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NEW RECORD OF THE NARROW-MOUTHED FROG, *MICROHYLA BORNEENSIS* PARKER (AMPHIBIA: ANURA: MICROHYLIDAE) FROM SINGAPORE, WITH TAXONOMIC NOTES AND LARVAL DESCRIPTION

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ABSTRACT. - The occurrence of a diminutive forest-dwelling microhylid species, *Microhyla borneensis* Parker, 1928 is recorded for the first time in Singapore. A taxonomic account is provided and a surface-feeding larval form is assigned to this species.

KEY WORDS. - New record, *Microhyla borneensis*, Singapore, Microhylidae.

INTRODUCTION

During a field survey of the Central Catchment Area, a batch of tadpoles which closely resembled, but were distinct from those of *Microhyla heymonsi* were encountered in a forest pool. Of the six larvae collected, only one was successfully reared to metamorphosis. However, the emergent alone was insufficient for positive identification of the parental species. An adult male was finally obtained after repeated nocturnal suveys of the same locality.

Subsequent examination of the Singapore voucher specimens, comparisons with a Bornean specimen and descriptions of the adult by previous authors (Parker, 1928, 1934; Inger, 1966; Berry, 1975; Dring, 1979) confirmed the identity of the adult as *Microhyla borneensis* Parker, 1928. This discovery constitutes a third species in the genus *Microhyla* to be recorded from Singapore, in addition to *M. butleri* and *M. heymonsi*. This find also increases the representative species of the family Microhylidae from four (Lim & Lim, 1992) to five and brings the total number of anuran species recorded in Singapore from 23 (Leong et al., 1996) to 24.

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MATERIALS AND METHODS

In the field, larvae were collected using fine-mesh scoop nets and contained in plastic vials during transportation to the laboratory. In captivity, the larvae were reared in a small glass tank with shallow, aged water and fed with powdered commercial pellet fish food dusted lightly over the water surface. Subsequent preservation and storage of larvae was in 10% buffered formaldehyde. Staging of the larvae was in accordance with the tables devised by Gosner (1960). Location of the adults at night was by tracing the calls of adult males, which is not dissimilar to the 'kriick' sounds created by *Microhyla heymonsi*, except that the calls are often solitary, have longer intervals and are shorter than that of *M. heymonsi*. The larvae, emergent and adult specimens are deposited at the Zoological Reference Collection (ZRC), National University of Singapore (NUS). All measurements were obtained using sliding verniers (± 0.1 mm).

TAXONOMY

Parker (1928) first assigned a female type-specimen (BM.1911.1.30.43) collected from the Kidi district, Sarawak, Borneo, by C. J. Brooks as the holotype for *Microhyla borneensis*. This specimen was originally regarded as *Microhyla annectens* Boulenger, 1900 in Boulenger (1912). Parker (1928) continued to mention that 'this new species is closely allied to *M. annectens*, the species with which it has previously been confounded, *M. berdmorei*, and *M. annamensis*.' It was further explained that *M. borneensis* differs from *annectens* in having two metatarsal tubercles (instead of only one inner metatarsal tubercle) and comparatively 'shorter hind limbs'; from *berdmorei* in terms of 'its colour-pattern, reduced first finger, less fully webbed toes, shorter hind limbs, and much smaller size'; from *annamensis* in 'having two metatarsal tubercles, smooth skin, a slightly longer snout, and less fully webbed toes.' *M. annamensis* has a 'warty dorsum, lacks an outer metatarsal tubercle and has a different pattern' instead (Dring, 1979). A male specimen (BM.1928.11.12.1) from Klong Bang Lai, Patiyu, Thailand, assigned to *M. annectens* by Smith (1916) and Parker (1934), is actually *M. borneensis* according to Dring (1979), who compared the Thai specimen with the holotype of *M. borneensis*.

