

Lichenized *Ascomycota* on *Piptadenia moniliformis* and *Solanum mauritianum* in the Raso da Catarina Ecoregion, Caatinga, Brazil

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ABSTRACT—Our taxonomic survey of the lichenized *Ascomycota* associated with *Piptadenia moniliformis* (“quipembe”) and *Solanum mauritianum* (“cassatinga”) in the Raso da Catarina Ecoregion, Bahia State, Brazil was conducted in the village of Juá (municipality of Paulo Afonso) from July 2017 to April 2018. All specimens were analyzed in the Mycology Laboratory and are curated in the Didactic Collection, Fungal Herbarium, and Fungal Culture Collection (MICOLAB UNEB-VIII). We identified twenty-four lichenized fungal taxa representing 16 genera based on morphological characterizations and measurements of the fungal structures; of those, 16 had been collected on *P. moniliformis* and eight on *S. mauritianum*. Those plants are here described as new hosts for those fungi. Additionally, we report three new lichen records for Brazil and 13 for Bahia State.

KEY-WORDS—biodiversity, lichenization, semiarid, taxonomy

Introduction

Fungi have coevolved with other life forms and have established mutualistic relationships with many of them. The symbiosis between fungi and algae/cyanobacteria forms unique structures known as lichens. Lichenized fungi compose about 40% of the entire phylum *Ascomycota* (Costa 2013). There are more than 66,000 described representatives of the phylum *Ascomycota* (Wijayawardene & al. 2017), making it one of the largest and most diverse groups among the Kingdom Fungi.

The Raso da Catarina is located in the semiarid region of Bahia State, Brazil, and represents one of the eight Caatinga Ecoregions (Queiroz & al. 2005). The region has a hot and dry climate typical of the semiarid region, with an average temperature between 24° and 26°C, rainfall rates between 400 and 800 mm and evaporation above 2,000 mm per year (Araújo Filho 2011; Pinheiro & al. 2016). Phytophysognomy is marked by a predominantly shrubby vegetation, with anatomical and physiological adaptations related to the biome where it is found, such as the presence of succulence, deciduality and modifications of leaves on thorns. The Raso da

Summary: Mycotaxon 136: 1—Mycobiota new to www.mycotaxon.com

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Catarina ecoregion is considered an area of biological research and determined as a priority place for conservation because it houses many native species, whether animals or plants (Varjão & al. 2013).

Among the plant species composing the flora of the Raso da Catarina are *Piptadenia moniliformis* Benth. (*Fabaceae* – *Mimosoideae*) and *Solanum mauritianum* (*Solanaceae*), known popularly as "quipembe" and "cassatinga" respectively (Azeredo & al. 2011; CNIP 2018). Both species are of significant socio-bioeconomic importance to human communities in northeastern Brazil as they are sources of raw materials for construction, furniture, tools, charcoal, and home remedies, and provide food resources for honey production (Ruschel & al. 2008; Azeredo & al. 2016). However, the mycota of these hosts is little studied. There are few publications available.

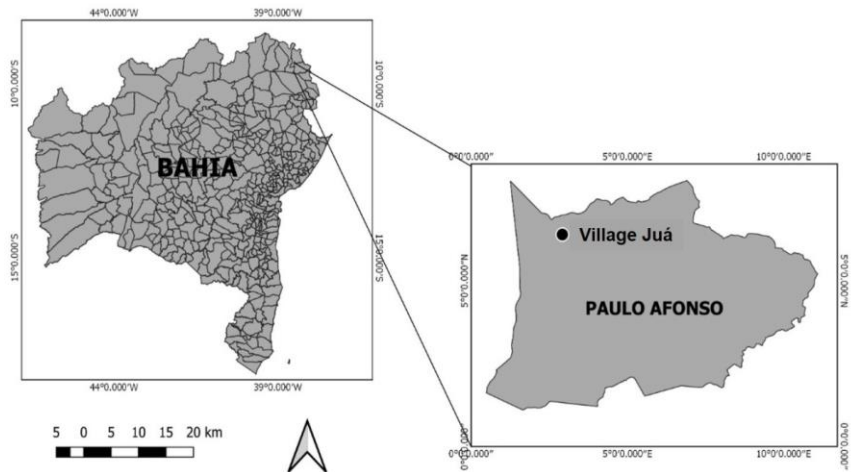
In the state of Bahia there are few studies on lichens in general (Santos & al. 2016; Aptroot & Cáceres 2018), with the need to explore poorly studied areas. According to Maia & al. (2015), the number of fungal species, *sensu lato* and *sensu stricto*, for the State of Bahia is 876. After 2015, some works were also published revealing new discoveries and the richness of the State (Santos & al. 2016; Santos & al. 2016, 2019, 2020; Rocha & Vitória 2020; Vitória & al. 2016a, b, 2019, 2020; Santos & al. 2018; Galvão Palha & al. 2018; Barbosa & Vitória 2019; Silva & al. 2019).

