New lichen species from Chapada Diamantina, Bahia, Brazil

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ABSTRACT. Nine species of lichens from Bahia are described as new: Arthonia saxistellata, Cladonia inflata, Cladonia lichexanthonica, Cladonia minisaxicola, Coniocarpon piccolioides, Pertusaria lichexanthofarinosa, Pertusaria lichexanthoimmersa, Pertusaria lichexanthoverrucosa and Physcia sorediiconvexa. Many of the new species contain lichexanthone in the cortex and the substance is reported for the first time from Cladonia.

KEYWORDS. Arthonia, Cladonia, Coniocarpon, Pertusaria, Physcia.

Brazil is the country with the world’s richest lichen flora. Historical lichen exploration in Brazil focused mostly on the southern subtropical states and on the Amazon region (e.g., Cáceres & Aptroot 2017). Beginning a few years ago, the north-eastern states have received much attention (e.g., Cáceres 2007; Cáceres et al. 2017). As part of a continuing effort to explore lichenologically relatively unknown regions, we investigated the lichens situated in a region in between these relatively well-studied regions—part of the Chapada Diamantina in the state of Bahia. This appeared to us to be a promising area because, on a recent collecting trip focusing on corticolous pyrenocarpous lichens in a different part of this Chapada region, numerous undescribed species of Pyrenula were found (Mendonça et al. 2016).

The Chapada Diamantina is an upland area in the state of Bahia in tropical Brazil. The natural vegetation of the Chapada Diamantina is evergreen dry tropical forest, belonging to different biomes, including Caatinga, Cerrado and Atlantic rain forest. The bedrock is siliceous, geologically mostly Precambrian and it surfaces in many parts in the form of isolated inselbergs, which are surrounded by evergreen forest. These inselbergs are usually only around 500 m higher than the surrounding country, but the climate on the often rather flat tops and the generally very steep slopes differs markedly from that in the valleys, leading to the presence of elfin forest (Fig. 1A).

There are no previous publications on the lichen flora of the Chapada Diamantina, but some records can be found in monographs, especially in Ahti (2000) and Sipman et al. (2009). Their reports of relatively large numbers of Cladonia and Hypotrachyna species, respectively, from the Chapada Diamantina suggested that the inselbergs (where these genera mostly occur as opposed to in evergreen forest) are rich in lichens. To date, 32 Cladonia (Fig. 1B–D), and 11 Hypotrachyna species are known from Bahia state (mainly from the Chapada Diamantina), but for instance only two Parmotrema species have ever been reported from the state, notwithstanding the fact that this is the most species-rich genus of lichens in all southern states of Brazil. Here we describe 9 species new to science from the region.

MATERIALS AND METHODS

During four days in July 2017, over 700 specimens were collected by the authors, using knife or hammer and chisel, examined by 10× hand lens (Leuchtlupe) and air-dried. Specimens were often selected in the field as representative of a known species or a characteristic morphology; in addition, a selection of species that cannot be recognized in the field was collected. All specimens are preserved in herbarium ISE, with duplicates in ABL.

Specimens were observed with an Olympus SZX7 and pictures taken with Nikon Coolpix 995.

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Figure 1. A. Collecting area. B. Vegetation with various Cladonia species, from left to right C. substellata, C. bahiana and C. clathrata. C. Cladonia dissecta. D. Cladonia friabilis. E–F. Arthonia saxistellata. E. Apothecia. F. Ascospores. Scales: C, D = 5 mm; E = 0.2 mm; F = 10 μm.
Hand-made sections of ascomata and thallus were studied in water, 5% KOH (K) and/or Lugol’s reagent (1% I₂) after pre-treatment with KOH (IKI). Microscopic photographs were prepared using an Olympus BX50 with Nomarski interference contrast and Nikon Coolpix 995. Chemical spot reactions are abbreviated as K (5% KOH), C (commercial bleach), KC (K followed by C), P (paraphenylenediamine), and UV refers to fluorescence at 366 nm. Thin-layer chromatography (Orange et al. 2001) has been undertaken by A. Aptroot in solvent A.

