

***Phaeomegaceros fimbriatus* (Gottsche) Duff, J.C.Villarreal, Cargill *et* Renzaglia new to Bolivia**

Beata CYKOWSKA*

Laboratory of Bryology, Institute of Botany, Polish Academy of Sciences, Poland

Abstract – A remarkable range extension of the Neotropical hornwort *Phaeomegaceros fimbriatus* (Gottsche) Duff, J.C. Villarreal, Cargill *et* Renzaglia is presented. *Phaeomegaceros fimbriatus* was found on the alluvium of a river in a montane cloud forest of the Carrasco National Park in Bolivia. The morphological features and habitat preferences of the species are briefly described and its global distribution range is mapped.

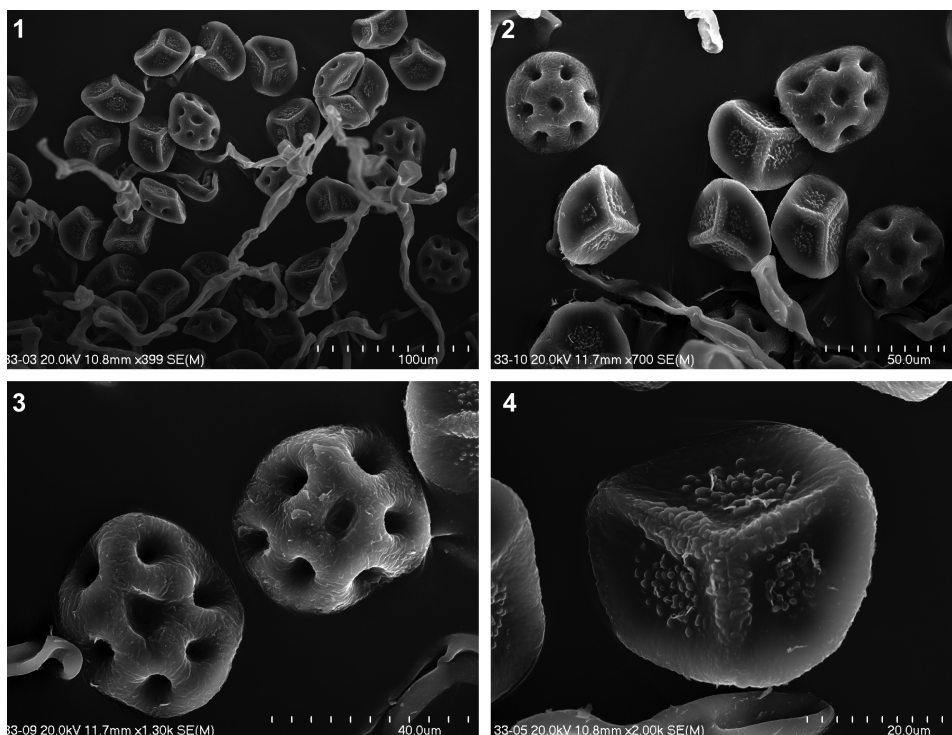
Anthocerotophyta / Dendrocerotaceae / new record / hornworts / Neotropic

INTRODUCTION

Phaeomegaceros Duff, J.C. Villarreal, Cargill *et* Renzaglia was recently circumscribed and consists of at least seven pantropical to subtemperate species (Villarreal *et al.*, 2010a). The genus shares several morphological features with *Phaeoceros* Prosk. and *Megaceros* Campbell (Villarreal & Renzaglia, 2006), although molecular data place *Phaeomegaceros* in the family Dendrocerotaceae (Duff *et al.*, 2007; Villarreal & Renzaglia 2006; Duff *et al.*, 2007). *Phaeomegaceros* was separated from *Phaeoceros* on the basis of the differences in thallus, chloroplast and sporophyte features. In contrast to *Phaeoceros*, *Phaeomegaceros* has a solid and broad thallus, a massive foot, chloroplasts without pyrenoids, monandrous androecia and a sporophyte with several rows of tetrads (Villarreal & Renzaglia 2006; Duff *et al.*, 2007). The most distinguishing feature of *Phaeomegaceros* are the yellow vermiculated spores with foveas or depressions on the distal face (Duff *et al.*, 2007; Villarreal *et al.*, 2010b).

