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## Two new species of *Phyllodistomum* Braun, 1899 (Digenea: Gorgoderidae), from freshwater fishes (Cyprinodontiformes: Goodeidae: Goodeinae) in central Mexico: An integrative taxonomy approach using morphology, ultrastructure and molecular phylogenetics

GERARDO PÉREZ-PONCE DE LEÓN<sup>1</sup>, ANDRÉS MARTÍNEZ-AQUINO<sup>2</sup>  
& BERENIT MENDOZA-GARFIAS<sup>1</sup>

<sup>1</sup>Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Ap. Postal 70-153 C.P. 04510, México D.F., México.  
E-mail: [ppdleon@ib.unam.mx](mailto:ppdleon@ib.unam.mx); [berenit@ib.unam.mx](mailto:berenit@ib.unam.mx)

<sup>2</sup>División Zoología Invertebrados, Museo de La Plata, FCNyM, UNLP, Paseo del Bosque s/n, 1900 La Plata, Argentina.  
E-mail: [maandres\\_@hotmail.com](mailto:maandres_@hotmail.com)

### Abstract

An integrative taxonomy approach is used to characterise the diversity of gorgoderid trematodes that parasitize freshwater fishes of the subfamily Goodeinae in central Mexico. Records of *Phyllodistomum* sp. and *Dendrorchis* sp. from the urinary bladder of goodeines have been previously published, although the identification at species level was not achieved. A few specimens were collected and fixed to conduct a scanning electron microscopy study, and to obtain sequences of a mitochondrial (COI) and nuclear (28S rRNA) gene, to be analysed in the context of the molecular phylogeny of gorgoderid trematodes. Based on the new findings, two new species of *Phyllodistomum* Braun, 1899 are described. *Phyllodistomum cribbi* n. sp. was found in *Zoogoneticus quitzeensis* (Bean), *Allotoca zacapuensis* Meyer, Radda & Domínguez-Domínguez, *Hubbsina turneri* de Buen and *Z. purhepechus* Domínguez-Domínguez, Pérez-Rodríguez & Doadrio from Zacapu Lake, and La Luz Spring, in Michoacan, central Mexico. *Phyllodistomum wallacei* n. sp. parasitized *Xenotaenia resolanae* Turner, *Ilyodon furcidens* (Jordan & Gilbert), and *Allodontichthys tamazulae* Turner from the Cuzalapa, Ayuquila and Tamazula Rivers in Jalisco, western Mexico. These species are compared with several freshwater *Phyllodistomum* species from different areas of the world, especially a group of eight species that comprise a monophyletic clade in recent phylogenetic hypotheses of the Gorgoderidae Looss, 1899. The two new species are distinguished from other close relatives by the combination of morphological traits such as the body shape, sucker ratio, shape of the gonads, and extension of intestinal ceca. The new species are distinct in some ultrastructural characters of the body surface when compared with those species where scanning electron micrographs (SEM) and/or microphotographs are available. Data of two molecular markers (28S rRNA and COI genes) demonstrate that the two new species are distinct from each other and from those species of *Phyllodistomum* Braun, 1899 for which sequences are available.

**Key words:** 28S, COI, Cuzalapa River, Gorgoderidae, new species, *Phyllodistomum cribbi*, *Phyllodistomum wallacei*, scanning electron microscopy, species tree, Trematoda, *Xenotaenia resolanae*, Zacapu Lake, *Zoogoneticus quitzeensis*

### Introduction

*Phyllodistomum* Braun, 1899 is probably the most diverse genus within the Digenea, with more than 120 species, and with a worldwide distribution, containing parasites of amphibians, and both marine and freshwater fishes (Campbell 2008; Ho *et al.* 2014; Pérez-Ponce de León *et al.* 2015; Nakao 2015). In Mexico, nine nominal species of *Phyllodistomum* have been recorded thus far, four of them in marine or brackish water fishes, and five in freshwater fishes, including two undescribed cryptic species discovered in ictalurid catfishes (Mendoza-Garfias & Pérez-Ponce de León 2005; Rosas-Valdez *et al.* 2011; Razo-Mendivil *et al.* 2013; Pérez-Ponce de León *et al.* 2015). Even though the inventory of the helminth parasite fauna of Goodeinae, an endemic subfamily of freshwater fish cyprinodontiforms occurring in central Mexico (comprising 41 species) is thought to be complete (see