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# A New Species of *Leptolalax* from Sarawak, Western Borneo (Anura: Megophryidae)

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**A new megophryid species is described from southwestern Sarawak, Malaysian Borneo. In appearance, *Leptolalax marmoratus* sp. nov. is most similar to *L. hamidi* also from southwestern Sarawak, but differs from it by mtDNA sequence, larger body size, and higher dominant frequency of advertisement call. The assumption that more than one species of *Leptolalax* coexist at one locality in Borneo is supported. The finding of the new species raises the species number of *Leptolalax* known from Borneo to nine, and the island is thought to be one of the diversification centers of the genus.**

**Key words:** acoustics, Borneo, *Leptolalax*, new species, Southeast Asia, molecular phylogeny

## INTRODUCTION

It is now becoming common to identify cryptic anuran species through molecular phylogenetic methods, but an even more biologically significant method is acoustic analysis. Analyses of call characteristics play an important role in detecting cryptic taxa among frogs, and this is particularly the case in the Southeast Asian megophryid genus *Leptolalax* Dubois, 1980, whose members are otherwise very difficult to identify (Malkmus and Riede, 1993; Matsui, 1997, 2006; Matsui et al., 2009; Matsui and Dehling, 2012; Dehling and Matsui, 2013; Matsui et al., 2014). Eight species of *Leptolalax*, *L. arayai* Matsui, 1997, *L. dringi* Dubois, 1987, *L. fritinniens* Dehling and Matsui, 2013, *L. gracilis* (Günther, 1872), *L. hamidi* Matsui, 1997, *L. maurus* Inger, Lakim, Biun, and Yambun, 1997, *L. pictus* Malkmus, 1992, and *L. sabahmontanus* Matsui, Nishikawa, and Yambun, 2014, have been recognized from the island of Borneo. Call characteristics of all of the named species have been described and proved to be species-specific (Malkmus and Riede, 1993; Matsui, 1997; Malkmus et al., 2002; Sukumaran et al., 2010; Matsui and Dehling, 2012; Dehling and Matsui, 2013; Matsui et al., 2014).

During our field survey in southwestern Sarawak, Malaysian part of Borneo Island (Fig. 1), we collected several *Leptolalax* specimens that are very similar to *L. hamidi* in color pattern, but which had significantly larger body sizes than that species. Moreover, their calls were higher in frequency than in *L. hamidi* in spite of their larger body size. Detailed analyses of acoustic, morphological, and molecular characteristics have revealed that they represent a distinct species that is different from any other congeners. In this paper, we describe this species as new to science.

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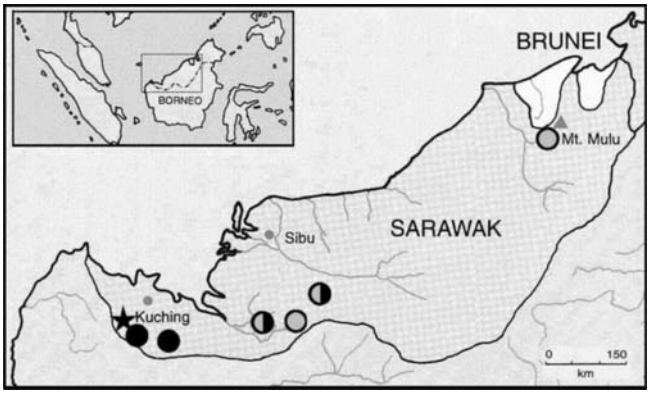


**Fig. 1.** Map of Sarawak, Malaysian Borneo, showing the known distribution of *Leptolalax marmoratus* sp. nov. (filled circles), *L. hamidi* (open circles), and literature record of either of the two species (half-filled circles). The filled star indicates the type locality.

## MATERIALS AND METHODS

We collected *Leptolalax* in southwestern Sarawak (Annah Rais, Padawan; Gunung [= Mount] Penrissen, Padawan; and Ranchan, Serian) during our field survey during 2009–2014. We made recordings of calls in the field using digital recorders (Zoom H2 or Olympus LS11). At the time of recording, we made temperature measurements using a quick-recording thermistor thermometer. We analyzed the recorded calls with SoundEdit Pro (MacroMind-Paracomp, Inc.) and Raven Lite 1.0 for Mac OS X (http://www.birds.cornell.edu/raven) on a Macintosh computer. Temporal data were obtained from the oscillogram and frequency information was obtained from the audiospectrograms using fast Fourier transformation (1024 point Hanning window).

After recording calls, we collected specimens, took tissues for subsequent biochemical analysis, and fixed the specimens for vouchers. Specimens, fixed in 10% formalin and later preserved in 70% ethanol, are stored at the Molecular Ecology Laboratory, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS), Sarawak Research Collections, Forest Research Center