The generitype of *Phaeomegaceros* is *Ph. fimbriatus* (Gottsche) Duff, J.C. Villarreal, Cargill *et* Renzaglia. This species was originally described from Colombia as *Anthoceros fimbriatus* Gottsche (Gottsche, 1864) and subsequently transferred to *Phaeoceros* by Gradstein and Hekking (1979) because of its yellow spores. *Phaeomegaceros fimbriatus* is easily distinguished from other species of the genus by its characteristic spores whose distal surfaces are foveate-reticulate due to regularly arranged depressions and a proximal face with prominent verrucae. A central depression is surrounded by a ring of additional depressions around the periphery (Figs 1-4). *Phaeomegaceros fimbriatus* is likely to be confused with *Ph. foveatus* J. Haseg. from the Malay archipelago (Philippines, Borneo and Sumatra). *Phaeomegaceros foveatus* has the same type of spores but it differs from *Ph. fimbriatus* in the proximal surface of the spores (Hasegawa, 2001). *Phaeomegaceros foveatus* has a distinct depression in the centre of each

* Correspondance and reprints: b.cykowska@botany.pl



Figs 1-4. *Phaeomegaceros fimbriatus* (Gottsche) Duff, J.C. Villarreal, Cargill *et* Renzaglia. **1.** Spores and elaters. **2.** Spores enlarged. **3.** Distal face of spore. **4.** Proximal face of spore. SEM micrographs taken from *Flakus s.n.* (KRAM B-206768). Scale bar: 20 μ m.

triangular area that it is lacking in *Ph. fimbriatus* (Fig. 4). In addition, the two species differ in the length of the capsule, length of the guard cells of the stomata on the capsule walls, sexual condition and spore size (Hasegawa, 2001).

So far, *Phaeomegaceros fimbriatus* is known from a few localities in Central America, the West Indies and the northern part of South America [Colombia, Costa Rica, Ecuador, Guadeloupe, Panama and Venezuela (Hässel de Menéndez, 1989; Hasegawa, 2001; Dauphin, 2005; Villarreal & Renzaglia, 2006; Duff *et al.*, 2007; Villarreal *et al.*, 2010b)]. The new record in Bolivia represents its southernmost locality and a remarkable change to the knowledge of the range of the species.

MATERIAL AND METHODS

Herbarium material of *Phaeomegaceros fimbriatus* was studied using light and scanning electron microscopy (SEM). For SEM a mature sporophyte was opened and the spores were placed on a stub covered with double-sided tape. The spores were coated four times with gold palladium by two minutes with 20 mA. Digital SEM images were obtained from a Hitachi S-4700 Scanning Electron Microscope at the Scanning Electron Microscopy Laboratory of the Biological and Geological Sciences at the Jagiellonian University in Cracow (Poland).

