The Lichenologist **46**(4): 573–588 (2014)
doi:10.1017/S0024282914000036

New species and interesting records of *Arthoniales* from the Amazon, Rondônia, Brazil

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Abstract: The following new species of *Arthoniales* are described from Rondônia: *Alyxoria fuscospora* with 3-septate clavate ascospores of 20–23 × 4·5–5·5 µm having a gelatinous layer soon appearing evenly brown (also known from other tropical countries). *Chiodecton complexum* with discrete soralia, immersed apothecia in branched lines and 3-septate ascospores (26–)33–40 × 2·5–3·5 µm. *Coniarthonia rosea,* similar to *C. pulcherrima* but with the apothecia pink and more irregular in outline and the ascospores 13–16 × 5·5–6·5 µm. *Cresponea flavosorediata* with yellow-olive soralia, apothecia with yellow pruina and 7–9-septate ascospores, 26–38(–50) × 5·0–6·5 µm. *Cresponea lichenicola*, lichenicolous on a *Pyrenula*, with 0·1–0·3 mm wide apothecia with yellow pruina. *Eremothecella helicella* with helicoid curved *c.* 17–29-septate conidia *c.* 70–95 × 2 µm long if uncoiled, with septa 3–6 µm apart. The *Arthoniales* are a speciose component of the lowland rainforest of Rondônia. A key is provided to the corticolous species of most groups of *Arthoniales* found in Rondônia. The foliicolous species found so far are listed. Most are new records for Rondônia. *Chrysothrix occidentalis* is new to the Neotropics.

Key words: *Arthoniaceae, Chrysothricaceae,* lichens, rainforest, *Roccellaceae*, taxonomy

Accepted for publication 10 *December* 2013

Introduction

The rainforests of Rondônia in the Amazon Basin are lichenologically largely unknown; until 2010 only 30 lichen species had been reported, mostly foliicolous species (Lücking 2008) and species of *Cladonia* (Ahti 2000). However, recent projects to survey the lichens in these still mostly primary forests have started and the first results show that the region is among the richest sites for lichen diversity in the world (Cáceres *et al.* 2012; Aptroot & Cáceres 2013; Parnmen *et al.* 2013). It is especially surprising that some undescribed species are locally abundant, like some of the *Pyrenula* species recently described from the area (Aptroot *et al.* 2013).

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The vast majority of the lichen species in Rondônia grow on tree bark in closed rainforest. Fewer species occur on other substrata, such as living leaves or on the soil of termite nests (Aptroot & Cáceres 2014). The lower tree trunks in the rainforest in Rondônia are predominantly covered by crustose lichens, not by bryophytes as is usual in many lowland rainforests. The reason seems to be that the trees are naturally more dispersed than in many other rainforest areas, such as the Guyana Highlands (M. E. S. Cáceres & A. Aptroot, pers. obs.), due to the poor soils that do not sustain a denser vegetation. As a result of the availability of more light at forest floor level, more lichen species occur on the lower trunks than usual. Therefore, sampling the lichen diversity does not depend much on the lucky encounter of recently fallen trees or the availability of logging sites. As a result, many different species could be collected within a relatively short period during two collecting trips in 2012.

The lichen flora of a tropical lowland rainforest is largely composed of crustose

species. Macrolichens are sparse, and mostly represented by microfoliose species. Among the crustose lichens, there are four speciose and abundant groups, *viz*. the *Arthoniales*, the *Ostropales* (mainly *Graphidaceae*), the *Lecanorales* and the pyrenocarpous lichens (comprising several non-related groups). Within the *Arthoniales*, the genera belonging to the *Roccellaceae* in a wide sense are much better known than those in the *Arthoniaceae* in a wide sense, partly because they have ascomata with more characters and because more, and generally smaller, genera are described in the family *Roccellaceae*, making it more feasible to identify undescribed species. Here we describe six new species of *Arthoniales*, in five different genera.

Material and Methods

Identification and descriptive work was carried out in Itabaiana, Universidade Federal de Sergipe, using a Leica EZ4 stereomicroscope and a Leica DM500 compound microscope, and also in Soest using an Olympus SZX7 stereomicroscope and an Olympus BX50 compound microscope with interference contrast, connected to a Nikon Coolpix digital camera. Sections were mounted in tap water, on which all measurements were also made, and often IKI (undiluted Lugol) was added later to examine iodine reactions. The specimens from this study are preserved in ISE, with a complete set of duplicates in ABL. The chemistry of all specimens was investigated by a UV lamp, and occasionally spot tests with 10% KOH were made. Some specimens were investigated by thin-layer chromatography (TLC) using solvent A (Orange *et al.* 2001).

All specimens cited below were collected by M. E. S. Cáceres & A. Aptroot in Rondônia State, Brazil at *c.* 100 m elevation, and are preserved in both ABL and ISE. Collection numbers in the 11000s refer to collections from March 2012, numbers in the 15000s refer to collections from November 2012. Unless otherwise stated, the collections are from tree bark in rainforest. Only one representative collection is mentioned. Full collection details are given below only for the newly described species.

Main collecting sites and corresponding short name:

Buriti: Sítio Ecológico Buriti on Lago Cujubim E of Porto Velho, 8°35′17″S, 63°40′40″W.

Circuito: Porto Velho, Parque Circuito, 8°43′54″S, 63°54′04″W.

Cuniã: Estação Ecológica de Cuniã, km 760 on road BR 319 N of Porto Velho, 8°02′44″S, 63°29′11″W.

São Francisco: Fazenda São Francisco off BR319, 30 km N of Porto Velho, 8°24′33″S, 63°58′56″W.

Parque: Porto Velho, Parque Natural Municipal de Porto Velho, 8°41′10″S, 63°52′05″W.

Santo Antonio: Porto Velho, Santo Antonio church, 8°48′27″S, 63°56′40″W.

UNIR: Porto Velho, UNIR Federal University campus S of city, 8°50′14″S, 63°56′25″W.

The New Species

Alyxoria fuscospora Ertz, Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 805957

Alyxoria growing on soil or bark, with non-pruinose ascomata, 3-septate clavate ascospores 20–23 × 4·5–5·5 µm with *c.* 1·5 µm thick gelatinous layer which soon appears uniformly brown.

Type: Brazil, Rondônia, Sítio Ecológico Buriti on Lago Cujubim E of Porto Velho, 8°35′17″S, 63°40′40″W, alt. *c.* 100 m, on tree bark in primary rainforest, 18 November 2012, *M. Cáceres & A. Aptroot* 15372 (ISE—holotype; ABL—isotype).

(Fig. 1)

Thallus continuous, slightly shiny, green, without prothallus. *Algae* trentepohlioid.

Apothecia dispersed, immersed to erumpent, elongate to furcate, partly simple but mostly branched, up to 1·5 mm long, 0·2–0·3 mm wide, margin black, *c.* 0·1 mm wide; *disc* not or narrowly exposed. *Excipulum* carbonaceous, continuous and often very thick below the hymenium, *c.* 50–100 µm thick. *Hymenium* not inspersed, partly IKI+ yellowish, partly pale bluish (hemiamyloid); *paraphysoids* anastomosing, *c.* 1 µm wide, apices not swollen. *Asci* clavate, *c.* 30–55 × 12–18 µm. *Ascospores* 8 per ascus, initially hyaline but soon (and in the majority in every section) appearing brown, 3-septate, clavate, 20–23 × 4·5–5·5 µm, with smooth, *c.* 1·5 µm thick gelatinous layer that probably contains most of the brown pigment, lumina rounded-rectangular.

Pycnidia not observed.

Chemistry. Thallus UV−, C−, P−, K−. TLC: no secondary metabolites detected.

Ecology and distribution. On soil of a terricolous termite nest in primary rainforest (type material), but also on tree bark in rainforest. Pantropical, so far known from Brazil, Guatemala, Bénin, Gabon, Malaysia, Papua New Guinea and Thailand.

