

# Additions to the genera *Asterolibertia* and *Cirsosia* (Asterinaceae, Asterinales), with particular reference to species from the Brazilian Cerrado

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**Abstract:** Four new *Asterolibertia* species and a new variety of *Cirsosia splendida*, all found on native Cerrado plants, belonging to three host families are described, illustrated and named as: *A. bahiensis* sp. nov. on *Erythroxylum* sp. (*Erythroxylaceae*); *A. barrinhensis* sp. nov. on *Diospyros burchellii* (*Ebenaceae*); *A. campograndensis* sp. nov. on *Hirtella glandulosa* (*Chrysobalanaceae*); *A. parinaricola* sp. nov. on *Parinari obtusifolia* (*Chrysobalanaceae*); and *Cirsosia splendida* var. *laevigata* var. nov., showing both sexual and asexual morphs, on *H. glandulosa* and *H. gracilipes* (*Chrysobalanaceae*). Finally, *A. licaniae* is reported on a new host, *H. gracilipes*. Keys to all the known species of *Asterolibertia* and *Cirsosia* are included.

## Key words:

biotrophic ascomycetes  
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## INTRODUCTION

Molecular data are generally unavailable for members of *Asterinaceae* and the taxonomy of most genera in this family to date relies chiefly on morphological data. That is the case of *Asterolibertia* and *Cirsosia*. Overcoming this limitation will depend on recollecting the taxa described in the past and where appropriate epitypifying these after extracting and sequencing genomic DNA. There have been a few cases where this was performed successfully from old herbarium specimens (Telle & Thines 2008, O’Gorman *et al.* 2010, Hawksworth 2013, Guatimosim *et al.* 2015, Thomas *et al.* 2015).

The genera of *Asterinaceae* are presently segregated using well-defined morphological characters, such as the presence or absence of appressoria on the external mycelium, setae on ascumata and/or on the external mycelium, appressorium type (intercalary or lateral), and ascospore septation (Bezerra 2004, Hosagoudar 2012). Within the family, only three genera have intercalary appressoria: *Asterolibertia*, *Cirsosia*, and *Bheemamyces* (Arnaud 1918, Bezerra 2004, Hosagoudar 2010, 2012). However, in *Bheemamyces* the appressoria are both lateral and intercalary (Hosagoudar *et al.* 2010).

For almost a century, *Asterolibertia* was considered a well-supported genus, due to the presence of intercalary appressoria as originally established by Arnaud (1918), and this has been always regarded as a strong morphological character. However, Hongsanan *et al.* (2014), without any molecular basis and morphological justification, recombined species of *Asterolibertia* into *Asterina*, a genus with species showing only lateral appressoria. Such recombinations must

be regarded as questionable, particularly in the absence of molecular data.

Currently, *Asterolibertia* includes 35 species (Tables 1–2) found only in the tropics and mainly on the host families *Chrysobalanaceae*, *Malpighiaceae*, and *Rubiaceae* (Hosagoudar 2010, Farr & Rossman 2015). The genus *Cirsosia* accommodates 15 species and one variety, all from the tropics (Tables 3–4), found mainly on *Arecaceae*, *Chrysobalanaceae*, *Dipterocarpaceae*, and *Malpighiaceae* (Hosagoudar 2010, Farr & Rossman 2015).

*Asterolibertia couepiae*, the type species of the genus, was collected in the Brazilian Cerrado by Ule in 1892, while *C. manaosensis*, the type species of *Cirsosia*, also from Brazil, was collected also by Ule in the Amazonian forest (Arnaud 1918). *Asterolibertia* species are characterized by having circular thyriothecial ascumata opening by a central star-shape fissure, adhering to the host by superficial hyphae with intercalary appressoria, and showing 2-celled ascospores. *Cirsosia* species differ from *Asterolibertia* in the lirelliform or V–Y-shaped ascumata, opening by a longitudinal fissure. However, as in *Asterolibertia*, *Cirsosia* species have superficial hyphae with intercalary appressoria and 2-celled ascospores (Bezerra 2004, Hosagoudar 2010, 2012). The specimens studied here were collected from different areas of the Brazilian Cerrado (including a fragment of Cerrado vegetation inserted in an area of the Brazilian Atlantic Forest in the State of Bahia) and yielded what is here recognised as novel taxa and host-associations for *Asterolibertia* and *Cirsosia*.

This paper describes four new *Asterolibertia* species, a new variety of *C. splendida*, and illustrates *A. licaniae* in association with a new host.

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Table 1. Morphometric characteristics of *Asterolibertia* species ( $\mu\text{m}$ ), including five new ones described in this study.

<i>Asterolibertia</i> Species	Ascomata	Hypphae	Appressoria	Asci	Ascospores	Source and country
<i>anisopteræ</i> (Syd. & P. Syd.) Hansf.	< 800 × 300–450	6–7	15–20 × 10–15	50–70 × 45–55	28–38 × 17–22	Hansford (1949), Philippines
<i>bahiensis</i> Firmino, Inácio & Dianese	175–235	4–5	14–17.5 × 9–10	35–52.5 × 30–42.5	32.5–37.5 × 10–14	Present study, Brazil
<i>bakeri</i> (Syd. & P. Syd.) Hansf.	< 350	3–5	10–15 × 5–8	50–70 × 30–40	26–36 × 12–14	Hansford (1949), Philippines
<i>barrinhensis</i> Firmino & Dianese	105–167.5	4–5	9–15 × 7.5–10	30–42.5 diam	20–27.5 × 9–12.5	Present study, Brazil
<i>bredemeyeræ</i> (Rehm) Arx	170–280	4–5.5	–	55–70 × 18–27	18–25 × 8–10	Müller & Arx (1962), Brazil
<i>burchelliae</i> (Doidge) Doidge	90–120	3–4	5–5.5 wide	27–37.5 × 16–20	13–17.5 × 5–6.5	Doidge (1942), South Africa
<i>campograndensis</i> Firmino & Dianese	75–160	5–7	9–14 × 7.5–12	30–40 × 20–32.5	22.5–30 × 9.5–10.5	Present study, Brazil
<i>couepiae</i> (Henn.) G. Arnaud	150–200	6–8	–	30–35 × 26–32	16–24 × 8–13	Arnaud (1918), Brazil
<i>crustacea</i> (Ellis & Everh.) Hansf.	< 400	4.5–5.5	4.5–5.5 wide	100 × 20–25	25–28 × 8–14	Hansford (1955), Dominican Republic
<i>cryptocaryæ</i> (Cooke) Hansf.	< 300	4–5	–	100 × 35	25–32 × 11–13	Hansford (1954b), Australia
<i>gibbosa</i> (Gaillard) Hansf.	< 90	5–6	10–14 × 7–8	27–32 × 18–24	17–21 × 8–9	Hansford (1949), Brazil
<i>hيرانensis</i> (W. Yamam.) W. Yamam.	35–62	3–4.5	7–11 × 5.5–7	23–30 × 16–23	14–16 × 6.5–7	Yamamoto (1957), Taiwan
<i>hydnocarpi</i> Hosag. & T.K. Abraham	< 264	11–13.5	14–16 × 11–13.5	< 67 diam	49–51.5 × 26–32.5	Hosagoudar & Abraham (1997), India
<i>inaequalis</i> (Mont.) Toro	180–280	6–9	9–14 wide	100 diam	32–40 × 18–25	Toro (1933), French Guiana
<i>licantæ</i> (Cooke) Hansf.	< 450 × 300	6–9	7–13 × 9–13	–	30–33 × 18–20	Hansford (1949), Brazil
<i>licanicola</i> Hansf.	170	4–5	9–11 × 6–7	–	24–28 × 12–15	Hansford (1949), Brazil
<i>malpighii</i> Bat. & H. Maia	120–185	4–8	13.5–21 × 4–8	37–43 × 27–32	29–35 × 15–16.5	Batista & Maia (1960a), Brazil
<i>mangiferae</i> Hansf. & Thirum.	250–300	7	12–15 × 10–11	< 70 diam	35–42 × 16–19	Hansford & Thirumalachar (1948), India
<i>megathyria</i> (Doidge) Doidge	140–200	5–6	7.5–10 wide	27–40 × 15–20	16–20 × 8–9	Doidge (1942), South Africa
<i>myocoproides</i> (Sacc. & Berl.) Arx	500	8.5–9	16–20 wide	50–60 × 20–22	26–28 × 10–12	Müller & Arx (1962), Brazil
<i>nodulifera</i> (Syd. & P. Syd.) T.A. Hofmann	320–420	4.5–7	9–13 × 8–12	33–36 × 13–15	33–36 × 13–16	Hofmann & Piepenbring (2014), Philippines
<i>nodulosa</i> (Speg.) Hansf.	< 250	5–6	10–15 × 10–12	100 × 50	30–40 × 14–18	Hansford (1949), Costa Rica
<i>nothopegiae</i> Hosag. & T.K. Abraham	< 265	5–7	10–12 × 9.5–11	32–35 × 24–27	19–21 × 9–10	Hosagoudar & Abraham (1997), India
<i>parinaricola</i> Firmino, Inácio et al.	150–207.5	4.5–5.5	10–15 × 7–9	37.5–47.5 × 29–32.5	34–40 × 10–14	Present study, Brazil
<i>parinari</i> (Syd.) Hansf.	130–160	3–4.5	6.5–7.5 × 5–6	30–38 × 25–35	18–22.5 × 5–6	Hansford (1947), Democratic Republic of the Congo
<i>peruviana</i> Hansf.	200	4–6	4–6 wide	–	17 × 8	Hansford (1955), Peru
<i>pogonophoræ</i> Bat. & H. Maia.	125–175	4–6	10–12 × 6–8	43–55 × 33–35	33–35 × 10–12	Batista et al. (1961), Brazil
<i>randiae</i> (Doidge) Arx	75–100	2–4	20 × 5–8	–	15–18 × 5–6.5	Müller & Arx (1962), Southern Africa
<i>santiriæ</i> (Syd. & P. Syd.) Hansf.	400 × 250–300	5–7	15–20 × 8–10	50–75 × 45–60	32–36 × 17–22	Hansford (1954a), Philippines
<i>schroeteri</i> (Rehm) Arx	220–300	6–8	10–13 wide	60–70 × 42–46	38–42 × 11–13	Müller & Arx (1962), Brazil
<i>spatholobi</i> Hansf.	250	5–6	6–8 × 6–8	45 × 35	18–20 × 7.5–8.5	Hansford (1954a), Java
<i>sporoboli</i> E. Castell. & Graniti	60–110	6	6–16 × 7–10	–	16–22 × 7–9	Castellani & Graniti (1950), Ethiopia
<i>thaxteri</i> Hansf.	250	3–5	6–7 × 4–7	–	50–55 × 21–24	Hansford (1957), Grenada
<i>uleri</i> Hansf.	200	6–7	8–12 × 9–11	–	24–30 × 12–17	Hansford (1949), Brazil
<i>vateriæ</i> Hosag.	300–400 × 150–250	11–13	10–15 × 2–14	< 35 diam	36–39 × 21–23	Hosagoudar et al. (2006), India

## MATERIAL AND METHODS

Leaves bearing black colonies were collected and dried in a plant press before being processed and deposited in the Fungarium known as the UB Mycological Collection, a part of Herbarium UB (Universidade de Brasília). Colonies were initially examined using a Zeiss Discovery v.8 stereomicroscope. Entire colonies were removed from the leaves by applying small drops of nail polish. After these had solidified and fungal structures became embedded preventing the collapse of the colonies, these were peeled from the leaf surfaces. These colonies and small samples taken directly from the leaves were mounted on slides containing lacto-glycerol for light microscopic observations. Imaging and measurements were done using a Leica DM 2500 light microscope adapted with a DFC 490 Leica digital camera, operated by a Leica Qwin Plus digital image-processing software. For scanning electron microscopy (SEM), air-dried material was fixed to disks using carbon double-sided tape, and then treated with gold using a 25-mA current, at 1.10–2 mbar for 2 min and 30 s. Photographs were obtained using a JEOL Model JSM-700 1 F SEM.