The adult specimen from Singapore, ZRC.1.3451, was collected on the night of 5 Dec.1996, at around 2300 hr and found among dense leaf litter on the forest floor, adjacent to a network of clear, shallow forest pools created by consecutive days of heavy rain. It is *Microhyla borneensis* Parker based on a suite of externally observable morphological characters. Key diagnostic features include: the absence of a tympanum; presence of an inner elongate and outer conical metatarsal tubercle; toes 2/3 webbed, toe discs bearing a median distal notch on dorsal surface; tibio-tarsal articulation reaching slightly beyond snout (Parker, 1928; Inger, 1966; Berry, 1975).

ZRC.1.3451 has a snout-vent length (SVL) of 16.5 mm and tibia length 0.67 of the SVL. The skin has scattered low tubercles and a thin, faint, longitudinal dermal ridge. This low skin-fold extends from the snout towards the vent and may have been referred to as the 'thin, pale, vertebral line' by Smith (1916). Live adult is light brown on the dorsum, with an ill-defined darker brown pattern along the middle of the back; this pattern stretches from between the eyes, being truncate anteriorly, narrowing behind the occiput, widening at the pectoral region, narrowing again at mid-dorsum and widening again towards the posterior, becoming indistinct beyond the sacrum. As noted by Dring (1979), two oval, fawn patches are present

between the scapular and mid-dorsal expansions of the pattern on the back (Fig. 1a). The upper lip is spotted with black and an oblique, whitish streak stretches from behind the eye to the snout tip. An interrupted, narrow, black lateral stripe extends from above the shoulder to half length of trunk. A dark area around the anus is light-edged dorsally and becomes indistinct ventrally. Cross-bands are present dorsally on the radio-ulna of the fore limb and on the femur, tibia and tarsus of the hind limbs. Dark patches are present on the anterior of the knees and posterior of the elbows. Ventrally, the specimen is mottled with brown, especially at the throat region, but not on the abdominal region (Fig. 1b).

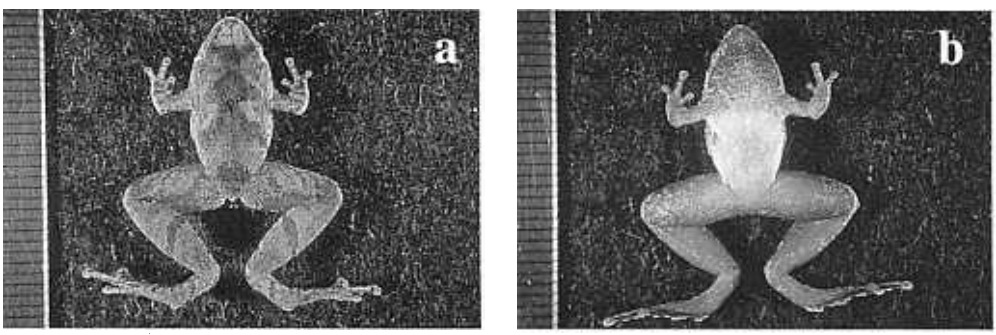

Fig. Dorsal (a) and ventral (b) aspects of adult *Microhyla borneensis* Parker (ZRC.1.3451).

A Bornean specimen of *M. borneensis* (ZRC.1.3164) of comparable size (16.3 mm SVL) from the Batu Apoi Forest Reserve, Temburong District, Brunei, has external morphological structures and colour markings like those of ZRC.1.3451. Its tibia length was 0.66 of the SVL.

Based on confirmed records and re-assigned identities of previously collected specimens, *Microhyla borneensis* has been found in Borneo (Brunei, Sabah and Sarawak), southern Thailand and Peninsular Malaysia (Boulenger, 1912; Smith, 1916; Parker, 1928, 1934; Taylor, 1962; Inger, 1966, 1985; Grandison, 1972; Berry, 1975; Dring, 1979; Kiew, 1984; Frost, 1985; Inger & Stuebing, 1989, 1992; Das, 1995; Inger & Tan, 1996).

