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DNA barcodes for Cladocera and Copepoda from Mexico and Guatemala, highlights and new discoveries

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Abstract

DNA barcoding, based on sequence diversity in the mitochondrial COI gene, has proven an excellent tool for identifying species in many animal groups. Here, we report the first barcode studies for freshwater zooplankton from Mexico and Guatemala and discuss the taxonomic and biological implications of this work. Our studies examined 61 species of Cladocera and 21 of Copepoda, about 40% of the known fauna in this region. Sequence divergences among conspecific individuals of cladocerans and copepods averaged 0.82% and 0.79%, respectively, while sequence divergences among congeneric taxa were on average 15-20 times as high. Barcodes were successful in discriminating all species in our study, but sequences for Mexican *Daphnia exilis* overlapped with those of *D. spinulata* from Argentina. Our barcode data revealed evidence of many species overlooked by current classification systems —for example, based on COI genotypes the *Diapahanosoma birgei* group appears to include 5 species, while *Ceriodaphnia* cf. *rigaudi*, *Moina* cf. *micrura*, *Mastigodiaptomus albuquerquensis* and *Mastigodiaptomus reidae* all include 2–3 taxa. The barcode results support recent taxonomic revisions, such as recognition of the genus *Leberis*, and the presence of several species in the *D. birgei* and *Chydorus sphaericus* complexes. The present results indicate that DNA barcoding will provide powerful new insights into both the incidence of cryptic species and a better understanding of zooplankton distributions, aiding evaluation of the factors influencing competitive outcomes, and the colonization of aquatic environments.

Key words: CO1, mitochondrial DNA, Anomopoda, Ctenopoda, Branchiopoda, Maxillopoda

Introduction

Species boundaries in the two main freshwater crustacean groups, Cladocera and Copepoda, have long been uncertain. More than 25 years ago, Frey (1982) began to question the presumed broad distributions of cladocerans, suggesting that many species are regional endemics, similar to the accepted situation in calanoid copepods. The status of cyclopoid copepods remains uncertain. Some species, such as *Acanthocyclops robustus* (Sars), have been regarded as cosmopolitan, but there is increasing evidence for overlooked taxa. For example, the American species *Acanthocyclops rebecae* Fiers & Ghenne was recently split from this taxon (Fiers *et al.* 2000). Viewed collectively, it is clear that taxonomic knowledge of freshwater zooplankton is incomplete. Studies of their diversity in 'frontier' regions such as Mexico have revealed many new species since the early 90's, although only a small percentage of habitats has been surveyed (Elías-Gutiérrez 1995; Elías-Gutiérrez *et al.* 1999; Elías-Gutiérrez *et al.* 2006; Elías-Gutiérrez & Suárez-Morales 2003; Grimaldo-Ortega *et al.* 1998; Suárez-Morales & Elías-Gutiérrez 2003; Suárez-Morales *et al.* 2005). It seems unlikely that taxonomic knowledge can be advanced rapidly without the adoption of new methods because the few specialists that can discriminate microcrustaceans are flooded with material. Furthermore, identifications are