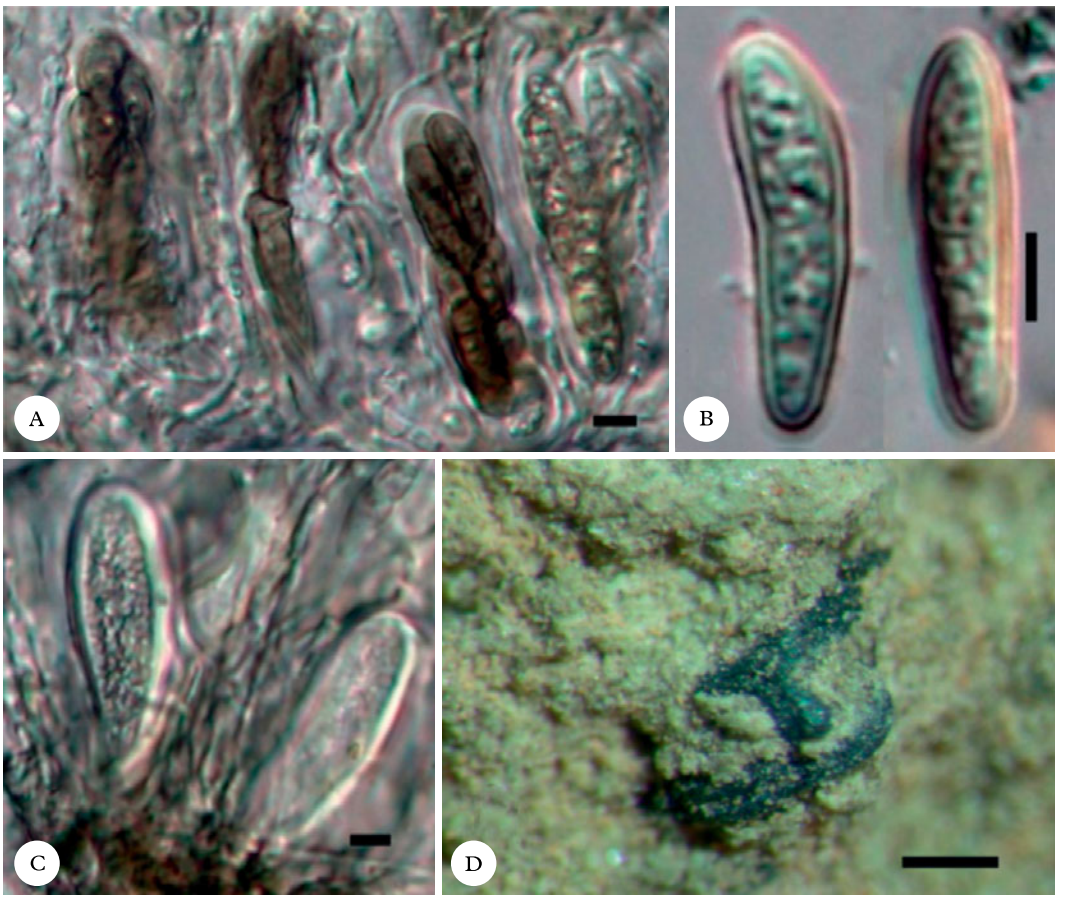

FIG. 1. *Alyxoria fuscospora* (isotype); A & C, asci; B, ascospores; D, thallus with apothecia. Scales: A–C = 5 µm; D = 0·5 mm. In colour online.

Discussion. The genus *Opegrapha* is a large assemblage of lineages, some of which are apparently speciose (Ertz 2009; Ertz *et al.* 2009). *Alyxoria* Ach. is a genus that was recently reinstated for the *Opegrapha varia* group based on phylogenetic studies (Ertz & Tehler 2011). The genus is morphologically recognizable and characterized by, for example, wide open apothecium discs, asymmetrical ascospores and asci of the '*Varia* type' as defined by Torrente & Egea (1989). Our new species most probably belongs to this group, as indicated by its ascomata, ascus and ascospore types, and is therefore described in *Alyxoria*. This species is easily recognized by its 3-septate ascospores with a distinct gelatinous layer soon becoming brown. Other species of *Opegrapha* s. lat. usually have ascospores that become pale brown only when postmature, and most of them have a roughly ornamented exospore.

Opegrapha species with brown ascospores were traditionally described in the genus *Sclerographa* (Vain.) Zahlbr. Only five species have ever been placed in this genus, including two European species which have hyaline ascospores, and three tropical corticolous species, *viz*. *Opegrapha indica* (Räsänen) Upreti & Ajay Singh from India, which turned out to be a *Graphidaceae* (Ertz 2009), *Opegrapha agelaeotera* Vain. described from Mozambique, which also have hyaline ascospores

https://doi.org/10.1017/S0024282914000036 Published online by Cambridge University Press

(Ertz 2009), and *Opegrapha quinqueseptata* Vain. from Brazil with 5-septate ascospores.

The new species is identical to the paleotropical material named *Opegrapha herbarum* Mont. s. lat. by Ertz (2009). *Opegrapha culmigena* Lib. is considered as an older name for *O. herbarum* Mont. (Sérusiaux *et al.* 1999) and differs from our new species in the sense of its type [isotype of *O. culmigena* Lib. examined by AA and DE; now *Alyxoria culmigena* (Lib.) Ertz] by the ascospores that only become brown when over-mature. This would mean that the new species *A. fuscospora* is pantropical and also commonly occurs corticolous.

Our species shares some key characters with *Opegrapha bengalensis* Upreti & Ajay Singh from India, which is said to have brown, 3-septate ascospores which are, however, longer and especially much wider (29–34 × 8–12 µm) than in the new species (Upreti & Singh 1987). Its assignment to the *Arthoniales* is, however, questionable (Ertz 2009).

Additional specimens seen. See Ertz (2009) sub *Opegrapha herbarum* Mont. s. lat.

Chiodecton complexum Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 805958

Corticolous *Chiodecton* species with discrete soralia, immersed apothecia in branched lines in stromata and 3-septate ascospores (26–)33–40 × 2·5–3·5 µm.

Type: Brazil, Rondônia, Porto Velho, UNIR Federal University campus S of city, 8°50′14″S, 63°56′25″W, alt. *c.* 100 m, on tree bark in forest remnant, 8 March 2012, *M. Cáceres & A. Aptroot* 11020 (ISE—holotype; ABL—isotype).

(Fig. 2A–E)

Thallus continuous, rimose in places, covering areas up to 5 cm diam., smooth to felty, closely appressed, greenish grey, with pinkish hue when fresh, dull, partly uneven/verrucose due to the presence of initials of soralia, pycnidia or stromata, surrounded by a felty dark brown prothallus line. *Soralia* numerous, mostly in central areas of the thallus, rounded, capitate, 0·2–0·6 mm diam., occasionally confluent but individual soralia remaining recognizable, with farinose soredia, pale green with a pink hue that fades in the herbarium. *Algae* trentepohlioid.

Apothecia immersed and pyriform, 0·1–0·2 mm diam., only visible from above by black shiny ostioles *c.* 0·05 mm diam. *Stromata* originating in the marginal areas of some thalli, outside of thallus colour or generally somewhat paler, emergent from the thallus, 0·5–2·5 mm diam., containing 5–50 ascomata in branched lines, without yellow pigment. *Excipulum* black, dark brown in section; *hypothecium* black, extending far downwards; *epihymenium* hyaline. *Hymenium* not inspersed, IKI+ blue (amyloid); *paraphysoids* 1·0–1·5 µm wide, anastomosing. *Asci* cylindrical, 45–50 × 10–13 µm. *Ascospores* 8 per ascus, hyaline, 3-septate, narrowly fusiform, (26–)33–40 × 2·5–3·5 µm, not constricted at the septa, without gelatinous sheath, ends rather pointed.

Pycnidia originating in the marginal areas of some thalli, black, punctiform, *c.* 0·1 mm diam., immersed in *c.* 0·2 mm diam. emergent warts of thallus colour or generally somewhat paler. *Conidia* hyaline, filiform, curved, 13–18 × 1 µm.

Chemistry. Thallus UV−, C−, P−, K−. TLC: roccellic acid (but in concentrations too low to cause a significant UV-reaction).

Ecology and distribution. On smooth bark of trees in or near rainforest. Known only from Brazil.

