

Revalidation of *Rana laterimaculata* Barbour et Noble, 1916 from the Synonymy of *Rana baramica* Boettger, 1901

TZI MING LEONG¹, MASAFUMI MATSUI^{2*}, HOI SEN YONG³, AND ABANG
ABDUL HAMID⁴

¹ Systematics and Ecology Lab, Department of Biological Sciences, National University of
Singapore, Kent Ridge, SINGAPORE 119260

² Graduate School of Human and Environmental Studies, Kyoto University, Sakyo-ku,
Kyoto 606–8501, JAPAN

³ Department of Zoology, Faculty of Science, University of Malaya, 59100 Kuala Lumpur,
MALAYSIA

⁴ Forest Department Sarawak, Bangunan Wisma Sumber Alam, Jalan Stadium, Petra Jaya,
93660 Kuching, MALAYSIA

Abstract: *Rana laterimaculata* Barbour et Noble, 1916 had been previously regarded as a junior synonym of *R. baramica* Boettger, 1901 by Inger (1966). An examination of literature, photographs, and live and preserved specimens revealed that visible and audible differences were apparent between two ‘forms’ of *R. ‘baramica’*, which may even be sympatric in some localities. The acoustic characters of the two ‘forms’ are analysed and compared. *Rana laterimaculata* is here recognized as a valid species and a neotype is assigned in place of the missing holotype. The species is redescribed and diagnostic differences separating it from *R. baramica* are explained. The present known distribution of both species is provided. Both species are confined to the Sunda region.

Key words: Sunda; *Rana baramica*; *Rana laterimaculata*; Synonymy; Revalidation; Acoustics

INTRODUCTION

Rana baramica was first described by O. Boettger (1901) from Baram River, Sarawak, Borneo. A small series of specimens (syntypes: one male, two females, one sub-adult and four juveniles, collected by W. Kükenthal in 1894) were deposited at the Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt, Germany (SMF), with detailed measurements

provided for the three adult specimens (Table 1). Boettger specified diagnostic characters of very reduced toe webbing, a granular dorsum, lack of glandular folds, and distinctly widened toe tips, and mentioned that it was comparable with *R. signata* Günther. As no specific holotype was assigned by Boettger, a lectotype (SMF 4331, an adult female) was subsequently designated by Robert Mertens (1967).

Rana laterimaculata was described by Thomas Barbour and Gladwyn Kingsley Noble (1916) from Sadong, Sarawak, Borneo. The description was based on a single type speci-

* Corresponding author. Tel/Fax: +81–75–753–6846; E-mail address: fumi@zoo.zool.kyoto-u.ac.jp

TABLE 1. Morphometric measurements (in mm) of three of the adult syntypes (one male, two females) of *Rana baramica* (after Boettger, 1901), alongside our own measurements of both females. SMF 4331 and 4332 correspond to Females #1 and #2 respectively.

Measurements	Three adult syntypes (After Boettger, 1901)			Examined by authors	
	Male	Female #1	Female #2	SMF 4331 (Lectotype)	SMF 4332
SVL	40	54	55	54.1	54.8
Head length	13½	18	18	18.3	18.7
Head width	12	17	16½	16.8	17.6
Tympanum	3½	4½	4½	3.9	4.5
Forelimb	27	35½	36	32.3	33.5
Hindlimb	68	87½	90	83.8	84.5
Tibia length	21½	28	28	28.9	28.6
Finger disc width	⅞	1	1	1.1	0.9
Toe disc width	1	1¼	1¼	0.8	1.0

men (sex and measurements not provided) collected by Harrison W. Smith in 1912 and deposited at the Museum of Comparative Zoology, Harvard, USA (MCZ 3811). Although Barbour and Noble did not specify any diagnostic details or make comparisons with other species, two characters were indicated (black tympanum and continuous white line on posterior half of upper lip) which may be used to separate *R. laterimaculata* from *R. baramica*. Up until 1932, both names were still regarded as valid, at least by Van Kampen (1923), although Boulenger (1920) did not list this species in his *Rana* monograph. However, *R. laterimaculata* was considered to be synonymous with *R. baramica*, according to Inger (1966), after examination of the holotype. Thereafter, frogs identified as belonging to this species have been recorded from other parts of Borneo: Sabah, Brunei, Kalimantan (Inger and Stuebing, 1997), Java, Sumatra, Bangka (Iskandar, 1998), Peninsular Malaysia (Berry, 1975; Dring, 1979; Manthey and Grossmann, 1997; Chan-ard et al., 1999) and Singapore (Lim and Lim, 1992).