## RESULTS

A total of 35 species of *Asterolibertia* have previously been described on 19 different host families (Hosagoudar 2010, Farr & Rossman 2015). These have been described on the families: *Chrysobalanaceae* (9 species, including two new species described here), *Rubiaceae* (4); *Anacardiaceae*, *Annonaceae*, *Dipterocarpaceae*, *Fabaceae*, and *Malpighiaceae* (2 on each); and *Achariaceae*, *Arecaceae*, *Bignoniaceae*, *Bromeliaceae*, *Burseraceae*, *Ebenaceae* (described here), *Erythroxylaceae* (described here), *Euphorbiaceae*, *Lauraceae*, *Melastomataceae*, *Myrtaceae*, *Poaceae*, *Polygalaceae*, and *Styracaceae* (1 on each; Table 2). *Asterolibertia bredemeyerae* was reported from two different families (*Polygalaceae* and *Fabaceae*), as well as *A. schroeteri* (*Annonaceae* and *Chrysobalanaceae*) and *A. peruviana* (*Bignoniaceae* and *Chrysobalanaceae*). However, *A. peruviana* apparently belongs to *Microthyriaceae* due to the well-defined circular ostiole present on the ascomata (Hansford 1955, Wu *et al.* 2011). As *Asterolibertia* species are usually host specific, a reevaluation of the three species that occur in two different host families is recommended.

A total of 15 species and one variety of *Cirsosia* have been described on six different host families (Hosagoudar 2010, Hofmann & Piepenbring 2014, Farr & Rossman 2015): *Dipterocarpaceae* (5 species); *Arecaceae* (4); *Chrysobalanaceae* (3, including the new variety described here); *Malpighiaceae* (2); and *Burseraceae* and *Lauraceae* (1 on each; Table 4). There is no record of the same *Cirsosia* species being found on two different host families (Hosagoudar 2010, Farr & Rossman 2015).

## TAXONOMY

The data in Tables 1–4 that include the characteristics of the new taxa herein proposed were used to formulate the keys provided for the identification of *Asterolibertia* and *Cirsosia* species, thus simplifying the text.

### *Asterolibertia bahiensis* Firmino, Inácio & Dianese, **sp. nov.**

Mycobank MB813315

(Fig. 1)

*Etymology*: Refers to the state of Bahia where the fungus was collected.

*Diagnosis*: *Asterolibertia bahiensis* is quite close to *A. nodulifera* but differs in having smaller paraphysate ascomata and larger appressoria.

*Type*: **Brazil**: *Bahia*: Una, Bolandeira Farm, on an enclosure of Cerrado vegetation in the Brazilian Atlantic Forest, close to the entrance to Comandatuba Island, 15° 21' 12.7" S 39° 00' 7.7" W, on leaves of *Erythroxylum* sp. (*Erythroxylaceae*), 26 Aug. 1995, M. Sanchez (UB-Mycol Col. 9882 – holotype).

*Description*: Colonies amphigenous, circular to irregular, single to confluent, black, 1–12 mm diam. *Hyphae* straight to flexuous, branching irregularly, pale brown, septate, hyphal cells cylindrical, 4–5 µm diam, smooth. *Appressoria* numerous, entire, sessile, intercalary, elongated with a lateral protuberance, unicellular, 14–17.5 × 9–10 µm, brown, penetration peg central on the appressorial cell. *Ascomata* superficial, thyriothecia, scutiform, on top of mycelial mat, circular, single to confluent, fringed at margins, randomly distributed in the colony, 175–235 µm diam, opening by a central star-shaped fissure, dark brown; wall of *textura radiata*, cells cylindrical. *Pseudoparaphyses* cylindrical, septate, branched, hyaline, to 1 µm wide. *Asci* bitunicate in structure, fissitunicate, disposed as an upright palisade layer, globose to ovoid, 8-spored, hyaline, 35–52.5 × 30–42.5 µm. *Ascospores* cylindrical, ends rounded, straight or slightly arched, 1-septate, constricted at the septum at the suprmedian septum, hyaline, becoming brown at maturity, verruculose, 32.5–37.5 × 10–14 µm. Asexual morph not seen.

*Other specimens examined*: On leaves of *Erythroxylum* sp. (*Erythroxylaceae*). **Brazil**: *Minas Gerais*: Buritis, Pedra Grande Farm, 8 May 1993, J. C. Dianese 863 (UB-Mycol Col. 3934). *Bahia*: Una, on an enclosure of Cerrado vegetation in the Brazilian Atlantic Forest at Fazenda Bolandeira, near entrance to Comandatuba Island, J.C. Dianese (UB-Mycol Col. 9871).

*Notes*: The type material was collected in a rare small enclosure of Cerrado vegetation in the Brazilian Atlantic Forest. However another specimen (UB – Mycol Col. 3934) was found in a typical Cerrado natural landscape in Buritis, Minas Gerais. In addition, this is the first *Asterolibertia* species found on a member of *Erythroxylaceae* (Hosagoudar 2010, Farr & Rossman 2015).

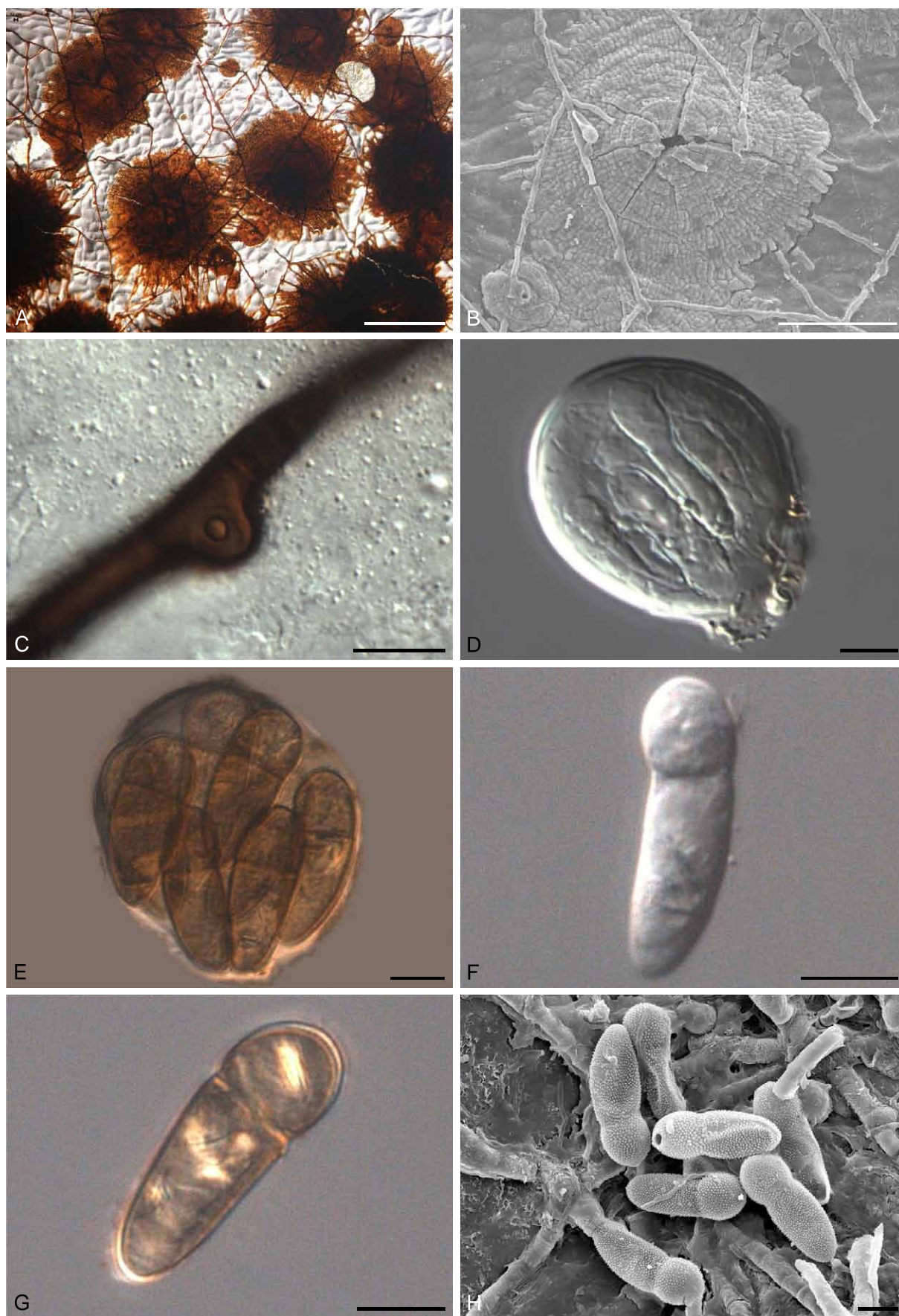
**Table 2.** Summary of the main characteristics of *Asteroliberia* species indicating respective host family, host species, and morphology of colonies, appressoria, paraphyses, asci, and ascospores.