LARVAL DESCRIPTION

Prior to the discovery of the adult frog, a batch of larvae had been sighted on 20 August, 1996, at a forest pool in the exact locality where the adult was observed. The larvae belong to the family Microhylidae as they possessed a median-ventral spiracle and lacked the basic oral apparatus of labial papillae, denticles or horny mandibles on the mouth.

At the survey site, records of other anurans and their larvae included *Bufo quadriporcatus*, *Occidozyga laevis*, *Rana blythii* and *R. chalconota*. Other than *M. borneensis*, no other members of the family Microhylidae have been sighted in the vicinity. This permits the conclusion that the microhylid larval forms obtained probably belong to the parental species of *M. borneensis*. Moreover, an individual larva which successfully completed metamorphosis was found to resemble the adult.

The first larval assignment to the parental species *Microhyla borneensis* was based on a developmental series (BM.1914.5.12.61-78) collected by Hewitt from the pitcher of a

Nepenthes at Kuching, Sarawak (Parker, 1934). However, Inger (1966) verified that the Kuching lot of larvae actually belonged to those of a *Kalophrynus* species. Two large developmental series of larvae collected from the Third and Fourth Divisions, Sarawak, were described as 'probably the young of *M. borneensis*' (Inger, 1966). Subsequently, a description of *M. borneensis* larvae was included among the five forms (A-E) of larval *Microhyla* found in the forested regions of Borneo (Inger, 1985).

Inger (1985) assigned Form A larvae to *M. borneensis* based on the characteristic of a very short first finger distinct from the palm in the advanced larvae. He also noted that adults of *M. borneensis* were collected from the same locality (Nanga Tekalit) as the larvae. However, Inger (1985) mentioned that although association of the larvae with this species is 'probably correct', a degree of uncertainty still remained because it was found that the advanced larvae of Forms B and C also 'have first fingers of the same shape and proportion as those of Form A.' The descriptions of larval *Microhyla* species C by Inger (1985) agreed closely with the microhylid larvae collected from the forest pool in Singapore.

Both larval forms (Bornean *Microhyla* sp. C and Singapore *M. borneensis*) share characteristics: (i) the tail which tapers abruptly in the distal quarter to a short , narrow tip; (ii) the presence of a dark, vertical band crossing both fins just before the tail tip; (iii) a rounded spiracular flap; (iv) an expanded lower lip; (v) relatively small size (head-body length 3.8-5.7 mm, Stages 31-40); (vi) a short, but distinctly projecting first finger in the mature larvae and (vii) heavy pigmentation dorsally, laterally and under the chin. Therefore, it is likely that the true larval identity of *M. borneensis* is actually that of *Microhyla* sp. C. The following is an account of the larval microhabitats, larval morphology, colour/markings, oral disc structure, feeding strategy and developmental aspects of the Singapore larvae.

Larval Microhabitats. - Seven to eight larvae at the hind limb bud stage (Stages 27-28) were seen in an isolated, clear, forest pool formed as a result of heavy downpours. The temporary pool measured approximately 80 x 50 cm and not more than 5 cm deep. The bottom was covered with a mixture of silt and leaf litter. The larvae were observed to be hovering just beneath the water surface, with their tail tips beating rapidly, in a manner similar to that of *Microhyla heymonsi* larvae.

Larval Morphology. - Head-body ovoid, flattened above, spheroidal below; body width 0.51-0.53 of head-body length; snout truncate; nostrils dorsal, nearer to snout-tip than eye, inter-narial 0.25-0.27 of inter-orbital; eyes lateral, visible from above and below; mouth dorso-terminal, lower lip slightly expanded, lateral corners of lip with knob-like protruberance; papillae, labial teeth and horny beaks absent; spiracle median, fused with venter; spiracular opening with smooth, convex margin, position of spiracle 0.69-0.71 of head-body length from snout-tip; vent median, opening into a short, thick tube in line with margin of ventral fin. Tail tapering abruptly at posterior fourth towards a short, terminal filament; fins subparallel, dorsal fin originating from root of tail, shallower than tail muscle for anterior half, ventral fin deeper than or equal to height of caudal muscle at anterior half; tail length 1.85-2.13 head-body length. (Dimensions from ZRC.1.3427, Stages 27-31, n=5).

