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Checklist of the species of *Neoechinorhynchus* (Acanthocephala: Neoechinorhynchidae) in fishes and turtles in Middle-America, and their delimitation based on sequences of the 28S rDNA

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Abstract

Among the acanthocephalans, *Neoechinorhynchus* is one of the most speciose genera, with 116 described species distributed worldwide. The adults of *Neoechinorhynchus* are found in the intestine of freshwater and brackish water fish, as well as in freshwater turtles. In this study, a checklist of the congeneric species of *Neoechinorhynchus* occurring in Middle-American fish and turtles is presented. The checklist contains the records established in all published accounts, as well as novel data from survey work conducted in the region comprising Neotropical areas of Mexico, as well as some localities in Central America. The species delimitation criteria used to discriminate among species is based on molecular data. In the last years, a large database derived from sequences of the D2 + D3 domains of the large subunit of rDNA (28S) was generated for 262 specimens corresponding to nine species of *Neoechinorhynchus*. This molecular marker has shown to be useful in establishing species limits within *Neoechinorhynchus* and in resolving phylogenetic relationships at species level. Based on our results, the domains D2 + D3 of the 28S rDNA could be considered as potential DNA barcodes to complement mitochondrial DNA to discriminate among acanthocephalan species.

Key words: Acanthocephala, *Neoechinorhynchus*, 28S rDNA, species delimitation, Middle-America

Introduction

Middle-America is one of the most complex biogeographical areas in the world (Contreras-Balderas & Lozano-Vilano 1996; Morrone 2002; Zaldivar-Riveron *et al.* 2004; Huidobro *et al.* 2006). This complexity reflects the confluence of Neotropical and Nearctic biotas with a long history of geological activity (Iturralde-Vinent & MacPhee 1999; Guzman-Speziale *et al.* 2005); such activity created barriers and land-bridges that have affected the distribution of freshwater fishes (Bermingham & Martin 1998; Martin & Bermingham 1998; Mateos 2005). Also, it has been postulated that during the Pliocene (~3.3 Mya) took place the closure of the Panama Isthmus, resulting in faunal exchange between the Nearctic and Neotropical biogeographical regions and in a barrier that separated the Pacific Ocean and Atlantic Ocean (Bussing 1985).

Species of *Neoechinorhynchus* Hamann 1892 are endoparasites of freshwater and brackish water fish, and freshwater turtles, with approximately 116 described species divided into two subgenera: *Neoechinorhynchus* and *Hebesoma* Van Cleave 1928, both distributed worldwide (Amin 2013; Smales 2013). A total of 49 species have been described from the Americas, 33 from North America and 16 from Central and South America (Amin 2002; Barger *et al.* 2004; Amin & Heckmann 2009; Pinacho-Pinacho *et al.* 2012, 2014). Some morphological traits such as the proboscis shape, number and size of hooks, proboscis receptacle shape and in the shape of anterior region of the trunk, have been traditionally used to diagnose and delimit congeneric species. However, the identification of various species of the genus *Neoechinorhynchus* is rather difficult due to the morphological variability exhibited by some of these traits, resulting in a problematic species differentiation.