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Description of the tadpoles of two endemic frogs: the Phu Luang cascade frog *Odorrana aureola* (Anura: Ranidae) and the Isan big-headed frog *Limnonectes isanensis* (Anura: Dicroglossidae) from northeastern Thailand

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Abstract

We describe the external morphology of the tadpoles of two frogs endemic to Thailand: the Phu Luang cascade frog (*Odorrana aureola*) and the Isan big-headed frog (*Limnonectes isanensis*) from the type localities in the Phu Luang Wildlife Sanctuary, Loei Province, northeastern Thailand. Morphological and genetic characters (16S rRNA) were used to identify specimen and match tadpoles to the adults. Detailed descriptions of external morphology and coloration in life are provided for both species. We provide a brief discussion of the ecology of these tadpoles and a comparison to previously published data from tadpoles of closely related taxa. Additionally, we provide evidence for the utility of larval morphology in resolving the taxonomic puzzles presented by cryptic species complexes.

Key words: amphibian, biodiversity, conservation, morphology, mitochondrial DNA, species complex

Introduction

Thailand is considered a global biodiversity hotspot and includes a tremendous diversity of amphibian species (Myers *et al*. 2000). In Thailand, amphibians were reported more than 130 species and at least 32 species are considered to be endemic (Frost 2015). Phu Luang Wildlife Sanctuary (PLWS) in Loei Province, northeastern Thailand, is an economically and environmentally important forest conservation area covered by a mixture of dry deciduous dipterocarp forest, mixed deciduous forest, hilly dry evergreen forest, montane evergreen forest, coniferous forest, and tropical grassland (Phochayavanich 2007; Wanchai *et al*. 2012; Wanchai *et al*. 2013). Elevations at PLWS ranges 400–1500 m above sea level (ASL). Several species endemic to Thailand, including *Limnonectes isanensis* (Isan big-headed frog), *Odorrana aureola* (Phu Luang cascade frog), and *Tylototriton panhai* (Salamandrid newt) have been reported from this site (Stuart *et al*. 2006a; McLeod *et al*. 2012; Nishikawa *et al*. 2013). With respect to amphibian diversity, Phochayavanich *et al*. (2010) documented 22 species at PLWS with greatest diversity occurring at lower elevations.

In recent years, a growing amount of attention has been given to species complexes and the underestimation of amphibian diversity, particularly in Southeast Asia (Bain *et al*. 2003; Stuart *et al*. 2006a,b; McLeod 2008; McLeod 2010; Matsui *et al*. 2010a,b; Inger & Stuart 2010). In Thailand, the *Odorrana livida* complex (Stuart *et al*. 2006a,b) and the *Limnonectes kuhlii* complex (McLeod 2008, 2010; Matsui *et al*. 2010b; McLeod *et al*. 2012) exemplify the diversity that can be obscured by morphological similarities of postmetamorphic individuals. On the basis of molecular data, Stuart *et al*. (2006b) identified seven species in the *O. livida* complex, two species of which occur in Thailand. Similarly, more than 22 species (or candidate species) have been identified in the *L. kuhlii* complex (Matsui *et al*. 2010b; McLeod 2010), of which four species occurs in Thailand.

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