Studies focusing on the taxonomy of lichen communities in the semiarid region of Northeast Brazil are important to better understand the little-known wealth and diversity. Thus, this study aimed to carry out a taxonomic study of lichenized *Ascomycota* associated with *P. moniliformis* (quipembe) and *S. mauritianum* (cassatinga) in the Raso da Catarina Ecoregion, in the State of Bahia, Brazil, as it is an area of Great ecological importance, and little studied mycologically.

Materials and methods

Study area

The village of Juá is located in the municipality of Paulo Afonso, in the state of Bahia, Brazil, in the Caatinga biome (Fig. 1). This area is part of the Raso da Catarina Ecoregion, at 9°26.32.5'S 38°25.23.2'W (Nascimento & Santos 2016), about 480 km from Salvador, the State Capital. The climatic types presented in this region are those of the Bsh group, according to the Köppen classification, that is, predominantly semiarid, hot and dry, with low precipitation, high temperatures, strong insolation and high evaporation (Varjão & al. 2013; Santos & al. 2018).



Caption

- Collection point

Elaboração: SILVA, A. V. B. A. (2019)
 Base Cartográfica: Superintendência de
 Estudos Econômicos e Sociais da Bahia
 Datum: SIRGAS 2000

FIG. 1. Map of Bahia State and location of the village of Juá.

Collection and identification of material

We undertook expeditions between July/2017 and April/2018 from the method of the walking along trails according to Cáceres & al. (2008). The collection area has an average annual temperature of 25.8°C and an average annual rainfall of 540 mm. The municipality of Paulo Afonso has extreme seasonal variation in humidity.

Lichens were collected from two tree species *P. moniliformis* (quipembe) and *S. mauritanum* (cassatinga), using sharp drilling material (machete and hammer when necessary) (Fig. 2). The material was subsequently held in kraft paper sacks for transport to the laboratory.

Macroscopic and microscopic analyses of the lichen thalli were made at MICOLAB - UNEB VIII (Mycology Laboratory: Didactic Collection, Fungal Herbarium and Fungal Culture Collection) using tests with chemical reagents. For this, cuts were made the samples using the Zeiss stereomicroscope and to visualize the anatomical structures was used the optical microscope. The fungal structures were then removed using a small scraper and mounted on slides with coverslips with lactophenol and cotton blue stain, Melzer's reagent (10%), 10% KOH, 10% sodium hypochlorite, and water.

The morphological identifications of the taxa were made based on the specialized literature up to the highest possible taxonomic level, and later it was deposited in the collection of MICOLAB - UNEB VIII.

