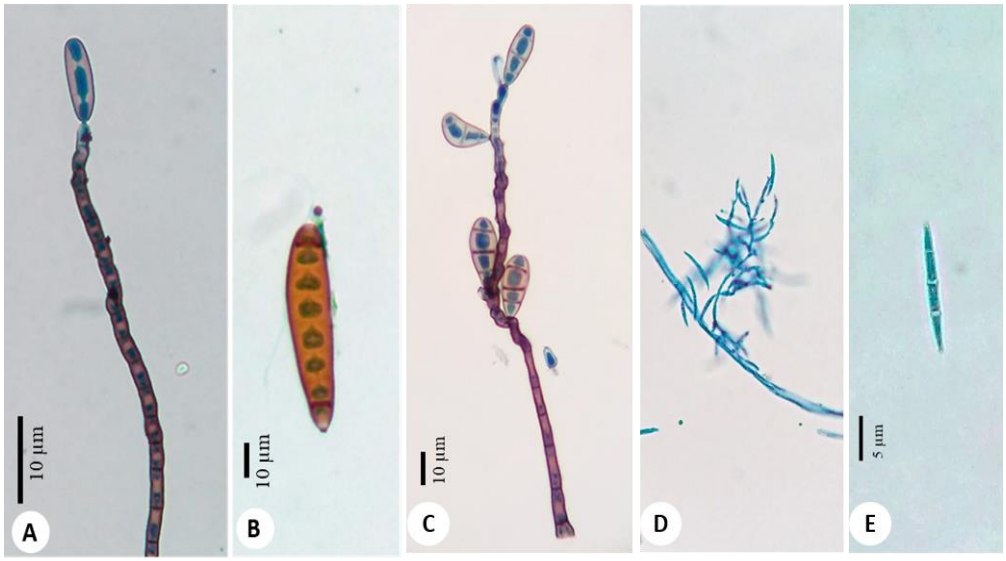

Figure 4. A-B. *Bipolaris* sp. **a.** Conidiophore **b.** Conidium. **C**. *Curvularia* sp. **c.** Conidiophore and conidia. **D-E.** *Fusarium* sp. **d.** Conidiophore. **e.** Conidium.

***1. Bipolaris* sp.** Figure 4. A-B

Consulted literature: Manamgoda et al. (2014)

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, submetido a

tratamento em câmara úmida durante 6 dias, 30.08.2017, *col*. P.Q. Rocha, 09°39' 05.1" S 038° 29' 07.7" W, 611 m (MICOLAB-UNEB VIII 0148).

Distribution: Worldwide. In Brazil, recorded for the States of Bahia, Maranhão, Minas Gerais, Santa Catarina, and São Paulo (Marin-Felix et al., 2017; Species Link, 2020).

Substrates: Found growing on grasses and recorded growing on other 60 genera of Anacardiaceae, Araceae, Euphorbiaceae, Fabaceae, Malvaceae, Rutaceae and Zingiberaceae (Marin-Felix et al., 2017), and on *S. coronata* (present study).

2. Curvularia **sp.** Figure 4. C

Consulted literature: Ellis (1971).

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, submetido a tratamento em câmara úmida 30.08.2017, *col*. P.Q. Rocha, 09°39' 05.1" S 038° 29' 07.7" W, 611 m (MICOLAB-UNEB VIII 0149).

Distribution: Worldwide (Marin-Felix et al., 2017).

Substrates: Found mainly growing on members of Poaceae, but also in genera of Actinidiaceae, Aizoaceae, Caricaceae, Convolvulaceae, Fabaceae, Iridaceae, Lamiaceae, Lythraceae, Oleaceae, Polygonaceae and Rubiaceae (Marin-Felix et al., 2017), and on *S.coronata* (leaflets) (Vitória et al., 2016b).

3. Fusarium **sp.** Figure 4. D-E

Consulted literature: Barnett and Hunter (1998).

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, submetido a tratamento em câmara úmida, 30.08.2017, *col*. P.Q. Rocha, 09°39' 05.1" S 038° 29' 07.7" W, 611 m (MICOLAB-UNEB VIII 0151).

Distribution: Recorded for over 55 countries, including Brazil (SMML, 2020).

Substrates: Reported growing on 1,245 different plant species (SMML, 2020; Species Link, 2020), plus *S. coronate* (present study). It has also been reported growing on the soil, humans, and animals (SMML, 2020).