The acoustic signal plays a very important role in preventing heterospecific breeding of anuran species, and is thus regarded as one of the key characteristics for clarifying taxonomic relationships of these animals (e.g., Matsui,

1997). In our observations and collections in the field, we found that there are two discrete call types in *R. baramica*. Subsequent studies involving literature reviews and examination of museum specimens revealed that *R. laterimaculata* deserves to be resurrected from synonymy with *R. baramica*. At least seven characters (six morphological, one behavioural - acoustic) may be used to distinguish between the two species, despite their superficial similarities. Additionally, in the course of this investigation, it was discovered that the holotype of *R. laterimaculata* is missing (José Rosado - MCZ herpetology curator, pers. comm.). Hence, another specimen (from type locality, previously identified as *R. baramica*) is designated as the neotype. *Rana laterimaculata* is redescribed in greater detail (based on specimens from Borneo, Singapore, Peninsular Malaysia and south Thailand) and comparisons are made with *R. baramica*.

MATERIALS AND METHODS

Field observations were conducted in Singapore, Malaysia (Peninsula: Johor, Pahang, Selangor; Sarawak: Mulu, Niah, Sibul, Semantan), and Indonesia (East Kalimantan: Bukit Soeharto, near Samarinda; Natuna Besar Island). Calls were mainly recorded at night in

the field using a cassette tape recorder (Sony TC-D5) with an external microphone (Sony ECM-23). Calls were later analysed from three to five individual males for each locality using the computer programs, SoundEdit Vers. 2 and SoundEdit Pro (MacroMind-Paracomp, Inc.) on a Macintosh computer. Terminology for acoustic characteristics follows Matsui (1997).

The types (lectotype and paralectotypes) of *R. baramica* were examined on loan from SMF, Germany. Specimens labeled as *R. 'baramica'* were examined from the collections of MCZ, FMNH (Field Museum of Natural

History, Chicago), MZB (Museum Zoologicum Bogoriense, Java), NSM (National Science Museum, Thailand), DWNP (Department of Wildlife and National Parks, Peninsular Malaysia), ZRC (Zoological Reference Collection, Singapore), and KUHE (Graduate School of Human and Environmental Studies, Kyoto University, Kyoto). All measurements were made with slide calipers (to 0.1 mm). Denotions to specific digits are used as follows: for example, F1 and T1 for the first finger and toe, respectively. Degree of webbing between toes was determined by carefully stretching adjacent toes in order to examine its true extent.

