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## Three new lichen species from cloud forest in Veracruz, Mexico

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**Abstract** – The following new lichen species are described: *Astrothelium coccineum*, with ascomata immersed in groups in pseudostromata that are red outside and yellow pigmented inside, ostioles black, and ascospores 3-septate, 25-30 × 10-12.5 µm. *Micarea viridicapitata*, with olive green thallus with many pale green globose soredia and brown ascomata that are often in botryose groups, and ascospores bacillar with rounded ends, (1-)3-septate, (11-)15-17 × 3-3.5 µm. *Protoparmelia microspora*, a corticolous *Protoparmelia* with sessile brown ascomata and ascospores 8/ascus, (6-)7.5-10 × 3.5-5 µm. These species were all found in cloud forest in La Cortadura, Coatepec, Veracruz, Mexico. *Protoparmelia dadiola* is reported from the same area; it is new to the northern hemisphere.

*Astrothelium* / *Micarea* / *Protoparmelia* / *Pilocarpaceae* / *Parmeliaceae* / *Trypetheliaceae*

### INTRODUCTION

The first lichen studies in Mexico were carried out at the onset of the 19th century, when lichen species were identified by Carl Segismund Kunth. The samples were collected by Alexander von Humboldt and Aimé Bonpland (Herrera-Campos *et al.*, 2014). Since then, lichens studies in the country have been sporadic for a long time, mostly dependent on collectors and explorers from foreign institutions and countries.

During the 1990's, Thomas H. Nash III made the first modern and complete study of the lichens in a region of Mexico with his book *Lichen Flora of the Sonoran Desert*. This project involved approximately one hundred lichenologists from 23 countries, who treated over 1,900 species from 341 genera in the three volumes of "The Lichen Flora of the Great Sonoran Desert Region" (Nash *et al.*, 2002, 2004, 2007).

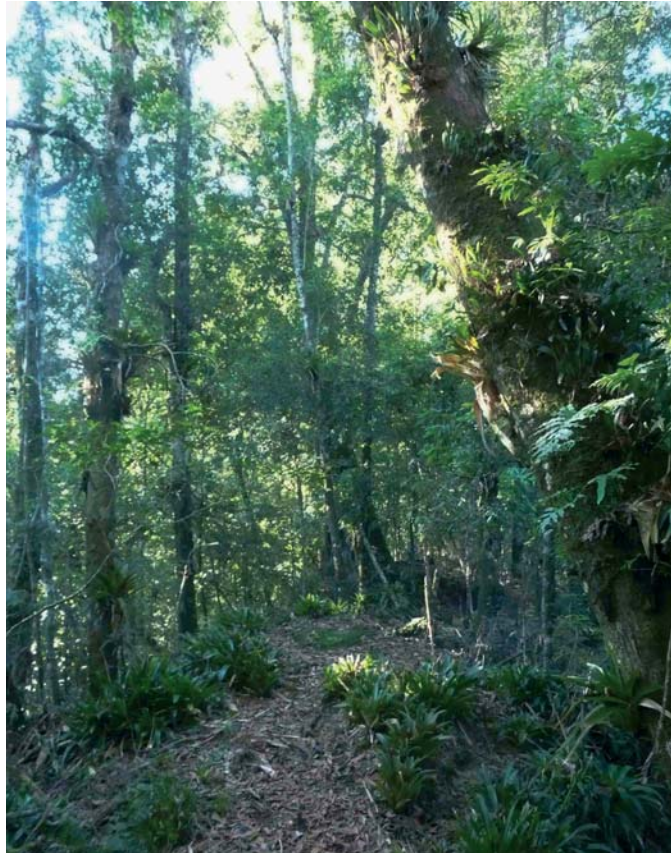
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After this, more studies on lichen ecology and biodiversity were developed in other regions of the country, expanding the awareness of these organisms. Despite this, the knowledge of the lichen taxonomy in Mexico is still unequal. Most surveys were carried out in just a few states. An estimated number of about 5,000 lichen species is expected to occur in the country, although only c. 2,750 species have so far been reported (Herrera-Campos *et al.*, 2014). The states with the most recorded species are Baja California (710) and Veracruz (700), followed by Chihuahua, Baja California Sur and Sonora (each over 500).