***Diplodia* sp**

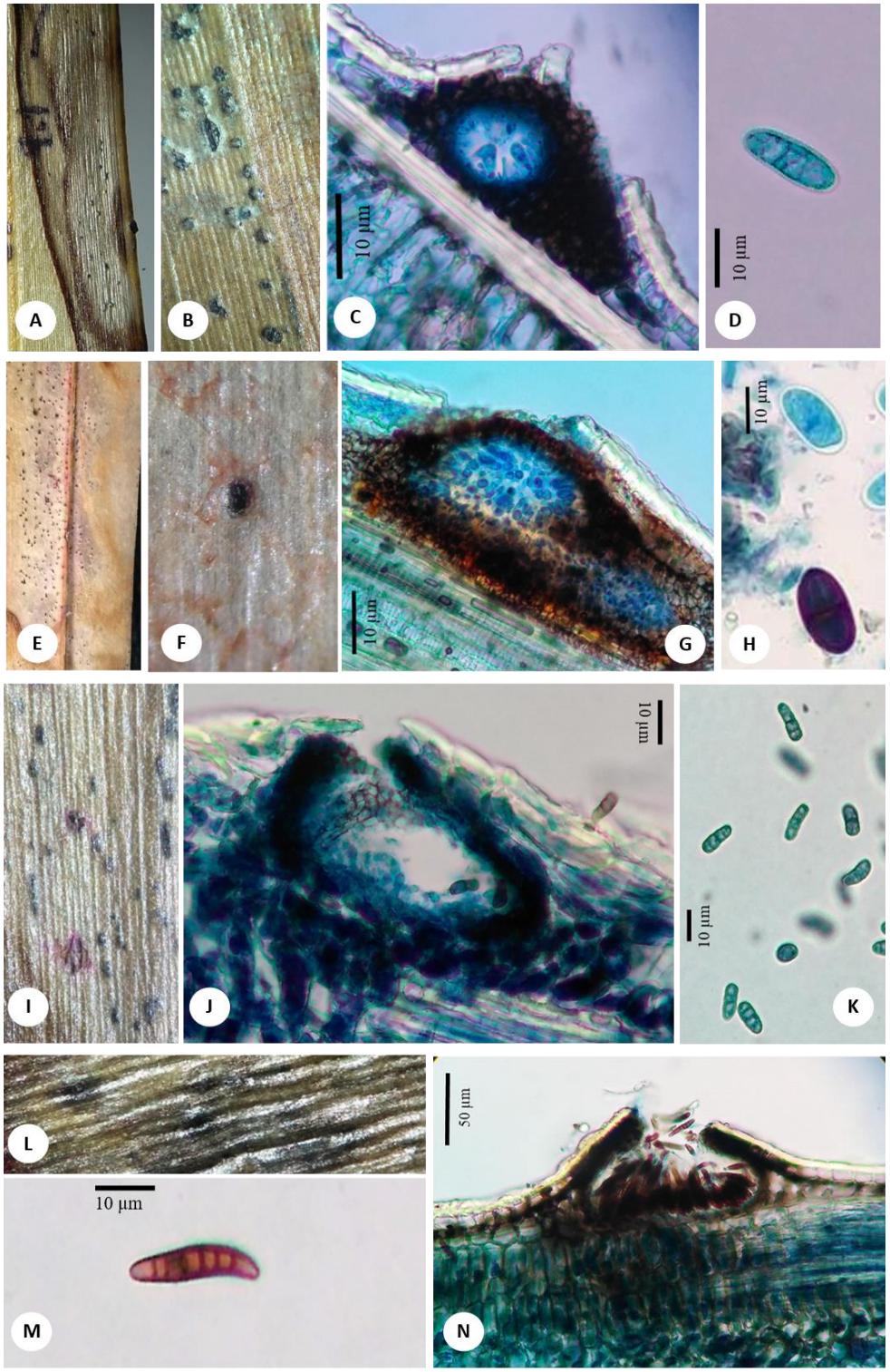

Figure 5. A-D *Diplodia* sp. **a-b** Habit. **c.** Conidioma in longitudinal section. **d.** Conidium. **E-H.** *Lasiodiplodia theobromae* **e-f.** Habit. **g.** Conidioma in longitudinal section. **h.** Conidium. **I-K.** *Hendersonula australis* **i.** Habit. **j.** Conidioma in longitudinal section. **k.** Conidia. **L-N.** *Wojnowiciella* sp. **l**. Habit. **m**. Conidium. **n.** Conidioma in longitudinal section.

