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Reappraisal of the Javanese Bullfrog complex, *Kaloula baleata* (Müller, 1836) (Amphibia: Anura: Microhylidae), reveals a new species from Peninsular Malaysia

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Abstract

A new species of Narrow-mouthed frog of the genus *Kaloula* is described from northern Peninsular Malaysia. *Kaloula latidisca* **sp. nov.** is genetically and morphologically most similar to *K. baleata* and *K. indochinensis* but differs from those and other congeners by the unique combination of the following characters: (1) adult males SVL 49.2–56.2 mm ($\bar{x}$=53.5 ± 3.0; N=4); (2) finger tips expanded into large, transversely expanded discs (disc width 2.8–3.1 mm, $\bar{x}$=3.0 ± 0.1); (3) inner metatarsal tubercle large, oval, distinctly raised, slightly shorter than first toe; (4) three subarticular tubercles on fourth toe; (5) toe webbing formula: I 1–2 II 1–3 III 2–3.5 IV 4–2 V; and (6) yellow to orange irregularly shaped patch on the axillary, inguinal and posterior region of thigh.

Key words: morphology, multivariate, statistics, systematics, taxonomy

Introduction

Recent re-evaluations of widespread amphibian and reptile species complexes in Southeast Asia have revealed a staggering amount of hidden diversity. Many of these previously widespread species have been shown to comprise complexes of distinct lineages with more restricted distributions (eg. Chan & Grismer 2010; Chan *et al.* 2011; Chan *et al.* 2013; Grismer *et al.* 2012a,b; Johnson *et al*. 2012; Matsui *et al*. 2010; McLeod 2010; Sumontha *et al.* 2012; Wood *et al*. 2009). The Javanese Bullfrog complex, *Kaloula baleata*, is a widespread microhylid frog that has been reported from Vietnam (Nguyen 2009; Orlov *et al.* 2002), Laos (Teynié *et al.* 2004), Thailand (Pauwels *et al.* 2000), Peninsular Malaysia (Berry 1975; Chan *et al.* 2010), Borneo (Inger & Stuebing 2005; Das & Kraus 2007), Indonesia (Iskandar 1998), and Palawan Island in the Philippines (Diesmos & Brown 2011; Taylor 1920), with a subspecies *K. baleata goshi* reported from Little and South Andaman Islands, India (Das & Dutta 1998). In a study on adaptive radiation of *Kaloula* in the Philippines, Blackburn *et al*. (2013) showed that the *K. baleata* complex formed a monophyletic group that consisted of at least five genetically distinct lineages i.e. the true *K. baleata* from Java and four other lineages from Vietnam, Peninsular Malaysia, Palawan, and Sulawesi (Fig. 1). The Vietnamese lineage (conspecific with Laos and Cambodian populations) was subsequently described as a new species, *K. indochinensis*, based on genetic divergence and phenotypic differentiation (Chan *et al.* 2013). In this study, we evaluate the northern Peninsular Malaysian lineage under a similar framework to determine whether this genetically divergent population could also be morphologically differentiated from its closest described relatives, *K. baleata* and *K. indochinensis*. We further compared the northern Peninsular Malaysian lineage with all other congeners to demonstrate that this lineage possesses a unique suite of morphological characters that set it apart from the true *K. baleata* and all other species of *Kaloula*.

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presented, which would require this action. Additionally, given their phylogenetic affinity (Fig. 1), we provisionally recommend the identification of these populations as *K.* cf. *baleata,* pending the acquisition of additional data that may definitively resolve their taxonomic placement.

As the rapid pace of species discovery continues in Southeast Asia (Brown & Stuart 2012), the targeted multitaxon comparisons of patterns of diversification across geographical barriers of Sundaland will become increasingly desired. Like Wallace's Line and the Isthmus of Kra, marine channels between Peninsular Malaysia, Sumatra, Java, and Borneo clearly have influenced evolutionary processes of diversification in Sundaland amphibians (Inger 1999). Great strides towards accurate realization of the regions of amphibian species diversity could be achieved by a research program focused on co-distributed lineages throughout the islands of the Sunda Shelf.

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