Discussion. This species is characterized by the abundance of discrete soralia and the regular presence of stromata with punctiform apothecia in branched lines, and pycnidia with long, filiform conidia. The genus *Chiodecton* currently comprises 20 accepted species, most of which were treated by Thor (1990). Among the species that have since been described (Harada 1990; Henssen & Thor 1998; Thor 2007; Lumbsch *et al.* 2011), there is one more or less sorediate species, *Chiodecton pustuliferum* Aptroot (Lumbsch *et al.* 2011). It differs notably by the paler, much thicker thallus with black byssoid prothallus. The new species also differs from all described species in *Chiodecton*

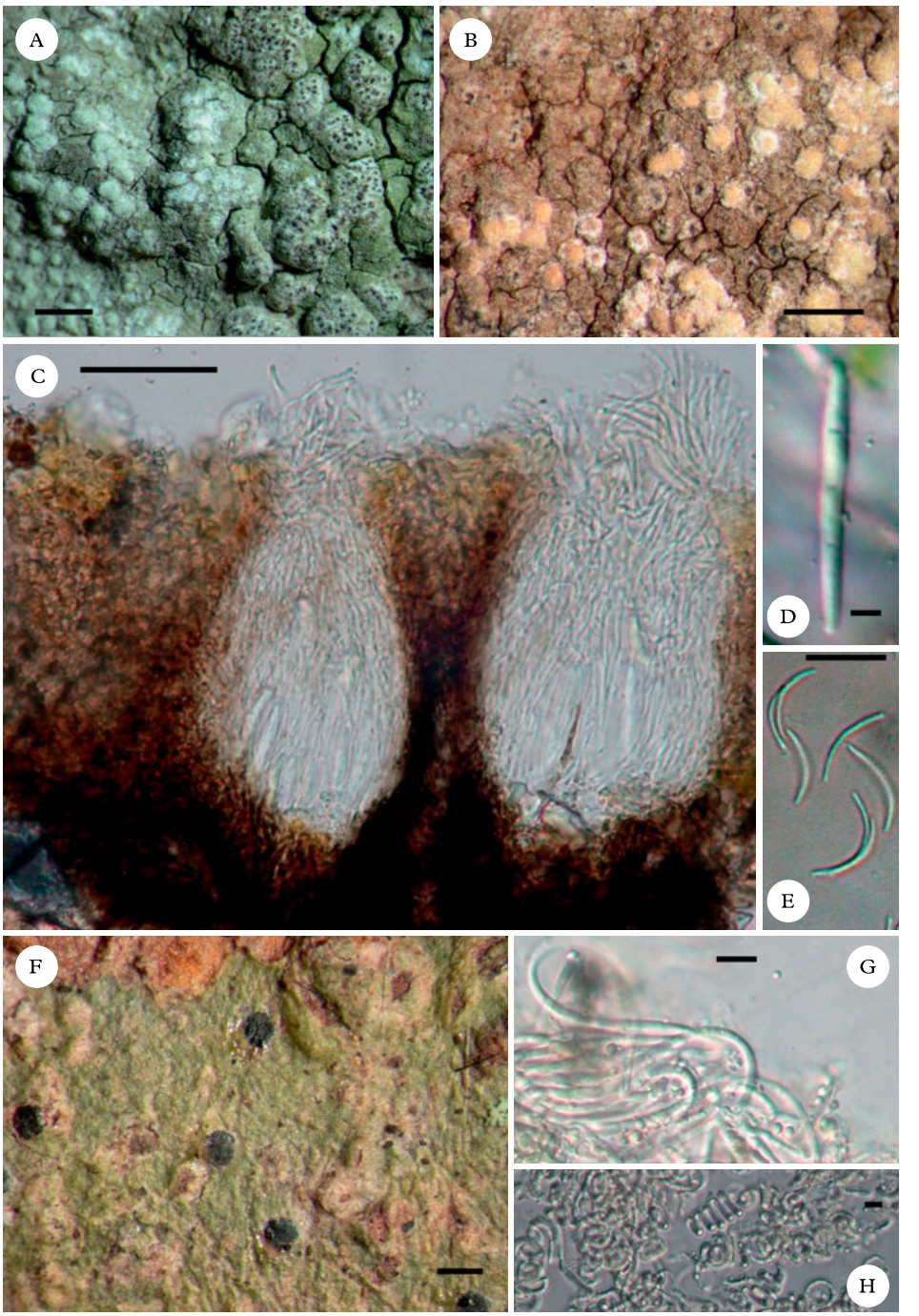

FIG. 2. A–E, *Chiodecton complexum* (isotype); A, thallus with soralia (left) and stromata (right); B, thallus with soralia and pycnidia, fresh specimen; C, section through ascomata; D, ascospore; E, conidia. F–H *Eremothecella helicella* (isotype); F, thallus with pycnidia; G & H, conidia, in G uncoiled, in H coiled. Scales: A, B & F = 0·5 mm; C = 50 μm; D, E, G & H = 5 μm. In colour online.

https://doi.org/10.1017/S0024282914000036 Published online by Cambridge University Press

when the soredia are disregarded, that is if the material is interpreted as a sorediate morph of a normally non-sorediate species. It would key out close to the Australasian *Chiodecton leptosporum* Müll. Arg. in Thor (1990) (recently recorded from one outpost locality in Réunion; van den Boom *et al.* 2011), but that species differs by the absence of soredia, evenly dispersed apothecia (not in lines) and shorter conidia. These characters, together with the occurrence on another continent, exclude the possibility that the Rondônian material is just a sorediate morph of *C. leptosporum*.

Additional specimens seen. **Brazil:** *Rondônia*: same as the type, *M. Cáceres & A. Aptroot* 11089; Porto Velho, Parque Natural Municipal de Porto Velho, 8°41′10″S, 63°52′05″W, alt. *c.* 100 m, on tree bark of *Ceiba samauma* in primary rainforest, 2012, *M. Cáceres & A. Aptroot* 11225; Porto Velho, Parque Circuito, 8°43′54″S, 63°54′04″W, alt. *c.* 100 m, on tree bark of *Hevea brasiliensis* in plantation, 2012, *M. Cáceres & A. Aptroot* 11447 (all ISE & ABL). *Ceará*: Chapada do Araripe, Aerupuerto Antigo, on bark of tree, *c.* 800 m, 2013, *M. M. E. Alves* 027, 897 (ISE).

Coniarthonia rosea Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 805959

Corticolous *Coniarthonia* similar to *C. pulcherrima* but with the apothecia pink and more irregular in outline and the ascospores 13–16 × 5·5–6·5 µm.

Type: Brazil, Rondônia, Estação Ecológica de Cuniã, km 760 on road BR 319 N of Porto Velho, 8°02′44″S, 63°29′11″W, alt. *c.* 100 m, on tree bark in primary rainforest, 20 November 2012, *M. Cáceres & A. Aptroot* 15696 (ISE—holotype; ABL—isotype).

(Fig. 3A–C)

Thallus spreading, covering an area of up to 5 cm diam., brown to dark brown, very thin and mostly visible near the ascomata, dull, without prothallus. *Algae* trentepohlioid.

Apothecia irregular in outline with linear or branched shapes, only slightly raised above the thallus, 0·5–1·4 mm diam., occasionally confluent, pale pink throughout, without differently coloured pruina, margins not differentiated. *Excipulum* not developed. *Hymenium* without gel, IKI+ blue; *paraphysoids* anastomosing. *Asci* short ellipsoid to nearly globose, IKI−, dispersed in the hymenium, 25–30 µm diam. *Ascospores* 8 per ascus, hyaline, clavate, 1-septate, 13–16 × 5·5–6·5 µm, slightly constricted at the septum, ends broadly rounded, wall and septum *c.* 1 µm thick.

Pycnidia not observed.

Chemistry. Apothecia UV−, C−, P−, K+ purple-red, pigment dissolving and colour becoming orange before vanishing. TLC: an anthraquinone.

Ecology and distribution. On smooth bark of trees in primary rainforest. Known only from Brazil.

Discussion. The genus *Coniarthonia* is a small genus with only seven known species (Grube 2001; Menezes *et al.* 2013). It is characterized by the hydrophobic ascomata with red pigments and without margins, and also by the crustose thallus. This new species grows side by side with *Coniarthonia pulcherrima* (Müll. Arg.) Grube (see Fig. 1A, showing both species in the field) and mainly, but consistently, differs by a much paler colour of the apothecia which also have a more irregular outline and are smaller. The apothecium pigment is probably an anthraquinone (Rf 4 in solvent A), not chiodectonic acid as in *C. pulcherrima*. The possibility that it is badly developed, pigment-poor, young or old material of *C. pulcherrima* can be ruled out because there is also a difference in the shape of the apothecium.