Two species of which the generic placement was uncertain were sequenced at ALVALAB by Dr P. Alvarado. Total DNA was extracted from dry specimens employing a modification of Murray & Thompson’s (1980) protocol. A portion was blended with the aid of a micropestle in 600 μL CTAB buffer (CTAB 2%, NaCl 1.4 M, EDTA (pH 8.0) 20 mM, Tris-HCl (pH 8.0) 100 mM). The resulting mixture was incubated for 15 min at 65°C. A similar volume of chloroform: isoamylalcohol (24:1) was added and carefully mixed with the samples until their emulsion. It was then centrifuged for 10 min at 13,000 g and the DNA in the supernatant was precipitated with isopropanol. After a new centrifugation of 15 min at the same speed, the pellet was washed in 70% cold ethanol, centrifuged again for 2 min and dried. It was finally resuspended in 200 μL of ddH₂O. PCR amplification was performed with the primers ITS1F and ITS4 (Gardes & Bruns 1993; White et al. 1990) for the rDNA internal transcribed spacer 1, 5.8S and internal transcribed spacer 2 (collectively referred to as ITS) region of the nuclear ribosomal repeat. PCR reactions were performed under a program consisting of a hot start at 95°C for 5 min, followed by 35 cycles at 94°C, 54°C and 72°C (for 45, 30 and 45 s respectively) and a final 72°C step for 10 min. PCR products were checked in 1% agarose gels and positive reactions were sequenced with primer ITS4. Chromatograms were checked searching for putative reading errors, and these were corrected.

Sequences selected for alignment were downloaded from GenBank. Sequences were first aligned in MEGA 5.0 (Tamura et al. 2011) software with its ClustalW application and then corrected manually. Gblocks 0.91b (http://molevol.cmima.csic.es/castresana/Gblocks_server.html) was used to eliminate poorly aligned positions with the less stringent options available. The resulting alignment was loaded in PAUP* 4.0b10 (Swofford 2001) and subjected to MrModeltest 2.3 (Nylander 2004). The model GTR+F was selected and implemented in MrBayes 3.1 (Ronquist & Huelsenbeck 2003), where a Bayesian analysis was performed (two simultaneous runs, six chains, temperature set to 0.2, sampling every 100th generation) until convergence parameters were met after c. 4960000 generations, standard deviation having fallen below 0.01. The 50% majority rule was used to get the consensus phylogram. Finally, a full search for the best scoring maximum likelihood tree was performed in RAxML (Stamatakis 2006) using the standard search algorithm (2000 bootstrap replications). The significance threshold for node support was set above 0.95 for posterior probability (PP) and 70% for bootstrap proportion (BP).

**Taxonomy**

*Arthonia saxistellata* Aptroot & M. Cáceres, *sp. nov.*

**MycoBank** MB 824151

*Saxicolous Arthonia with reduced thallus and somewhat stellate groups of apothecia, ascospores 3-septate, clavate, 12–13 × 4–4.5 μm.*

**Type:** BRAZIL. BAHIA: Lençóis, Chapada Diamantina, Serrano along Rio de Lençóis, 12°34’34”S, 41°23’55”W, alt. c. 450–500 m, 24 July 2017, on siliceous rock in transitional forest, M.E.S. Cáceres & A. Aptroot isep 40997 (holotype: isep; isotype: ABL).

**Description.** Thallus crustose, saxicolous, reduced to patches and reticulate lines between sandstone grains, pale ochraceous to pale orange, slightly uneven, in section with numerous hyaline crystals; without prothallus. Photobiont *Trentepohlia*, cells rounded to irregular in outline, 6–8 × 6–10 μm, yellowish green to orange. Ascomata apothecia, superficial on the thallus or directly on the substratum, irregular in outline, often in unbranched to sparsely branched lines and eventually confluent, 0.2–0.4 mm diam.; disc dark brown; margin absent. Hymenium brownish; ephymenium dark brown; hypothecium dark brown. Paraphyses agglutinated, also in K. Asci pyriform. Ascospores hyaline, 8 per ascus, 3-septate, clavate, 12–13 × 4–4.5 μm, surrounded by 2 μm wide gelatinous sheath. Pycnidia not observed.

**Chemistry.** Thallus too small to test chemically.
**Etymology.** Named after the saxicolous habit and the somewhat stellate groups of apothecia.

**Ecology and distribution.** Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on vertical, somewhat sheltered siliceous sandstone rock in transitional forest close to a river.