Species	Host	Families	Colonies	Appressoria	Pseudoparaphyses	Asci	Ascospores
<i>anisopterae</i>	<i>Anisoptera thurifera</i>	Dipterocarpaceae	epiphyllous	protuberance towards one side	absent	globose	constricted in the upper third, verruculose
<i>bahiensis</i> sp.nov.	<i>Erythroxyllum</i> sp.	Erythroxylaceae	amphigenous	protuberance towards one side	branched	globose to ovoid	constricted in the upper third, verruculose
<i>bakeri</i>	<i>Calamus</i> sp.	Arecaceae	epiphyllous	barrel-shaped to subglobose	absent	ovoid	constricted in the upper third, verruculose
<i>barrinhensis</i> sp. nov.	<i>Diospyrus burchellii</i>	Ebenaceae	epiphyllous	protuberance towards one side	unbranched	globose to ovoid	constricted in the upper third, verruculose
<i>bredemeyerae</i>	<i>Bredemeyera lucida</i> <i>Sweetia nitens</i>	Polygalaceae Fabaceae	amphigenous	subglobose	unbranched	ovoid to clavate-cylindrical	constricted at the central septum, smooth
<i>burchelliae</i>	<i>Bertiera racemosa</i> <i>Burchellia bubalina</i> <i>Cremaspora triflora</i> <i>Tarenna pavettooides</i>	Rubiaceae	epiphyllous	barrel-shaped to cylindrical	absent	ellipsoid-ovoid	constricted in the upper third, smooth
<i>campograndensis</i> sp.nov.	<i>Hirtella glandulosa</i>	Chrysobalanaceae	epiphyllous	protuberance towards one side	unbranched	globose to ovoid	constricted in the upper third, smooth
<i>couepiae</i>	<i>Couepia grandiflora</i>	Chrysobalanaceae	epiphyllous	protuberance towards one side	absent	globose to subglobose	constricted in the upper third, smooth
<i>crustacea</i>	<i>Psidium guajava</i>	Myrtaceae	epiphyllous	cylindrical	absent	clavate to cylindrical	constricted in the upper third, smooth
<i>cryptocaryae</i>	<i>Cryptocarya grandis</i>	Lauraceae	amphigenous	–	absent	ellipsoid	constricted in the upper third, smooth
<i>gibbosa</i>	<i>Basanacantha spinosa</i>	Rubiaceae	amphigenous	barrel-shaped to cylindrical	absent	ovoid to globose	constricted in the upper third, smooth
<i>hiiranensis</i>	<i>Styrax hayataianus</i> <i>Styrax suberifolius</i>	Styracaceae	epiphyllous	–	absent	obovoid to subglobose	constricted at the central septum, smooth
<i>hydnocarpi</i>	<i>Hydnocarpus macrocarpa</i>	Achariaceae	epiphyllous	globose to ovoid	–	globose	constricted in the upper third, smooth
<i>inaequalis</i>	<i>Melastomataceae</i> member	Melastomataceae	epiphyllous	barrel-shaped to subglobose	absent	subglobose	constricted in the upper third, verruculose
<i>licaniae</i>	<i>Licania</i> sp.	Chrysobalanaceae	epiphyllous	barrel-shaped	absent	globose	constricted at the central septum, smooth
<i>licanicola</i>	<i>Licania</i> sp.	Chrysobalanaceae	epiphyllous	barrel-shaped	absent	–	constricted at the central septum, smooth
<i>malpighii</i>	<i>Malpighiaceae</i> member	Malpighiaceae	epiphyllous	protuberance towards one side	absent	ellipsoid to subglobose	constricted at the central septum, verruculose
<i>mangiferae</i>	<i>Mangifera indica</i>	Anacardiaceae	epiphyllous	barrel-shaped	absent	globose	constricted in the upper third, smooth

Table 2. (Continued).

Species	Host	Families	Colonies	Appressoria	Pseudoparaphyses	Asci	Ascospores
<i>megathyria</i>	<i>Tricalysia capensi</i> <i>T. lanceolata</i> and <i>T. sonderiana</i>	<i>Rubiaceae</i>	amphigenous	barrel-shaped	-	ovoid to clavate-cylindrical	constricted in the upper third, smooth
<i>myocoproides</i>	<i>Guzmania plumieri</i>	<i>Bromeliaceae</i>	amphigenous	-	branched	ovoid to cylindrical	constricted at the central septum, verruculose
<i>nodulifera</i>	<i>Angelesia splendens</i>	<i>Chrysobalanaceae</i>	amphigenous	protuberance towards one side	absent	globose to ovoid	constricted in the upper third, verruculose
<i>nodulosa</i>	<i>Guatteria dolichopoda</i>	<i>Annonaceae</i>	epiphyllous	barrel-shaped to subglobose	absent	ovoid to ellipsoid	constricted at the central septum, verruculose
<i>nothopegiae</i>	<i>Nothopegia aureofulva</i>	<i>Anacardiaceae</i>	epiphyllous	globose	-	ovoid	constricted at the central septum, smooth
<i>parinaricola</i> sp. nov.	<i>Parinari obtusifolia</i>	<i>Chrysobalanaceae</i>	epiphyllous	protuberance towards one side	branched	globose to ovoid	constricted in the upper third, verruculose
<i>parinari</i>	<i>Parinari subcordata</i>	<i>Chrysobalanaceae</i>	epiphyllous	protuberance towards one side	unbranched	ellipsoid to subglobose	constricted in the upper third, smooth
<i>peruviana</i>	<i>Bignoniaceae</i> member <i>Licania macrophylla</i>	<i>Bignoniaceae</i> <i>Chrysobalanaceae</i>	epiphyllous	cylindrical	-	-	constricted in the upper third, smooth
<i>pogonophorae</i>	<i>Pogonophora schomburgkiana</i>	<i>Euphorbiaceae</i>	epiphyllous	protuberance towards one side	absent	oblong to subglobose	constricted in the upper third, smooth
<i>randiae</i>	<i>Randia dumetorum</i> , <i>Keetia guinziland</i> <i>Canthium capensis</i>	<i>Rubiaceae</i>	amphigenous	protuberance towards one side	-	ovoid to subclavate	constricted in the upper third, smooth
<i>santiriae</i>	<i>Santiria</i> sp.	<i>Burseraceae</i>	amphigenous	globose	absent	ovoid to ellipsoid	constricted in the upper third, smooth
<i>schroeteri</i>	<i>Annona</i> sp. <i>Chrysobalanus icaco</i>	<i>Annonaceae</i> <i>Chrysobalanaceae</i>	epiphyllous	protuberance towards one side	absent	ovoid to ellipsoid	constricted in the upper third, smooth
<i>spatholobi</i>	<i>Spatholobus ferrugineus</i>	<i>Fabaceae</i>	epiphyllous	barrel-shaped to cylindrical	absent	ovoid to globose	constricted in the upper third, smooth
<i>sporoboli</i>	<i>Sporobolus ruspolianus</i>	<i>Poaceae</i>	epiphyllous	globose to ellipsoid	-	-	constricted in the upper third, verruculose
<i>thaxteri</i>	unknown plant	-	hypophyllous	-	-	-	constricted in the upper third
<i>ulei</i>	<i>Malpighiaceae</i> member	<i>Malpighiaceae</i>	epiphyllous	subglobose	absent	ovoid to globose	constricted in the upper third, verruculose
<i>vateriae</i>	<i>Vateria indica</i>	<i>Dipterocarpaceae</i>	amphigenous	oblong to ovoid	-	ovoid to globose	constricted at the central septum, smooth





**Fig. 1. A–H.** *Asterolibertia bahiensis* (UB-Mycol. Col. 9882 – holotype): **A.** Colony showing thyriothecial ascomata on superficial mycelium. **B.** Central star-shape fissure in SEM. **C.** Intercalary appressoria with lateral protuberance. **D.** Immature ascus. **E.** Globose to ovoid mature ascus. **F.** Immature ascospores. **G.** Brown, verruculose, cylindrical ascospores. **H.** Verruculose ascospores in SEM. Bars: A = 100  $\mu$ m; B = 50  $\mu$ m, and all others = 10  $\mu$ m.

**Asterolibertia barrinhensis** Firmino & Dianese, **sp. nov.**

MycoBank MB813316

(Fig. 2)

*Etymology:* Epithet refers to the type locality in Brazil, Barrinha.

*Diagnosis:* *Asterolibertia barrinhensis* is quite close to *A. campograndensis* but differs in having opposite hyphal branching, loose ascomatal fringes and verruculose ascospores.

*Type: Brazil: Minas Gerais:* Divinópolis, Barrinha Farm, right side of Highway from Divinópolis to Formiga, 20° 13' 54.9" S 45° 05' 33.7" W, on leaves of *Diospyros burchellii* (*Ebenaceae*), 16 Feb. 1994, J. C. Dianese (UB-Mycol Col. 5890 – holotype).

*Description:* Colonies epiphyllous, circular to irregular, single to confluent, black, 1–8 mm diam. *Hyphae* straight to flexuous, with opposite branches, ferruginous to brown, septate, hyphal cells cylindrical, 4–5 µm diam, smooth. *Appressoria* numerous, entire, intercalary, elongated with a lateral protuberance, unicellular, 9–15 × 7.5–10 µm, ferruginous to brown, penetration peg central on the appressorial cell. *Ascomata* superficial, thyriothecia, scutiform, on top of mycelial mat, circular, single to confluent, fringed at the margins, randomly distributed in the colony, 105–167.5 µm diam, opening by a central star-shaped fissure, brown; wall of *textura radiata*, cells isodiametric to cylindrical. *Pseudoparaphyses* cylindrical, septate, unbranched, hyaline, to 2.5 µm wide. *Asci* bitunicate in structure, fissitunicate, forming as an upright palisade layer, globose to ovoid, 8-spored, hyaline, 30–42.5 µm diam. *Ascospores* cylindrical, oblong-clavate, ends broadly rounded, straight, 1-septate, slightly constricted at suprmedian septum, hyaline, becoming brown at maturity, verruculose, 20–27.5 × 9–12.5 µm. Asexual morph not seen.

*Other specimens examined:* On leaves of *Diospyros burchellii* (*Ebenaceae*). **Brazil: Minas Gerais:** Divinópolis, Barrinha, 16 Feb. 1994, J. C. Dianese (UB-Mycol Col. 5891, and 5901); **Goiás:** Mineiros, Parque Nacional das Emas, Água Ruim, 18° 8' 12.04" S 52° 58' 44.06" W, 7 Apr. 1997, J. C. Dianese (UB-Mycol Col. 13844).

*Notes:* This new *Asterolibertia* species is the first reported on a member of *Ebenaceae* (Hosagoudar 2010, Farr & Rossman 2015). It shows characteristics in common with several species (Tables 1–2), including the one described below, but clear differences persist as shown in the discussion that follows the description of *A. campograndensis*.

**Asterolibertia campograndensis** Firmino & Dianese, **sp. nov.**

MycoBank MB813317

(Fig. 3)

*Etymology:* Epithet refers to the city where the fungus was collected, Campo Grande.

*Diagnosis:* *Asterolibertia campograndensis* differs from *A. parinarii* in having larger hyphae, appressoria and ascospores, and globose to ovoid asci.