Additional specimens seen. **Brazil:** *Rondônia*: same as the type, 2012, *M. Cáceres & A. Aptroot* 11716; Fazenda São Francisco off BR 319, 30 km N of Porto Velho, 8°24′33″S, 63°58′56″W, alt. *c.* 100 m, on tree bark in primary rainforest, 2012, *M. Cáceres & A. Aptroot* 11952 (all ISE & ABL).

Cresponea flavosorediata Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 805960

Corticolous *Cresponea* with yellow-olive soralia, apothecia with yellow pruina and ascospores 7–9-septate, 26–38(–50) × 5·0–6·5 µm.

Type: Brazil, Rondônia, Estação Ecológica de Cuniã, km 760 on road BR 319 N of Porto Velho, 8°02′44″S, 63°29′11″W, alt. *c.* 100 m, on tree bark in primary rainforest, 20 November 2012, *M. Cáceres & A. Aptroot* 15661 (ISE—holotype; ABL—isotype).

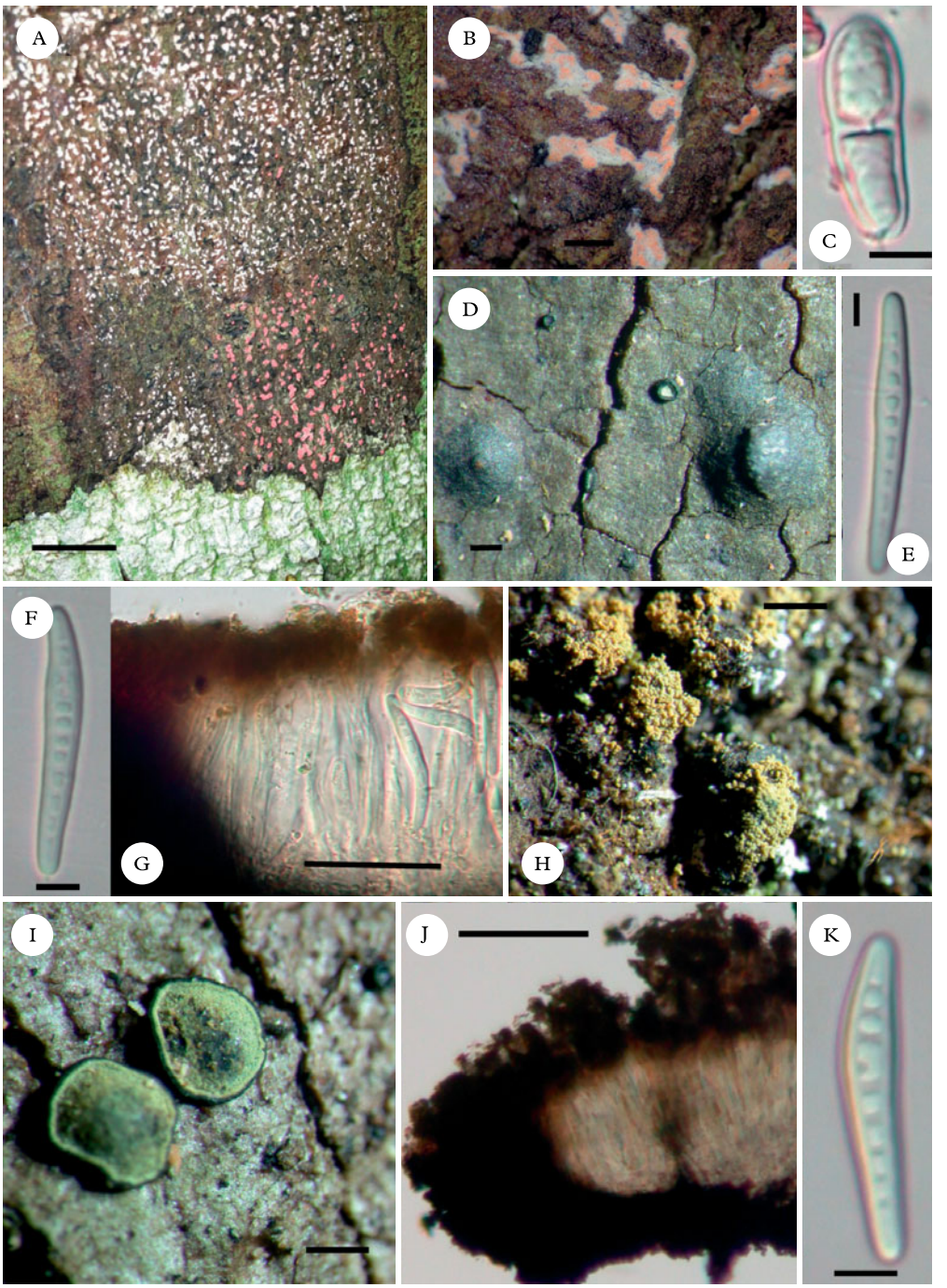

FIG. 3. A–C, *Coniarthonia rosea*; A, habitus in the field (the pale apothecia), side by side with *C. pulcherrima* (pink); B, apothecia (holotype); C, ascospore (isotype). D–G *Cresponea lichenicola* (isotype); D, habitus; E & F, ascospores; G, section through apothecium. H–K, *Cresponea flavosorediata* (isotype); H, soredia; I, apothecia; J, section through apothecium; K, ascospore. Scales: A = 1 cm; B, D, H & I = 0·5 mm; C, E, F & K = 5 μm; G & J = 50 μm.

https://doi.org/10.1017/S0024282914000036 Published online by Cambridge University Press

(Fig. 3H–K)

Thallus covering large areas of bark on tree trunks (up to nearly 10 dm^2), not corticate, dull to slightly glossy, olivaceous green to usually olivaceous brown, without prothallus line. *Soralia* always present but varying from sparse (as few as 1 per 10 cm^2) to abundant and then often confluent and covering most of the thallus, individual soralia mostly round, 0·5–2·5 mm diam., raised above the thallus. *Soredia* farinose, yellow-olive. *Algae* trentepohlioid.

Apothecia sessile, round to slightly lobate, solitary, often sparse (as few as 1 per 10 cm^2), 0·5–1·6 mm diam.; *disc* flat, densely vivid greenish yellow pruinose, margin black, inner side with yellow pruina, entire, somewhat glossy, higher than the disc. *Excipulum* black, outside rough; *epihymenium* dark brown; *hypothecium* black. *Hymenium* hyaline, IKI+ blue; *paraphysoids* branched, tips brown and covered by a dense and thick layer of pruina. *Asci* numerous, clavate, with 8 irregularly arranged ascospores. *Ascospores* hyaline, 7–9-septate, narrowly clavate, 26–38(–50) × 5·0–6·5 µm, often slightly curved, ends rounded.

Pycnidia not observed.

Chemistry. Thallus and apothecia UV–, C–, P–; thallus K–; epihymenium K+ red (an anthraquinone). TLC: thallus with zeorin and pigment (not an anthraquinone).

Ecology and distribution. On smooth bark of trees in primary rainforest. Known only from Brazil.

Discussion. The genus *Cresponea* so far contains two sorediate species, *viz*. *C. leprieuroides* (Nyl.) Egea & Torrente and *C. sorediata* Elix *et al.* The first has whitish rather than greenish yellow soredia and contains lecanoric acid, and the second is a subarctic species known only sterile. The unidentified pigment colouring the soredia of *C. flavosorediata* is different from the anthraquinone of the pruina, and also different from the xantholepinone pigment in the only other known species with a medullary pigment, *Cresponea endosulphurea* A. A. Menezes *et al.* (Menezes *et al.* 2013). The new species is quite conspicuous in the field, not by its colour, but mostly because it occupies large parts (up to nearly 10 dm^2) of single trunks. If the material is interpreted as a sorediate morph of a normally non-sorediate species, it would key out close to *Cresponea leprieurii* (Mont.) Egea & Torrente in Egea & Torrente (1993), but that species differs by more septate, *viz*. (8–)9–14-septate, and longer, *viz*. (34–)38–65 µm long, ascospores, as well as by the absence of soredia; *C. proximata* (Nyl.) Egea & Torrente differs by shorter, *viz*. 25–38(–40) µm long, ascospores, and a hemiamyloid IKI reaction of the hymenium.

