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A Synopsis of Bioacoustic Studies of Anuran Amphibians of Borneo

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We summarize information on acoustics recorded from the anuran amphibians of Borneo. Currently, 154 species of frogs and toads (Amphibia: Anura) are known from Borneo (Das 2005; Das and Haas 2005; Inger and Stuebing 2005). The five species of Ichthyophiidae known from Borneo presumably do not call. The quality of acoustic information of Bornean amphibians reported in the literature varies significantly. In this review, we scored call data from 0–5, where 0 = unknown; 1 = abbreviated, onomatopoeic or verbal description; 2 = analytical description only, no sonogram/oscillogram; 3 = sonogram/oscillogram only, no ana-

lytical description; 4 = sonogram/oscillogram and analytical description; and 5 = recording on a CD. In the context of this review, “analytical description” refers to an explicit summary of important call characters, such as fundamental frequency, dominant frequency, and call rate. The respective references cited are in chronological order. We report whether descriptions are based on extralimital samples; all other references pertain to Borneo, and where possible, the locality of recording is mentioned.

In total, the calls of 101 species of anuran amphibians (65.6%) known from Borneo are described in the literature. The list includes calls of several species that have been described exclusively from extralimital areas (including India, Nepal, Thailand, and the Malay Peninsula). At least in some cases (e.g., *Fejervarya limnocharis* and *F. cancrivora*), the extralimital calls refer to non-conspecific cryptic species. In a manuscript under preparation, we will describe the calls of three additional species: *Bufo quadriporcatus*, *Leptotalax maurus* and *Microhyla borneensis* (Sukumaran et al., in prep.).

Species with unknown calls include the sole Bornean representative of Bombinatoridae (*Barbourula kalimantanensis*, an endemic of Kalimantan, Indonesia); 15 species of Bufonidae; four species of Megophryidae; 12 species of Microhylidae; 12 species of Ranidae; and nine species of Rhacophoridae. A number of familiar species from the family Ranidae have unknown calls, or have calls inadequately described in the literature. This may be due to the logistical difficulty in getting reliable recordings due to either calling behavior (such as short, sporadic calls; call shyness; or long periods between calls) or environment (e.g., high ambient noise levels in the stream habitat characteristic of many such ranids). In addition, males of some members of the genus *Limnonectes* lack vocal sacs, resulting in their characterization in the past as ‘voiceless frogs’ (e.g., Emerson and Inger 1992; Emerson and Berrigan 1993; Emerson et al. 1993; Emerson and Voris 1992). However, further observations have since established that females of some of these ‘voiceless frogs’ do indeed vocalize (see, for instance, Emerson 1992; Inger and Stuebing 2005; Matsui 1995).

Even when call descriptions are available, these may be in an abbreviated form (descriptive or onomatopoeic), lacking sonograms or oscillograms, and thereby not available for analysis. When descriptive accounts of calls are excluded, only 75 species (48.7% of the fauna) of Bornean frog calls have been analyzed. In many cases, no vouchers are listed, sometimes making identification of the species concerned uncertain.

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