**Discussion.** This species seems to belong to the core group of *Arthonia* s.str. with a thin thallus with trentepohlioid algae. Saxicolous species are extremely sparse in this large genus, and due to the strong interaction with the often-living bark substratum, very few if any corticolous species are occasionally found on rock. Strictly saxicolous species of *Arthonia* s.l. usually either have chloroccoid algae, and are referable to the genus *Bryostigma* (Frisch et al. 2014), or they have a thick, cretaceous thallus.

**Cladonia inflata** Aptroot & M.Cáceres, sp. nov. **Fig. 2A–C**

**MYCOBANK MB** 824152

*Cladonia* species with fumarprotocetraric acid, without squamules, with very irregularly branched, inflated podetia with rough cortex.

**Type:** BRAZIL. BAHIA: Palmeiras, Chapada Diamantina, Morro do Pai Inácio, 12°27′24″S, 41°28′20″W, alt. c. 1050–1140 m, 23 July 2017, on siliceous rock in transitional forest, M.E.S. Cáceres & A. Aptroot (holotype: ISE; isotype: ABL).

**Description.** Thallus fruticose, terricolous, consisting of upright hollow podetia of c. 4–7 cm high in a cushion of up to 10 cm diam.; surface mineral grey, corticate, quite uneven to rugose and occasionally abraded; at the base c. 4 mm diam, very irregularly branched into inflated parts of up to 1 cm diam. that are occasionally so deformed that the inside becomes the surface; some terminal branches attenuated into a short pale cillum; in section hollow, inside dense, outside with numerous hyaline crystals. Primary and secondary squamules absent. Photobiont chloroccoid. Ascomata not observed. Pycnidia punctiform, brown, on inflated thallus parts; conidia not observed.

**Chemistry.** Medulla K−, P+ red, C−, UV−. TLC: Fumarprotocetraric acid.

**Etymology.** Named after the inflated thallus.

**Ecology and distribution.** Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on horizontal, exposed siliceous sandstone rock on top of a table mountain. Very conspicuous but not abundant at the type locality, where it grows together in intricate *Cladonia* mats with the *Cladonia* species *C. bahiana* Ahti, *C. clathrata* Ahti & Xavier Filho, *C. dissecta* Ahti (which is only known from the Chapada Diamantina and seems to be restricted to this region), *C. divaricata* Nyl., *C. friabilis* Ahti, *C. furfuracea* Vain., *C. metaminiata* S.Stenroos & Ahti, *C. miniata* G.Meyer, *C. obscurata* Ahti, *C. parvipes* (Vain.) Zahlbr., *C. pityrophylla* Nyl., *C. polycypha* Ahti & Xavier Filho, *C. salmonea* S.Stenroos, *C. secundana* Nyl. and *C. substellata* Vain.

**Discussion.** This species was already recognized in the field as an undescribed macrolichen not treated in the *Cladonia* monograph for the Neotropics (Ahti 2000), nor resembling any *Cladonia* from other regions. It differs from all other *Cladonia* species without squamules by the very irregular, inflated podetium shape and the rough cortex. A sequence was obtained from the type, but it has not yet been fully evaluated. Therefore, the position of the species within the genus remains unclear.

**Cladonia lichexanthonica** Aptroot & M.Cáceres, sp. nov. **Figs. 3, 4A–D**

**MYCOBANK MB** 824153

ITS BArCODING SEQUENCE ACcESsion MG979786

Predominantly squamulose saxicolous *Cladonia* with *lichexanthone* and other xanthones and a thick hyaline cortex that breaks into prisms.

**Type:** BRAZIL. BAHIA: Palmeiras, Chapada Diamantina, Morro do Pai Inácio, 12°27′24″S, 41°28′20″W, alt. c. 1050–1140 m, 23 July 2017, on siliceous rock in transitional forest, M.E.S. Cáceres & A. Aptroot (holotype: ISE; isotype: ABL).