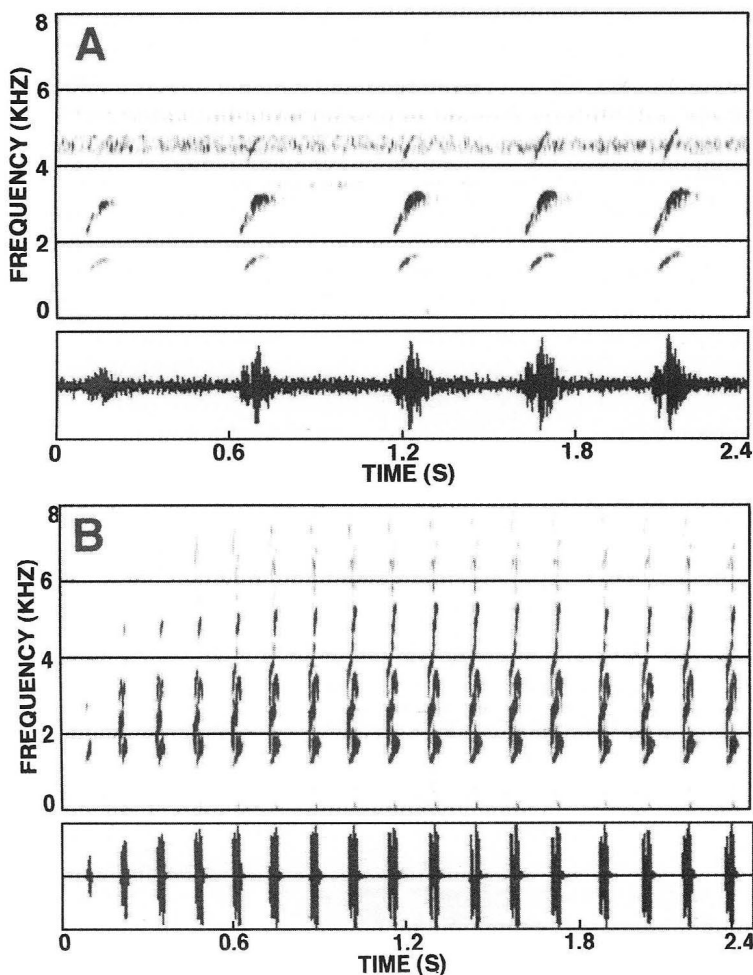


FIG. 1. Sonograms (top) and wave forms (bottom) of advertisement calls of *Rana laterimaculata* Barbour et Noble from Sematan, Sarawak (A) and *R. baramica* Boettger from Niah, Sarawak (B).

RESULTS

*Acoustic Comparisons**Rana laterimaculata*

We recorded the calls of frogs identified as *R. laterimaculata* at Sematan, Sarawak, on 5 September 1993 (air temperature 24.6 C), at Kuala Lumpur, Peninsular Malaysia, on 30 December 1992 (air temperature 26.4 C), and at Tempeler Park, near Kuala Lumpur, Peninsular Malaysia, on 21 January 1993 (air temperature 25.9 C).

This species has two call types. The normal advertisement call consists of a series of about 6–17 unpulsed notes and lasts about 1.9–7.5 s (Fig. 1A). The note repetition rate is 1.62–2.57 notes per second. Each note lasts 79–167 ms, and time interval between two notes varies from 333–800 ms. The dominant frequency lies at approximately 3000–3500 Hz, and harmonics are at about 1100–1700 and 4400–5000 Hz. The call has marked frequency and intensity modulations, and frequencies tend to increase once and then slightly decrease towards the end of a note. When calling actively, the normal advertisement call is often followed by several long notes and by a call of another type, which is slower and more intensive.

Rana baramica

The calls of 'true' *R. baramica* were recorded at Headquarters of Gunung Mulu, Sarawak, on 14 December 1989 (air temperature 24.3 C), at Niah, Sarawak, on 26 December 1990 (air temperature 26.1 C), at Sibu, Sarawak, on 17 January 1990 (air temperature 24.4 C), and at Bukit Soeharto, near Samarinda, East Kalimantan, on 1 August 1994 (air temperature 27.5 C).

This species also emits calls of two types. The normal advertisement call (Fig. 1B) consists of a series of 14–30 unpulsed or weakly pulsed notes and lasts 2.0–6.3 s. The note repetition rate is 4.09–6.92 notes per second. Each note lasts about 12–81 ms, and time interval between two notes varies from 128 to 275 ms. The dominant frequency lies at 2000–2800 Hz, and harmonics are at about 1100–1900, 3200–3900, 5200–5400, and 7000–7200 Hz. The call has marked frequency and intensity modulations, and frequencies tend to increase towards the end of a note. Males often emit calls of another type during active calling just like *R. laterimaculata*. Calls of males from East Kalimantan differ slightly from those from Malaysia in that the main part of a call includes alternative successions of intensive and weak notes.

TABLE 2. Comparisons of normal calls between *Rana laterimaculata* Barbour et Noble and *R. baramica* Boettger.

