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Delimiting the distribution range of *Indirana leithii* (Boulenger, 1888) (Anura: Ranixalidae), an endemic threatened anuran of the Western Ghats, based on molecular and morphological analysis

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Abstract

Indirana leithii (Boulenger, 1888) (Anura: Ranixalidae) is a frog species endemic to the Western Ghats and is categorized as Vulnerable according to IUCN red list. This species is currently considered to be widespread over the entire Western Ghats. Our study based on molecular data (using DNA sequence fragments of the mitochondrial 12S rRNA and 16S rRNA genes and the nuclear rhodopsin gene), morphological analysis of topotypic material as well as material collected from a wide range within the northern Western Ghats, suggests that the species has instead a restricted range in the state of Maharashtra. Specimens identified as *I. leithii* from the southern Western Ghats as well as from outside the Western Ghats probably belong to hitherto undescribed species. To facilitate future studies in understanding the nature of this species complex and provide better means for identification and delimitation of species we provide molecular, morphological and osteological characters of *I. leithii* from topotypic material.

Key words: Vulnerable, Molecular phylogeny, species complex

Introduction

Indirana leithii was described as *Rana leithii* by Boulenger (1888) from a single female specimen collected at Matheran (18.98°N; 73.27°E; 772 mASL), northern Western Ghats, India. After several taxonomic revisions (Kirtisinghe 1958; Dubois 1986; 1987a; 1987b; Laurent 1986) and molecular evidence (Roelants *et al.* 2004) *I. leithii* is now included in a Western Ghats endemic and monogeneric family Ranixalidae Dubois, 1987. Because of the restricted and fragmented distribution and severe decline in the quality of the habitat, the species is currently assessed as Vulnerable in IUCN Redlist (Biju *et al.* 2004).

According to current knowledge, the species *Indirana leithii* is supposed to occur in Gujarat (Daniel & Shull 1964), Maharashtra (Boulenger 1888; McCann 1932; Chari & Daniel 1953; Abdulali & Daniel 1954; Sekar 1992; Padhye & Mahabaleshwarkar 2001; Dahanukar & Padhye 2005; Katwate *et al.* 2013); Andhra Pradesh (Srinivasulu *et al.* 2007; Srinivasulu & Das 2008); Karnataka (Krishnamurthy & Katre 1993; Krishnamurthy 2003; Nair *et al.* 2012a) and Kerala (Radhakrishnan 1996; Nair *et al.* 2012a). However, Biju *et al.* (2004) have doubted the presence of *I. leithii* from localities other than the Western Ghats of Maharashtra.

In the current communication, based on the study of topotypic material and material collected from a wide range within the northern Western Ghats, we show that *Indirana leithii* is restricted to the Western Ghats parts of Maharashtra and that DNA sequence considered as *I. leithii* from southern India are genetically divergent. We provide molecular and morphological evidences to restrict species distributional boundaries for *I. leithii* and also provide an osteological study of the topotypic material so as to facilitate future studies in understanding the nature of this species complex and provide better means for identification and delimitation of the species.

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APPENDIX A. Comparative material examined.

Indirana leithii (n = 60) : **Maharashtra**: Raigad District, Matheran, **BNHS 5588, 5589** (adult males), collected by N. Modak & A. Bayani on 25 August 2012; **AGCZRL-Amphibia-200** (adult female), collected by N. Modak & A. Bayani on 25 August 2012; Raigad District, Matheran, **ZSI-WRC A/1486, 1487** (adult males), collected by N. Modak & A. Bayani on 25 August 2012; Raigad District, Matheran, **BNHS 5590, 5591** (adult females), collected by N. Modak on 30 September 2012; Raigad District, Matheran, **BNHS 1197** (unsexed), collected by C. McCann on 6 October 1945; Raigad District, Matheran, **BNHS 1212, 1213, 1216, 1217, 1218, 1225, 1238, 1240** (unsexed), collected by V. K. Chari on 10 February 1953; Raigad District, Khandala, **BNHS 1204, 1243** (unsexed), collected by H. Abdulali on 30 August 1953; Raigad District, Matheran, **BNHS 1253, 1254** (unsexed), collected by H. Abdulali on 19 October 1954; Raigad District, Matheran, **BNHS 1261** (unsexed), collected by V. K. Chari on 22 July 1956; Raigad District, Matheran, **BNHS 1275** (unsexed), collected by J. C. Daniel in November 1966; Raigad District, Matheran, **BNHS 1695** (unsexed), collected by H. Abdulali in October 1967; Raigad District, Matheran, **BNHS 2830, 2831, 2833, 2837, 2838, 2841** (unsexed), collected by A. G. Sekar and V. Hegde on 8 January 1991; Raigad District, Matheran, **BNHS 4151** (unsexed), collected by V. Giri, I. Das and A. Captain in 2002; Pune District, Tamhini, **WILD-013-AMP-175, 176** (adult male), collected by A. Padhye and N. Dahanukar on 11 September 2011; Pune District, Adarwadi, **AGCZRL-Amphibia-107** (adult male) collected by A. Padhye and N. Dahanukar on 28 September 2011; Pune District, Tamhini, **ZSI-WRC A/1488, 1489** (adult females), collected by N. Modak, A. Padhye and N. Dahanukar on 15 February 2013; Pune District, Visapur fort, **WILD-013-AMP-178** (adult female), collected by N. Modak on 23 March 2013; Pune District, Lonavala, **BNHS 1262** (unsexed), collected by Humayun Abdulali on 22nd September 1957; Pune District, “Malchis” (=Malshej?) ghat, **BNHS 2516, BNHS 2516**