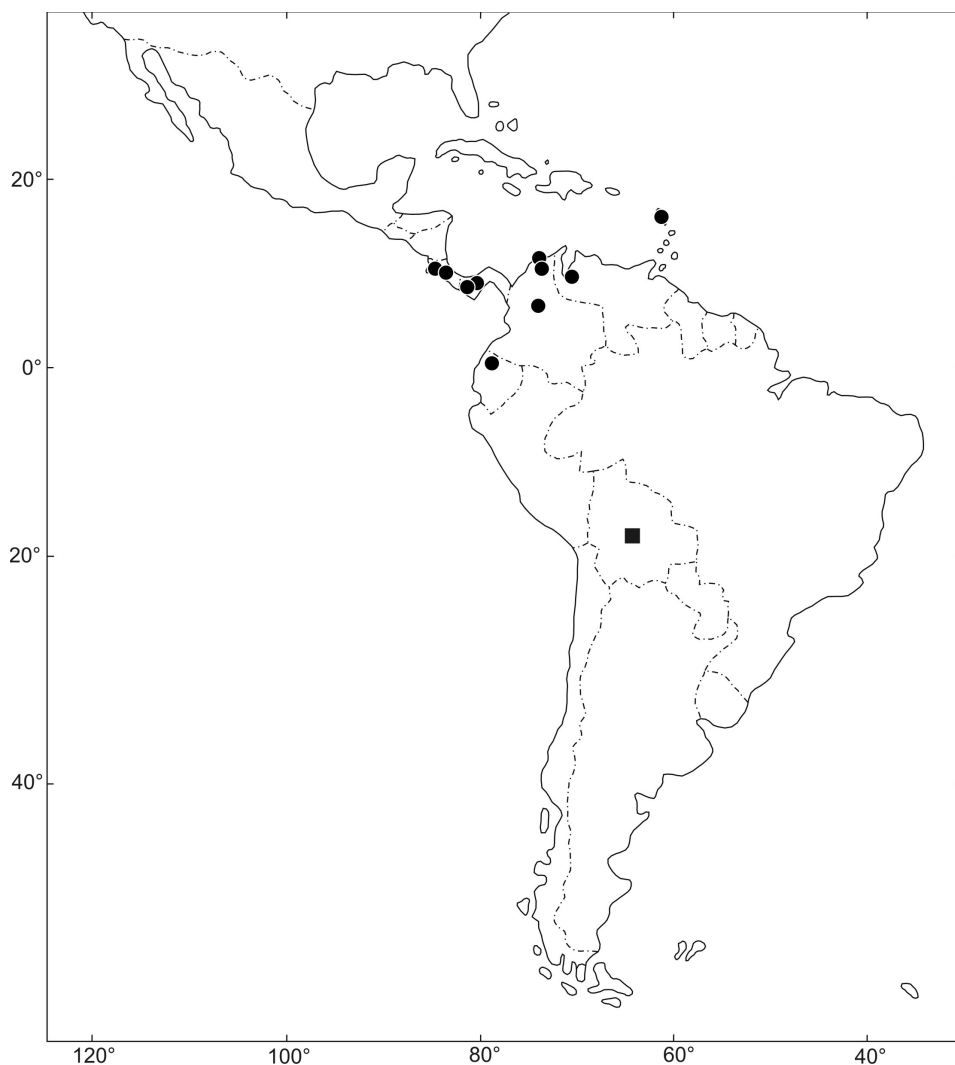


Fig. 5. Distribution map for *Phaeomegaceros fimbriatus* (Gottsche) Duff, J.C. Villarreal, Cargill et Renzaglia in tropical America. The new locality is marked with a black square.

A distribution map of *Ph. fimbriatus* was arranged based on literature reports and the new record (Fig. 5).

NEW LOCALITY

Phaeomegaceros fimbriatus is a perennial hornwort that grows on soil banks along roads or in wet places of cloud forests or paramos (Hasegawa, 2001; Villarreal & Renzaglia, 2006). In Bolivia the species was found growing on the alluvium of a river in a montane cloud forest, as follows:

BOLIVIA, Dept. Cochabamba, Prov. Carrasco, Carrasco National Park, near Phaqcha, 20 km of Monte Punku village, 17°27'13"S, 65°16'44"W, alt. 2850 m, montane cloud forest, 20 July 2008, *leg. A. Flakus s.n.* (KRAM B-206768).

MORPHOLOGY (BOLIVIAN MATERIAL)

Thallus small-erect, forming 200-450 µm (7-10 cells) thick rosettes from 0.8 to 3 cm diameter, fleshy, green and irregularly branched. Thallus branches mostly vertically directed, strap-shaped to flabellate, to 7-8 mm long, with irregularly crenulate or lacinate margin. Dorsal surface smooth, tubers absent. Epidermal cells (cross section) of thallus (20-25 × 25-30 µm) smaller than inner cells (30-43 × 37-75 µm). Plants dioicous, androecia about 80-90 µm in diameter, usually aggregated in narrow parts of smaller plants (0.8-1.5 cm of diameter), antheridia globose, about 200 µm in diameter, occurring on bigger plants (2-3 cm in diameter). Involucre scattered, usually one per branch, short cylindrical, smooth, about 3 mm high. Capsules cylindrical, to 4 cm long, bivalved. Spores pale yellow, rounded tetrahedral, ca. 37-41 µm in diameter, with distinct triradiate marks; proximal surface granulate-vermiculate, with verrucae aggregated in each triangular area; distal surface granulate-vermiculate, with central depression surrounded by a ring of six (sometimes seven to eight) peripheral depressions, all about 7-8 µm in diameter (Figs 1-4). Pseudoelaters pale brown, (1-)2-3-celled, to 150 µm long and 7-12 µm wide.

HORNWORT FLORA OF BOLIVIA

The presented record of *Phaeomegaceros fimbriatus* and the recent discovery of *Phaeoceros carolinianus* (Michx.) Prosk. (Ellis *et al.*, 2013), elevates the number of species of hornworts for the Bolivian flora. A total of six hornwort species in five genera has so far been reported for the country, namely *Anthoceros tuberulatus* Lehm. & Lindenb., *Megaceros jamesoni* (Taylor) Steph., *Nothoceros vincentianus* (Lehm. *et* Lindenb.) J.C. Villareal, *Phaeoceros laevis* (L.) Prosk., *Ph. carolinianus* and *Phaeomegaceros fimbriatus* (Churchill *et al.*, 2009; Ellis *et al.*, 2013). In South America, the richest hornwort flora is known from Brazil (11 species, Costa, 2013) whereas only two species are known from Paraguay (Spruce, 1888; Stephani, 1916). However, the present record demonstrates that the hornwort flora of South America is still incompletely known.