It is surprising that two apparently undescribed *Cresponea* species were found in Rondônia, but no known species could be found in the region. This is very different to experiences on past collecting trips elsewhere in the tropics, when invariably one or more of the pantropical *Cresponea* species were found. See also the discussion under the next taxon.

Additional specimens seen. **Brazil:** *Rondônia*: same as the type, 2012, *M. Cáceres & A. Aptroot* 11609, 11611 & 11699 (all ISE & ABL).

Cresponea lichenicola Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 805961

Cresponea growing lichenicolous on *Pyrenula* thallus, having 0·1–0·3 mm wide apothecia with yellow pruina.

Type: Brazil, Rondônia, Porto Velho, Parque Natural Municipal de Porto Velho, 8°41′10″S, 63°52′05″W, alt. *c.* 100 m, on tree bark in primary rainforest, lichenicolous on *Pyrenula* thallus, 9–12 March 2012, *M. Cáceres & A. Aptroot* 11412a (ISE—holotype; ABL—isotype).

(Fig. 3D–G)

Thallus not visible; lichenicolous on *Pyrenula* thallus.

Apothecia sessile, round, solitary, rather dispersed; *disc* flat, densely vivid greenish yellow pruinose, margin black, somewhat glossy, higher than the disc. *Excipulum* black, outside rough; *epihymenium* dark brown; *hypothecium* black. *Hymenium* hyaline, IKI+ blue; *paraphysoids* branched, tips brown and covered by a dense and thick layer of pruina. *Asci* numerous, clavate, with 8 irregularly arranged

ascospores. *Ascospores* hyaline, 11–13-septate, narrowly clavate, 30–45 × 4·5–5·5 µm, often slightly curved, ends rounded.

Pycnidia not observed.

Chemistry. Apothecia UV−, C−, P−; thallus K−; epihymenium K+ red (an anthraquinone).

Ecology and distribution. On thallus of *Pyrenula* species on smooth bark of trees in primary rainforest. Known only from Brazil.

Discussion. So far 17 species are described in the genus *Cresponea*, mostly treated in Egea & Torrente (1993), the remainder in some later publications (Egea *et al.* 1996; Elix 2007; Sakata *et al.* 2009; Elix *et al.* 2011; Lumbsch *et al.* 2011; Menezes *et al.* 2013). This is the first species reported without a proper thallus and with apparently a lichenicolous lifestyle. It is morphologically rather close to the species above, which differs by the sorediate thallus, the much larger apothecia and the wider ascospores with fewer septa. If the material is interpreted as lichenicolous material of a usually autonomous species, it would key out close to *Cresponea leprieurii* (Mont.) Egea & Torrente in Egea & Torrentes (1993), but that species differs, as well as by the presence of soredia, by larger ascomata and broader, *viz.* 5–7 µm wide, ascospores.

Additional specimen seen. **Brazil:** *Rondônia*: Fazenda São Francisco off BR 319, 30 km N of Porto Velho, 8°24′33″S, 63°58′56″W, alt. *c.* 100 m, on tree bark in primary rainforest, lichenicolous on *Pyrenula* thallus, 2012, *M. Cáceres & A. Aptroot* 11841a (ISE & ABL).

Eremothecella helicella Aptroot & M. Cáceres sp. nov.

MycoBank No.: MB 805962

Corticolous *Eremothecella* with helicoid curved *c.* 17–29-septate conidia, *c.* 70–95 × 2 µm long if uncoiled, with septa 3–6 µm apart.

Type: Brazil, Rondônia, Porto Velho, Parque Natural Municipal de Porto Velho, 8°41′10″S, 63°52′05″W, alt. *c.* 100 m, on tree bark in primary rainforest, 9–12 March 2012, *M. Cáceres & A. Aptroot* 11309 (ISE—holotype; ABL—isotype).

(Fig. 2F–H)

Thallus continuous, green, slightly glossy, without prothallus line. *Algae* trentepohlioid (not *Phycopeltis*).

Apothecia not observed.

Pycnidia black, round to oval or with slightly wavy outline, superficial, flat, 0·2–0·4 mm diam. *Conidia* hyaline, filiform, mostly helicoid curved like a corkscrew, *c.* 17–29-septate, *c.* 70–95 × 2 µm long if uncoiled, septa 3–6 µm apart.

Chemistry. Thallus UV−, C−, P−, K−. TLC: no secondary metabolites detected.

Ecology and distribution. On smooth bark of trees in primary rainforest. Known only from Brazil.

Discussion. The genus *Eremothecella* is a small genus with only six species known to date (Lücking 2008), all of them strictly foliicolous. The new species is the first to be found growing corticolous. In gross morphology it is very reminiscent of the foliicolous members of the genus, which are mainly characterized by the very applanate grey pycnidia with filiform conidia arising on one side. Although the new species is known only in the pycnidial state, the conidia differ from those of the described species by their strong coiling, which has not been reported in any species of *Eremothecella* before, or among other lichenized ascomycete is known only in Micarea subnigrata.

Key to the corticolous *Arthoniales* of Rondônia

There is no doubt that the *Arthoniales* are one of the most speciose lichen groups in the region. However, only about half of the corticolous species could be identified to species level with some certainty. Here we present a key for a rapid identification of these taxa (and a few saxicolous species). Long numbers between brackets are collecting numbers of the authors. Foliicolous species are not included; they are mentioned below. For details about morphology and nomenclature see, for example, Thor (1990), Egea & Torrente (1994), Grube (2001), Aptroot & Sparrius (2003), Cáceres (2007), Lücking (2008), Aptroot (2009), Aptroot *et al.* (2009), Lücking *et al.* (2011) and Lima *et al.* (2013).

This key indicates the diversity present. Much of the remaining unidentified diversity is in the genera *Arthonia* s. lat., *Cryptothecia* s. lat., and *Opegrapha* s. lat. No fruticose *Arthoniales* were encountered. There are in particular many sterile species with a crustose thallus, often with soredia or isidia and a characteristic chemistry, but most of these are undescribed and their affiliation is unknown. In the absence of apothecia, it is difficult to decide in which genus they should be placed. They may partly belong to additional groups, such as the largely sterile genus *Herpothallon*.

1 Thallus and/or apothecia with yellow, orange, pink or red pigments 2
Thallus and apothecia without pigments 17

2(1) Thallus and/or apothecia with yellow or yellow-orange pigments 3
Thallus and/or apothecia with pink or red pigments 7

3(2) Pigment on the apothecium disc, another pigment sometimes present in discrete soralia 4
Pigment in medulla, prothallus and/or pseudisidia, or throughout the leprose thallus, if on the apothecia, then apothecia completely yellow, also in section, not only on the disc surface 5

4(3) Lichenicolous on *Pyrenula* . . . . . **Cresponea lichenicola** Aptroot & M. Cáceres (Fig. 3D–G)
Lichenized, with discrete soralia . . . . . **Cresponea flavosorediata** Aptroot & M. Cáceres (Fig. 3H–K)

5(3) Thallus byssoid, pigment localized in medulla, prothallus and/or pseudisidia. Cunião (15639) & Parque . . . . . **Herpothallon aurantiacoflavum** (B. de Lesd.) Aptroot *et al.* (Fig. 5A)
Thallus granular, leprose throughout 6

6(5) Thallus bright golden yellow. Parque (15241) . . . . . **Chrysothrix xanthina** (Vain.) Kalb
Thallus mostly vivid greenish yellow. Parque (15239), first report from the Neotropics . . . . . **Chrysothrix occidentalis** Elix & Kantvilas (Fig. 4D)

7(2) Thallus byssoid or felty/squamulose, pigment localized in medulla, prothallus and/or pseudisidia 8
Thallus not byssoid, pigment in the apothecia 13

8(7) Thallus felty, squamulose, green, apothecia immersed in stromata, usually present. Cunião (11722) . . . . . **Erythrodecton granulatum** (Mont.) G. Thor
Thallus byssoid, some shade of grey, apothecia absent 9

