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A NEW *BUFO* (ANURA: BUFONIDAE) FROM THE PEAT SWAMPS OF SELANGOR, WEST MALAYSIA

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ABSTRACT. – A new species of the genus *Bufo* is described from the peat swamps of North Selangor, West Malaysia. *B. kumquat*, new species, is a member of the *B. biporcatus* group (sensu Inger, 1972), differentiable from its members in showing the following combination of characters: small adult male body size (SVL to 27.5 mm); first two fingers subequal; tip of toe III reaches median subarticular tubercle of toe IV; preparatoid crest absent; internarial distance greater than tympanum diameter; metatarsal tubercle elongate; subarticular tubercle not enlarged; parotoid gland elongated; outer carpal tubercle oval; breeding males lacking nuptial pads; tympanum pigmented; vocal sac yellow with scattered dark grey pigmentation; flanks with scattered dark pigmentation, lacking a distinct dark band; and dorsum pale yellow with scattered dark pigments.

KEY WORDS. – Amphibia, Anura, *Bufo*, new species, *Bufo kumquat*, systematics, peat swamps, North Selangor, West Malaysia.

INTRODUCTION

There has been no modern synthesis of the amphibian fauna of Peninsular Malaysia since Boulenger (1912), the last compilation, a field guide, being that of Berry (1972). Mohamed (1998) provided a description of the commoner species and a checklist. Systematicists working on the fauna of Malaya have referred to works on the adjacent Thai (Taylor, 1962) and Bornean (Inger, 1966; Inger and Stuebing, 1989; 1997) faunas, in addition to that of Bourret (1942) and Van Kampen (1923), besides works of a more global scope (e.g., Boulenger, 1882).

The genus Bufo is cosmopolitan in distribution (Frost, 1985), the Old World species from the Palearctic and Oriental regions conveniently divisible into six species groups (possibly reflecting lineages) by Inger (1972). A small species of bufonid collected from the peat swamps of Selangor, on the west coast of approximately in the middle of the Malay Peninsula, matches the general description of the members of the *Bufo biporcatus* group (including *biporcatus*, *claviger*, *divergens*, *parvus*, *philippinicus* and *quadriporcatus*), while not agreeing with any of them. In this paper, we describe this unusual species and provide a name. The species was referred to Ansonia malayana in Ng et al. (1992: 35), probably on account of its small size. However, the distinct parotoid glands and cranial crests differentiate the present species from members of the genus *Ansonia*.

MATERIALS AND METHODS

Measurements were taken with a Mitutoyoô dial vernier calliper (to the nearest 0.1 mm) from specimens in 70 per cent ethanol. The following measurements were taken: snout-vent length, SVL (from tip of snout to vent); tibia length, TBL (distance between surface of knee to surface of heel, with both tibia and tarsus flexed); trunk length (distance between axilla and groin); head length, HL (distance between angle of jaws and snout-tip); head width, HW (measured at angle of jaws); head depth, HD (greatest transverse depth of head, taken at the posterior of the orbital region); eye diameter, ED (diameter of eye); interorbital width, IO (least distance between upper eyelids); internarial distance, IN (distance between nostrils); eye to snout-tip distance, E-S

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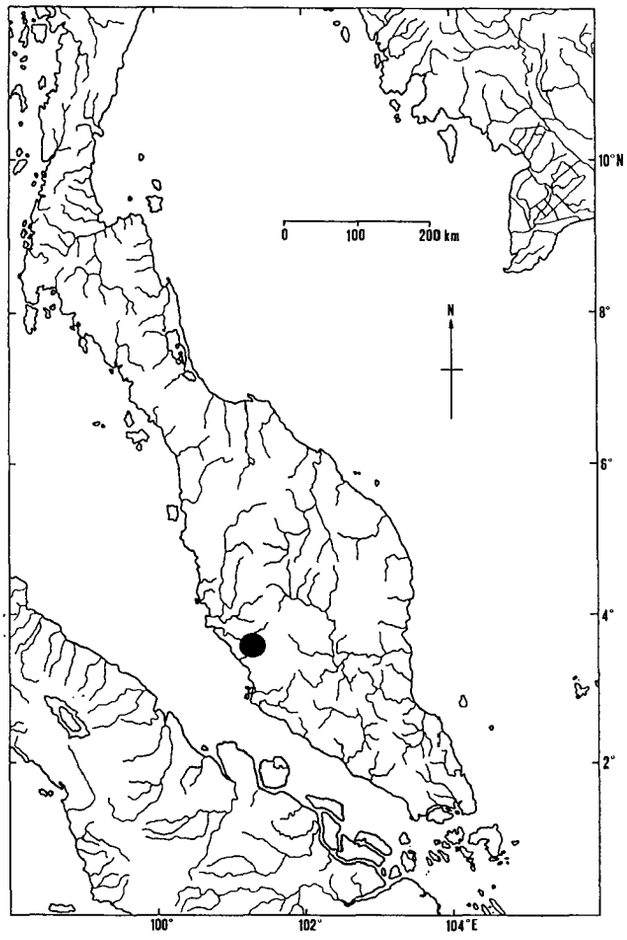

Fig. 1. Map of Peninsular Malaysia, showing the type locality of *Bufo kumquat* at the North Selangor peat swamp forest.