The cloud forest is an ecosystem that supports the most diverse flora and fauna per square meter in Mexico (Challenger & Soberón, 2008). With only 0.8% of extension in the country, it has around 2,500 plant species, which represents 10 to 12% of the total plant biodiversity in the country, being the epiphytes the most diverse biological form in the community (Williams-Linera, 2012). The cloud forest consists of temperate tree species with a tropical understory. It is located at an altitude between 800 and 2,200 m, most commonly between 1,000 and 1,500 m. Various types of secondary vegetation have replaced approximately half of the original vegetation in the course of time (Challenger, 1998).

La Cortadura (Fig. 1) is an ecological reserve located in Coatepec, in the mountainous center of Veracruz State. Its altitude range is from 1,800 to 2,000 m. The annual average temperature is 18°C. In this reserve, 80% of the original vegetation is still present (García-Franco *et al.*, 2008). Despite the importance of the cloud forest as an ecosystem, few lichenological studies have been made in this vegetation, with only 230 recorded lichen species, in contrast to other ecosystems records such as the temperate forest which has 947 recorded species (Herrera-Campos *et al.*, 2014).

During ecological studies realized by the first author in La Cortadura, Coatepec, several undescribed lichen species were found which are here described.



**Fig. 1.** Cloud forest in La Cortadura, Coatepec, Veracruz.

## 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, in which also all measurements were taken. The chemistry of the type specimens has been investigated by thin-layer chromatography (TLC) using solvent A (Orange *et al.*, 2001).

## TAXONOMY

*Astrothelium coccineum* Córdova-Chávez, Aptroot & M. Cáceres **sp. nov.** **Fig. 2**

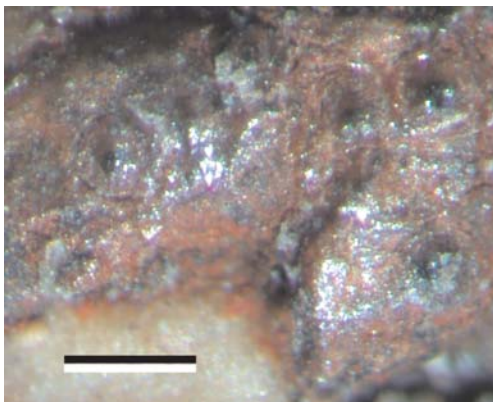
*Mycobank*: MB 808551

**Thallus** crustose, corticate, dull, olive brown, warted to bullate with hemispherical to flattened warts of c. 0.2-0.5 mm diam., not surrounded by a prothallus line. **Algae** trentepohlioid. **Ascomata** pyriform, immersed in groups of 2-10 in pseudostromata, 0.2-0.4 mm diam., only visible from above by a black ostiole, arranged in broad lines or branched groups. **Pseudostromata** raised above the thallus, round to usually irregular in outline, upper surface deep red, inside with yellow pigment, c. 0.4-1.5 mm diam., c. 0.2-0.4 mm high. **Hamathecium** not interspersed with oil droplets. **Ascospores** 8/ascus, hyaline, 3-septate, long ellipsoid, 25-30 × 10-12.5 µm, lumina diamond-shaped. **Pycnidia** not observed.

**Chemistry**: Thallus UV-, C-, P-, K-, pseudostromata UV-, C-, P-, outside K+ purple, inside K+ crimson. TLC: a red anthraquinone at Rf 7 and a yellow anthraquinone at Rf 2.

**Type**: MEXICO. **Veracruz**, La Cortadura, Coatepec, on bark of tree, c. 2062 m alt., 2013, *O. Córdova-Chávez 464* (XAL-holotypus); same locality, *O. Córdova-Chávez 476* (ABL-paratypus), 988, 1019 (XAL-paratypi).