9(8) Thallus rather thick and easily removed intact from the substratum, confluentic acid the major secondary metabolite besides the pigments 10
Thallus thin, not easily removed from the substratum, often neodiffractaic acid the major secondary metabolite besides the pigments 11

10(9) Prothallus red. Cunião (11650) & Parque . . . . . **Herpothallon rubrocinctum** (Ehrenb. : Fr.) Aptroot *et al.*
Prothallus pale pink. São Francisco (11884) . . . . . **Herpothallon roseocinctum** (Fr.) Aptroot *et al.*

11(9) Hypothallus whitish, confluentic acid the major secondary metabolite besides the pigments. (Parque 15542) . . . . . **Herpothallon adnatum** G. Thor
Hypothallus red or black, neodiffractaic acid the major secondary metabolite besides the pigments 12

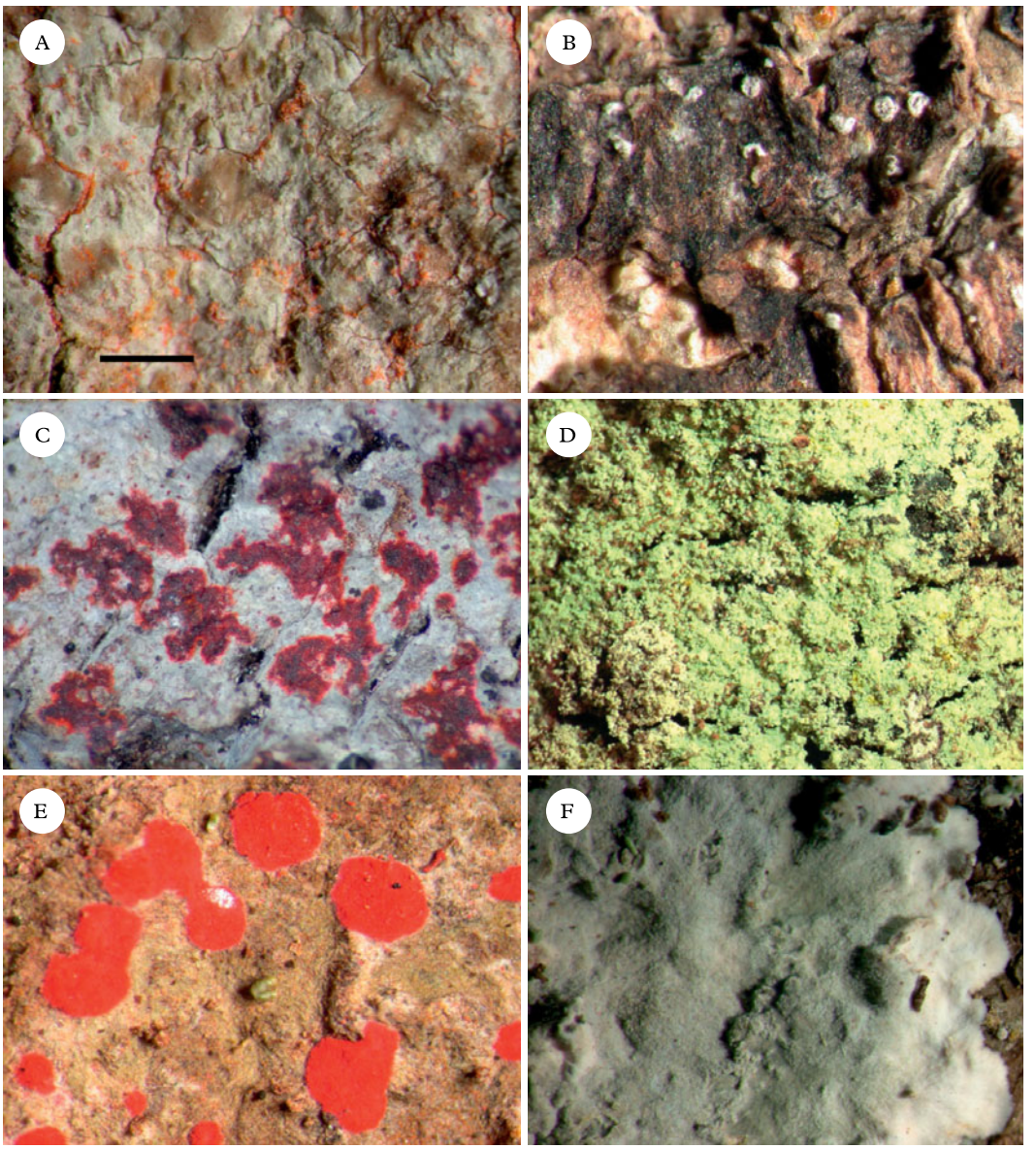

FIG. 4. Habitus of species of *Arthoniales*; A, *Arthonia parantillarum* (11423); B, *A. redingeri* (11122a); C, *A. rubrocincta* (*Cáceres* 9124); D, *Chrysothrix occidentalis* (15239); E, *Coniarthonia pulcherrima* (11731); F, *Cryptothecia striata* (15089). Scale: A–F = 0·5 mm.

12(11) Hypothallus black. Buriti (15477) . . . . . **Herpothallon nigroisidiatum** G. Thor
Hypothallus red. Cuniã (15621) . . . . . **Herpothallon rubromaculatum** G. Thor (Fig. 5C)

13(7) Hymenium without gel 14
Hymenium with gel between the filaments 15

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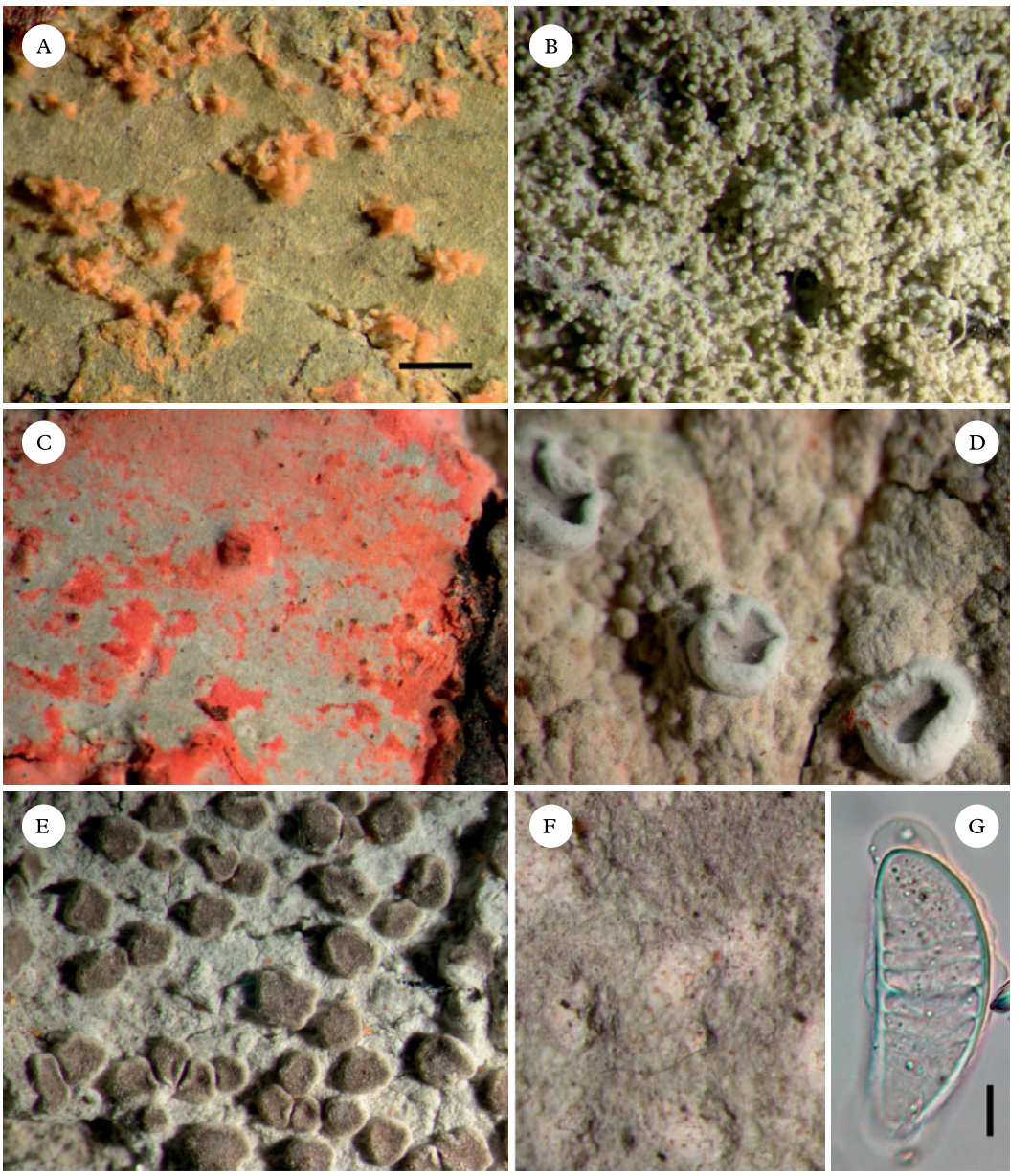