(distance between anterior-most point of eyes to tip of snout); eye to nostril distance, E-N (distance between anterior-most point of eyes and nostrils); length of supraorbital ridge, SORB (straight-line distance from the beginning to the end of the supraorbital ridge); and length of parotoid gland, PARL (straight-line distance from the beginning to the end of the parotoid gland, along its greatest length). Measurements of fingers and toes were taken from base of each phalange to tip, on right fore and hind limbs, respectively. Specimens were sexed through examination of gonads. Comparative material examined are in Appendix I. Sources of information on distribution include Frost (1985) and Duellman (1993). Museum abbreviations follow Leviton et al. (1985), except we retain ZRC as the abbreviation for the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, instead of USDZ. In addition, SSM is the Sabah State Museum, Kota Kinabalu, Sabah, East Malaysia.

SYSTEMATICS

Bufo kumquat, new species

(Figs. 2-3)

Holotype. - ZRC 1.3137 (adult male), 0.63 km from 35 km point on Sungei Besar-Tanjung Malim Road, Sabak Bernam, North Selangor, West Malaysia (Fig. 1), coll. P. K. L. Ng, 18 Sep.1992.

Paratypes - ZRC 1.3138-41 (4 adult males), ZRC 1.3142 (adult female), same data as holotype; ZRC 1.3584 (adult male), Sabak Bernam, North Selangor, West Malaysia, coll. Tan Heok Hui, 9 Sep.1993.

Diagnosis. – A small species of the *Bufo biporcatus* group (sensu Inger, 1972), diagnosable from members of the genus in showing the following combination of characters: small adult male body size (SVL to 27.5 mm); first two fingers subequal; tip of toe III reaches median subarticular tubercle of toe IV; preparatoid crest absent; internarial distance greater than tympanum diameter; metatarsal tubercle elongate; subarticular tubercle not enlarged; parotoid gland elongated; outer carpal tubercle oval; breeding males lacking nuptial pads; tympanum pigmented; vocal sac yellow with scattered dark grey pigmentation; flanks with scattered dark pigmentation, lacking a distinct dark band; and dorsum pale yellow with scattered dark pigments.

Description (based on holotype). – Body size small (SVL 27.2 mm); habitus stout, with a relatively narrow waist, head relatively long (HL/SVL ratio 0.195), exceeded by its width (HL/HW ratio 1.06), snout flattened (HL/HD ratio 0.943); obtusely acuminate in dorsal view, truncate, projecting beyond mandible in lateral profile; nostrils closer to snout tip than to orbit (E-N/E-S ratio 0.694), canthus rostralis vertical in transverse section; lores slightly concave; supraorbital crest parallel, their tips converging slightly; paired supraorbital ridges run from midorbital position to nearly the posterior of occipital region, continuing as a parietal ridge; preparatoid crest absent; eye relatively large (ED/HL ratio 0.509), eye diameter greater than eye-nostril distance (ED/E-N ratio 1.08), upper eyelid width less than half interorbital distance (IO/UE ratio 2.35); internarial region narrow (IN/ED ratio 0.889); supratympanic fold absent; tympanum small, oval, flattened, less than eye in diameter (HTYD/ED ratio 0.703), situated postero-ventrally to orbit; not in contact with orbit or with jaws; its greatest diameter at a vertical plane (HTYD/VTYD ratio 0.826). Nares laterally oriented, protuberant, oval; inferior aspect of snout weakly nicked; parotoid gland narrowly elongate, separated from lower level of upper eyelid by warts, extending to beyond level of axilla, where it is interrupted; inner margin of mandible juncture with a slight w-shaped notch. Tongue small, elongate, with a rounded tip, its dorsal surface covered with papillae; bifid, free posteriorly.

Tips of fingers weakly swollen but not dilated, first and second fingers subequal; fingers unwebbed; relative lengths of fingers (measurements in parentheses, in mm): 3 (4.5) > 2 (2.4) = 1 (2.4) > 4 (1.5).

Tibia relatively short (TBL/SVL ratio 0.393); tips of toes slightly swollen but not dilated; webbing reaches the tip of digits on all phalanges as a narrow fringe, and broadly to median subarticular tubercle on outer aspect of toe I; to median subarticular tubercle of inner aspect of toe II; to distal subarticular tubercle of outer aspect of toe II; to basal subarticular tubercle of inner aspect of toe III; to median subarticular tubercle of outer aspect of toe III; to basal subarticular tubercle of inner aspect of toe IV; to basal

subarticular tubercle of outer aspect of toe IV; and to distal subarticular tubercle of inner aspect of toe V. Tarsal fold and femoral gland absent; heels do not overlap when held at right angle to body; large, oval outer metatarsal tubercle, nearly the size of first finger; small (greatest length = 1.2 mm), oval inner metatarsal tubercle, two-third the size of outer metatarsal tubercle; tip of toe III fail to reach median subarticular tubercle of toe IV; relative lengths of toes (measurements in parentheses, in mm): 4 (8.1) > 3 (4.8) > 5 (4.2) > 2 (3.0) > 1 (1.1).

