

# A wide hybrid zone mediated by precipitation contributed to confused geographical-structure of *Scutiger boulengeri*

Xiuqin Lin<sup>1</sup>, Yinmeng Hou<sup>1</sup>, Weizhao Yang<sup>2</sup>, Shengchao Shi<sup>2</sup>, Puyang Zheng<sup>2</sup>, Chungkun Shih<sup>3</sup>, Jianping Jiang<sup>2</sup>, and Feng Xie<sup>4</sup>

<sup>1</sup>Chengdu Institute of Biology, Chinese Academy of Sciences

<sup>2</sup>Chengdu Institute of Biology

<sup>3</sup>College of Life Sciences,

<sup>4</sup>Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu, Sichuan, China

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## Abstract

Confused geographical-structure of population and mito-nuclear discordance have been shaped by a combination of rapid population demographic changes and ecological shifts. In this study, we generated a time calibrated phylogeny of *Scutiger boulengeri*, an endemic Tibetan alpine toad occurring in mountain streams in Qinghai-Tibet Plateau, based on three mitochondria (mtDNA) genes, in which eight clades were assigned into three deeply divergent lineages. While nuclear DNA (nuDNA) revealed three distinct clusters without geographical structure indicating significantly high rates of gene flow by population structure analysis. The coalescent theory framework (approximate Bayesian computation model DIYABC and Migrate-N) suggested that the intraspecific main clusters divergence was the result of hybridization after secondary contact in Holocene around 0.59 Ma, with population size change. The ratio of mtDNA divergence to nuDNA divergence was 2.3, less than 4, failed to test a sex-biased dispersal. Geographic cline analysis showing a wide hybrid zone initially established in southwestern China, without significant reproductive isolation but a strong influence of introgression in *S. boulengeri*, suggested high fitness of hybrids. Moreover, mtDNA exhibited isolation by distance (IBD) while nuDNA showed significant isolation by environment (IBE). Our results suggested such mito-nuclear discordance might have been first caused by geographic isolations, followed by hybridization mediated by precipitation, and produced a wide hybrid zone, which contributed to confused geographical-structure of the nuDNA in *S. boulengeri*. This study unveiled the complicated historical process that might have led to specific genetic pattern and specific climate factor facilitating phenotypic diversity in this system.

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