Locality	AT (C)	n	Call L (ms)	N (notes)	Note L. (ms)	Note gap (ms)	Fund.Freq (kHz)	Domin.Freq. (kHz)
<i>R. laterimaculata</i>								
Sematan	24.6	3	6785	14	138	511	1538	3000
Kuala Lumpur	26.4	4	4717	10	119	508	1515	3344
Tempeler	25.9	3	3330	8.3	117	430	1717	3388
\bar{x}			4943.8	10.8	124.4	483.0	1590.0	3244.9
SD			1738.4	3.0	11.4	45.8	110.2	212.4
<i>R. baramica</i>								
Mulu	24.3	3	3741	22	34	173	1578	2009
Sibu	24.4	5	2449	16.8	44	151	1812	2344
Samarinda	27.5	4	4406	23.8	54	173	1774	2513
\bar{x}			3532.0	20.9	44.0	165.7	1721.3	2288.7
SD			995.1	3.6	10.0	12.7	125.5	256.5

Thus, the normal advertisement calls are somewhat similar in the two species in that notes include marked frequency and intensity modulations, and that the normal advertisement call is followed by the call of another type. However, they clearly differ from each other in important characteristics (Fig. 1, Table 2) and are easily differentiated by the human ear. The number of notes in a call (mean=20.9 in *baramica* vs. 10.8 in *laterimaculata*) and call length (mean=3.5 s in *baramica* vs. 4.9 s in *laterimaculata*) slightly overlap between the two species, but the note and gap between notes are decidedly shorter in *baramica* (mean=44.0 ms and 165.7 ms, respectively) than in *laterimaculata* (mean=124.4 ms and 483.0 ms, respectively), and the dominant frequency is lower in *baramica* (mean=2289 Hz) than in *laterimaculata* (mean=3245 Hz).

Redescription of Rana laterimaculata
Barbour et Noble

Neotype

MCZ A-3885 [adult female, SVL (snout-vent length) 41.0 mm], Sadong, Sarawak, Borneo (type locality); collected by H. W. Smith (collector of holotype), date unknown (possibly around 1912). Additional measurements of neotype: head length 14.7 mm, head width 13.0 mm, body width 10.8 mm, axilla-groin distance 19.0 mm, interorbital distance 4.0 mm, internarial distance 3.4 mm, tympanum diameter 3.8 mm, tibia length 21.6 mm, foot length 18.7 mm.

Diagnosis

A small species of *Rana*, males (with humeral glands, nuptial pads, and paired subgular vocal sacs) to 39.0 mm, females (with unpigmented ova) to 47.5 mm; without dorsolateral skin folds; scattered tubercles over dorsum and flanks; finger and toe tips slightly expanded into discs not wider than twice the width of penultimate phalanx; webbing of fourth toe not reaching middle sub-articular tubercle on both sides; tympanum entirely black (dark

brown in faded specimens); an uninterrupted white line on upper lip from posterior margin of tympanum to below eye. In life, actively calling males may be recognised by their high pitched “yip-yip-yip” calls.

Description

Habitus slender, head obtusely pointed, snout slightly rounded and projecting in profile; canthus rostralis distinct, lores concave; nostrils nearer to snout tip than to eye; tympanum conspicuous, ca. 3/4 eye diameter, with distinct supratympanic fold from behind eyelid to jaw angle; vomerine teeth in oblique rows, in line with and bounded by choanae.

Finger tips slightly widened, width not more than twice penultimate phalanx, with circum-marginal grooves; fingers long, F1 longer than F2, penultimate phalanx of F1 reaches tip of F2 when adpressed, F3 longest, F2 and F4 subequal; three metacarpal tubercles present, innermost one largest, middle and outer ones subequal; toe tips as in finger tips, slightly widened and bearing circum-marginal grooves; webbing between T1 and T2 reaching subarticular tubercle of T1 but not that of T2, webbing between T2 and T3 just surpassing subarticular tubercle of T2 and reaching proximal subarticular tubercle of T3, webbing between T3 and T4 reaching distal subarticular tubercle of T3 and just surpassing proximal subarticular tubercle of T4, webbing between T4 and T5 surpassing proximal subarticular tubercle of T4 and just surpassing distal subarticular tubercle of T5; an elongated oval inner metatarsal tubercle and a rounded outer metatarsal tubercle; fingers and toes without peripheral dermal fringes or flaps.

Dorsum and flanks with distinctly raised granules and tubercles, some forming short longitudinal ridges along flanks; tibia with parallel longitudinal dermal ridges; venters smooth, rugose on undersides of femur and around vent.