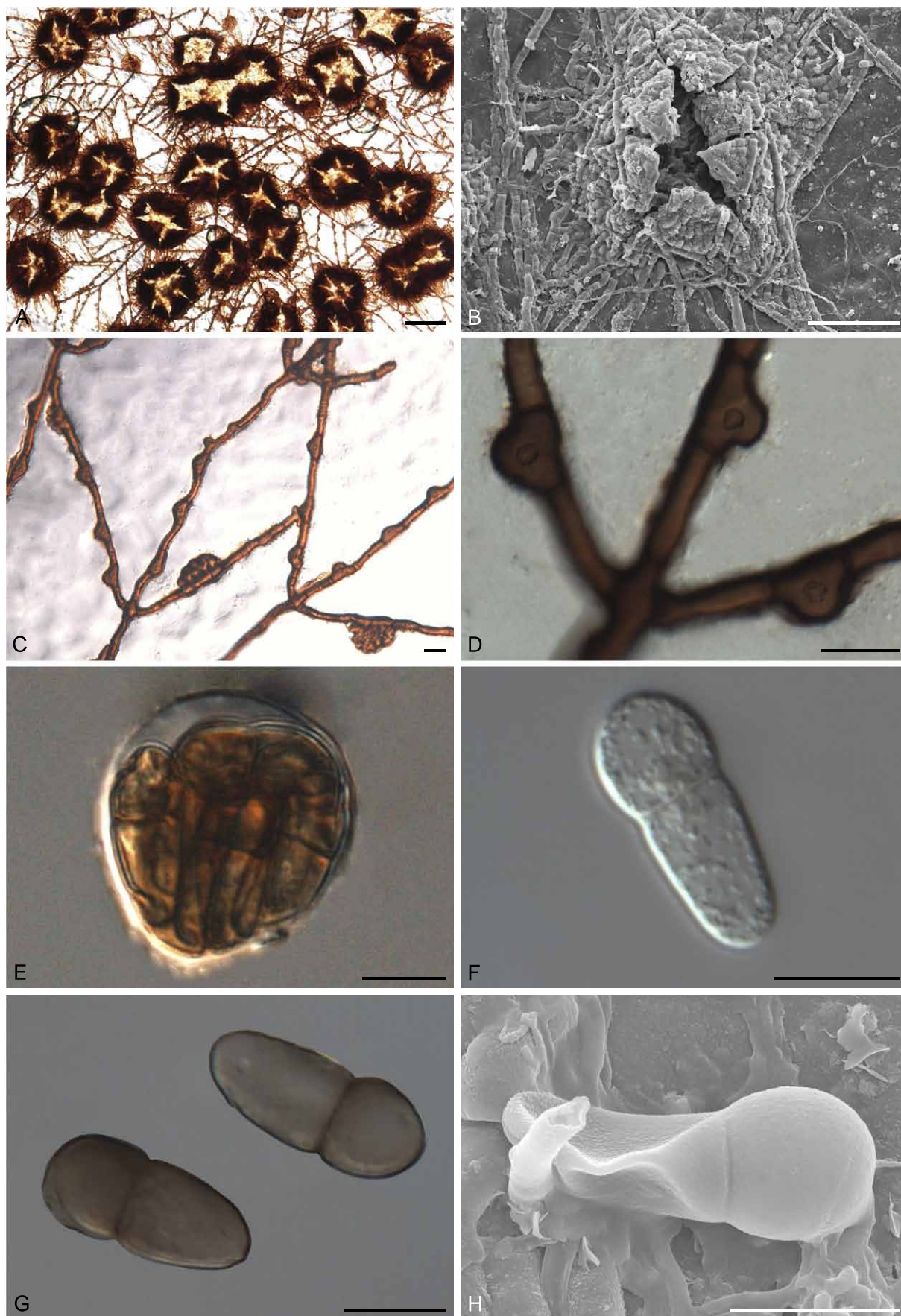
*Type: Brazil: Mato Grosso do Sul:* Campo Grande, left lane of BR-163 Highway, 200 m from the roundabout turn to São Paulo, behind Cerealista Juliana, 20° 35' 8.58" S 54° 34' 49.51" W, on leaves of *Hirtella glandulosa* (*Chrysobalanaceae*), 22 Aug. 1996, M. Sanchez (UB-Mycol Col. 12712a – holotype).

*Description:* Colonies epiphyllous, circular to irregular, single to confluent, black, 1–6 mm diam. *Hyphae* straight to flexuous, mostly showing opposite seldom irregular branches, ferruginous to brown, septate, hyphal cells cylindrical, 5–7 µm diam, smooth. *Appressoria* numerous, entire, intercalary, elongated with a lateral protuberance, unicellular, 9–14 × 7.5–12 µm, ferruginous to brown, penetration peg central on the appressorial cells. *Ascomata* superficial, thyriothecia, scutiform, on top of mycelial mat, circular, single to confluent, fringed at margins, massed in the centre of the colony, 75–160 µm diam, opening by a central star-shaped fissure, dark brown; wall of *textura radiata* to *irregulata*, cells cylindrical to irregular. *Pseudoparaphyses* cylindrical, septate, unbranched, hyaline, to 1 µm wide. *Asci* bitunicate in structure, fissitunicate, disposed as an upright palisade layer, globose to ovoid, 8-spored, hyaline, 30–40 × 20–32.5 µm. *Ascospores* oblong-clavate, rounded ends, straight, 1-septate, septum suprmedian, constricted at septum, hyaline, becoming brown at maturity, smooth, 22.5–30 × 9.5–10.5 µm. Asexual morph not seen.

*Notes:* Seven species of *Asterolibertia* have been reported previously in association with living leaves of chrysobalanaceous hosts. Four of these were recorded from Brazil: *A. couepiae* on *Couepia grandiflora*, *A. licaniae* and *A. licanicola* on *Licania* sp., and *A. peruviana* on *Licania macrophylla*. Additionally, *A. nodulifera* was recorded on *Angelesia splendens* from the Philippines, *A. parinarii* on *Parinari subcordata* from the Democratic Republic of the Congo, and *A. schroeteri* on *Chrysobalanus icaco* from India (Arnaud 1918, Hansford 1947, 1949, 1955, Müller & von Arx 1962, Hosagoudar 2010, Hofmann & Piepenbring 2014, Farr & Rossman 2015).

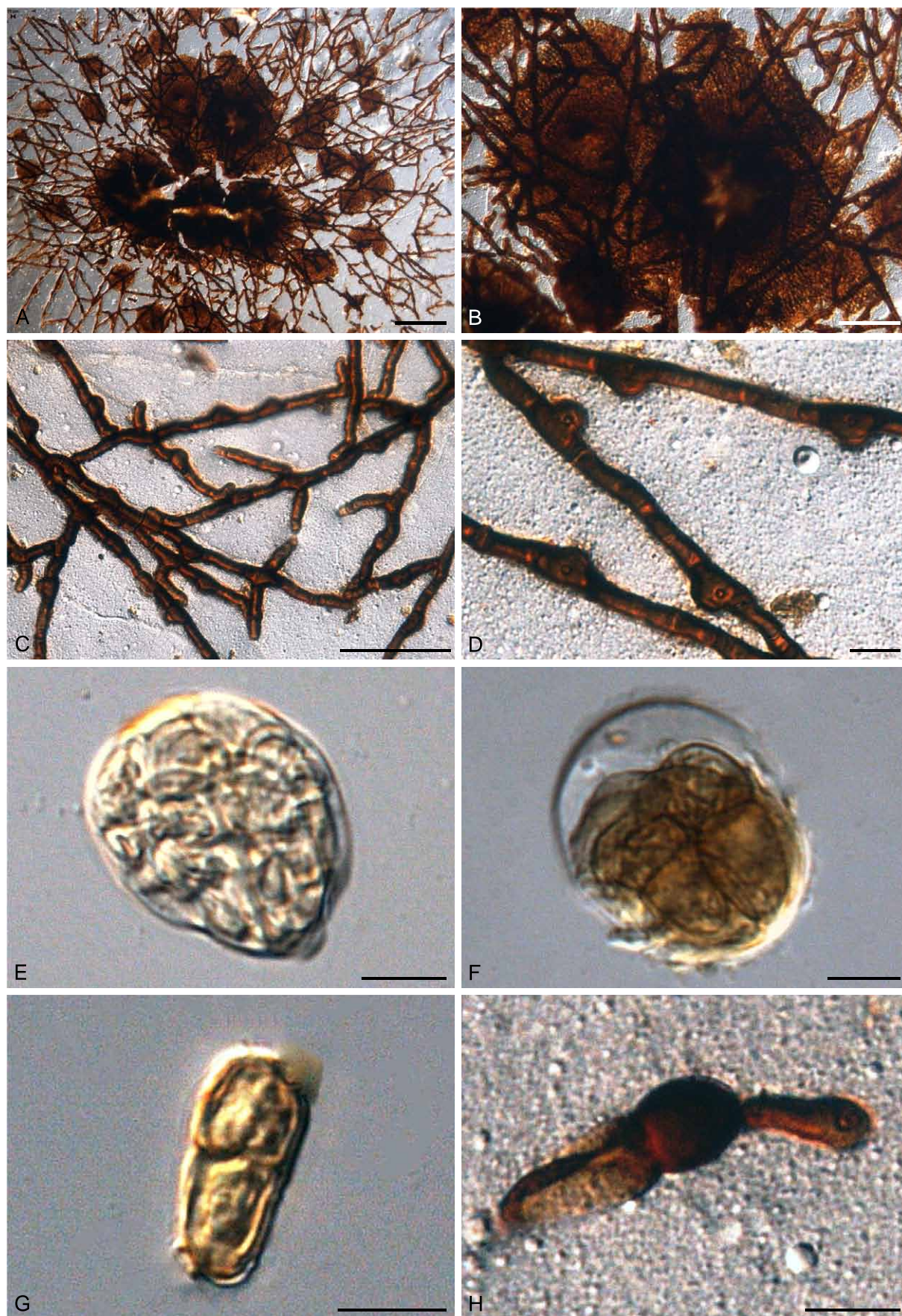
*Asterolibertia campograndensis* differs from the species previously reported on *Chrysobalanaceae* (Table 1) (Arnaud 1918, Hansford 1947, 1949, 1955, Müller & von Arx 1962, Hosagoudar 2010, Hofmann & Piepenbring 2014, Farr & Rossman 2015). It is closest to *A. parinarii*, which has smaller appressoria and ascospores, narrower hyphae, and ellipsoid to subglobose asci. *Asterolibertia couepiae* is distinct from the new species in having black hyphae, larger thyriothecial ascomata, lacking pseudoparaphyses, 4–6-spored asci, and ovoid ascospores. *Asterolibertia nodulifera* has amphigenous colonies, no pseudoparaphyses, larger ascomata and larger, echinulate ascospores. *Asterolibertia licaniae* differs from *A. campograndensis* in the dark brown hyphae, barrel-shaped and larger appressoria, ascomatal dehiscence by an irregular fissure, a lack of fringes at the margins of the ascomata, the absence of pseudoparaphyses, and finally larger, ellipsoidal, dark brown ascospores with a central septum. *Asterolibertia*





**Fig. 2. A–H.** *Asterolibertia barrinhensis* (UB-Mycol. Col. 5890 – holotype): **A.** Colony showing thriothecial ascomata on superficial mycelium. **B.** Ascomata showing central star-shape fissure in SEM. **C.** Superficial mycelium showing intercalary appressoria. **D.** Intercalary appressoria with lateral protuberance. **E.** Globose to ovoid mature ascus. **F.** Immature ascospores. **G.** Brown smooth cylindrical to oblong-clavate ascospores. **H.** Smooth ascospores in SEM. Bars: A = 100  $\mu$ m; B = 50  $\mu$ m, and all others = 10  $\mu$ m.





**Fig. 3.** A–H. *Asterolibertia campograndensis* (UB-Mycol. Col. 12712a – holotype): **A.** Colony showing thyriothecial ascomata on superficial mycelium. **B.** Ascomata showing central star-shape fissure in SEM. **C.** Superficial mycelium with intercalary appressoria. **D.** Intercalary appressoria with lateral protuberance. **E.** Immature ascus. **F.** Globose to ovoid mature ascus. **G.** Light brown immature ascospores. **H.** Brown, smooth, oblong-clavate ascospores, constricted at septum on its upper third. Bars: A = 100  $\mu$ m; B, C = 50  $\mu$ m, and all others = 10  $\mu$ m.



*licaniicola* differs from *A. campograndensis* in the wider hyphae, barrel-shaped appressoria, larger ascomata, absence of pseudoparaphyses, and dark brown ascospores with a central septum. *Asterolibertia peruviana* has narrower appressoria, larger ascomata that are not fringed at the margins, and smaller appressoria and ascospores. *Asterolibertia schroeteri* differs in the larger ascomata with an irregular fissure, the absence of pseudoparaphyses, and larger asci and ascospores (Tables 1–2) (Arnaud 1918, Hansford 1947, 1949, 1955, Müller & von Arx 1962, Hofmann & Piepenbring 2014).