***1. Diplodia* sp.** Figure 56. A-D
Consulted literature: Phillips et al. (2013).

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, 30.08.2017, *col*. P.Q. Rocha, 09°39' 05.1" S 038° 29' 07.7" W, 611 m (MICOLAB-UNEB VIII 0162). Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, 30.08.2017, *col*. P.Q. Rocha, 09°39' 05.1" S 038° 29' 07.7" W, 611 m. (MICOLAB-UNEB VIII 0163). Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, submetido à câmara úmida, 30.08.2017, *col*. P.Q. Rocha, 09°39' 05.1" S 038° 29' 07.7" W, 611 m (MICOLAB-UNEB VIII 0164). Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo verde de *S. coronata* (causando mancha foliar), 11.04.2018, *col*. P.Q. Rocha, 09° 39'05.9" S 038° 29'07.7" W, 602 m (MICOLAB-UNEB VIII 0165). Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo verde de *S. coronata* (causando mancha foliar), 11.04.2018, *col*. P.Q. Rocha, 09° 39'05.9" S 038° 29'07.7" W, 602 m (MICOLAB-UNEB VIII 0166).

Distribution: Reported for over 41 countries, including Brazil (SMML, 2020). It was recorded for the State of Bahia by Vitória et al. (2016b).
Substrates: Reported growing on 336 plant species (SMML, 2020), plus *S. coronata* (rachis, leaflets, and fruits) (Vitória et al., 2016b; Santos et al., 2020)

2. Hendersonula australis Speg., Anal. Soc. cient. argent. 10 (4): 160 (1880) Figure 5. I-K

Description: Conidioma 42.5 × 92.5 in longitudinal section, immersed to erumpent, solitary, ostiolate, visible on the leaf surface as black dots. Conidia 12.5–17.5 × 5 µm, cylindric, verrucate, olivaceous, 1–3(–4)-septate, 2–4-celled, mucilaginous sheath absent, dwarf cell absent.

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo verde de *S. coronata* (sem causar dano aparente) 11.04.2018, *col*. P.Q. Rocha, 09° 39'05.9" S 038° 29'07.7" W, 602 m (MICOLAB-UNEB VIII 0152).

Distribution: Argentina (SMML, 2020; Sutton and Dyko, 1989) and Brazil (present study)

Substrates: Solanaceae: *Solanum laxum* Spreng. (leaves) (SMML, 2020; Sutton Dyko, 1989); and *S. coronata* (present study).

3. Lasiodiplodia theobromae (Pat.) Griffon & Maubl., Bull. Soc. mycol. Fr. 25: 57 (1909)
Figure 5. E-H

Description: Conidioma 75 × 130 µm in longitudinal section, submersed, erumpent, solitary, visible on the surface as black dots, non-ostiolate, wall thick, brown. Conidia (12.5–)15–17.5(–20) × 7.5–10 µm, ovoid, smooth, hyaline when young, becoming brown with longitudinal striations when mature, 1-septate, mucilaginous sheath absent, dwarf cell absent.

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo verde (causando mancha foliar) (1) e seco (1) de *S. coronata* ainda preso à planta e em folíolo de serrapilheira (1) 30.08.2017, *col*. P.Q. Rocha, 09°39’ 05.1” S e 038° 29’ 07.7” W, 611 m (MICOLAB-UNEB VIII 0159); (MICOLAB-UNEB VIII 0160); (MICOLAB-UNEB VIII 0161).

Distribution: Widely distributed across the tropical and subtropical regions of the globe. In Brazil, it is recorded for the States of Alagoas, Amazonas, Bahia, Ceará, Espírito Santo, Maranhão, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Rondônia, Roraima, Santa Catarina, and São Paulo (SMML, 2020; Species Link, 2020; Mendes and Urben, 2018).

Substrates: Reported growing on 389 plant species (SMML, 2020) and *S. coronata* (rachis and leaflets) (Santos et al., 2016; Vitória et al., 2016b).

***4. Wojnowiciella* sp.** Figure 5. L-N
Consulted literature: Crous et al. (2015)

Examined Material: BRASIL. BAHIA: Estação Ecológica Raso da Catarina (ESEC), Paulo Afonso, em folíolo seco de *S. coronata* ainda preso à planta, submetido à

câmara úmida por 6 dias, 30.08.2017, *col*. P.Q. Rocha, 09°39’ 05.1” S 038° 29’ 07.7” W, 611 m (MICOLAB-UNEB VIII 0153).

Distribution: Australia, Brazil, China, Colombia, and South Africa (Li et al., 2015; Crous et al., 2016; Hernandez-Restrepo et al., 2016; Species Link, 2020; Santos et al., 2020).