In life, basal colour of dorsum and flanks brown, with darker brown to black blotches and spots (more conspicuous on flanks); tubercles along dorsolateral region usually of lighter

shade; limbs also brown with darker brown barring/blotches extending onto fingers and toes; tympanum entirely black; an uninterrupted white streak from posterior margin of tympanum to just below eye; iris yellowish in dorsal third, reddish brown in ventral two thirds; throat and chest heavily mottled with dark brown, often with a white dividing line from chin towards sternum; belly and underside of femur with reduced pigmentation. In preservative, a slight fading of the original colour occurs.

Sexual dimorphism

Males a little smaller than females, SVL of males to 39.0 mm, females to 47.5 mm. Males possess distinctly bulbous humeral glands, nearer to axilla than elbow; paired subgular vocal sacs; finely granular, unpigmented nuptial pads on first finger arranged in two separate groups, one opposite the subarticular tubercle and the other immediately adjacent to the inner metacarpal tubercle. Females with unpigmented ova. A gravid female from Singapore (ZRC. 1.4763) aborted her ova (ZRC.1.4764, ca. 400 counted) in captivity and the ova had a diameter of 1.3–1.6 mm.

Natural history

Predominantly inhabitant of lowland freshwater and peat swamp forests. Males call from among or atop leaf litter of forest floor, or perched on low vegetation up to one metre above ground. Call of male consists of an initially ascending series of high-pitched “yip-yip-yip” accelerating towards the end. *Rana laterimaculata* is syntopic with *R. baramica* in some parts of its range, and may be found with other Sundaic lowland swamp forest anurans, such as *Bufo quadriporcatus*, *Leptobrachium nigrops*, *Limnonectes paramacrodon*, *Phrynoglossus laevis*, *Rana glandulosa*, *Microhyla borneensis*, or *Rhacophorus appendiculatus*. Neither in situ nor ex situ amplexus has been observed. Its diagnostic larval identity remains as yet unknown.

Geographic distribution

Apart from the type locality, Sadong, Sarawak, and newly recorded locality, Semantan, Sarawak, other Bornean records have not been reported. Healthy populations occur within the inland swamp forests of Singapore (Central Catchment Nature Reserve, Bukit Timah Nature Reserve) and Peninsular Malaysia (Johor, Selangor, Pahang, Trengganu). It has been collected from similar habitats as far north in the peninsula as south Thailand (Hala Bala Wildlife Sanctuary - NSM voucher specimens). Its distinctive calls were heard in peat swamp forest on Natuna Besar Island (South China Sea), Indonesia. The populations from Singapore, Johor, and Natuna Besar Island are syntopic with *R. baramica* (T. M. Leong, pers. obs.).

DISCUSSION

In the field, calling males of *R. laterimaculata* may be detected by their distinctive high pitched “yip-yip-yip”, as previously recorded and analysed by Julian C. M. Dring (1979). *R. baramica* instead calls with a rapid series of “kwuck-kwuck-kwuck”, as observed in Peninsular Malaysia, Singapore, Borneo and Natuna Besar. Once located, frogs may be positively identified as *R. laterimaculata* (Fig. 2) by

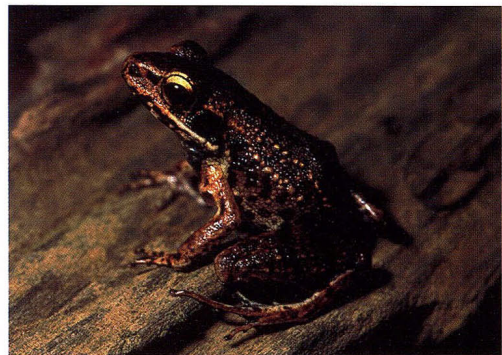


FIG. 2. Adult male *Rana laterimaculata* Barbour et Noble from Singapore. Note black tympanum and continuous white streak (along upper lip) from beneath eye to posterior margin of tympanum.

noting the following combination of characters: (a) tympanum entirely black, without gold spot in center, (b) upper lip with a continuous white streak from beneath eye to posterior margin of tympanum, (c) iris yellowish in dorsal third, reddish brown in lower two thirds. While the first two characters are retained upon preservation, the iris colour is not. Fur-



FIG. 3. Adult male *Rana baramica* Boettger from Singapore. Note gold spot in centre of brown tympanum and interrupted light and brown barings along upper lip.