*Asterolibertia campograndensis* is morphologically rather similar to *A. barrinhensis*. However, these species differ in important morphological details such as ascospore ornamentation, the shape of the ascomatal fringes (loosely set in *A. barrinhensis*), and hyphal branching patterns (opposite in *A. barrinhensis*, and irregular in *A. campograndensis*).

*Asterolibertia campograndensis* is the fifth species of *Asterolibertia* reported on hosts belonging to *Chrysobalanaceae* in Brazil, and the first on *Hirtella*.

***Asterolibertia parinaricola* Firmino, Inácio & Dianese, sp. nov.**

Mycobank MB813319

(Fig. 4)

*Etymology*: Refers to the host genus, *Parinari*.

*Diagnosis*: *Asterolibertia parinaricola* differs from *A. licaniicola* in having conspicuous lateral protuberance of the appressoria, presence of pseudoparaphyses, and much larger, verruculose ascospores constricted at a suprmedian septum.

*Type*: **Brazil**: *Distrito Federal*: Brasília, PAD-DF, on leaves of *Parinari obtusifolia* (*Chrysobalanaceae*), 10 Nov. 1992, C. Furlanetto (UB-Mycol Col. 2567 – holotype).

*Description*: Colonies epiphyllous, circular or irregular, single or confluent, black, 3–10 mm diam. *Hyphae* straight, with opposite branches, brown, septate, hyphal cells cylindrical, 4.5–5.5 µm diam, smooth. *Appressoria* numerous, entire, intercalary, elliptical or with a lateral protuberance, unicellular, 10–15 × 7–9 µm, brown, penetration peg central on the appressorial cells. *Ascomata* superficial, thyriothecia, scutiform, on top of a mycelial mat, circular, single to confluent, fringed at the margins, randomly distributed in the colony, 150–207 µm diam, opening by a central star-shaped fissure, dark brown; wall *textura radiata*, with isodiametrical cells. *Pseudoparaphyses* cylindrical, septate, branched, hyaline, 1–1.5 µm wide. *Asci* bitunicate in structure, fissitunicate, disposed as an upright palisade layer, globose to ovoid, 8-spored, hyaline, 37.5–47.5 × 29–32.5 µm. *Ascospores* oblong to oblong-clavate, ends rounded, straight to slightly arched, 1-septate, constricted at the suprmedian septum, hyaline, becoming pale brown to brown at maturity, verruculose, 34–40 × 10–14 µm. Asexual morph not seen.

*Other specimens examined*: On leaves of *Parinari obtusifolia* (*Chrysobalanaceae*). **Brazil**: Maranhão: Nogueiras, 60 km North of

Balsas, 6° 57' 52.47" S 46° 10' 13.19" W, 11 Apr. 1995, M. A. de Freitas (UB-Mycol Col. 8020). *Distrito Federal*: Brasília, PAD-DF, 04 Nov. 1993, C. Furlanetto (UB-Mycol Col. 2568 and 2569).

*Notes*: Seven species of *Asterolibertia* have been reported previously in association with living leaves of chrysobalanaceous hosts. *Asterolibertia couepiae* on *Couepia grandiflora* from Brazil, *A. nodulifera* on *Angelesia splendens* from the Philippines, *A. licaniae* and *A. licaniicola* on *Licania* sp. from Brazil, *A. parinari* on *Parinari subcordata* from the Democratic Republic of the Congo, *A. peruviana* on *Licania macrophylla* from Brazil, and *A. schroeteri* on *Chrysobalanus icaco* from India (Arnaud 1918, Hansford 1947, 1949, 1955, Müller & von Arx 1962, Hosagoudar 2010, Hofmann & Piepenbring 2014, Farr & Rossman 2015).

*Asterolibertia parinaricola* differs from the species previously reported on *Chrysobalanaceae* (Table 1) (Arnaud 1918, Hansford 1947, 1949, 1955, Müller & von Arx 1962, Hosagoudar 2010, Hofmann & Piepenbring 2014, Farr & Rossman 2015), and is most similar to *A. licaniicola*. However, the latter has barrel-shaped appressoria, no pseudoparaphyses, and much smaller, smooth ascospores constricted at the central septum. *Asterolibertia couepiae* differs from the new species in the wider hyphae, lack of pseudoparaphyses, smaller asci and ascospores, and smooth ascospores. *Asterolibertia nodulifera* differs in the amphigenous colonies, smaller thyriothecia, lack of pseudoparaphyses, and echinulate ascospores. Additionally, *A. licaniae* differs from the new species in the larger thyriothecia and wider hyphae, barrel-shaped appressoria, the lack of pseudoparaphyses, and smaller, ellipsoidal, smooth ascospores that are constricted at the central septum. *Asterolibertia parinari* has narrower hyphae, unbranched pseudoparaphyses, smaller appressoria, asci and ascospores, and also smooth ascospores. *Asterolibertia parinaricola* and *A. parinari* are described on the same host genus, but on different *Parinari* species. Besides, there is no record of the host species of *A. parinari* in Brazil, further supporting that they are really distinct species (Sothers et al. 2015). *Asterolibertia peruviana* has narrower appressoria without a lateral protuberance to one side of the hypha, and smaller, smooth ascospores. Finally, *A. schroeteri* differs from *A. parinaricola* in the larger thyriothecia, asci and hyphae, the lack of pseudoparaphyses, and smooth ascospores (Tables 1–2) (Arnaud 1918, Hansford 1947, 1949, 1955, Müller & von Arx 1962, Hofmann & Piepenbring 2014). *Asterolibertia campograndensis*, newly described above, differs in the unbranched pseudoparaphyses and smaller, smooth ascospores.

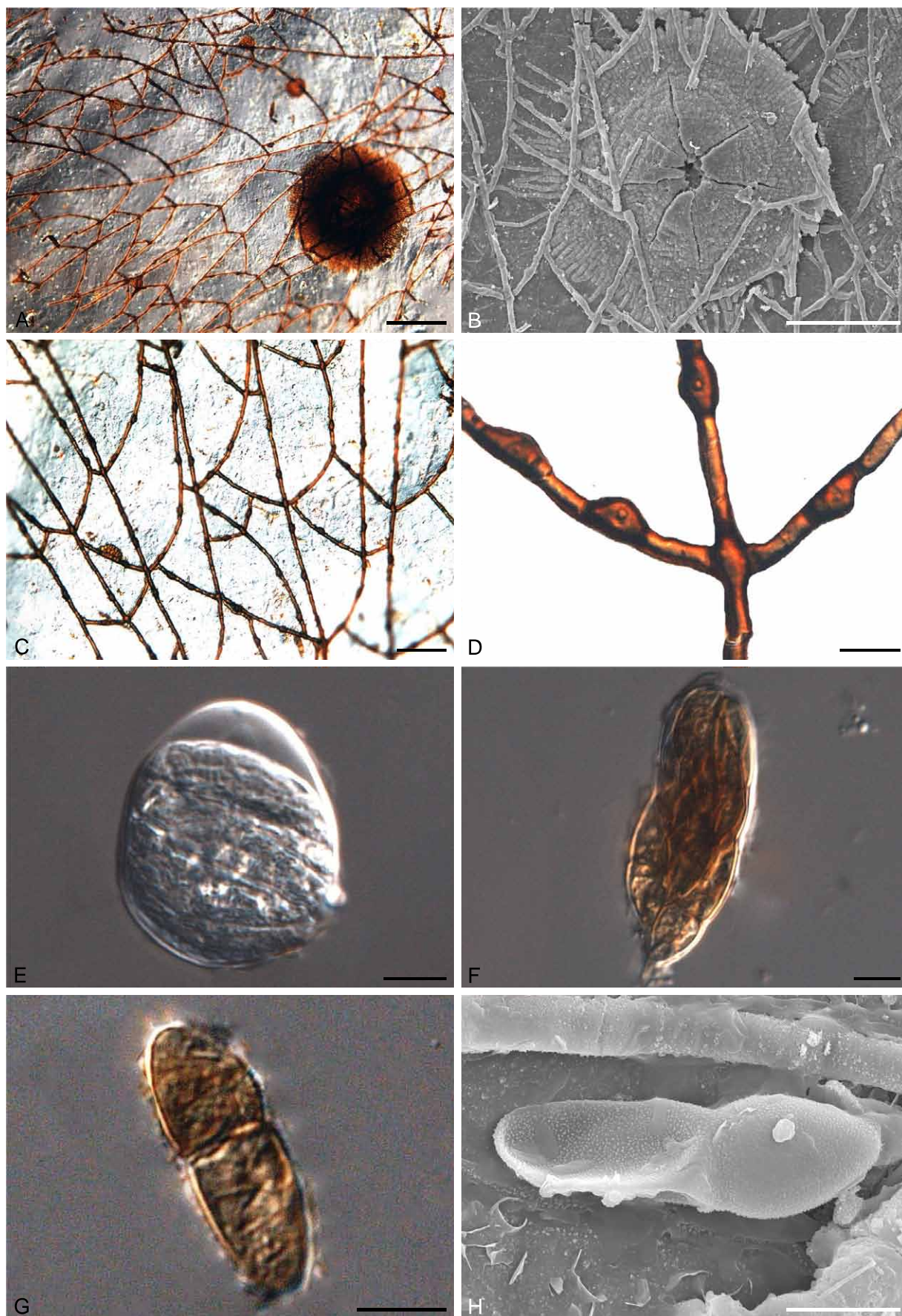
*Asterolibertia parinaricola* is distinct from all seven species known on *Chrysobalanaceae*, and represents the sixth species of *Asterolibertia* reported on this host family in Brazil. This is the second species of *Asterolibertia* described on *Parinari*, and the first species found on *P. obtusifolia*.