Substrates: Menispermaceae: *Cissampelos* sp.*;* Myrtaceae: *Eucalyptus grandis* Hill Ex-Maiden*;* Adoxaceae: *Viburnum* sp.*;* Verbenaceae: *Leptocarpus* sp. (Li et al., 2015; Crous et al., 2016; Species Link, 2020); and *S. coronata* (leaflets) (Santos et al., 2020).

DISCUSSION

Knowing the distribution of fungi and their relationships with their hosts is fundamental since the fungic community is a crucial part of the biosphere and plays a vital role in maintaining the ecosystems they are part of (Hyde et al., 2005). Their ability to produce various enzymes gives them the necessary advantage of colonizing almost all substrate types and allows them to assume several life forms (Maia et al., 2006).

In the present study, *Botryosphaeria* sp., *Bipolaris* sp., *Curvularia* sp. and *Fusarium* sp. were recorded as saprophytes. These genera are known for their phytopathogenic species. Some are important commercial cultures responsible for symptoms like burn marks and spots on leaves, root rotting, and damages to the seeds (Mendes and Urben, 2020). On *S. coronata* (licuri palm), *Botryosphaeria* sp. was reported as a phytopathogen by Vitória et al. (2016).

Camarotella torrendiella is the causing agent of the small tar spot disease (doença lixa pequena) on palms. In the present study, it was found growing on the green rachis of *S. coronata*, causing a verrucose necrosis characteristic of the small tar spot disease, which leads to the precocious senescence of the leaves (Vitória et al. 2008).

Specimens of *Diplodia* sp. and *L. theobromae* studied by us were associated with spots on the green leaflets of the licuri palm. These species were previously reported as plant pathogens (Punithalingam, 1980; SMML, 2020), and *L. theobromae* is a well-known pathogen of *S. coronata* (Santos et al., 2016; Vitória et al., 2016).

Fungi were observed colonizing different areas of the leaves of *S. coronata*. Despite the lack of studies focusing on these structures’ physio-anatomical characters,

several variables can influence the mycota's ability to colonize palm leaves in general, such as anatomical and volume variation, and differences in the amount of stored moisture and nutrients.

According to the author (Pinruan et al. 2007), leaflets present low water and nutrient contents, which might favor mitosporic fungi capable of using starches and sugars, which grow rapidly and dry out once nutrients run out. Nonetheless, the rachis and petioles are rich in cellulose and lignin, and only fungi that produce certain enzymes are able to use these resources. Furthermore, these structures retain more moisture and dry more slowly, favoring the development of meiosporic ascomycetes, which require longer periods for the development of their fruiting bodies.

In the present study, mitosporic ascomycetes were found exclusively associated with leaflets. In previous studies, these fungi were also observed growing on the rachis. However, they were far more frequently observed growing on the leaflets (Santos et al., 2016, 2019, 2020; Santos and Vitória, 2017; Vitória et al., 2016b, 2020; Rocha and Vitória, 2020). The meiosporic species recorded by us were found, almost with the same regularity, growing on the rachis and leaflets, in accordance with previous studies (Santos et al., 2016, 2019, 2020; Santos and Vitória, 2017; Vitória et al., 2016b, 2020; Rocha and Vitória, 2020).

Since *S. coronata* is found growing in semiarid regions, being subjected to its extreme climate (e.g., intense insolation, daytime temperature variation, and scarce water), it has adaptations to survive in these environments. For instance, in order to avoid desiccation, its leaflets present thick cuticle, non-vascular fiber bundles in the mesophyll, compact chlorenchyma, densely vascularized, and adaptations of its photosynthetic mechanisms (Leite and Scatena, 2001; Castro, 2016; Oliveira et al., 2016). Furthermore, during leaf senescence, the licuri palm still retains green leaf-sheaths for three to four years, working as water and nutrient storage. These reserves ensure the plant's vitality and survival, even during prolonged droughts (Drumond, 2007; Oliveira et al., 2015; Castro, 2016). It is likely that these characteristics also provide suitable environments for the establishment of fungic communities, making *S. coronata* a critical substrate for these organisms.

FINAL REMARKS

The present study contributes to understanding the distribution and occurrence of Ascomycota colonizing *S. coronata* in the Caatinga biome. It also allows the

discussion of the variables that might influence the establishment of fungic communities in different microhabitats of the licuri palm leaves, improving our understanding of the ecological importance of this palm species in the semiarid regions of Brazil.

Acknowledgments

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