**Ecology and distribution**: On smooth bark of trees in forest. Known only from Mexico.



**Fig. 2.** *Astrothelium coccineum*, paratype 476, habitus. Scale = 0.5 mm.

*Discussion:* This species is most similar in aspect to *Pyrenula cruenta* (Mont.) Vain. (e.g. Aptroot *et al.*, 2008), but has the internal structures of a Trypetheliaceae. It is much closer to the type of *Astrothelium* (*A. conicum* Eschw.), which has exactly the same ascospore type (Harris, 1986), than to the type of *Trypethelium* (*T. eluteriae* Spreng.). Therefore it is here described in the genus *Astrothelium*, although its ascomata are simple with separate ostioles.

Also, recent phylogenetic studies (Nelsen, pers. comm.) of the family Trypetheliaceae show that only species with rounded (not diamond-shaped) lumina cluster around the type of *Trypethelium*, while species with 3-septate ascospores with diamond-shaped lumina form another cluster around the *Astrothelium conicum*-group, regardless of their ascoma organization.

So far about 60 species are known in the genus, a number that will undoubtedly rise with the anticipated wider, more natural circumscription of the group. The centre of diversity is in South America. No species was so far known with a deep red pigment on the pseudostromata. It is remarkable that this new species in addition contains a yellow pigment in the medulla of the pseudostromata.

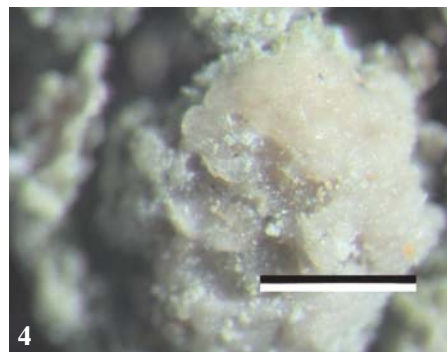
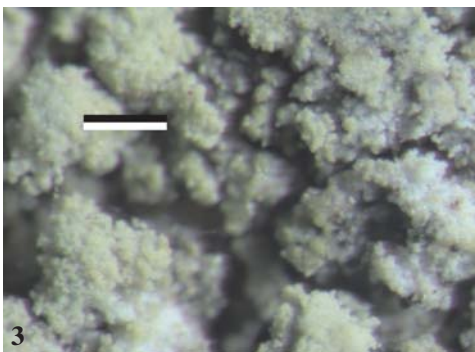
***Micarea viridicapitata*** Córdova-Chávez, Aptroot & R.-E. Pérez **sp. nov.** **Figs 3-4**

*Mycobank:* MB 808552

**Thallus** 0.1-0.2 mm thick, dull, consisting of isolated, olive green granules of c. 20 µm diam. **Soredia** pale green, abundant, sessile on the thallus, somewhat globose, 0.2-0.8 mm diam., c. 0.2-0.4 mm high, consisting of goniocysts of c. 3-5 µm diam. **Algae** myrmecoid, c. 3-5 µm diam. **Apothecia** appressed, initially on the thallus, later often emergent, up to 0.2 mm diam., usually aggregated in botryose groups of 2-25, forming clusters of up to 0.9 mm diam., immarginate, disc globose, pale pinkish brown. **Hymenium** hyaline, 30-41 µm high, paraphyses glued and sparse; hypothecium hyaline; excipulum inconspicuous. **Asci** with 8 ascospores, arranged in 2 loose bundles. **Ascospores** hyaline, curved, (1-)3-septate, (11-)15-17 × 3-3.5 µm, with rounded ends. **Pycnidia** not observed.

*Chemistry:* Thallus and ascomata UV-, C-, P-, K-. TLC: no pigments or secondary metabolites found; terpenoids are present but probably originate from the bark.

*Type:* MEXICO. **Veracruz**, La Cortadura, Coatepec, on bark of tree, c. 2046 m alt., 2013, O. Córdova-Chávez 765 (XAL-holotypus); same locality, O. Córdova-Chávez 595 (ABL-paratypus), 796 (XAL-paratypus).



**Figs 3-4.** *Micarea viridicapitata*, holotype. **3.** habitus with soredia; **4.** habitus with botryose apothecia. Scale = 0.5 mm.



*Ecology and distribution:* On smooth bark of trees in forest. Known only from Mexico.