FIG. 5. A–F, habitus of species of *Arthoniales*; A, *Herpothallon aurantiacoflavum* (11258); B, *H. echinatum* (11705); C, *H. rubromaculatum* (11851); D, *Sagenidiopsis undulata* (15584); E, *Lecanactis elaeocarpa* (11418a). F & G, *Stirtonia macrocarpa* (15089); F, habitus; G, ascospore showing complex gelatinous sheath with large pads at the top and bottom. Scales: A–F = 0·5 mm; G = 10 μm.

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14(13) Apothecia pale pink . . . . **Coniarthonia rosea** Aptroot & M. Cáceres (Fig. 3A–C)
Apothecia dark pink to dark salmon. Cuniã (11731) . . . . . **Coniarthonia pulcherrima** (Müll. Arg.) Grube (Figs 3A & 4E)

15(13) Ascospores consistently 3-septate. UNIR (11122a) . . . . . **Arthonia redingeri** Grube (Fig. 4B)
Ascospores variably 3–7-septate 16

16(15) Ascospores 4–7-septate. Parque (11215) . . . . . **Coniocarpon cinnabarinum** DC.
Ascospores (3–)4-septate. Parque (11208); also many specimens found in various localities that seem to differ by smaller ascospores than is usual for this species . . . . . **Arthonia rubrocincta** G. Merr. ex Grube & Lendemer (Fig. 4C)

17(1) Apothecia absent; little differentiated ascigerous areas without hymenium may be present 18
Apothecia with differentiated hymenium present 26

18(17) Thallus not byssoid, except sometimes the prothallus, without pseudisidia 19
Thallus byssoid, with pseudisidia 25

19(18) Thallus at least partly C+ pink or red 20
Thallus C− 22

20(19) Thallus partly C+ pink (gyrophoric acid), ascospores if present only transversely septate. UNIR (11112) . . . . . **Stirtonia neotropica** Aptroot
Thallus at least partly C+ red (lecanoric acid), ascospores if present muriform . . 21

21(20) Thallus with soredia. Buriti (15362) . . . **Cryptothecia punctosorediata** Sparrius
Thallus without soredia. Santo Antonio (15089) . . **Cryptothecia striata** G. Thor (Fig. 4F)

22(19) Thallus Pd+ yellow (psoromic acid). Parque (15205) . . . . . **Cryptothecia fabispora** M. Cáceres *et al.*
Thallus Pd− 23

23(22) Thallus with helicoid conidia . . . . . **Eremothecella helicella** Aptroot & M. Cáceres (Fig. 2F–H)
Thallus without helicoid conidia 24

24(23) Thallus UV+ yellow. Buriti (15353) . . . . . **Cryptothecia lichexanthonica** E. L. Lima *et al.*
Thallus UV−. Here would key out many unidentifiable sterile species, the only one that is identifiable is this species with transversely septate, thick-walled ascospores. Fresh ascospores have a gelatinous sheath that is lobe-like at the upper and bottom end, and wavy near the septa, a character that was not reported. Parque (11197) . . . . . **Stirtonia macrocarpa** Makhija & Patw. (Fig. 5F & G)

25(18) Thallus Pd+ yellow (psoromic acid). São Francisco (11886) . . . . . **Herpothallon echinatum** Aptroot *et al.* (Fig. 5B)
Thallus Pd−. São Francisco (11896) . . . . . **Herpothallon minimum** Aptroot & Lücking

26(17) Apothecia with differentiated margin 27
Apothecia without differentiated margin 34

27(26) Apothecia closed, immersed in stromata . . . . . **Chiodecton complexum** Aptroot & M. Cáceres (Fig. 2A–E)
Apothecia open or with closed slit-like disc, not in stromata 28

28(27) Apothecia partly carbonized 29
Apothecia not carbonized 32

29(28) Ascospores brown 30
Ascospores hyaline 31

30(29) Ascospores 1-septate. Cuniã (15630), lichenicolous on *Graphis* . . . . . **Melaspilea microspilota** Nyl.
Ascospores 3-septate. In Rondônia on soil of termitarium . . . . . **Alyxoria fuscospora** Ertz *et al.* (Fig. 1)

31(29) Disc densely white pruinose, ascospores 3-septate. Santo Antonio (15087), see Egea & Torrente (1994) . . . . . **Lecanographa aff. lynceoides** (Müll. Arg.) Egea & Torrente
Disc not white pruinose . . . . . **Opegrapha spp.**

32(28) Thallus farinose, apothecia tiny and partly elongate or branched. On papery substance of epiphytic termitarium. Parque (15308). TLC revealed gyrophoric acid and methyl gyrophorate, not the erythrin reported from the type and so far only specimen known (Sparrius 2004) . . . . . **Enterographa zephyri** Sparrius
Thallus not farinose, chalky, apothecia round to lobate 33

33(32) Thallus ochraceous, apothecia with thick whitish margin, mostly over 1·5 mm diam. Parque (15584) . . . . . **Sagenidiopsis undulata** (Fée) Egea *et al.* (Fig. 5D)
Thallus whitish, apothecia without conspicuous margin, mostly under 1·5 mm diam. Parque (11418a). . . . . **Lecanactis elaeocarpa** (Nyl.) Tehler (Fig. 5E)

34(26) Alga chlorococcoid, on soil of termitaria. Buriti (15475) . . . . . **Arthonia muscigena** Th. Fr.
Alga trentepohlioid. Many species of *Arthonia* s. lat. would key out here. 35
Only two are keyed out, which share pale branched/lobate apothecia and 3-septate ascospores.

35(34) Thallus UV+ yellow (lichexanthone). Santo Antonio (15076) . . . . . **Arthonia antillarum** (Fée) Nyl.
Thallus UV−. Circuito (11423) . . . . . **Arthonia parantillarum** Aptroot (Fig. 4A)

Foliicolous *Arthoniales* from the same collections

Foliicolous species were only collected extensively in Parque. All species in the material could be identified. Some of the species were also collected at Buriti: Sítio Ecológico Buriti, Cuniã and/or São Francisco. In Buriti, many foliicolous species were also found on the smooth surface of old painted planking of a bridge. Numbers refer to collection numbers of selected collections made by the authors. For details about morphology and nomenclature see Lücking (2008). The following species were found: *Arthonia accolens* Stirt. (11187q), *A. aciniformis* Stirt.(11187o), *A. cyanea* Müll. Arg.(11419n), *A. epidendri* (Rehm) R. Sant.(11187p), *A. leptosperma* (Müll. Arg.) R. Sant.(11419p), *A. orbygniae* (H. P. B. Upadhyay) Matzer*(11187n), *A. palmulacea* (Müll. Arg.) R. Sant.(11419j), *A. trilocularis* Müll. Arg.(11170f), *Cryptothecia filicina* (Ellis & Everh.) Lücking *et al.* (11187ds), *Enterographa angustissima* (Vain.) R. Sant.(11212), *Eremothecella calamicola* Syd.(11419q), *Herpothallon adnatum* G. Thor (15452), *H. aurantiacoflavum* (B. de Lesd.) Aptroot *et al.* (11419bu), *Mazosia bambusae* (Vain.) R. Sant.(11419cj), *M. dispersa* (Hedr.) R. Sant*(11170y), *M. melanophthalma* (Müll. Arg.) R. Sant*(11170l), *M. phyllosema* (Nyl.) Zahlbr.(11799w), *M. pilosa* Kalb & Vězda (11170j), *M. pseudobambusae* Kalb & Vězda*(11187bq), *M. rotula* (Mont.) A. Massal.(11187bn), *M. rubropunctata* R.

https://doi.org/10.1017/S0024282914000036 Published online by Cambridge University Press

Sant.(11799t), *M. tumidula* (Stirt.) Müll. Arg. (11187bt), and *Opegrapha serusiauxii* Lücking (11187bx). The above include some of the few lichen species that were previously reported from Rondônia, marked with * (Lücking 2008).

The CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) is thanked for a research grant to MESC (Processo 501633/2009-0). The collecting expeditions were financed by CNPq (CNPq-Simbiota Processo 563342/2010-2). Elton Bill Souza and Allyne Christina Gomes Silva are thanked for logistical support and for organizing the collecting trips. We are grateful to Leo Spier for performing thin-layer chromatography.

References

Ahti, T. (2000) *Cladoniaceae*. *Flora Neotropica* **78:** 1–362.

Aptroot, A. (2009) A revision of the lichen genus *Stirtonia*. *Lichenologist* **41:** 615–625.

Aptroot, A. & Cáceres, M. E. S. (2013) Pyrenocarpous lichens (except *Trypetheliaceae*) in Rondônia. *Lichenologist* **45:** 763–785.

Aptroot, A. & Cáceres, M. E. S. (2014) New lichen species from termite nests in rainforest in Brazilian Rondônia and adjacent Amazonas. *Lichenologist* **46:** 365–372.

Aptroot, A. & Sparrius, L. B. (2003) New microlichens from Taiwan. *Fungal Diversity* **14:** 1–50.

Aptroot, A., Thor, G., Lücking, R., Elix, J. A. & Chaves, J. L. (2009) The lichen genus *Herpothallon* reinstated. *Bibliotheca Lichenologica* **99:** 19–66.

Aptroot, A., Sipman, H. J. M. & Cáceres, M. E. S. (2013) Twenty-one new species of *Pyrenula* from South America, with a note on over-mature ascospores. *Lichenologist* **45:** 169–198.

Cáceres, M. E. S. (2007) Corticolous crustose and microfoliose lichens of northwestern Brazil. *Libri Botanici* **22:** 1–168.

Cáceres, M. E. S., Rivas Plata, E. & Lücking, R. (2012) *Malmographina*, a new genus for *Graphina malmei* (Ascomycota: *Ostropales*: *Graphidaceae*). *Lichenologist* **44:** 115–120.

Egea, J. M. & Torrente, P. (1993) *Cresponea*, a new genus of lichenized fungi in the order *Arthoniales* (Ascomycotina). *Mycotaxon* **48:** 301–331.

Egea, J. M. & Torrente, P. (1994) El género de hongos liquenizados *Lecanactis* (Ascomycotina). *Bibliotheca Lichenologica* **54:** 1–205.

Egea, J. M., Sérusiaux, E. & Torrente, P. (1996) The lichen genus *Lecanactis* and allied genera in Papua New Guinea. *Mycotaxon* **59:** 47–59.

Elix, J. A. (2007) Four new crustose lichens (lichenized Ascomycota) from Australia. *Australasian Lichenology* **60:** 14–19.

Elix, J. A., Øvstedal, D. O. & Gremmen, N. J. M. (2011) A new species of *Cresponea* (*Roccellaceae*, Ascomycota) from Gough Island. *Nova Hedwigia* **92:** 133–136.

Ertz, D. (2009) Revision of the corticolous *Opegrapha* species from the Paleotropics. *Bibliotheca Lichenologica* **102:** 1–176.

Ertz, D. & Tehler, A. (2011) The phylogeny of *Arthoniales* (Pezizomycotina) inferred from nucLSU and RPB2 sequences. *Fungal Diversity* **49:** 47–71.

Ertz, D., Miądlikowska, J., Lutzoni, F., Dessein, S., Raspe, O., Vigneron, N., Hofstetter, V. & Diederich, P. (2009) Towards a new classification of the *Arthoniales* (Ascomycota) based on a three-gene phylogeny focussing on the genus *Opegrapha*. *Mycological Research* **113:** 141–152.

Grube, M. (2001) *Coniarthonia*, a new genus of arthonioid lichens. *Lichenologist* **33:** 491–502.

Harada, H. (1990) *Chiodecton asahinae* Harada, a new lichen species from Japan. *Hikobia* **10:** 377–382.

Henssen, A. & Thor, G. (1998) Studies in taxonomy and developmental morphology in *Chiodecton*, *Dichosporidium*, *Erythrodecton* and the new genus *Pulvinodecton* (*Arthoniales*, lichenized Ascomycetes). *Nordic Journal of Botany* **18:** 95–120.

Lima, E. L., Mendonça, C. O., Aptroot, A. & Cáceres, M. E. S. (2013) Two new species of *Cryptothecia* from NE Brazil. *Lichenologist* **45:** 361–365.

Lücking, R. (2008) Foliicolous lichenized fungi. *Flora Neotropica* **103:** 1–866.

Lücking, R., Seavey, F., Common, R., Beeching, S. Q., Breuss, O., Buck, W. R., Crane, L., Hodges, M., Hodkinson, P. B., Lay, E., *et al.* (2011) The lichens of Fakahatchee Strand Preserve State Park, Florida: proceedings from the 18th Tuckerman Workshop. *Bulletin of the Florida Museum of Natural History* **49:** 127–186.

Lumbsch, H. T., Ahti, T., Altermann, S., Amo de Paz, G., Aptroot, A., Arup, U., Bárcenas Peña, A., Bawingan, P. A., Benatti, M. N., Betancourt, L., *et al.* (2011) One hundred new species of lichenized fungi: a signature of undiscovered global diversity. *Phytotaxa* **18:** 1–127.

Menezes, A. A., Lima, E. L., Xavier-Leite, A. B., Maia, L. C., Aptroot, A. & Cáceres, M. E. S. (2013) New species of *Arthoniales* from NE Brazil. *Lichenologist* **45:** 611–617.

Orange, A., James, P. W. & White, F. J. (2001) *Microchemical Methods for the Identification of Lichens*. London: British Lichen Society.

Parnmen, S., Cáceres, M. E. S., Lücking, R. & Lumbsch, H. T. (2013) *Myriochapsa* and *Nitidochapsa*, two new genera in *Graphidaceae* (Ascomycota: *Ostropales*) for chroodiscoid species in the *Ocellularia* clade. *Bryologist* **116:** 127–133.

Sakata, A., Harada, H. & Sato, H. (2009) *Cresponea* (lichenized Ascomycota, *Roccellaceae*) of Japan. *Lichenology* **8:** 91–115.

Sérusiaux, E., Diederich, P., Brand, A. M. & van den Boom, P. (1999) New or interesting lichens and lichenicolous fungi from Belgium and Luxembourg. VIII. *Lejeunia* **162:** 1–95.

Sparrius, L. B. (2004) A monograph of *Enterographa* and *Sclerophyton*. *Bibliotheca Lichenologica* **89:** 1–141.

Thor, G. (1990) The lichen genus *Chiodecton* and five allied genera. *Opera Botanica* **103:** 1–92.

Thor, G. (2007) The genera *Chiodecton*, *Dichosporidium* and *Erythrodecton* in Peninsular Malaysia. *Bibliotheca Lichenologica* **95:** 543–548.

Torrente, P. & Egea, J. M. (1989) La familia *Opegraphaceae* en el area Mediterranea de la Peninsula Iberica y Norte de Africa. *Bibliotheca Lichenologica* **32:** 1–282.

Upreti, D. K. & Singh, A. (1987) *Opegrapha bengalensis*, a new lichen species from India with comments on the taxonomic status of *Sclerographa* sensu Zahlbruckner. *Beiträge zur Biologie der Pflanzen* **62:** 233–237.

van den Boom, P. P. G., Brand, M., Ertz, D., Kalb, K., Magain, N., Masson, D., Schiefelbein, U., Sipman, H. J. M. & Sérusiaux, E. (2011) Discovering the lichen diversity of a remote tropical island: a working list of species collected on Réunion (Mascarene archipelago, Indian Ocean). *Herzogia* **24:** 325–349.