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The Genus *Anthoceros* (Anthocerotaceae, Anthocerotophyta) in Central Mexico

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Abstract

The anatomy and morphology of six species of *Anthoceros* found in central Mexico are described. *Anthoceros hispidus* is reported new to Mexico. A key to the species of the genus in the region is provided.

Key words: *Anthoceros hispidus, A. lamellatus, A. punctatus, A. sambesianus, A. scariosus, A. tristanianus,* hornworts, Mexican bryophytes

Introduction

The hornworts, division Anthocerotophyta, constitute one of the less diverse groups of embryophytes with 200 to 250 species and 13 to 14 genera worldwide (Duff *et al.* 2007, Villarreal *et al.* 2010). The genus *Anthoceros* Linnaeus (1753:1139), with around 83 species, is the most diverse of the group (Villarreal *et al.* 2010).

Linnaeus (1753) formalized the genus *Anthoceros*, in which he included three species based on previous work of Dillenius (1742) and Micheli (1729). In 1951, Proskauer proposed that *Anthoceros s.l.* included two groups of species: species with black spores, schizogenous cavities in the thallus and antheridia with a regular four-tiered jacket, and species with yellow spores, without schizogenous cavities and antheridia with irregularly arranged jacket cells. Consequently, he segregated the second group into the newly named genus *Phaeoceros* Proskauer (1951:346). Since Proskauer's work, two other genera have been segregated from *Anthoceros*: *Folioceros* D. C. Bharadwaj (1971:9) and *Sphaerosporoceros* Hässel (1988:79) that are distinguished primarily by spore and pseudoelater characters.

The genus *Anthoceros* has a worldwide mainly tropical distribution (Villarreal *et al.* 2010) and despite the large tropical regions of Mexico, there are only a few isolated and imprecise records of *Anthoceros* from the country, most of them cited in studies of North American hornworts that included the north of Mexico (Austin 1875, Delgadillo-Moya & Juárez-Martínez 2012, Howe 1898, Schuster 1992, Stotler & Crandall-Stotler 2005) (Table 1). Hässel (1990) listed 12 species of *Anthoceros* in America, whereas Stotler & Crandall-Stotler (2005) reported six species for North America and North Mexico (Table 1).

The sporadic records of hornworts in Mexico point to a need for focused regional studies of hornwort genera (Delgadillo-Moya & Juárez-Martínez 2012). In this study we describe anatomical and morphological characters of six species of *Anthoceros* found in Central Mexico. One of the species is a new record for the country, *A. hispidus* Stephani (1916:998) and one for the continent, *A. sambesianus* Stephani (1916:996). We also present a key to the species of *Anthoceros* in the region. This intensive localized study provides new localities for *Anthoceros* and an extend platform on which to test hypotheses of dispersal (e.g., distribution of *A. tristanianus*/*A.lamellatus*) and species differentiation.

Material & Methods

Plants of *Anthoceros* were collected from several localities of central Mexico, including the states of Puebla, Hidalgo, Morelos, Guerrero and Distrito Federal (Fig. 1, Table 2).

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Spore morphology presents less variation across Mexican populations of *A. tristanianus* than the characters described in the morphotypes and shows slight geographical variation, such that the morphologically different populations of the same geographical area had more similar spores than those of the same morphotype in two different localities (Fig. 8).

Specimens examined:—MEXICO: Distrito Federal: Magdalena Contreras, 3er Dinamo, on a cliff at the side of the road, 2917 m, 19°16'48.7"N, 99°16'40.6"O, 25 February 2013, *A. Ibarra-Morales 43a* (FCME); Magdalena Contreras, 4to Dinamo, in the border of a stream, 3120 m**,** 19°16'1.5"N, 99°17'46"O, 25 February 2013, *A. Ibarra-Morales 42a* and *42b* (FCME). Morelos: Huitzilac, Lagunas de Zempoala, along a stream, 3091 m, 19°02'42"N, 99°19'03"O, 4 August 2011, *A. Ibarra-Morales 16a* and *16b* (FCME).

Discussion

Here we provide the first detailed taxonomic study in the American continent of any hornwort genus outside of North America north of Mexico. We found six species of the genus *Anthoceros* in 10 localities within five states of central Mexico. *Anthoceros hispidus*, *A. lamellatus* and *A. scariosus* have a mainly tropical range, *A. punctatus* has a worldwide range, whereas *A. tristanianus* and *A.* cf. *sambesianus* show a disjunct distribution, the latter species newly reported for the American continent.

Most of the species of *Anthoceros* found in central Mexico are difficult to differentiate from each other, even with a hand lens, because all species of the genus have thalloid gametophytes, cylindrical and erect capsules, brownish to blackish spores and numerous antheridia per chamber. Because the few identification keys available use spore ornamentation as the main character for recognition of species, species identification in this study was based on the spore ornamentation in the SEM and anatomical characters from sectioned material that were complemented by characters from fresh material (Table 3).

Localized geographical studies such as the present one are crucial in understanding the biogeography of hornworts, which at present is poorly known. As disjunct collections such as those reported for *A. tristanianus* and *A.* cf. *sambesianus* are found, genetic differences associated with minute traits may emerge as useful diagnostic features.

TABLE 3. Distinctive characters of six species of *Anthoceros* found in Central Mexico.

Species	Pyrenoid	Dorsal lamellae	Number of antheridia per chamber	Sporophyte foot	Capsule length (mm)	Spore size (μm)
A. hispidus	Present	Scarce or absent	10–15	Palisade-like cells present	14–58	29–41
A. lamellatus	Present	Abundant	7–11	Palisade-like cells present	40–50	33–39
A. punctatus	Present	Abundant	7–10	Palisade-like cells present	12–30	33–44
A. sambesianus	Present	Abundant	6–12	Palisade-like cells present	5–8.3	29–38
A. scariosus	Present	Regular to abundant	5–6	Palisade-like cells present	18–50	34–41
A. tristanianus	Absent	Scarce to regular	4–16	Palisade-like cells absent	6–43	54–57

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