Colour/Markings. - (Live) Body and tail muscle orange- to reddish-brown; distinct dark patch in between and at the rear of eyes, dorso-lateral patch beginning from mid-body straight towards root of tail; a dark lateral band running from the snout, through the eyes, towards hind limb buds; head speckled with orange-gold iridocytes; lateral corners of upper lip reddish; venters light, speckled with dark pigments especially around the throat; anterior half of tail

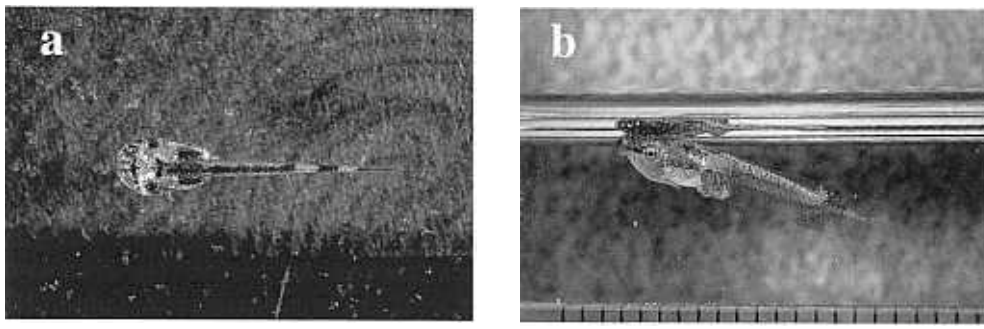

Fig. 2. Larval form of *Microhyla borneensis* Parker: (a) dorsal aspect (Stage 31), (b) lateral aspect (Stage 39).

pigmented black, followed by an unpigmented zone, after which a characteristic dark band extends onto dorsal and ventral fins; posterior to this is another orange band, ending in a dark terminal filament (Fig. 2).

Feeding Tactic. - In captivity, larvae were reared on a diet of crushed/powdered pellet fish food. The presence of such finely ground particles would be quickly detected by the larvae and increased gulping actions would follow as soon as the larvae rise to the water surface. The floating particles would gradually be drawn towards the mouth; finer particles would be ingested and larger ones would be rejected forcefully.

Development. - Of the larvae collected, only one individual successfully completed metamorphosis. Five of the larvae were preserved 14 days after collection and catalogued as ZRC.1.3427. The larvae were measured at Stages 27-31 of development (head-body length 3.4-3.6 mm, total length 10.5-10.6 mm). Hind limb development proceeded steadily over the following month. By the fifth week from collection, the remaining larva had well developed hind limbs (Stage 39, head-body length 5.9 mm, total length 17.5 mm). Within the next three days, the fore limbs emerged (Stage 42, head-body length 6.2 mm, total length 11.5 mm) and tail resorption was complete in another day. The emergent (ZRC.1.3428, SVL 5.0 mm) was kept for three more weeks to allow for further development of colouration. Its dorsum was reddish-brown with an indistinct dark brown marking at the pectoral region. Cross-bars were faintly visible on the hind limbs. Ventrally, its belly was pale and translucent but the throat region was heavily mottled with dark pigments. In the emergent, the inner metatarsal tubercle was very small, yet distinct but the outer metatarsal tubercle was hardly distinguishable.

Additional Remarks. - An excellently preserved specimen (ZRC.1.2221) collected by C. F. Lim (27 Oct.1974) 'in leaf litter' at a swamp forest in Singapore and catalogued as 'undetermined' was encountered among the larval collection in the ZRC. This Stage 37 larva is comparable to the ones collected in the field, in terms of its size (total length 17.7 mm), external morphology and pigmentation patterns. The characteristic dark band at the posterior third of the tail was still distinguishable.

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