**Description.** Thallus squamulose, saxicolous, extending over more than 10 cm diam., consisting of a c. 5 mm thick layer of crowded ascending squamules of c. 1–5 mm diam.; squamules shallowly incised, pale olive green, becoming olive brown towards the centers, surrounded by a sometimes indistinct whitish rim, smooth but not shiny, cartilaginous and deeply fissured at the centres; lower surface dull, pale brown mottled with darker brown, almost black towards the base; cortex up to 300 µm thick, mostly hyaline but brown at the upper surface. Photobiont green. Ascomata apothecia,
superficial on the thallus, marginally on the squamules, round to irregular in outline, 0.2–0.7 mm diam.; disc chocolate brown, flat, glossy, often gyrose to umbilicate with sterile marginal strands alternating with hymenium; margin c. 0.1 mm wide, dark brown (paler outside), glossy, only slightly higher than the disc. Hymenium hyaline; epihymenium chocolate brown; excipulum dark brown outside, hyaline inside, densely filled with hyaline crystals; hypothecium contiguous with the excipu-
lum, hyaline, densely filled with hyaline crystals. Paraphyses rather agglutinated. Asci cylindrical, unripe. Ascospores not observed. Pycnidia not observed.

**Chemistry.** Cortex UV+ intense yellow, medulla K–, P–, C–, UV–. TLC: Lichexanthone and several other xanthones.

**Etymology.** Named after the presence of lichexanthone.

**Ecology and distribution.** Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on horizontal, exposed siliceous sandstone rock on top of a table mountain.

**Discussion.** This is the first species of the genus with lichexanthone (Ahti 2000). Its position within the genus was the rather unexpected result of the phylogenetic analysis (Fig. 3). The new species consists mostly of large, thick squamules, which...
resemble those in certain species of the Cladonia miniata aggregate. The apothecia are apparently still young in the type material, and do not contain anthraquinones, in contrast to other members of the Cladonia miniata aggregate.

**Cladonia minisaxicola** Aptroot & M.Cáceres, *sp. nov.*

Figs. 3, 5A–B

**MYCOBANK MB 824154**

ITS BARCODING SEQUENCE ACCESSION MG979787

Saxicolous Cladonia with crustose, areolate, non-squamulose mottled greyish brown thallus with fumarprotocetraric acid and 0.4–1 mm high and c. 0.3 mm wide podetia consisting of a few stalked pycnidia with or without a cover of a few thallus areoles. Podetia relatively scarce, 0.4–1 mm high and c. 0.3 mm wide, not hollow, consisting of a few pycnidia on a solid stalk, with or without a cover of a few thallus areoles. Photobiont green. Ascomata absent. Pycnidia on branched brown podetium-like stalks that can be covered with thallus or not, dark brown; conidia not observed.

**Chemistry.** Medulla K–, P+ red, C–, UV–. TLC: Fumarprotocetraric acid.

**Etymology.** Named after the small size and saxicolous habit.

**Ecology and distribution.** Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on loose boulders of exposed siliceous sandstone rock on top of a table mountain.

**Discussion.** This species was already recognized in the field as something special; however, it was thought to be a tiny Stereocaulon, and it superficially indeed strongly resembles some species of that genus. Upon closer examination, however, it was recognized that the solid “podetia” are in fact branched, stalked pycnidia not unlike those present in some Cladonia species. Also, the chemistry conforms to many species of this genus. It differs from all described species (Ahti 2000) by the non-squamulose primary thallus. Its position within the genus was confirmed by the phylogenetic analysis (Fig. 3).

**Coniocarpon piccolioides** Aptroot & M.Cáceres, *sp. nov.*

Fig. 5C–D

**MYCOBANK MB 824155**

Saxicolous Coniocarpon with golden yellow pruinose apothecia and thallus and pruina with anthraquinone.

**Type:** BRAZIL. BAHIA: Palmeiras, Chapada Diamantina, Morro do Pai Inácio, 12°27’24”S, 41°28’20”W, alt. c. 1050–1140 m, 23 July 2017, on siliceous rock in transitional forest, M.E.S. Cáceres & A. Aptroot isotype: ABL)