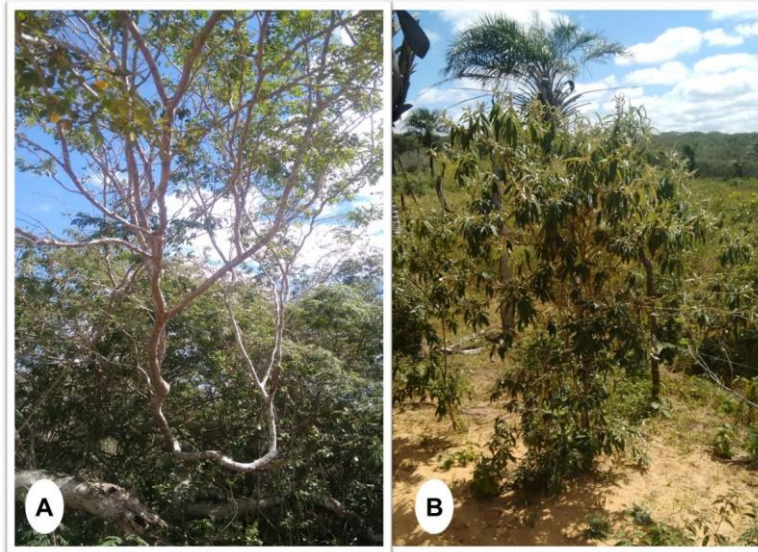


FIG. 2: A- *Piptadenia moniliformis* (quipembe). B- *Solanum mauritianum* (cassatinga).

Results

We identified 24 lichenized fungal taxa distributed among 17 genera (*Arthonia* Ach., *Bacidia* De Not., *Bacidina* Vězda, *Cryptothecia* Stirt., *Chrysothrix* Mont., *Dirinaria* (Tuck.) Clem., *Graphis* Adans., *Lecanora* Ach., *Mycomicrothelia* Keissl., *Ochrolechia* A. Massal., *Opegrapha* Ach., *Pertusaria* DC., *Phaeographis* Müll. Arg., *Polymeridium* (Müll. Arg.) R.C. Harris, *Ramboldia* Kantvilas & Elix, *Teloschistes* Norman, and *Trypethelium* Spreng.), 10 families (*Arthoniaceae*, *Chrysothricaceae*, *Caliciaceae*, *Graphidaceae*, *Lecanoraceae*, *Pertusariaceae*, *Ramboldiaceae*, *Rocelaceae*, *Teloschistaceae*, and *Trypetheliaceae*), and seven orders (*Arthoniales*, *Caliciales*, *Lecanorales*, *Ostropales*, *Pertusariales*, *Teloschistales*, and *Trypetheliales*).

Of the 24 lichenized *Ascomycota* identified here, 16 were found on *P. moniliformis* and eight on *S. mauritianum*, with three new records for Brazil and 13 for Bahia State (TABLE 1).

Three morphological categories of the lichen thallus were found: crustose, fruticose, and foliose. Most of the reported lichens were crustose. *Teloschistes* sp. was the only fruticose species, and *Dirinaria* aff. *confusa*, *D. appianata* and *D. leopoldii* were the only taxa with microfoliose habit.

Taxonomy

Bacidia arceutina (Ach.) Arnold Fig. 3-A

DESCRIPTION: Ekman (1996).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *S. mauritianum* (cassatinga), 10-IV-2018. Barbosa, R.L. (MICOLAB UNEB VIII 0094).

Bacidina phacodes (Körb.) Vězda Fig. 3-B

DESCRIPTION: Ekman (1996).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *S. mauritianum* (cassatinga), 10-IV-2018. Barbosa, R.L. (MICOLAB UNEB VIII 0089).

***Chrysothrix* sp.** Fig. 3-C

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *S. mauritianum* (cassatinga), 10-IV-2018. Barbosa, R.L. (MICOLAB UNEB VIII 0095).

Chrysothrix xanthina (Vain.) Kalb. Fig. 3-D

DESCRIPTION: Elix (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0083).

Coniocarpon cinnabarinum DC. Fig. 3-E

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *S. mauritianum* (cassatinga), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0088).

TABLE 1. Distribution of the lichenized *Ascomycota* colonizing *Piptadenia moniliformis* and *Solanum mauritianum* in Juá, Paulo Afonso, Raso da Catarina Ecoregion, Brazil.