*Discussion:* Species of the genus *Micarea* occur in all biospheres including wet lowland tropics, but most species are described so far from temperate or arctic/alpine environments (Coppins, 1983). Several *Micarea* species with soredia are known, but the soralia in this genus are usually punctiform or of irregular shape, while the new species has almost sessile, capitate to almost globose soralia. The ascospores are regularly bacillar with blunt ends, and 3-septate, which is also rather unusual in the genus.

***Protoparmelia microspora* Córdova-Chávez, Aptroot & M. Cáceres sp. nov. Fig. 5**

*Mycobank:* MB 808553

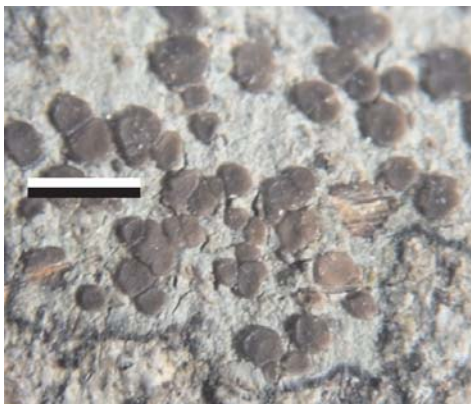
**Thallus** c. 0.1 mm thick, dull, pale mineral grey, cracked and much dissected, without prothallus line. **Algae** green, c. 10-13  $\mu\text{m}$  diam. **Apothecia** sessile, round or usually with wavy outline, 0.4-0.8 mm diam., disc flat, smooth, dull, dark brown; margin dull, c. 0.1 mm wide, whitish at the outside, not or only slightly higher than the disc. **Hymenium** hyaline, not interspersed with oil droplets, up to 110  $\mu\text{m}$  high; epihymenium fuscous brown; hypothecium hyaline, c. 50-75  $\mu\text{m}$  thick including subhymenium; excipulum hyaline throughout, with a 5-15  $\mu\text{m}$  thick layer of pseudocortex without crystals, without algae, extending below the hypothecium, lumina c. 2  $\mu\text{m}$  diam., smaller than the wall thickness. **Paraphyses** simple, c. 1.5  $\mu\text{m}$  wide, thickened at the tips, tips c. 3  $\mu\text{m}$  wide. **Asci** cylindrico-clavate, I+ blue, up to 75  $\times$  6  $\mu\text{m}$ , with 8 mostly uniseriate ascospores. **Ascospores** hyaline, IKI-, simple, ellipsoid, (6-)7.5-10  $\times$  3.5-5  $\mu\text{m}$ . **Pycnidia** not observed.

*Chemistry:* Thallus and ascomata UV-, C-, P-, K-. TLC: no secondary metabolites found.

*Type:* MEXICO. **Veracruz**, La Cortadura, Coatepec, on bark of tree, c. 2013 m alt., 2013, O. Córdova-Chávez 679 (XAL-holotypus); same locality, O. Córdova-Chávez 1044 (ABL-paratypus).

*Ecology and distribution:* On smooth bark of trees in forest. Known only from Mexico.

*Discussion:* This species is unique in the genus by the combination of small ascospores and the asci with 8 ascospores. Similar small ascospores are known in corticolous taxa in the the genus only from the species which were formerly united in the genus *Maronina* (Papong *et al.*, 2011). However, the asci in this species group always contain c. 50 ascospores. The new species is quite similar



**Fig. 5.** *Protoparmelia microspora*, holotype, habitus. Scale = 0.5 mm.

in many respects to *Protoparmelia dadiola* (Müll. Arg.) Kalb, which grows side-by-side in the type collection of *P. microspora* (1044) and also in specimen 156d from the same locality. The latter is newly reported herewith from Mexico, and thus new to the northern hemisphere. This species has much larger ascospores (15-17.5 × 7-8 µm in the Mexican material). It was so far only known from Paraguay (Aptroot *et al.*, 2013). Most tropical species of the genus contain lobaric acid (Aptroot *et al.*, 2013), but species without secondary chemistry such as *P. dadiola* are also known.

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