



Zootaxa 4016 (1): 001–111
www.mapress.com/zootaxa/

Copyright © 2015 Magnolia Press

Monograph

ISSN 1175-5326 (print edition)

ZOOTAXA

ISSN 1175-5334 (online edition)

<http://dx.doi.org/10.11646/zootaxa.4016.1.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:218E59D6-BA59-4E68-8EDA-93C51D587CD6>

ZOOTAXA

4016

Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment

ARNE SCHULZE^{1,2*}, MARTIN JANSEN¹ & GUNTHER KÖHLER¹

¹ Senckenberg Forschungsinstitut und Naturmuseum, Senckenberganlage 25, 60325 Frankfurt am Main, Germany

² Hessisches Landesmuseum Darmstadt (HLMD), Friedensplatz 1, 64283 Darmstadt, Germany

* corresponding author: arne.schulze@hlmd.de



Magnolia Press
Auckland, New Zealand

Accepted by S. Castroviejo-Fisher: 17 Jul. 2015; published: 11 Sept. 2015

ARNE SCHULZE, MARTIN JANSEN & GUNTHER KÖHLER

Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment

(*Zootaxa* 4016)

111 pp.; 30 cm.

11 Sept. 2015

ISBN 978-1-77557-791-1 (paperback)

ISBN 978-1-77557-792-8 (Online edition)

FIRST PUBLISHED IN 2015 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: zootaxa@mapress.com

<http://www.mapress.com/zootaxa/>

© 2015 Magnolia Press

All rights reserved.

No part of this publication may be reproduced, stored, transmitted or disseminated, in any form, or by any means, without prior written permission from the publisher, to whom all requests to reproduce copyright material should be directed in writing.

This authorization does not extend to any other kind of copying, by any means, in any form, and for any purpose other than private research use.

ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

Table of contents

Abstract	4
Introduction	4
Material and methods	5
Study areas	5
Sampling methods	6
Captive breeding	6
Microhabitat assessment and ecomorphological guilds	6
Morphological tadpole assessment and characterisation	6
DNA barcoding and analysis of tadpoles	7
Nomenclature	12
Results	14
Bufonidae	14
<i>Rhinella mirandaribeiroi</i>	14
<i>Rhinella</i> cf. <i>schneideri</i>	18
Dendrobatidae	20
Colostethinae	20
<i>Ameerega picta</i>	20
Hylidae	21
Hylinae	23
<i>Dendropsophus leali</i>	23
<i>Dendropsophus leucophyllatus</i> A	24
<i>Dendropsophus melanargyreus</i>	26
<i>Dendropsophus minutus</i> A	28
<i>Dendropsophus minutus</i> B	31
<i>Dendropsophus nanus</i> A	31
<i>Dendropsophus</i> cf. <i>nanus</i>	33
<i>Dendropsophus salli</i>	35
<i>Hypsiboas geographicus</i> A	36
<i>Hypsiboas punctatus</i> A	38
<i>Hypsiboas raniceps</i>	40
<i>Osteocephalus taurinus</i>	41
<i>Pseudis paradoxa</i>	43
<i>Scinax fuscovarius</i>	45
<i>Scinax nasicus</i> A	46
<i>Scinax</i> cf. <i>nasicus</i>	48
<i>Scinax ruber</i> F	50
<i>Trachycephalus typhonius</i> A	52
Phyllomedusinae	53
<i>Phyllomedusa azurea</i>	53
<i>Phyllomedusa azurea</i> A	55
<i>Phyllomedusa boliviana</i>	57
Leptodactylidae	58
Leiuperinae	59
<i>Eupemphix nattereri</i>	59
<i>Physalaemus biligonigerus</i>	61
<i>Physalaemus centralis</i> A	64
<i>Physalaemus centralis</i> B	66
<i>Physalaemus</i> cf. <i>albonotatus</i>	68
<i>Pseudopaludicola mystacalis</i>	69
Leptodactylinae	69
<i>Leptodactylus</i> cf. <i>didymus</i>	71
<i>Leptodactylus chaquensis</i>	73
<i>Leptodactylus elenae</i> A	75
<i>Leptodactylus fuscus</i> A	76
<i>Leptodactylus leptodactyloides</i> A	78
<i>Leptodactylus podicipinus</i> A	80
<i>Leptodactylus syphax</i>	81
<i>Leptodactylus vastus</i>	83
Microhylidae	83
Gastrophryninae	83
<i>Chiasmocleis albopunctata</i>	85
<i>Dermatonotus muelleri</i>	86
<i>Elachistocleis</i> sp. A	86