ther examination of preserved specimens, where available, will confirm its identity as *R. laterimaculata* by checking that: (a) webbing between T4 and T5 does not reach middle subarticular tubercle of T4, (b) SVL of males

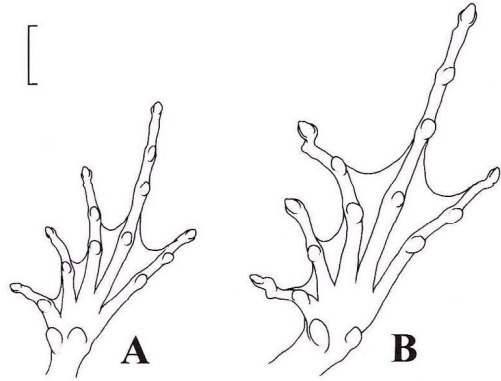


FIG. 4. Ventral aspects of the left hindfeet of (A) *Rana laterimaculata* and (B) *R. baramica*, illustrating their relative sizes and degree of webbing (note fourth toe). Both illustrated from adult male specimens (ZRC.1.10033 and ZRC.1.6111 respectively) collected in Singapore. Scale bar equals 3 mm.

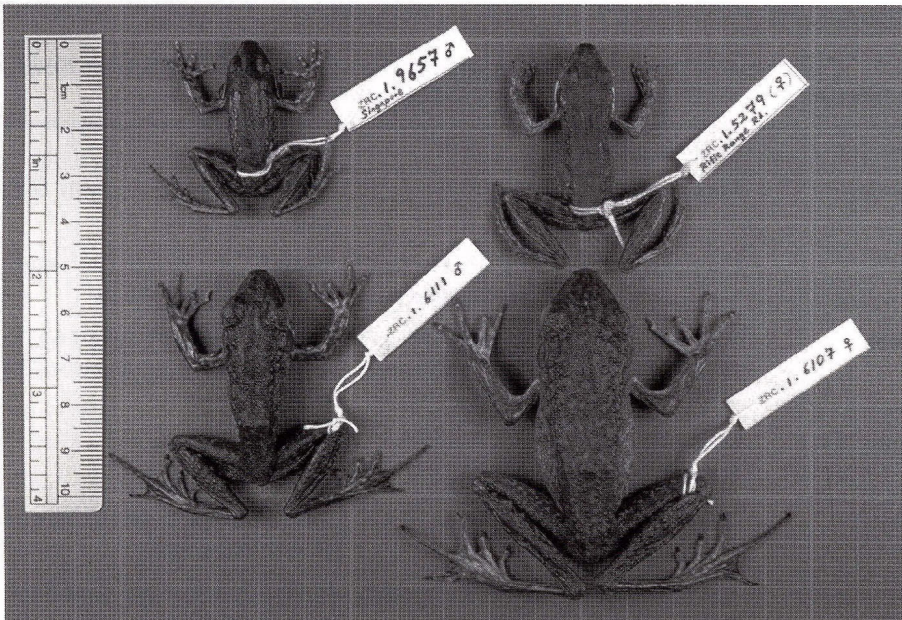


FIG. 5. Preserved specimens of adult male (left) and female (right) *Rana laterimaculata* Barbour et Noble (above) and *R. baramica* Boettger (below) from Singapore, illustrating the size differences between sexes of both species.

not greater than 39.0 mm, females not exceeding 47.5 mm, (c) pineal spot not visible.

Rana baramica (Fig. 3), on the other hand, may be distinguished from *R. laterimaculata* by the following characters: (a) tympanum brown with distinct gold spot in center, (b) upper lip with alternate light and dark bands throughout, (c) webbing between T4 and T5 just reaching middle subarticular tubercle of T4, (d) SVL of males to 55.6 mm, females to 70.9 mm, (e) presence of light gold pineal spot. In life, its iris is golden in dorsal and ventral halves, with a tinge of red at the lateral corners. The differences between both species are summarised in Table 3. Comparisons between the relative size/webbing of their hindfeet are illustrated (Fig. 4). The size differences between adults of the two species are significant, with males and females of *R. baramica* up to 40% and 50%, respectively, larger than those of *R. laterimaculata* (Fig. 5).

