



Molecular and morphological evidence reveals three species within the California sister butterfly, *Adelpha bredowii* (Lepidoptera: Nymphalidae: Limenitidinae)

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Abstract

In recent decades the butterfly *Adelpha bredowii* (Lepidoptera: Nymphalidae), known in the USA as the California Sister, has been considered to be a polytypic array of taxa, composed of two, three or four subspecies. The most recent review of the genus (Willmott 2003a) recognized three: *A. b. bredowii*, *A. b. eulalia* (= *guatemalensis*) and *A. b. californica*. We used mitochondrial (*COII*) and nuclear (*Tpi*) DNA sequence data, coupled with a reevaluation of traditional morphological characters, to determine the phylogenetic relationships between members of the *A. bredowii* complex, and to elucidate their taxonomic status. Phylogenetic analysis of molecular data corroborated the monophyly of each of the three subspecies (sensu Willmott), with the following topology: (*bredowii* + (*eulalia* + *californica*)). Average levels of *COII* variation among these taxa were much greater than the average variation within each taxon (3.4% vs. 0.2%, respectively). There were no shared alleles among these taxa, even from localities where two lineages (*bredowii* and *eulalia*) were collected in exact sympatry and synchrony. The degree of genetic divergence, reciprocal monophyly, and absence of shared alleles between taxa, coupled with unique morphological and distributional attributes of each, strongly suggest that *A. bredowii*, *A. eulalia* and *A. californica* are all species-level taxa, as they are treated herein (rev. stat.). *Adelpha bredowii* is endemic to western, central and southern Mexico: the syntype female (herein designated Lectotype) most likely originated near Oaxaca City, Oaxaca. *Adelpha eulalia* occurs from Guatemala, through much of Mexico, to Arizona, New Mexico and Texas, United States (as permanent residents; further north as vagrants), and occurs in exact sympatry with *A. bredowii* at least in Oaxaca, Mexico, but potentially in much of western and southwestern Mexico. The syntype female of *eulalia* (herein designated Lectotype) most likely originated from south-central Mexico. *Adelpha californica* is allopatric with respect to the other two species, occurring in northern Baja California, much of California, far western Nevada, Oregon and Washington. Our results highlight the continuous need for systematic scrutiny of familiar taxa, and raise the prospect that the genus *Adelpha* may be comprised of many more hidden species.

Key words: phylogeny, DNA barcoding, Mexico, molecular systematics, taxonomy

Introduction

Describing and classifying biodiversity has always been a major objective of the biological sciences. Recently, there has been an effort to promote the use of molecular sequence data as a central methodology in identifying species-level taxa, especially the use of a small segment of the mitochondrial gene Cytochrome Oxidase-I, or *COI* (e.g., Tautz *et al.* 2003; Hebert *et al.* 2003; Smith *et al.* 2006). This effort has encountered justifiable criticism from systematists who have questioned the analytical details and universal applicability of