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**Phylogeny of the *boulengeri* group (Iguania: Liolaemidae, *Liolaemus*)
based on morphological and molecular characters**

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Phylogeny of the *boulengeri* group (Iguania: Liolaemidae, *Liolaemus*) based on morphological and molecular characters

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Abstract

The genus *Liolaemus* belongs to the family Liolaemidae, together with the genera *Phymaturus* and *Ctenoblepharys*, and for its diversity, it can only be compared with the genus *Anolis* among the iguanians because at the present, about 200 species are recognized in the literature and almost every year new taxa are described. Also, this genus is diverse and is widely distributed from central Peru to Tierra del Fuego at the southern end of the continent and lizards of this genus live in a variety of habitats in Argentina, Bolivia, Chile, Peru, Paraguay, the Uruguay coasts and southeastern Brazil.

Due to the great morphological diversity and to their extensive distribution, many authors have divided and classified species of the genus in different ways, describing other genera, subgenera, groups and complexes of species that, in turn, have changed through the time.

One of the groups now recognized is the *boulengeri* group, also called "the patch group," because it is characterized by the presence of a group of enlarged scales on the posterior surface of the thigh. This group has also been under continuous taxonomic modifications, mainly about the number of species that form part of it, since new species are continually described inside the group. In the last two years nine species were described, and apparently it might include up to 60 taxa in total and not only the 46 that are recognized now.

The *boulengeri* group is widely distributed in Argentina, and is also found in Bolivia, Chile, Paraguay, Uruguay and Brazil. Several species of the group are endemic, while others have a wide distribution. The species of the group have a great variety of characteristics, in reference to their "life histories:" oviparous and viviparous, insectivorous, omnivorous and herbivorous species, saxicolous and psammophilous, with and without sexual dichromatism, etc.

In this work the phylogeny of the *boulengeri* group was recovered, using the approach of parsimony, combining morphological and molecular characters. The morphological phylogeny is also presented using the method of implied weights. Several morphological characters used, mainly referred to color pattern, are original in this work. Also provided is the history of the classifications and taxonomic arrangements for the genus *Liolaemus*, a review about the femoral

patch, and there is a critical study of the different relationship hypotheses found within the *boulengeri* group. Based on the results of the total evidence analysis, the *boulengeri* group is redefined, the phylogenetic position of the *anomalus* group's species is analyzed, a new classification is proposed based on clades and subclades recovered in this analysis, and an identification key is presented for the males of the species of the group under study.

Resumen

El género *Liolaemus* pertenece a la familia Liolaemidae al igual que los géneros *Phymaturus* y *Ctenoblepharys* y por su diversidad, puede ser comparado solamente con el género *Anolis* entre los iguanios ya que hasta el momento se reconocen en la literatura alrededor de 200 especies y prácticamente cada año se describen nuevos taxones. Además de ser un género diverso, está ampliamente distribuido desde el centro de Perú hasta Tierra del Fuego en el extremo sur del continente, abarcando variados ambientes en Argentina, Bolivia, Chile, Perú, Paraguay, las costas de Uruguay y Brasil.

Debido a la gran cantidad de formas y a su extensa distribución, varios autores han dividido y reagrupado al género dando origen a otros géneros, subgéneros, grupos y complejos de especies que, a su vez, han ido cambiando con el transcurso del tiempo.

Uno de los grupos actualmente reconocidos, es el de *Liolaemus boulengeri*, también llamado "grupo del parche", ya que está caracterizado por la presencia de un grupo de escamas agrandadas en la parte posterior del muslo. Este grupo ha sufrido también continuas modificaciones taxonómicas, sobre todo en el número de especies que lo integran, ya que continuamente se describen especies dentro del grupo. En los últimos dos años se describieron nueve especies y aparentemente podría estar formado por 60 taxones en total y no únicamente por los 46 que se reconocen actualmente.

El grupo de *L. boulengeri* se distribuye ampliamente en la Argentina, encontrándose también en Bolivia, Chile, Paraguay, Uruguay y Brasil. Varias especies del grupo presentan un marcado endemismo mientras que otras poseen una vasta distribución. Las especies del grupo tienen una gran variedad de características diferentes en cuanto a sus "historias de vida", existiendo especies ovíparas y vivíparas, insectívoras y herbívoras, saxícolas y psamófilas, con y sin dicromatismo sexual, etc.

En el presente trabajo se realizó la filogenia del grupo de *L. boulengeri*, bajo el criterio de parsimonia, combinando caracteres morfológicos y moleculares. También se presenta la filogenia morfológica utilizando los Pesos Implicados como metodología. Varios caracteres morfológicos utilizados, principalmente referidos al patrón de coloración, son originales de este trabajo. También se sintetiza la historia de las clasificaciones y arreglos taxonómicos para el género *Liolaemus*, una reseña sobre el "parche femoral" y se comenta sobre las diferentes hipótesis de relaciones del grupo de *L. boulengeri*. En base a los resultados del análisis de "evidencia total" se redefine al grupo de *L. boulengeri*, se analiza la posición filogenética de las especies del grupo de *L. anomalus*, se propone una nueva clasificación para los diferentes subgrupos que componen al grupo en estudio y se presenta una clave de identificación para los machos de las diferentes especies que componen al grupo de *L. boulengeri*.

Key words: Phylogeny, cladistics, parsimony, total evidence, morphological characters, Liolaemidae, *Liolaemus*

Introduction

The genus *Liolaemus* is a natural group of iguanians that is, without doubt, one of the more interesting and attractive taxonomic groups of neotropical saurians for investigations in taxonomy, systematic, biogeography, conservation, physiology, behavior, anatomy, molecular biology, etc. Such interest is mainly due to the great diversity of biological traits present in this genus including species with saxicolous, arboricolous, and psammophilous habits, with viviparous or oviparous reproductive modality, and insectivorous, herbivorous and omnivorous diets. The variety of color patterns, sizes and morphologies make this genus even more attractive.

Another factor that makes them so fascinating is their wide latitudinal and altitudinal distribution, including the greater part of the western region of South America, from the Andes range in Peru in the north to