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A new species of dwarf crayfish (Decapoda: Cambaridae) from central México, as supported by morphological and genetic evidence

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Abstract

Dwarf crayfish are a subfamily of freshwater decapods distributed along the southeastern coast of United States and the Central Plateau of México. Recent phylogenetic studies have found that diversity of dwarf crayfish in México could be currently underestimated, and suggested the existence of possible new species for a number of clades for which taxonomic identity was uncertain, including one from Zacapu, a small lake in the Trans-Mexican Volcanic Belt. Here, a congruence criterion between morphological and molecular evidence is used to test if this previously detected clade should be considered as a new species. A set of morphometric variables was taken to characterize variation from this population (including some newly proposed traits possibly valuable for species discrimination) and to compare it statistically to its closest relative, *C. chapalanus*. Also, additional individuals to those previously sequenced were included using a set of molecular characters, including 5 molecular markers (three mitochondrial and two nuclear fragments) and all extant species described to date from México. Principal Component Analysis, Mann-Whitney paired test and Discriminant Factor Analysis support morphological differentiation of the Zacapu population. Phylogenetic analyses are congruent with morphology and confirm that this population constitutes an exclusive monophyletic clade with high support values. Additionally, genetic Cytochrome Oxidase subunit I (cox1) distance between Zacapu and the closest related species is above the average between species distance in crayfish ($\overline{D}_{ML}=3.6\%$). Congruence between morphology and molecular evidence support the hypothesis that the population from lake Zacapu should be considered a new species, to which the name *C. zacapuensis* sp. nov. is given and its description provided. With respect to its closest relatives, *C. zacapuensis* sp. nov. is diagnosed according to the following set of morphological characters: a wider cephalothorax (5.10–5.70 vs. 4.40–4.70), wider abdomen (4.52–4.84 vs. 3.94–4.35) a more robust chela (2.12–2.48 vs. 1.72–1.96) and a shorter merus (3.04–4.20 vs. 4.26–4.71) and mesial process of first pleopod of the form I male reaching distally well beyond the other elements. This study emphasizes the utility of using an integrative framework for species recognition in crayfish.

Key words: morphology, phylogeny, species recognition

Introduction

The dwarf crayfish conform a conspicuous subfamily of decapod crustaceans with all the species included in the genus *Cambarellus* Ortmann, 1905. With nearctic affinities, it consists of 17 recognized species distributed along several river basins in Southeastern United States and the Central Plateau in México (Fitzpatrick Jr 1983; Hobbs 1989; Pedraza-Lara *et al.* 2012). Phylogenetic relationships between most of the species have been inferred by using molecular traits (mitochondrial and nuclear markers), which has lead to the proposal of two divergent lineages in the evolutionary history of the genus *Cambarellus*, one including all species inhabiting North to the Rio Grande basin and a second lineage grouping all species occurring in México (Pedraza-Lara *et al.* 2012). Nine species are recognized from the so called Mexican lineage, three of them occurring in the northern part of the Central Plateau, from which two have been assessed as extinct by the IUCN (Alvarez *et al.* 2010). The other six species occur in central Mexico, along the Trans-Mexican Volcanic Belt (Pedraza-Lara *et al.* 2012). A previous phylogenetic hypothesis for *Cambarellus* has identified the existence of a number of lineages in which genetic