***Asterolibertia licaniae* (Cooke) Hansf., *Proc. Linn. Soc. Lond.* 160: 140 (1949).**

Mycobank MB284420

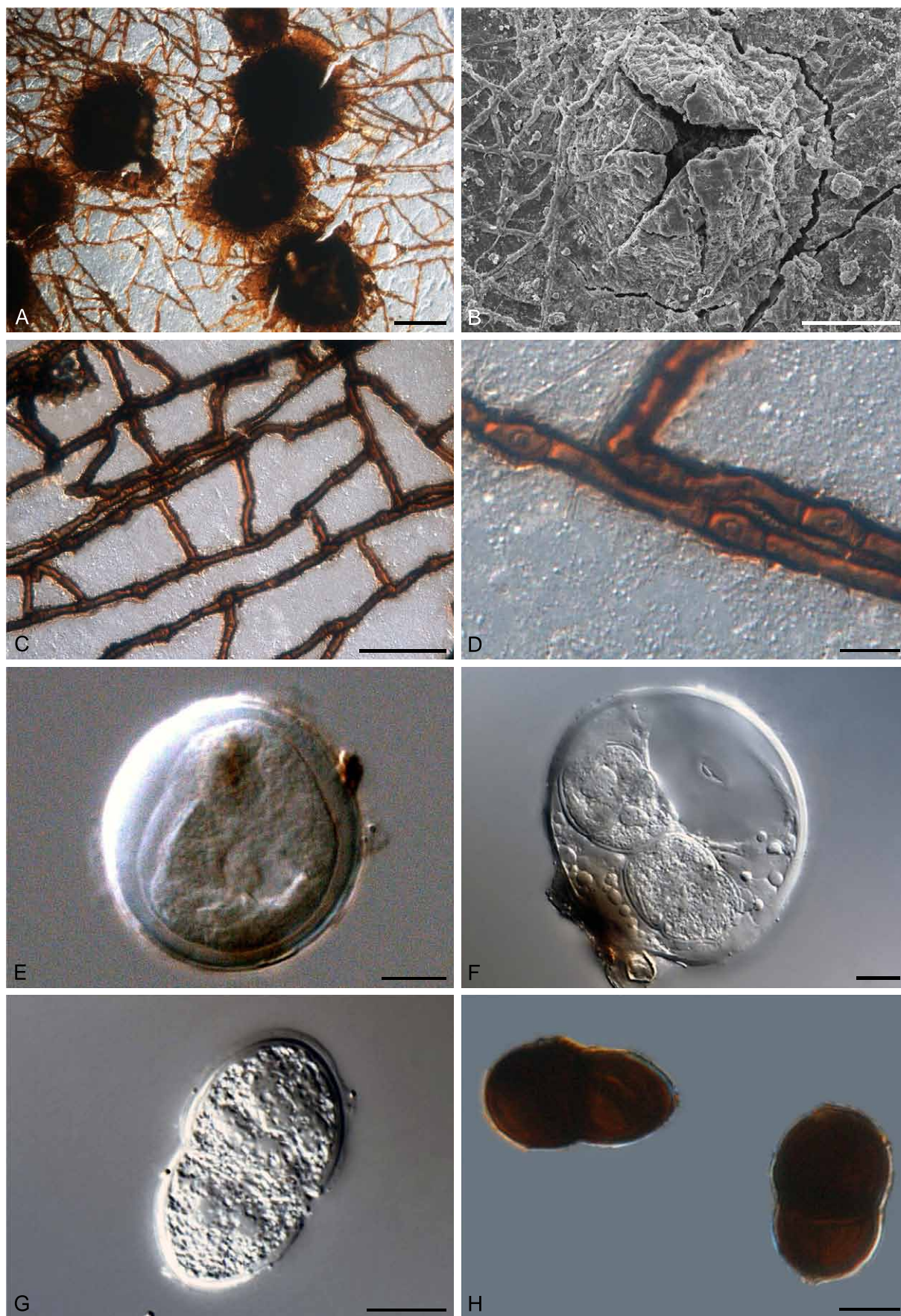
(Fig. 5)

*Basionym*: *Asterina licaniae* Cooke, *Grevillea* 12: 85 (1884).



**Fig. 4. A–H.** *Asterolibertia parinaricola* (UB-Mycol. Col. 2567 – holotype): **A.** Colony showing thyriothecial ascomata on superficial mycelium. **B.** Ascomata showing central star-shape fissure in SEM. **C.** Superficial mycelium with intercalary appressoria. **D.** Intercalary elliptic appressoria showing a lateral protuberance. **E.** Globose to ovoid immature ascus. **F.** Mature ascus. **G.** Pale brown to brown, ascospores, constricted at septum on its upper third. **H.** Verruculose ascospores on SEM. Bars: A, B = 100  $\mu$ m; C = 50  $\mu$ m, and all others = 10  $\mu$ m.





**Fig. 5.** A–H. *Asterolibertia licaniae* (UB-Mycol. Col. 9715): **A.** Colony showing thyriothelial ascomata on superficial mycelium. **B.** Ascomata showing central to irregular fissure in SEM. **C.** Superficial mycelium with intercalary appressoria. **D.** Intercalary, elliptical appressoria. **E–F.** Globose immature asci. **G.** Immature ascospores. **H.** Brown to ferruginous smooth ascospores constricted at middle septum. Bars: A, B = 100  $\mu$ m; C = 50  $\mu$ m, and all others = 10  $\mu$ m.

*Specimen examined:* **Brazil:** *Rondônia:* RO-494 Highway, 82 km from Pimenta Bueno towards Parecis, 11° 45' 16.43" S 61° 18' 54.45" W, on leaves of *Hirtella gracilipes* (*Chrysobalanaceae*), 13 Jul. 1995, M. Sanchez (UB-Mycol Col. 9715).

*Description:* Colonies epiphyllous, circular to irregular, single to confluent, dark brown to black, 3–5 mm diam. *Hyphae* straight or flexuous, branching irregularly, pale brown to brown, septate, hyphal cells cylindrical, 5–8 µm diam, smooth. *Appressoria* numerous, entire, intercalary, elliptical, unicellular, 9–15 × 7.5–10 µm, pale brown, penetration peg central on the appressorial cell. *Ascomata*, superficial, thyrtothecial, scutiform, radiate, arising on top of a mycelial mat, circular, single to confluent, fringed at the margins, randomly distributed in the colony, 180–410 µm diam, opening

by a central star-shaped fissure, dark brown; wall *textura radiata*, cells cylindrical. *Pseudoparaphyses* cylindrical, septate, branched, hyaline, 1–1.5 µm wide. *Asci* bitunicate in structure, fissitunicate, disposed as an upright palisade layer, globose, 8-spored, hyaline, 57.5–65 µm diam. *Ascospores* oblong, ends rounded, straight, 1-septate, constricted at the median septum, hyaline, becoming brown to ferruginous at maturity, smooth, 30–35 × 19–22.5 µm. Asexual morph not seen.

*Notes:* The specimen described above was collected in the state of Rondônia on living leaves of *Hirtella gracilipes*, a new host for *A. licaniae*. This species was originally described by Hansford (1949) based on material from Brazil collected on leaves of *Licania* sp.

**Key to the known *Asterolibertia* species**

See Tables 1–2 for further information on the characters of the species keyed out here.

1	Colonies amphigenous or epiphyllous .....	2
	Colonies hypophyllous .....	<b>A. thaxteri</b>
2 (1)	Ascospores smooth .....	3
	Ascospores verruculose .....	24
3 (2)	Ascospores medianly constricted .....	4
	Ascospores constricted suprmedianly .....	9
4 (3)	Ascomata with fringed margin .....	5
	Ascomata with uniform margin .....	<b>A. licaniae</b>
5 (4)	Ascomata opening by a stellar fissure .....	6
	Ascomata opening by an irregular fissure .....	<b>A. vateriae</b>
6 (5)	Colonies epiphyllous .....	7
	Colonies amphigenous .....	<b>A. bredemeyerae</b>
7 (6)	Ascospores more than 16 µm in length .....	8
	Ascospores 14–16 × 6.5–7 µm .....	<b>A. hiiranensis</b>
8 (7)	Ascospores 19–21 × 9–10 µm .....	<b>A. nothopegiae</b>
	Ascospores 24–28 × 12–15 µm .....	<b>A. licaniicola</b>
9 (3)	Colonies amphigenous .....	10
	Colonies epiphyllous .....	14
10 (9)	Ascomata with a fringed margin .....	11
	Ascomata with a uniform margin .....	12
11 (10)	Ascospores 15–18 × 5–6.5 µm .....	<b>A. randiae</b>
	Ascospores 32–36 × 17–22 µm .....	<b>A. santiriae</b>
12 (10)	Ascomata over 90 µm diam .....	13
	Ascomata to 90 µm diam .....	<b>A. gibbosa</b>
13 (12)	Ascospores 16–20 × 8–9 µm .....	<b>A. megathyria</b>
	Ascospores 25–32 × 11–13 µm .....	<b>A. cryptocaryae</b>
14 (9)	Ascomata opening by stellar or irregular fissure .....	15
	Ascomata opening by ostiole [may belong in <i>Mycrothyriaceae</i> ] .....	<b>A. peruviana</b>

15 (14) Pseudoparaphyses present .....	16
Pseudoparaphyses absent .....	17
16 (15) Ascospores 22.5–30 × 9.5–10.5 µm .....	<b>A. campograndensis</b>
Ascospores 18–22.5 × 5–6 µm .....	<b>A. parinarii</b>
17 (15) Ascomata with a fringed margin .....	18
Ascomata with a uniform margin .....	<b>A. hydnocarpi</b>
18 (17) No leaf discoloration under the colonies .....	19
Conspicuous leaf discoloration under the colonies .....	<b>A. crustacea</b>
19 (18) Ascomata opening by a stellar fissure .....	20
Ascomata opening by an irregular fissure .....	<b>A. schroeteri</b>
20 (19) Appressoria showing a lateral protuberance .....	21
Appressoria barrel-shaped to cylindrical .....	22
21 (20) Ascospores 16–24 × 8–13 µm .....	<b>A. couepiae</b>
Ascospores 33–35 × 10–12 µm .....	<b>A. pogonophorae</b>
22 (20) Ascospores less than 30 µm in length .....	23
Ascospores 35–42 × 16–19 µm .....	<b>A. mangiferae</b>
23 (22) Ascospores 13–17.5 × 5–6.5 µm .....	<b>A. burchelliae</b>
Ascospores 18–20 × 7.5–8.5 µm .....	<b>A. spatholobi</b>
24 (2) Ascomata with a fringed margin .....	25
Ascomata with a uniform margin .....	<b>A. sporoboli</b>
25 (24) Ascospores medianly constricted .....	26
Ascospores constricted suprmedianly .....	28
26 (25) Pseudoparaphyses absent .....	27
Pseudoparaphyses present .....	<b>A. myocoproides</b>
27 (26) Appressoria with a lateral protuberance .....	<b>A. malpighii</b>
Appressoria barrel-shape to subglobose without a lateral protuberance .....	<b>A. nodulosa</b>
28 (25) Colonies epiphyllous .....	29
Colonies amphigenous .....	34
29 (28) Pseudoparaphyses present .....	30
Pseudoparaphyses absent .....	31
30 (29) Pseudoparaphyses branched .....	<b>A. parinaricola</b>
Pseudoparaphyses unbranched .....	<b>A. barrinhensis</b>
31 (29) Appressoria showing a lateral protuberance .....	<b>A. anisopterae</b>
Appressoria barrel-shaped to subglobose without a lateral protuberance .....	32
32 (31) Hyphae 3–5 µm wide .....	<b>A. bakeri</b>
Hyphae more than 5 µm wide .....	33
33 (32) Ascospores 24–30 × 12–17 µm .....	<b>A. ulei</b>
Ascospores 32–40 × 18–25 µm .....	<b>A. inaequalis</b>
34 (28) Pseudoparaphyses present .....	<b>A. bahiensis</b>
Pseudoparaphyses absent .....	<b>A. nodulifera</b>



Table 3. Morphometric characteristics of *Cirsosia* species ( $\mu\text{m}$ ), including a new one described in this study.