**Description.** Thallus saxicolous, dimorphous; primary thallus crustose, consisting of nodulose simple or lobed areoles that form a discontinuous irregular crust of up to 4 cm diam. Areoles almost squamulose but firmly attached to the substratum with the full lower surface, brownish grey mottled with glaucous grey, partly dull, partly shiny, areoles partly confluent, in the center of confluences with irregular to globose upright eroding elements resembling soredia. Podetia relatively scarce, 0.4–1 mm high and c. 0.3 mm wide, not hollow, consisting of a few pycnidia on a solid stalk, with or without a cover of a few thallus areoles. Photobiont green. Ascomata absent. Pycnidia on branched brown podetium-like stalks that can be covered with thallus or not, dark brown; conidia not observed.
grey with ochraceous orange; areoles ranging from minute to c. 0.3 mm diam., up to 0.2 mm high, surface dull, occasionally abraded and such areas resembling soralia; in section with numerous yellowish crystals; surrounded by a c. 0.2 wide, dark brown, prothallus line. Photobiont *Trentepohlia*, cells elongate in outline, 6–8 × 7–12 μm, yellowish green to orange. Ascomata apothecia, superficial on the thallus, round to irregularly angular in outline, solitary or in dense groups of 2–5, 0.2–0.5 mm diam.; disc convex, black but with a thick layer of golden pruina; margin thin, black, not higher than the disc and in fact not structurally deviating from the disc and thus only a small rim of the disc without pruina. Hymenium hyaline, up to 100 μm high but varying widely in dimensions because of the convex apothecia; ephymenium golden brown; hypothecium dark brown. Paraphyses agglutinated, also in *K*. Asci pyriform. Ascospores hyaline, 8 per ascus, 3-septate, clavate, 11–12 × 4–4.5 μm, without gelatinous sheath. Pycnidia black, at the tips of micro-squamules; conidia not observed.
Chemistry. Thallus and disc K+ blood red, P–, C–, UV–. TLC: An unidentified anthraquinone.

Etymology. Named after the superficial resemblance with Piccolia species like P. conspersa (Fée) Hafellner and P. ochrophora (Nyl.) Hafellner.

Ecology and distribution. Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on vertical, slightly exposed siliceous sandstone rock on top of a table mountain.

Discussion. This is the first saxicolous species described in the genus Coniocarpon, which is not widely used (since Cáceres 2007) for an aggregate of Arthonia s.l. It differs from other species in this genus also by the golden yellow pruinose apothecia and the thallus with anthraquinone.

Pertusaria lichexanthofarinosa Aptroot & M.Cáceres, sp. nov. Fig. 6A

MYCOBANK MB 824156

Corticolous Pertusaria with lichexanthone and globose soralia with farinose soredia.

Type: BRAZIL. BAHIA: Lençóis, Chapada Diamantina, Cachoeira do Mosquito, 12°23′24″S, 41°22′40″W, alt. c. 450–500 m, 22 July 2017, on tree bark in Atlantic rain forest, M.E.S. Cáceres & A. Aptroot ISE 40764 (holotype: ISE; isotype: ABL).

Description. Thallus crustose, corticolous, ochraceous white, up to c. 0.5 mm thick, continuous, with numerous whitish round warts; warts 0.2–1.4 mm diam., up to 0.6 mm high, whitish, raised above the thallus, often eroded at the top to reveal or become covered by soredia; without or with undifferentiated whitish prothallus. Soredia farinose, mottled ochraceous white and whitish, covering most of the surface of the warts. Isidia absent. Photobiont green. Ascomata and pycnidia not observed.

Chemistry. Cortex UV+ yellow, medulla K–, P–, C–, UV–. TLC: Lichexanthone.

Etymology. Named after the presence of lichexanthone and the farinose soredia.

Ecology and distribution. Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on exposed tree bark in Atlantic rain forest close to a river.

Discussion. Lichexanthone is a cortical secondary substance that occurs in several different lichen groups, but almost exclusively in tropical regions. The genus Pertusaria is a large genus that is relatively well-known in temperate regions around the world and Australasia, but which has so far barely been studied in the Neotropics. We here describe new corticolous Pertusaria species with lichexanthone, neither of which key out in Archer & Elix (2011).

Pertusaria lichexanthoimmersa Aptroot & M.Cáceres, sp. nov. Fig. 6B–C

MYCOBANK MB 824157

Corticolous Pertusaria with lichexanthone and norstictic acid, thallus completely covered with pale mineral grey thalline warts, partly with pinkish apothecia, ascospores 2 per ascus, 30–36 × 13–17 μm.

Type: BRAZIL. BAHIA: Lençóis, Chapada Diamantina, Morro do Pai Inácio, 12°27′24″S, 41°28′20″W, alt. c. 1050–1140 m, 23 July 2017, on tree bark in transitional forest, M.E.S. Cáceres & A. Aptroot ISE 40930 (holotype: ISE; isotype: ABL).