Acknowledgements. I am grateful to Rosa I. Meneses Q. and Faviana Mogro (La Paz) for their help with permits and collaboration. I would also like to thank Prof. Ryszard Ochrya (Cracow) and Dr. Juan Carlos Villarreal (Munich) for their suggestions and help with literature and the reviewers for their valuable comments. Dr. Adam Flakus (Cracow) kindly provided the studied specimen. This work has been financially supported by the Polish Ministry of Science and Higher Education through grant no. NN 303 572038 for the author and by the program for Young Scientists and members of Doctoral Studies under the grant for 2013, and partly by the statutory fund of the W. Szafer Institute of Botany of the Polish Academy of Sciences.

REFERENCES

- CHURCHILL S.P., SANJINES N.N. & ALDANA M.C., 2009 — *Catálogo de las Briofitas de Bolivia: diversidad, distribución y ecología*. Santa Cruz de la Sierra, Missouri Botanical Garden & Museo Noel Kempff Mercado. 340 p.
- COSTA D.P., 2013 — *Antóceros* in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. (<http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB128470>).
- DAUPHIN G., 2005 — Catalogue of Costa Rican Hepaticae and Anthocerotae. *Tropical bryology* 26: 141-218.
- ELLIS L.T., ASTHANA A.K., GUPTA R., NATH V., SAHU V., BEDNAREK-OCHYRA H., OCHYRA R., CYKOWSKA B., CALVO ARANDA S., FISCHER E., GABRIEL R., GÓRSKI P., GREMMEN N., HESPAÑOL H., KURBATOVA L. E., LEWIS SMITH R.I., LONG D.G., BELL D., MOGRO F., SÉRGIO C., GARCÍA C.A., STOW S., MARTINS A., SMITH V.R., VÁA J., VANDERPOORTEN A., 2013 — New national and regional bryophyte records, 34. *Journal of Bryology* 35(1): 62-70.
- DUFF R.J., VILLARREAL J.C., CARGILL D.C., RENZAGLIA K.S., 2007 — Progress and challenges toward developing a phylogeny and classification of the hornworts. *The bryologist* 110(2): 214-243.
- GOTTSCHÉ C.M., 1864 — *Hepaticae*. In: Triana J. & Planchon J.H. (eds.), *Prodromus florae Novo-Granatensis ou énumération des plantes de la Nouvelle-Grenade avec description des espèces nouvelles. Annales des sciences naturelles, Botanique, série 5*, 1: 95-198.
- GRADSTEIN S.R. & HEKKING A., 1979 — Studies on Colombian cryptogams. IV. A catalogue of the Hepaticae of Colombia. *Journal of the Hattori botanical laboratory* 45: 93-144.
- HASEGAWA J., 2001 — A new species of *Phaeoceros* with remarkable spore features from Southeast Asia. *Bryological research* 7(12): 373-377.
- HÄSSEL DE MENÉNDEZ G., 1989 — Las especies de *Phaeoceros* (Anthocerotophyta) de América del Norte, Sud y Central; la ornamentación de sus esporas u taxonomía. *Candollea* 44(2): 715-739.
- SPRUCE R., 1888 — *Hepaticae paraguayensis*, Balansa lectae. *Revue bryologique* 15: 34-35.
- STEPHANI F. — *Species Hepaticarum* 5. Genève & Bale, George & Cie Libraires-Éditeurs. 1 044 p.
- VILLARREAL J.C. & RENZAGLIA K.S., 2006 — Sporophyte structure in the neotropical hornwort *Phaeomegaceros fimbriatus*: implications for phylogeny, taxonomy, and character evolution. *International journal of plant science* 167: 413-427.
- VILLARREAL J.C., CARGILL D.C., HAGBORG A., SÖDERSTRÖM L., RENZAGLIA K.S., 2010a — A synthesis of hornwort diversity: patterns, causes and future work. *Phytotaxa* 9: 150-166.
- VILLARREAL J.C., CARGILL D.C., GOFFINET B., 2010b — *Phaeomegaceros squamuliger* subspecies *hassellii* (Dendrocerotaceae, Anthocerotophyta), a new taxon from the Southern Hemisphere. *Nova Hedwigia* 91(3-4): 349-360.