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Species limits in the Morelet's Alligator lizard (Anguidae: Gerrhonotinae)

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ABSTRACT

The widely distributed, Central American anguid lizard *Mesaspis moreletii* is currently recognized as a polytypic species with five subspecies (*M. m. fulvus*, *M. m. moreletii*, *M. m. rafaeli*, *M. m. salvadorensis*, *and M. m. temporalis*). We reevaluated the species limits within *Mesaspis moreletii* using DNA sequences of one mitochondrial and three nuclear genes. The multi-locus data set included samples of all of the subspecies of *M. moreletii*, the other species of *Mesaspis* in Central America (*M. cuchumatanus* and *M. monticola*), and some populations assignable to *M. moreletii* but of uncertain subspecific identity from Honduras and Nicaragua. We first used a tree-based method for delimiting species based on mtDNA data to identify potential evolutionary independent lineages, and then analized the multilocus dataset with two species delimitation methods that use the multispecies coalescent model to evaluate different competing species delimitation models: the Bayes factors species delimitation method (BFD) implemented in *BEAST, and the Bayesian Phylogenetics and Phylogeography (BP&P) method. Our results suggest that *M. m. moreletii*, *M. m. rafaeli*, *M. m. salvadorensis*, and *M. m. temporalis* represent distinct evolutionary independent lineages, and that the populations of uncertain status from Honduras and Nicaragua may represent additional undescribed species. Our results also suggest that *M. m. fulvus* is a synonym of *M. m. moreletii*. The biogeography of the Central American lineages of *Mesaspis* is discussed.

1. Introduction

There are two major goals in systematics: one is to discover and describe species, and the other one to determine the phylogenetic relationships between the species (Wiens, 2007; Wiens and Penkrot, 2002). Traditionally, species have been delimited on the basis of one or more morphological characters whose variation shows no overlap between species or, if there is some overlap, by a unique combination of characters (Wiens, 2007). In addition, subspecies have been similarly delimited in many species exhibiting geographic variation (e.g., in many species of reptiles exhibiting geographic variation in scalation and color pattern; Wiens, 2008). Nevertheless, molecular studies have revealed that many subspecies actually represent distinct species under lineage-based species concepts (Ashton and de Queiroz, 2001; Burbrink and Guiher, 2015; Feria-Ortiz et al., 2011; Glor and Laport, 2012; Kubatko et al., 2011; Meza-Lázaro and Nieto-Montes de Oca, 2015; Mulcahy et al., 2006a,b). Thus, these studies have shown that traditional, morphology-based taxonomy has been underestimating species diversity partly by hiding it in the subspecies category; that is, that considerable diversity has been classified inappropriately (Wiens, 2008).

1.1. The systematics of Mesaspis moreletii

The genus *Mesaspis* Cope, 1878 contains seven recognized species, most of which have small geographic distributions (Good, 1988; Solano-Zavaleta et al., 2016). Of these, *M. antauges*, *M. gadovii*, *M. juarezi*, and *M. viridiflava* occur in the highlands of Guerrero, Oaxaca, and Veracruz, Mexico, west of the Isthmus of Tehuantepec (Good, 1988); *M. cuchumatanus* occurs in the Sierra de los Cuchumatanes in west-central Guatemala (Solano-Zavaleta et al., 2016), and *M. monticola* is distributed on the highlands of Costa Rica and extreme western Panamá (Savage, 2002). *Mesaspis moreletii*, the most widely distributed of the species of *Mesaspis*, occurs in disjunct populations at moderately high elevations in the temperate highlands of Nuclear Central America from both the Meseta Central and the Sierra Madre of Chiapas to northern Nicaragua (Campbell and Vannini, 1989; Good, 1988; Sunyer and Köhler, 2007; Wilson and Johnson, 2010).