<i>Cirsosia</i> Species	Ascomata	Hyphae	Appressoria	Asci	Ascospores	Source and country
<i>areacearum</i> Hosag. & M. Pillai	200–500 × 230–257	3–5	9–9.5 × 8–9.5	43–59 × 24–28	27–31 × 12–14	Hosagoudar & Pillai (1994), India
<i>dipterocarpi</i> (Henn.) Bat. & H. Maia	315–388 × 242–267	5–7	8–10 × 13.5–15	64–70 × 54–60	30–43 × 18–19	Batista & Maia (1960b), Philippines
<i>fiabellariae</i> (Syd.) Bat. & H. Maia	240–300 × 141–178	3–5.5	8–16 × 6.5–8	27–29.5 × 19–24	24–27 × 14–16	Batista & Maia (1960b), Sierra Leone
<i>globulifera</i> (Pat.) Arx	240–350 × 150–200	3–6.5	9–12.5 × 7–9.5	60–74.5 × 31–46.5	43–46.5 × 15–18.5	Müller & Arx (1962), Vietnam
<i>hopeae</i> Hosag., Jac. Thomas & D.K. Agarwal	300–470 × 250–300	9–12	9–15 wide	35–44 diam	22–25 × 11–13	Hosagoudar et al. (2011), India
<i>hughesii</i> Bat. & H. Maia	1090–1750 × 300–365	2.5–5.6	8–10.5 × 6.5–10.5	51–62 × 40.5–43	32.5–38 × 13.5–16.5	Batista & Maia (1960b), Ghana
<i>irregularis</i> (Syd.) Arx	500–1100 × 190–280	6–8	–	60–80 × 50–65	32–38 × 15–18	Müller & Arx (1962), Philippines
<i>litiseae</i> Hosag. & G.R. Archana	156–392 × 78–196	3–5	11–22 × 3–7	32–40 × 35–40	17–26 × 11–15	Hosagoudar (2012), India
<i>manaosensis</i> (Henn.) G. Arnaud	200–450 × 130–160	4–7	9–13 wide	30–40 diam	25–30 × 12–15	Arnaud (1918), Brazil
<i>moquileae</i> Bat. & H. Maia	150–375	3.5–5	10–12.5 × 6–7.5	25–45 × 22.5–40	20–25 × 14–20	Batista & Maia (1960b), Brazil
<i>moulmeinensis</i> Thaug	< 600 × 340	3.5–5.5	7.5–18.5 × 5.5–12	44.5–57.5 × 37–48	26–33.5 × 15–20.5	Thaug (1976), Myanmar
<i>sanitriae</i> Bat. & H. Maia	542–752 × 303–364	5.5–6.5	8–10.5 × 3–5.5	75–85 × 56.5–57.5	32.5–35 × 19–21.5	Batista & Maia (1960b), Philippines
<i>splendida</i> Bat. & H. Maia	330–510 × 160–250	2.5–5	8.5–15 × 4–7.5	20–31 × 17.5–28	17.5–21.5 × 6–7.5	Batista & Maia (1960b), Brazil
<i>splendida</i> var. <i>laevigata</i> Firmino & Dianese n. var.	110–290 × 60–90	2.5–5	10–15 × 4.5–7.5	25–37.5 × 17.5–27.5	17.5–27.5 × 6–9.5	Present study, Brazil
<i>transversalis</i> (Syd.) Deighton	300–900 × 180–280	4–5	11–14 × 7–8	60–80 × 50–70	40–46 × 16–20	Hughes (1952), Philippines
<i>vateriae</i> Hosag.	245–345 × 90–245	7–9	14–18 × 9–11	35–50 diam	28–32 × 15–18	Hosagoudar (2012), India

***Cirsosia splendida* var. *laevigata* Firmino & Dianese, var. nov.**

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(Figs 6–7)

*Etymology:* Refers to the smooth ascospores.

*Diagnosis:* *Cirsosia splendida* var. *laevigata* differs from *C. splendida* var. *splendida* in having smaller ascomata, pseudoparaphyses, and the smooth ascospores.

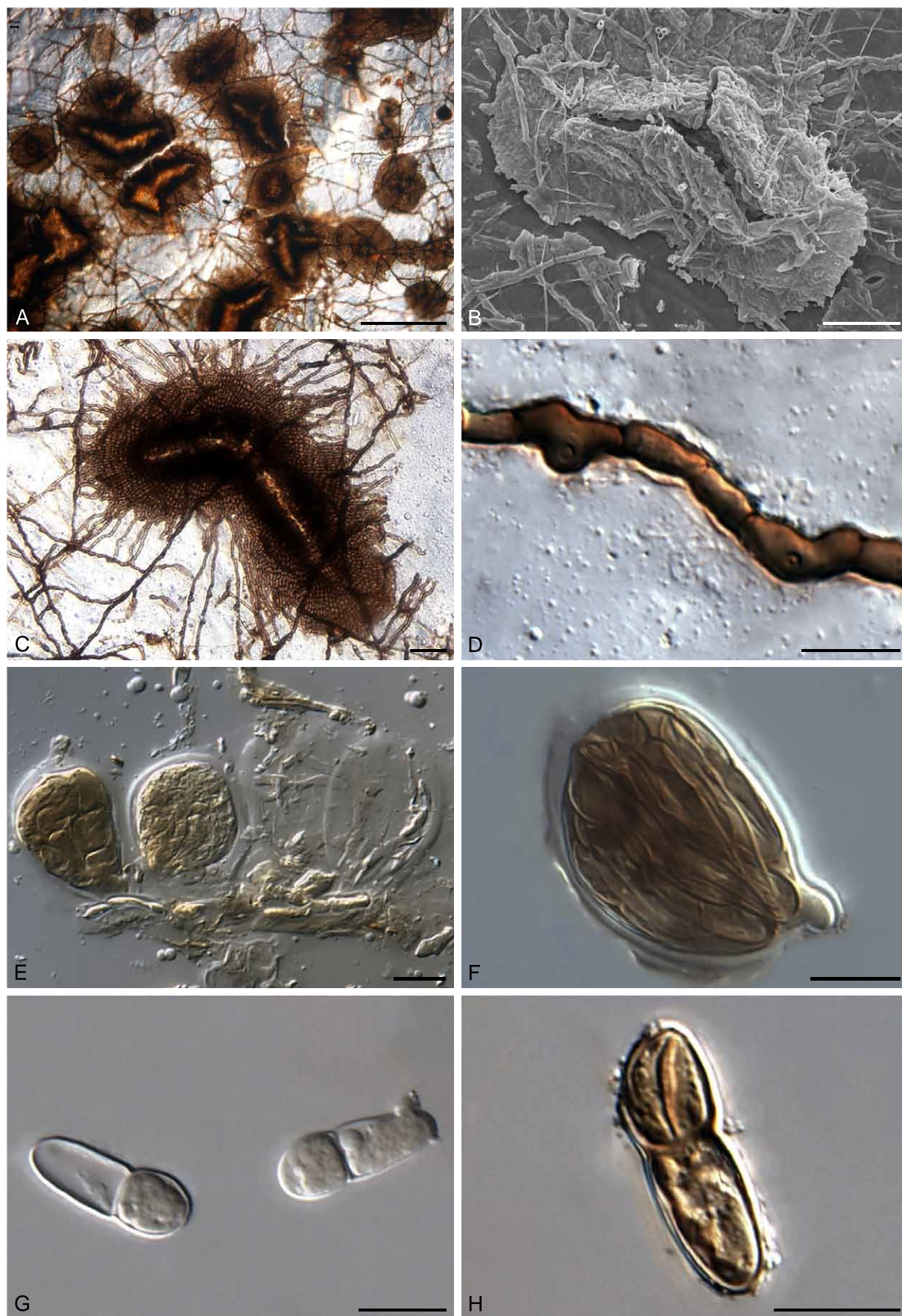
*Type:* **Brazil:** *Mato Grosso do Sul:* Campo Grande, BR-163 Highway left lane, 200 m from the roundabout turn to São Paulo, behind Cerealista Juliana, 20° 35' 8.58" S 54° 34' 49.51" W, on leaves of *Hirtella glandulosa* (*Chrysobalanaceae*), 22 Aug. 1996, M. Sanchez (UB-Mycol Col. 12712b – holotype).

*Description:* *Sexual morph:* Colonies hypophyllous, circular or irregular, single or confluent, black, 1–9 mm diam. *Hyphae* straight or flexuous, with opposite branches, rarely unilateral or irregular, brown, septate, hyphal cells cylindrical, 2.5–5  $\mu\text{m}$  wide, smooth. *Appressoria* numerous, entire, intercalary, elongated with a lateral protuberance, unicellular, 10–15 × 4.5–7.5  $\mu\text{m}$ , brown, penetration peg central or at the distal part of the appressorial cell. *Ascomata* superficial, hysterothecia, lirelliform, V–Y-shaped, on top of a mycelia mat, single to confluent, fringed at margins, randomly distributed in the colony, 110–290 × 60–90  $\mu\text{m}$ , opening by longitudinal fissures, brown; wall of *textura radiata*, cells isodiametric to cylindrical. *Pseudoparaphyses* cylindrical, septate, branched, hyaline, to 1  $\mu\text{m}$  wide. *Asci* bitunicate in structure, fissitunicate, disposed as an upright palisade layer, globose to subclavate, 8-spored, hyaline, 25–37.5 × 17.5–27.5  $\mu\text{m}$ . *Ascospores* cylindrical to oblong-clavate, ends rounded, straight, 1-septate, slightly constricted at the suprmedian septum, hyaline, becoming brown to ferruginous at maturity, smooth, 17.5–27.5 × 6–9.5  $\mu\text{m}$ . *Asexual morph:* Colonies amphigenous, circular or irregular, single or confluent, black, 1–8 mm diam. *Hyphae* straight or flexuous, branching irregularly, septate, hyphal cells cylindrical, 2.5–3  $\mu\text{m}$  wide, smooth. *Appressoria* numerous, entire, intercalary, elongated with a lateral protuberance, unicellular, 10–15 × 5–7.5  $\mu\text{m}$ , brown, penetration peg central on the appressorial cell. *Conidiomata* superficial, pycnothyrial, scutiform, on top of a mycelium mat, circular, single to confluent, fringed at margins, randomly distributed in the colony, 80–120  $\mu\text{m}$  diam, centrally ostiolate, light to dark brown; wall *textura radiata*, cells isodiametric to cylindrical. *Hymenium* lining the inner side of upper wall of the conidioma. *Conidiogenous cells* monoblastic, single, hyaline. *Conidia* initially 1-celled becoming 2-celled at maturity, ellipsoidal, upper cell with rounded end and lower cell with a truncate base, ends rounded when mature, straight, medianly or suprmedianly 1-septate, not constricted at the septum, hyaline, becoming brown to ferruginous at maturity, smooth, 20–25 × 4.5–5  $\mu\text{m}$ .

*Other specimen examined:* **Brazil:** *Rondônia:* RO494 Highway, 82 km from Pimenta Bueno towards Parecis, on leaves of *Hirtella gracilipes* (*Chrysobalanaceae*), 13 Jul. 1995, M. Sanchez (UB-Mycol Col. 23245).