True *Rana laterimaculata* occurs throughout Borneo (Sabah, Sarawak, Brunei, Kalimantan), Java, Sumatra, Bangka, Natuna Besar, Peninsular Malaysia (Johor, Selangor) and Singapore. Previous references using the name

of *R. baramica* for Peninsular Malaysia (Berry, 1975; Dring, 1979; Manthey and Grossmann, 1997; Chan-ard et al., 1999) and Singapore (Lim and Lim, 1992) actually refer to true *R. laterimaculata* instead. For Bornean *R. baramica*, the photograph in Inger and Stuebing (1997: Fig. 66, p. 128) depicts a recent metamorph, lacking the essential diagnostic characters of the adult. However, a more accurate specimen (male) of this species is available in Inger and Tan (1996: Fig. 41, pg. 29). As mentioned above, both *R. laterimaculata* and *R. baramica* are known to be syntopic in Singapore, Johor (southern Peninsular Malaysia), and Pulau Natuna Besar (South China Sea). As far as we could discern from presently available specimens, there were no great variations between populations of either *R. laterimaculata* or *R. baramica* from various localities (e.g., between Borneo and Peninsular Malaysia) that might have suggested an extended period of geographic isolation from each other.

Another Malaysian species, *R. glandulosa*, shares a common character with *R. laterimaculata* and *R. baramica* in that its ova are unpigmented. The species, however, may be

TABLE 3. Comparison of characters differentiating *Rana laterimaculata* Barbour et Noble from *R. baramica* Boettger. (T4 and T5 denote fourth and fifth toes, respectively)

Character	<i>R. laterimaculata</i>	<i>R. baramica</i>
Tympanum	Entirely black	Light to dark brown, with distinct gold spot in the centre
Upper lip	Continuous white streak from beneath eye to posterior margin of tympanum	Similar light streak but interrupted in between by brown bands
Hind foot	Webbing between T4 and T5 not reaching middle subarticular tubercle of T4	Webbing between T4 and T5 just reaching middle subarticular tubercle of T4
Size range (SVL)	Males: 28.3–39.0mm Females: 39.6–47.5mm	Males: 36.5–55.6mm Females: 49.5–70.9mm
Pineal spot	Not visible	Distinct light gold spot at anterior margin of interorbital area
Iris colour (live)	Yellowish in dorsal third, reddish brown in lower two thirds	Golden in dorsal and ventral halves with tinge of red at the laterals
Vocalisation (perception by ear)	High pitched “yip-yip-yip...”	Rapid “kwuck-kwuck- kwuck...”

clearly distinguished from either *R. baramica* or *R. laterimaculata* by its loud, slow series of “whack-whack-whack” calls. It is also a much larger *Rana*, with SVL of males to 93 mm and females to 84 mm (males larger than females, instead of vice versa); it has more rounded, pustulose glandules instead of tubercles on its dorsum and sides; its toe webbing is also slightly more extensive (Inger, 1966; Inger and Stuebing, 1997). Despite local abundance of these three species in certain preferred habitats, neither mating behaviour nor diagnostic larvae have been reported thus far.

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APPENDIX

Material Examined

Rana baramica

Java: MZB 2927 (Batu Gede, Ciberut, north Bogor); Sumatra: MZB 2925 (Mapala nabita, Riau), MZB 3932 (Musibanyuasin, Hulu Sungai Pejudian, South Sumatra); Borneo: SMF 4331 [lectotype], 4332–4335 [paralectotypes] (Baram River, Sarawak); FMNH 249868–249875 (Beaufort District, Sabah), FMNH 119721–119725, 131982–131985, 146436–146553, 148006–148047 (4th Division, Bintulu District, Sarawak), MZB 883 (Mentawir, East Kalimantan), MZB 2579 (Pontianak, West Kalimantan), MZB 2859 (Taman Nasional Gunong Palung, West Kalimantan), ZRC.1.4638–4639 (Long Iram, East Kalimantan), ZRC.1.7690 (Bentong, Sarawak), ZRC.1.9017 (Niah, Sarawak), ZRC.1.9456 (Kota Samarahan, Sarawak), ZRC.1.9460–9462 (Balai Ringin, Sarawak), ZRC.1.9486 (Bako, Sarawak), MCZ A-64832 (Nyabu Forest Reserve, Bintulu, Sarawak), KUHE 12079, 12082–12085, 12116–12121 (Niah, Sarawak), KUHE 10537, 17017, 17030–17031 (Mulu, Sarawak), KUHE 17068, 17119 (Gading, Sarawak); Peninsular Malaysia: ZRC.1.3027 (north Selangor peat swamp forest), 8032, 10386 (Panti, Johor); Singapore: ZRC.1.1400–1402, 4761 (Nee Soon swamp forest), ZRC.1.3491, 5199, 6107–6111, 6291–6293, 9178, 10034–10035, 10402–10403 (Sime road swamp forest).