Description. Thallus crustose, corticolous, pale mineral grey, up to c. 2 mm thick, continuous, irregularly deeply fissured, composed of compressed and contorted high areoles, each of which are probably initial apothecium warts; surface warty with many convex parts; cortex smooth; towards the margin thinning out, shiny and more regularly radiately fissured; surrounded by a c. 0.4 mm wide white, shiny prothallus. Soredia and isidia absent, but some areoles hollow with wide gaping openings, resembling soredia; these are locations where the hymenium is destroyed, possibly by grazing by arthropods. Photobiont green. Ascomata apothecia, immersed in the thallus inside thalline warts, almost globose to compressed or contorted, 0.2–0.4 mm diam. Hymenium pinkish; epihymenium pinkish; hypothecium hyaline. Paraphyses thin, mostly agglutinated to the asci. Ascii cylindrical, 120–165 × 25–35 μm, wall up to 10 μm thick. Ascospores hyaline, 2 per ascus, non-septate, ellipsoid, probably still juvenile, 30–36 × 13–17 μm, wall not rough. Pycnidia not observed.

Chemistry. Cortex UV+ yellow, medulla K+ yellow>red, P–, C–, UV–. TLC: Lichexanthone and norstictic acid.
Etymology. Named for the presence of lichexanthone and the immersed apothecia.

Ecology and distribution. Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on tree bark on rather exposed trees on the northern slope of a table mountain.

Discussion. Lichexanthone is a cortical secondary substance that occurs in several different lichen groups, but almost exclusively in tropical regions. The genus Pertusaria is a large genus that is relatively well-known in temperate regions around the world and Australasia, but which has so far barely been studied in the neotropics. We here describe new corticolous Pertusaria species with lichexanthone, neither of which key out in Archer & Elix (2011).

Pertusaria lichexanthoverrucosa Aptroot & M. Cáceres, sp. nov. Fig. 6D–E

MYCOBANK MB 824158
Corticolous Pertusaria with lichexanthone and norstictic acid, and thallus green with whitish small warts and larger warts containing apothecia.

Type: BRAZIL. BAHIA: Lençóis, Chapada Diamantina, Cachoeira do Mosquito, 12°23’S, 41°22’40”W, alt. c. 450–500 m, 22 July 2017, on tree bark in Atlantic rain forest, M.E.S. Cáceres & A. Aptroot (holotype: ISE; isotype: ABL).

Description. Thallus crustose, corticolous, greyish green, up to c. 0.5 mm thick, continuous, with numerous whitish round to elongate warts of c. 0.1 mm that partly open and can function as pseudo-cyphellae; with isolated to compressed warts, each of which are probably initial apothecium warts; warts 0.2–1 mm, whitish, raised above the thallus, often eroded at the top, becoming hollow with wide gaping openings; without or with undifferentiated whitish prothallus. Soredia and isidia absent, but some areoles hollow with wide gaping openings, resembling soredia; these are locations where apothecium initials have fallen out. Photobiont green. Ascomata apothecia, immersed inside the raised warts, almost globose to compressed or contorted, 0.2–0.4 mm diam. Hymenium pinkish; ephymenium pinkish; hypothecium hyaline. Paraphyses thin, mostly agglutinated to the asci. Asci cylindrical, 140–175 × 30–40 μm, wall up to 10 μm thick. Ascospores not observed. Pycnidia not observed.

Chemistry. Cortex UV+ yellow, medulla K+ yellow–red, P–, C–, UV–. TLC: Lichexanthone and norstictic acid.

Etymology. Named for the presence of lichexanthone and the verrucose thallus.

Ecology and distribution. Known only from the type locality, from the Chapada Diamantina Moun-

tains in Bahia, Brazil, where it grows on exposed tree bark in Atlantic rain forest close to a river.

Discussion. Lichexanthone is a cortical secondary substance that occurs in several different lichen groups, but almost exclusively in tropical regions. The genus Pertusaria is a large genus that is relatively well-known in temperate regions around the world and Australasia, but which has so far barely been studied in the Neotropics. We here describe new corticolous Pertusaria species with lichexanthone. This species is close to Pertusaria lichexanthoimmersa described above, but the thallus is markedly different; it is described even though no mature ascospores were found in the material; this is not unusual in the genus.