TAXA	HOST	FAMILY	ORDER	N° OF RECORDS
<i>Arthonia cinnabarina</i> *	<i>S. mauritianum</i>	Arthoniaceae	Arthoniales	1
<i>Bacidia arceutina</i> *	<i>S. mauritianum</i>	Ramalinaceae	Lecanorales	1
<i>Bacidina. phacodes</i> *	<i>S. mauritianum</i>	Ramalinaceae	Lecanorales	1
<i>Chrysothrix</i> sp.	<i>S. mauritianum</i>	Chrysothricaceae	Arthoniales	1
<i>C. xanthina</i>	<i>P. moniliformis</i>	Chrysothricaceae	Arthoniales	1
<i>Cryptothecia macrocephala</i> *	<i>P. moniliformis</i>	Arthoniaceae	Arthoniales	1
<i>Dirinaria</i> aff. <i>confusa</i>	<i>P. moniliformis</i>	Caliciaceae	Caliciales	1
<i>D. applanata</i> *	<i>S. mauritianum</i>	Caliciaceae	Caliciales	1
<i>D. leopoldii</i>	<i>P. moniliformis</i>	Caliciaceae	Caliciales	1
<i>Graphis</i> aff. <i>Inspersolongula</i> **	<i>P. moniliformis</i>	Graphidaceae	Ostropales	1
<i>G. cincta</i>	<i>S. mauritianum</i>	Graphidaceae	Ostropales	1
<i>Lecanora</i> sp.	<i>P. moniliformis</i>	Lecanoraceae	Lecanorales	1
<i>L. strobilina</i> *	<i>P. moniliformis</i>	Lecanoraceae	Lecanorales	1
<i>Mycocomrothelia</i> sp. *	<i>P. moniliformis</i>	Trypetheliaceae	Trypetheliales	1
<i>Ochrolechia pallescens</i>	<i>P. moniliformis</i>	Pertusariaceae	Pertusariales	1
<i>Opegrapha</i> sp.	<i>P. moniliformis</i>	Roccellaceae	Arthoniales	1

To be continued.

<i>Pertusaria carneola</i>	<i>P. moniliformis</i> <i>S. mauritianum</i>	<i>Pertusariaceae</i>	<i>Pertusariales</i>	2
<i>P. xanthodes</i> **	<i>P. moniliformis</i>	<i>Pertusariaceae</i>	<i>Pertusariales</i>	1
<i>Phaeographis</i> sp.	<i>P. moniliformis</i>	<i>Graphidaceae</i>	<i>Ostropales</i>	1
<i>Polymeridium</i> aff. <i>corticatum</i> *	<i>P. moniliformis</i>	<i>Trypetheliaceae</i>	<i>Trypetheliales</i>	1
<i>P. quinquenseptatum</i> *	<i>P. moniliformis</i>	<i>Trypetheliaceae</i>	<i>Trypetheliales</i>	1
<i>Ramboldia arandensis</i> **	<i>P. moniliformis</i>	<i>Ramboldiaceae</i>	<i>Lecanorales</i>	1
<i>Teloschistes</i> sp.	<i>S. mauritianum</i>	<i>Teloschistaceae</i>	<i>Teloschistales</i>	1
<i>Trypethelium eluteriae</i> *	<i>P. moniliformis</i>	<i>Trypetheliaceae</i>	<i>Trypetheliales</i>	2

(*) New records of lichens for Bahia State.

(**) New records of lichens for Brazil.

Cryptothecia macrocephala M. Cáceres & Aptroot Fig. 3-F

DESCRIPTION: Menezes & al. (2013).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0101).

Dirinaria aff. confusa D.D. Awasthi Fig. 3-G

DESCRIPTION: Elix (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, foliose thallus in *P. moniliformis* (quipembe), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0084).

Dirinaria applanata (Fée) D.D. Awasthi Fig. 3-H

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, foliose thallus in *S. mauritianum* (cassatinga), 10-IV-2018. Barbosa, R.L. (MICOLAB UNEB VIII 0093).