Geographic variation in the external morphology of *M. moreletii* has resulted in the recognition of five subspecies (Good, 1988). Tihen

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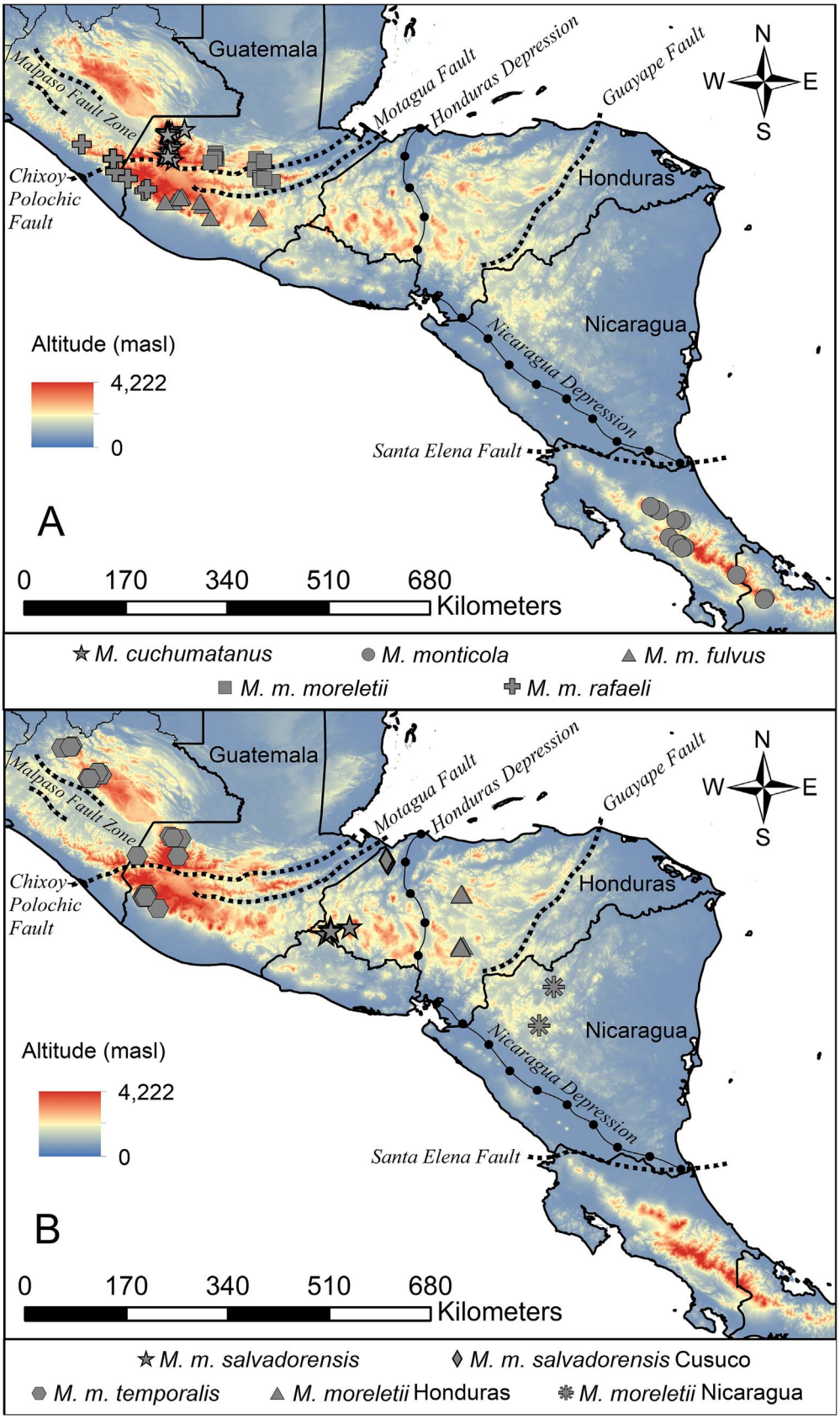

Fig. 1. Distribution records for the Central American clade of *Mesaspis*. A: *Mesaspis cuchumatanus* (stars), *M. monticola* (circles), *M. m. fulvus* (triangles), *M. m. moreletii* (squares), and *M. m. rafaeli* (crosses). B: *M. moreletii* Honduras (triangles), *M. moreletii* Nicaragua (asterisks), *M. m. salvadorensis* (stars), *M. m. salvadorensis* Cusuco (diamond), and *M. m. temporalis* (hexagons).

(1949) stated that *M. m. fulvus* occurs in "northwestern Guatemala, the limits of the range not established," and *M. m. moreletii* is distributed in "Alta Verapaz, Guatemala, westward possibly to, but not beyond, the Cuchumatanes, and southward into Honduras, where presumed intergrades with *M. m. salvadorensis* are found." *Mesaspis m. rafaeli* occurs from the Sierra Madre de Chiapas in southeastern Chiapas to Volcán Tajumulco in northwestern Guatemala (Tihen, 1949); *M. m. salvadorensis* is distributed in Honduras and El Salvador southward to