Additional material examined. BRAZIL. BAHIA: Lençóis, Chapada Diamantina, Cachoeira do Mosquito 12°23’S, 41°22’40”W, alt. c. 450–500 m, 22 July 2017, on tree bark in Atlantic rain forest, M.E.S. Cáceres & A. Aptroot (ise 40861 (ISE, ABL).

Physcia sorediiconvexa Aptroot & M. Cáceres, sp. nov. Fig. 6F

MYCOBANK MB 824159
Saxicolous Physcia with discrete lobes which are covered by reticulate maculae and capitate soralia; lower surface ivory to pale brown, medulla and cortex K+ yellow.

Type: BRAZIL. BAHIA: Lençóis, Chapada Diamantina, Serrano along Rio de Lençóis, 12°34’S, 41°23’55”W, alt. c. 450–500 m, 24 July 2017, on siliceous rock in transitional forest, M.E.S. Cáceres & A. Aptroot (ISE 42018 (ISE, ABL).

Description. Thallus foliose, saxicolous, closely appressed, up to 7 cm diam., mineral grey, slightly glossy; upper surface, also in the central part, reticulately white maculate; lobes irregularly branched, discrete with wide interspaces and almost not overlapping, 0.7–1.2 mm wide, outer rim truncated, often with recurved margins. Isidia absent. Soredia farinose, glaucous grey, in sparse
capitate soralia of c. 1–2 mm diam.; soralia not confluent. Medulla up to 0.3 mm thick, whitish. Lower surface pale brown, ivory towards the margin, glossy, paraplectenchymatous, with rhizines. Rhizines rather numerous, ivory or partly pale brown, simple, c. 0.1 mm thick, up to 0.4 mm long. Photobiont green. Ascomata and pycnidia not observed.

**Chemistry.** Cortex K+ yellow, medulla K+ yellow, P–, C–, UV–. TLC: Atranorin and zeorin and other terpenoids.

**Etymology.** Named for the similarity with *Physcia convexa* and the presence of soredia.

**Ecology and distribution.** Known only from the type specimen, from the Chapada Diamantina Mountains in Bahia, Brazil, where it grows on horizontal, exposed siliceous sandstone rock close to a river.

**Discussion**. This species is characterized by the discrete lobes which are covered by reticulate maculae. It is close to *Physcia convexa* Müll. Arg., with which it grows together in the type locality. *Physcia convexa* mainly differs in the absence of soralia (Moberg 1990) and is the most abundant and common *Physcia* species in the area. The two species may form a classical species-pair. The new species resembles some *Pyxine* species, but the pale lower cortex and the maculae instead of pseudocyphellae point to *Physcia*.

**DISCUSSION**

In this paper we describe nine new species to science in a first effort to describe the lichen flora of the Chapada Diamantina region, in Bahia. These were all collected within only four days of field work in an easily accessible area. If anything, this shows how many lichen species are still to be discovered in Brazil. This paper is the first report on the results of this expedition; results on e.g. foliicolous lichens, new Graphidaceae, Gomphillaceae, and new *Parmotrema* (of which genus there were indeed many species present) will be published in separate papers. Some specimens still remain unidentified, for instance because there are no identification keys or reliable treatments (e.g., in the case of corticolous *Arthothelium* and *Arthonia*).

Lichexanthone is a cortical secondary substance that occurs in several different lichen groups, but almost exclusively in tropical regions. We found relatively many new species with lichexanthone, also in the genus *Cladonia* where this substance was so far never reported.

The inselbergs are veritable oases for lichens, with an abundant cover of terricolous *Cladonia* species and a rich saxicolous flora of e.g. *Hypotrachyna* and *Parmotrema* species. Abundance of *Cladonia* is usually associated with boreal and arctic environments, but with 122 species (Ahti 2000 plus recent additions), Brazil harbours more different species than e.g. the whole of Scandinavia (95, see Ahti et al. 2013). Most of the *Cladonia* diversity in Brazil is centred in the inselberg regions in the states of Minas Gerais and Bahia, situated in between the Amazon and the subtropical southern states. The take home message: central Brazil is *Cladonia* heaven.

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