Dirinaria leopoldii (Stein) D.D. Awasthi Fig. 4-A

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, foliose thallus in *P. moniliformis* (quipembe), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0082).

Graphis aff. inpersolongula Aptroot Fig. 4-B

DESCRIPTION: Lücking & al. (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0099).

Graphis cincta (Pers.) Aptroot Fig. 4-C

DESCRIPTION: Lücking & al. (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *S. mauritianum* (cassatinga), 10-IV-2018. Barbosa, R.L. (MICOLAB UNEB VIII 0092).

***Lecanora* sp.** Fig. 4-D

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis*

(quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0096).

Lecanora strobilina (Spreng.) Kieff. Fig. 4-E

DESCRIPTION IN: Nash & al. (2004).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 10-VIII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0081).

***Mycomicrothelia* sp.** Fig. 4-F

DESCRIPTION IN: Aptroot (2016).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0091).

Ochrolechia pallescens (L.) A. Massal. Fig. 4-G

DESCRIPTION IN: Kukwa (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0086).

***Opegrapha* sp.** Fig. 4-H

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0097).

Pertusaria carneola (Eschw.) Müll. Arg. Fig. 5-A

DESCRIPTION: Cáceres (2007).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe) and *S. mauritianum* (caasatinga), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0090).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *S. mauritianum* (caasatinga), 10-IV-2018. Barbosa, R.L. (MICOLAB UNEB VIII 0102).

Pertusaria xanthodes Müll. Arg. Fig. 5-B

DESCRIPTION: Bungartz & al. (2015).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0087).

***Phaeographis* sp.**

Fig. 5-C

DESCRIPTION: Acher (2000).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0085).

Polymeridium* aff. *corticatum A.A. Menezes, M. Cáceres & Aptroot Fig. 5-D

DESCRIPTION: Aptroot & al. (2013).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0080).

Polymeridium* *quinqueseptatum (Nyl.) R.C. Harris

Fig. 5-E

DESCRIPTION: Ingle & al. (2017).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0100).

Ramboldia* *arandensis (Elix) Kalb, Lumbsch & Elix

Fig. 5-F

DESCRIPTION: Elix (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis* (quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0079).

***Teloschistes* sp.**

Fig. 5-G

DESCRIPTION: Mota & al. (2005)

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, fruticose thallus in *S. auriculatum* (cassatinga), 21-VII-2016. Barbosa, R.L. (MICOLAB UNEB VIII 0098).

Trypethelium* *eluteriae Spreng.

Fig. 5-H

DESCRIPTION: Aptroot (2009).

MATERIAL EXAMINED: BRAZIL, BAHIA: Paulo Afonso, Village Juá, 9°26'16"S 38°25'26"W, crustose thallus in *P. moniliformis*

(quipembe), 21-VII-2017. Barbosa, R.L. (MICOLAB UNEB VIII 0077 and 0078).

Discussion

Most lichenized *Ascomycota* reported in this work are crustose. This is the most abundant growth form for lichens found in nature. However, due to the lack of experts there is little ecological discussion about these taxa (Cáceres 2007). At ESEC Raso da Catarina public visitation is prohibited, except for educational reasons and scientific research. It is a conservation unit of the Caatinga biome, practically intact and difficult to access. The lichenized *Ascomycota* found in this practically unexplored area expands knowledge about the diversity of fungi.

According to information obtained from SpeciesLink (2019), Species Fungorum (2019) and EMBRAPA – Fungi reported on plants in Brazil (Mendes & Urben 2019), there were no records of *P. moniliformis* as a substrate colonized by fungi. In articles on germination of *P. moniliformis* seeds there are reports of fungal contamination, but without species identification (Azeredo & al. 2011, 2016). The only fungi documented in association with the host *S. mauritianum*, was the basidiomycete *Crinipellis* sp. and the ascomycetes *Aplosporella* sp. *Stilbella fimetaria* (Pers.) Lindau (Barbosa & Vitória 2019). As such, both plant species are presented here as new botanical hosts, amplifying data considering fungal distributions and information concerning the phylum *Ascomycota* in Brazil. The total number of plant and fungal species recorded in Brazil is low. Thus, there are many substrates whose micota is practically unknown, for example hosts *P. moniliformis* and *S. mauritianum*.