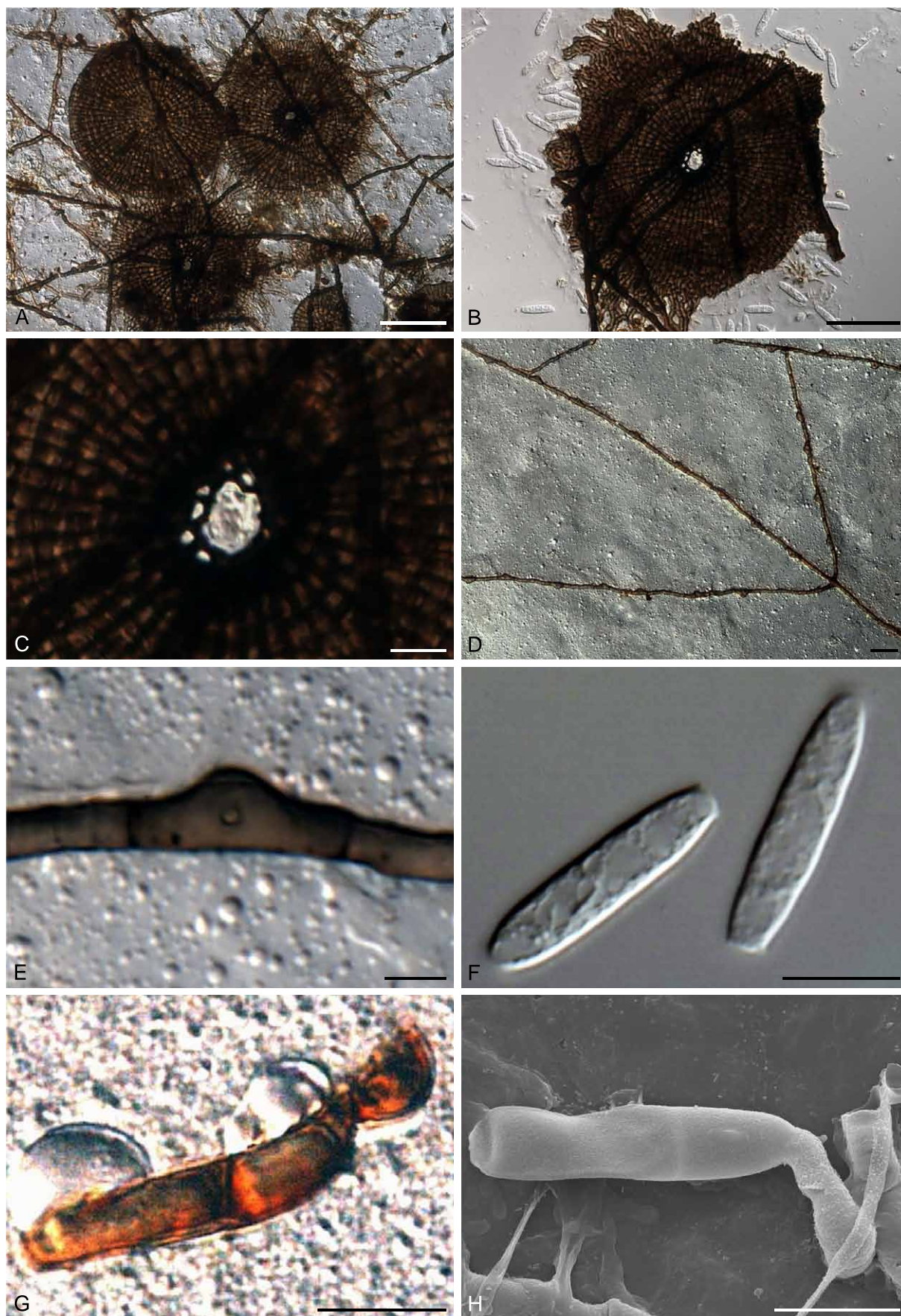
**Table 4.** Summary of the main characteristics of *Cirsosia* species indicating respective host family and species, and morphology of colonies, appressoria, paraphyses, asci, and ascospores.

Species	Host	Families	Colonies	Appressoria	Pseudoparaphyses	Asci	Ascospore
<i>areacearum</i>	<i>Calamus thwaitesii</i>	Areaceae	epiphyllous	globose	-	ovoid	constricted at the central septum, smooth
<i>dipteroearpi</i>	<i>Dipterocarpus grandiflorus</i>	Dipterocarpaceae	epiphyllous	protuberance towards one side	branched	globose to subglobose	constricted at the central septum, verruculose
<i>fiabellariae</i>	<i>Fiabellaria pedunculata</i>	Malpighiaceae	epiphyllous	barrel-shaped	unbranched	subglobose to ovoid	constricted at the central septum, verruculose
<i>globulifera</i>	<i>Calamus</i> sp.	Areaceae	epiphyllous	globose	-	globose to ovoid	constricted at the central septum, smooth
<i>hopeae</i>	<i>Hopea ponga</i>	Dipterocarpaceae	epiphyllous	globose to barrel-shaped	-	globose	constricted at the central septum, verruculose
<i>hughesii</i>	<i>Ancistrophyllum</i> sp.	Areaceae	epiphyllous	globose	unbranched	subglobose to ovoid	constricted in the upper third, smooth
<i>irregularis</i>	<i>Vatica obtusifolia</i>	Dipterocarpaceae	hypophyllous	-	absent	globose to ovoid	constricted at the central septum, verruculose
<i>litseae</i>	<i>Litsea travancorica</i>	Lauraceae	hypophyllous	barrel-shaped	-	globose to ovoid	constricted at the central septum, smooth
<i>manaosensis</i>	<i>Malpighiaceae</i> member	Malpighiaceae	epiphyllous	globose to barrel-shaped	present	ovoid	constricted at the central septum, verruculose
<i>moquileae</i>	<i>Licania tomentosa</i>	Chrysobalanaceae	amphigenous	protuberance towards one side	branched	subglobose	constricted in the upper third, smooth
<i>moulmeinensis</i>	<i>Dipterocarpus</i> sp.	Dipterocarpaceae	epiphyllous	protuberance towards one side	absent	globose to ovoid	constricted in the upper third, smooth
<i>santiriae</i>	<i>Santiria nitida</i>	Burseraceae	amphigenous	globose to barrel-shaped	branched	subglobose to ellipsoid	constricted at the central septum, smooth
<i>splendida</i>	<i>Hirtella americana</i>	Chrysobalanaceae	hypophyllous	globose	unbranched	subglobose	constricted in the upper third, verruculose
<i>splendida</i> var. <i>laevigata</i>	<i>Hirtella glandulosa</i>	Chrysobalanaceae	hypophyllous	protuberance towards one side	branched	globose to subclavate	constricted in the upper third, smooth
<i>transversalis</i>	Areaceae member	Areaceae	epiphyllous	protuberance towards one side	branched	subglobose to ellipsoid	constricted at the central septum, verruculose
<i>vateriae</i>	<i>Vateria indica</i>	Dipterocarpaceae	amphigenous	globose	-	globose	constricted at the central septum, smooth



**Fig. 6. A–H.** *Cirsosia splendida* var. *laevigata*, sexual morph (UB-Mycol. Col. 12712b): **A.** Colony showing opened lirelliform ascomata on superficial mycelium. **B–C.** Ascumata opened by a longitudinal fissure seen in SEM and light microscopy, respectively. **D.** Intercalary elliptic appressoria showing a lateral protuberance. **E–F.** Globose to subclavate asci. **G.** Immature ascospores. **H.** Brown to ferruginous, smooth, cylindrical to subclavate ascospores, showing slight constriction at septum. Bars: A = 100  $\mu$ m; B = 50  $\mu$ m; C = 20  $\mu$ m; G, H = 5  $\mu$ m, and all others = 10  $\mu$ m.





**Fig. 7. A–H.** *Cirrosia splendida* var. *laevigata*, asexual morph (UB-Mycol. Col. 12712b): **A.** Colony showing opened pycnothyrial condidiomata on superficial mycelium. **B–C.** Ostiolate pycnothyrium. **D.** Surface mycelium with intercalary appressoria. **E.** Intercalary appressorium showing lateral protuberance. **F.** Immature conidia. **G.** Brown to ferruginous, smooth, ellipsoidal germinating conidia. **H.** Smooth-walled conidium seen in SEM. Bars: A, B = 50  $\mu$ m; D = 20  $\mu$ m; E = 5  $\mu$ m, and all others = 10  $\mu$ m.

Notes: Two species of *Cirsosia* have been reported previously in association with living leaves of chrysobalanaceous hosts: *C. moquileae* on *Licania tomentosa* from Brazil, and *C. splendida* on *Hirtella americana*, *Chrysobalanus icaco*, and *H. triandra* from Brazil, Panama, and Puerto Rico, respectively (Batista & Maia 1960b, Hosagoudar 2010, Hofmann & Piepenbring 2014, Farr & Rossman 2015).

*Cirsosia splendida* var. *laevigata*, the first *Asterinaceae* reported on *H. glandulosa* and *H. gracilipes*, is almost identical to *C. splendida*, except for the smaller ascomata, presence of pseudoparaphyses, and smooth ascospores (Batista & Maia

1960b, Hofmann & Piepenbring 2014). Such differences are here considered enough to recognize the specimen studied as a new variety of *C. splendida*. Furthermore, both occur on the same host genus in Brazil, but on different species.

Finally, *Cirsosia moquileae* differs from the new variety by dehiscence through a central star-shaped fissure (instead of the longitudinal fissure normally shown in *Cirsosia* species), and narrower ascospores (Batista & Maia 1960b). Indeed, such a form of dehiscence and the shape of the ascomata in *C. moquileae* indicate that that species could be better accommodated in *Asterolibertia* (Batista & Maia 1960b).

### Key to the known *Cirsosia* species

See Tables 3–4 for further information on the characters of the species keyed out here.

1	Ascospores smooth .....	2
	Ascospores verruculose .....	10
2 (1)	Ascospores medianly constricted .....	3
	Ascospores suprmedianly constricted .....	7
3 (2)	Colonies amphigenous .....	4
	Colonies hypophyllous or epiphyllous .....	5
4 (3)	Ascospores 28–32 × 15–18 μm .....	<b>C. vateriae</b>
	Ascospores 32.5–35 × 19–21.5 μm .....	<b>C. santiriae</b>
5 (3)	Colonies epiphyllous .....	6
	Colonies hypophyllous .....	<b>C. litseae</b>
6 (5)	Asci 4-spored .....	<b>C. areacearum</b>
	Asci 8-spored .....	<b>C. globulifera</b>
7 (2)	Ascomata opening by a longitudinal fissure .....	8
	Ascomata opening by a stellar fissure .....	<b>C. moquileae</b>
8 (7)	Appressoria having a lateral protuberance .....	9
	Appressoria globose .....	<b>C. hughesii</b>
9 (8)	Ascospores 17.5–27.5 × 6–9.5 μm .....	<b>C. splendida</b> var. <b>laevigata</b>
	Ascospores 26–33.5 × 15–20.5 μm .....	<b>C. moulmeinensis</b>
10 (1)	Ascospores medianly constricted .....	11
	Ascospores suprmedianly constricted .....	<b>C. splendida</b> var. <b>splendida</b>
11 (10)	Colonies epiphyllous .....	12
	Colonies hypophyllous .....	<b>C. irregularis</b>
12 (11)	Appressoria with a lateral protuberance .....	13
	Appressoria barrel-shaped to globose .....	14
13 (12)	Appressoria 8–10 × 13.5–15 μm .....	<b>C. diptercarpi</b>
	Appressoria 11–14 × 7–8 μm .....	<b>C. transversalis</b>
14 (12)	Hosts in <i>Malpighiaceae</i> .....	15
	Hosts in <i>Dipterocarpaceae</i> .....	<b>C. hopeae</b>
15 (14)	Asci 27–29.5 × 19–24 μm .....	<b>C. flabellariae</b>
	Asci 55–65 × 45–50 μm .....	<b>C. manaosensis</b>



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