Rana laterimaculata

Thailand: NSM C-154, 3869, 3877–3881, 3980 (Hala-Bala Wildlife Sanctuary, Narathiwat Province); Peninsular Malaysia: FMNH 186156–186266, 191491 (Bukit Lanjan, Selangor), DWNP.A.0285, 0677 (FRIM, Kepong, Selangor), DWNP.A.0286–0287 (Sungkai, Perak), DWNP.A.0288 (Sungai Teris, Pahang), DWNP.A.1200 (Gunong Belumut, Johor), ZRC.1.303 (Baling, Kedah), ZRC.1.1114–1115 (Bukit Chintamani, Pahang), ZRC.1.5490, 5555 (FRIM, Kepong, Selangor), ZRC.1.10056 (Sungai Seneku, Lakun Forest Reserve, Bentong, Pahang), ZRC.1.10157 (Raub, Pahang), ZRC.1.10387 (Panti, Johor), ZRC.1.10748 (Bekok, Johor), KUHE 15677–15678 (Templer, Selangor); Singapore: ZRC.1.1540, 5603, 6116, 9179–9180, 9656–9658, 10032–10033, 10220–10223, 10404–10405 (Sime road swamp forest), ZRC.1.2929, 3016, 4762–4763 (Nee Soon swamp forest), ZRC.1.5279 (Rifle Range road swamp forest), ZRC.1.10279–10281, 10408, 10524 (Lower Peirce boardwalk, swampy area beside stream); Borneo: MCZ A-3885 (Sadong, Sarawak) [neotype], KUHE 17592–17594, 17607, 17650 (Sematan, Sarawak).

Rana glandulosa

Sumatra: MZB 918 (Sungai Siak, Central Sumatra), MZB 3263 (Rantau Prapat, Labuhan Batu, North Sumatra), MZB 6902 (Sungai Pasilog, Bukit Lawang, North Sumatra), MZB 3644 (Padang, West Sumatra), MZB 3755–3759 (Pulau Pini, north of Siberut), MZB 3322 (Tasik Serai, Mandau, Riau), MZB 893–895 (Sungai Tanajan, Pekan Baru, Riau); Thailand: CUHC 1072–1074 (Bhetong, Yala Province), NSM 4354 (Hala, Yala Province); Peninsular Malaysia: DWNP.A.0427 (Tasek Bera, Pahang), DWNP.A.0428 (Paya Indah, Kuala Langat, Selangor), DWNP.A.0429, 0430, 0433, 0434 (Krau Wildlife Reserve, Pahang), DWNP.A.0431–0432 (Sungkai Forest Reserve, Perak), DWNP.A.0566 (Kual Koh, Kelantan), DWNP.A.1133–1135 (Sungai Ambat, Tenggaraoh, Mersing, Johor), DWNP.A. 1166–1168, 1171 (Lubuk Rincing, Sungai

Keniam, Taman Negara, Pahang), ZRC.1.3881 (Batu Pahat, Johor), ZRC.1.6071 (Sungai Wang Burma forest, Perlis), ZRC.1.7956–7957 (Bukit Rengit, Pahang), ZRC.1.8614 (Kahang, Johor), ZRC.1.9164 (Sungai Kancing, Selangor), ZRC.1.10053 (Sungai Seneku, Lakun Forest Reserve, Bentong, Pahang),

ZRC.1.10149–10150 (Raub, Pahang); Borneo: MZB 3806 (Sungai Bilit, Karimun, West Kalimantan), MZB 2564–2565 (Kapuas, West Kalimantan), FMNH 146460 (Nyabau, Sarawak).

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