In areas of the Raso da Catarina Ecoregion, other botanical hosts such as *Syagrus coronata* (Mart.) Becc. (licuri) and *Cocos nucifera* L. (coqueiro) have been documented as good substrates for colonization of lichenized, non-lichenized teleomorphic and anamorphic *Ascomycota* (Vitória & al. 2016, 2020; Rocha & Vitória 2020; Santos & al. 2016, 2020). It is expected, therefore, that the number of records of lichens for this locality will increase with new surveys.

This work contributes to the knowledge of the lichens present in the Caatinga of Bahia, hitherto little explored, as well as highlights the importance and the need for new research related to these organisms as a way to expand the data on the richness and distribution of fungi in Brazil, mainly in arid regions.

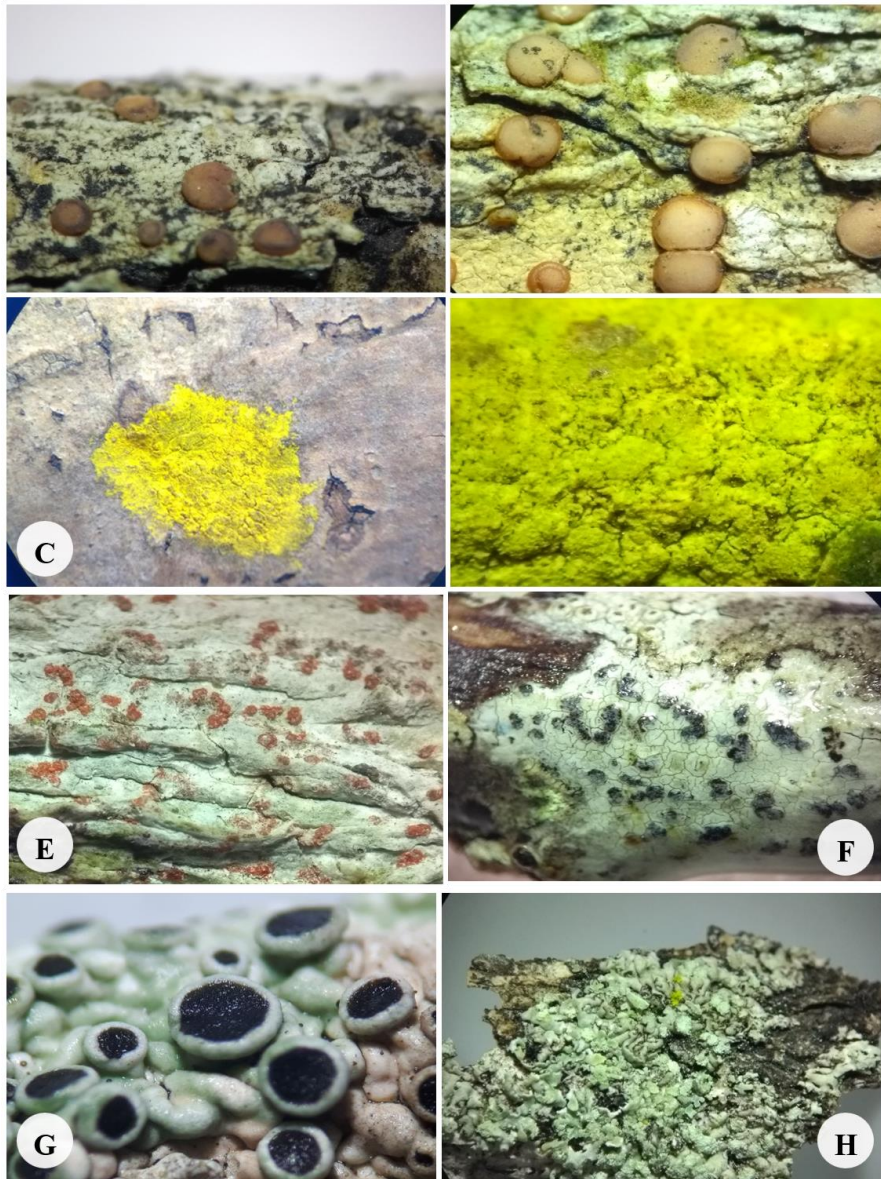


FIG. 3. A. *Bacidia arceutina*; B. *Bacidina phacodes*; C. *Chrysothrix* sp.; D. *C. xanthine*; E. *Coniocarpon cinnabarinum* F. *Cryptothecia macrocephala*; G. *Dirinaria applanata*; H. *D. confusa*.

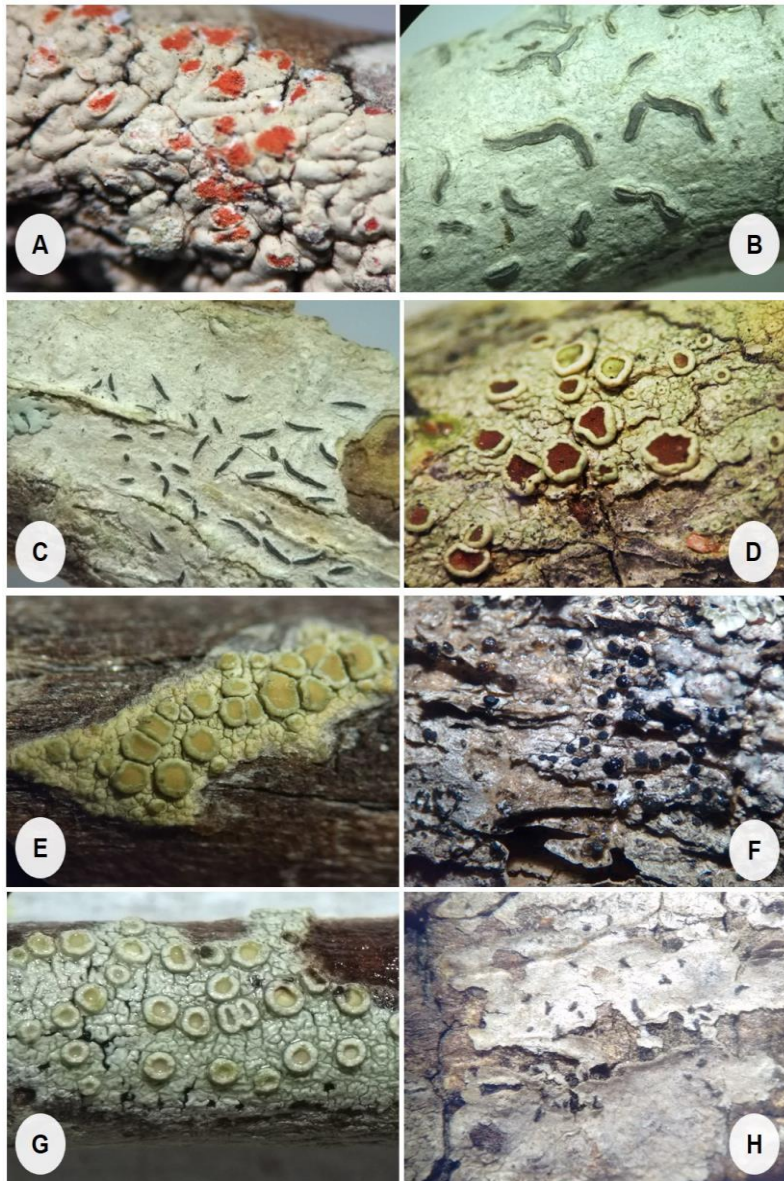


FIG. 4. A. *Dirinaria leopoldii*; B. *Graphis* aff. *inspersolongula*; C. *G. cincta*; D. *Lecanora* sp.; E. *L. strobilina*; F. *Mycomicrothellia* sp.; G. *Ochrolechia pallescens*; H. *Opegrapha* sp.