Discussion	88
Acknowledgements	89
References	89
Appendix I: 16SrRNA ME tree of Bufonidae and Dendrobatidae	95
Appendix II: 16SrRNA ME tree of Hylidae	95
Appendix III: 16SrRNA ME tree of Leptodactylidae	95
Appendix IV: 16SrRNA ME tree of Microhylidae	98
Appendix V: tadpoles examined in this study	99

Abstract

The last decades have witnessed a rapid increase in our knowledge about amphibian diversity, and a growing number of studies have focused on anuran larval stages. Tadpoles can provide key information for conservation issues and the understanding of amphibian evolution. Moreover, research in tadpoles has the potential to advance species delimitation in the diverse and still understudied Neotropical amphibian fauna. In this study we present morphological tadpole characterisations of 41 lowland species illustrated by detailed imagery (mainly of live specimens). The larvae were identified via captive breeding and genetically using recently published DNA barcodes of adult Bolivian frogs. Tadpoles of three species (*Rhinella mirandaribeiroi*, *Dendropsophus melanargyreus*, and *D. salli*) are described for the first time. The descriptions of 38 tadpoles are at least new for Bolivia (due to the divergent status of many of the Bolivian lineages, further studies are needed to clarify their taxonomy). In addition, we provide information on tadpole habitats, which—combined with morphological data—reveal ecomorphological guilds that further illustrate Bolivia's lowlands tadpole diversity.

Keywords: Bolivia's lowlands; ecomorphological guilds; tadpoles; tadpole microhabitats; tadpole morphology

Introduction

Tadpoles, the premetamorphic life stage of many frogs and toads, play a key role in anuran biology, and are the focus of various aspects of anuran research (McDiarmid & Altig 1999). The usually aquatic larval stage and the corresponding adults are exposed to notably different selective regimes due to the biphasic life cycle of anurans (e.g., Haas & Das 2011). Among terrestrial vertebrates, this unique free-living larval stage is considered a particularly suitable indicator of adaptive radiation processes in the evolutionary context of lineage diversification (Bossuyt & Milinkovitch 2000; Roelants *et al.* 2011). Under the conditions of current climate change, anuran larvae are of interest, as numerous effects of varying abiotic factors (e.g., temperature, availability of water, ultraviolet radiation) can be observed in tadpoles and tadpole communities (Reading 2002; Blaustein *et al.* 2003; Blaustein *et al.* 2010). Furthermore, extended amplitudes in temperature are correlated with chytrid fungus infection in tadpoles (Hamilton *et al.* 2012), as the latter host and transport the pathogen on their external keratinous mouthparts (Marantelli *et al.* 2004; Wake & Vredenburg 2008; Venesky *et al.* 2011). Given that larvae usually occupy different habitats than the adults, tadpoles are also important to conservation issues such as the global decline of amphibians that is attributed to habitat alteration (Becker *et al.* 2007). Properly characterising anuran larvae can assist with distinguishing species and inferring phylogenetic relationships (Eterovick & Sazima 2000; Vences *et al.* 2010a).

All these factors underline the importance of tadpole research and at the same time may demonstrate that anuran larvae are, to a certain extent, the “Achilles’ heel” of amphibians. Therefore, it is even more surprising that in the past, research on tadpoles has received less attention than that of adult amphibians (McDiarmid & Altig 1999). Misidentifications can lead to error cascades and seriously affect studies in other disciplines, e.g., ecology, physiology, behaviour (Bortolus 2008). Recently, several studies on tadpole identification have been conducted using molecular tools alongside morphological data, notably in Madagascar (Thomas *et al.* 2005; Raharivololoniaina *et al.* 2006; Randrianiaina *et al.* 2012). Studies of this kind are still underrepresented in the Neotropics (but see e.g., Schulze & Jansen 2012, Kolenc *et al.* 2013). In Brazil, for example, taxonomic studies on amphibians have been increasing substantially, yielding a current total of about 946 described frog species (Segalla *et al.* 2013), but larvae are only known of about 60% of the species (Provete *et al.* 2012). In Bolivia, even less is known about the tadpoles of native species and only about 30% have been described, partly even from bordering countries. A recent study, however, revealed that hidden diversity exists on a regional level in the country’s eastern lowlands (Jansen *et al.* 2011).