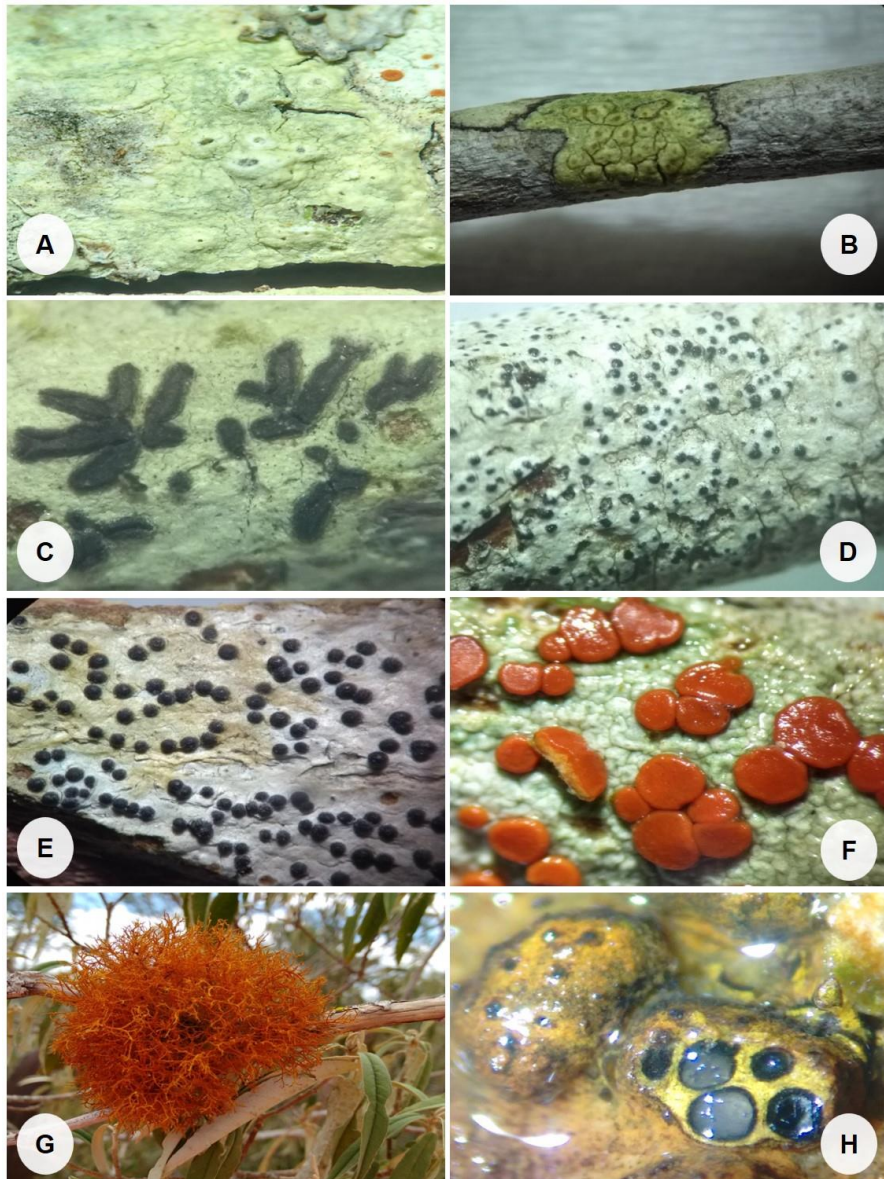


FIG. 5. A. *Pertusaria carneola*; B. *P. xanthodes*; C. *Phaeographis* sp.; D. *Polymeridium* aff. *corticatum*; E. *P. quinquenseptatum*; F. *Ramboldia arandensis*; G. *Teloschistes* sp.; H. *Trypethelium eluteriae*.

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