Tubercles fine, scattered dorsally, largest on vertebral region. Another enlarged series in nuchal region, between parotoid glands, forming a W-shape. A single, horny spicule present at tip of warts, and on parotoid glands, making it difficult to delimit parotoids. Cloacal opening directed postero-ventrally, slightly below upper level of thighs.

Coloration (in preservative). – Dorsally yellowish-orange, with scattered black pigments, especially on flanks; these are either spots or elongated blotches; a thin pale vertebral stripe extends from snout tip to over vent; grey paravertebral bands on dorsum at middle of torso at an obtuse angle; upper surfaces of limbs faintly dark-banded; ventrum comparatively more yellow than dorsum, especially on gular and pectoral regions; tympanum dark pigmented; upper surface of shank and foot pigmented with black; gular skin over vocal sac without melanophores; inner and outer metatarsal tubercles grey.

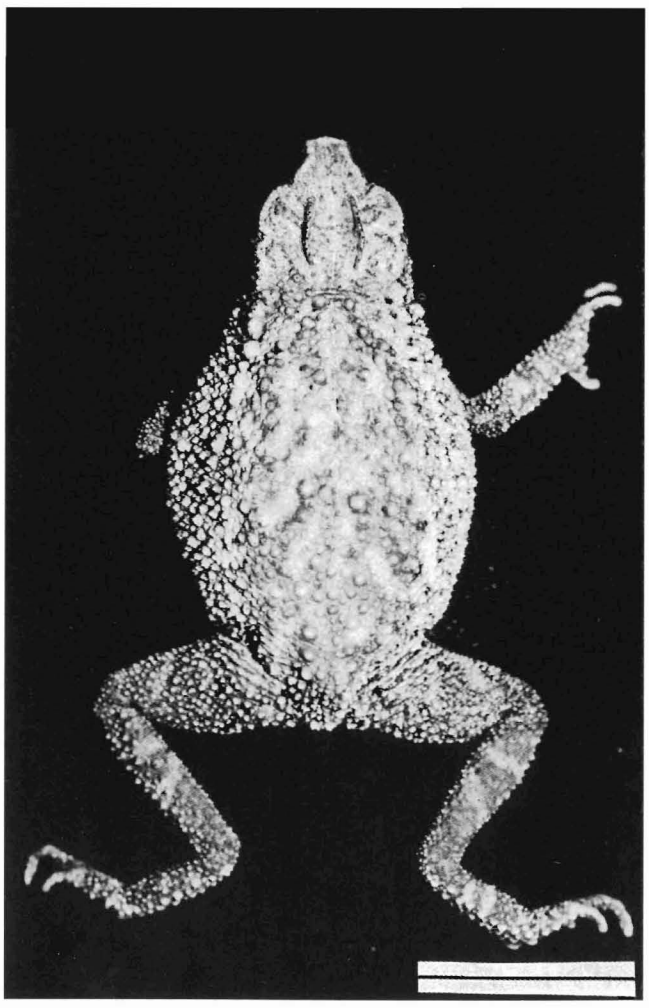

Fig. 2. Holotype of *Bufo quadriporcatus* Boulenger, 1887 (BMNH 1947.2.21.94).

Sexual dimorphism. – The single adult female examined (ZRC 1.3142) was larger (SVL 39.7 mm; TBL 15.9 mm vs SVL 22.4-27.5 mm; TBL 8.9-11.5 mm) than the six (ZRC 1.3137-41; 1.3584) adult males examined. Males also displayed single median vocal sacs with internal vocal openings, but no nuptial pads on fingers.

Natural history. – All specimens comprising the type series were taken from peat swamps, suggesting a unique habitat specialisation. They were found in marshy water-logged substrate of peat, among grasses. The water in the area is characteristically blackish-brown, indicating high concentrations of tannin, and very acidic (pH 4). The toads were located mainly by their calls during the night and by day. *Pseudobufo subasper, Rana glandulosa* and *Limnonectes paramacrodon* were found in sympatry with the new species. Accounts of the peat swamps of Selangor can be found in a volume edited by Prentice (1990), and the North Selangor peat swamp forest is threatened by development plans to convert large tracks into paddy fields.

Etymology. – The species is named *kumquat*, a small oval-shaped, orange-coloured citrus fruit, in reference to its small size and bright yellowish-orange colour of the males. The word derives from contemporary English, of Cantonese origin. It is used as a noun in apposition.

COMPARISONS

The new species is here assigned to the *Bufo biporcatus* group (sensu Inger, 1972) for showing the following features: supraorbital, parietal and supratympanic crests present; trasal ridge absent; vocal sac present; and tibial gland absent. The members of the group are distributed in mainland and insular south-east Asia, essentially in the Sundas, and includes six nominal species, with which the new species have been compared below.

According to the key to the genus in van Kampen (1923), the new species matches *Bufo quadriporcatus* Boulenger, 1887 (distribution: the Malay Peninsula, Sumatra and Borneo; see Fig. 3) closely. It can be differentiated, however,

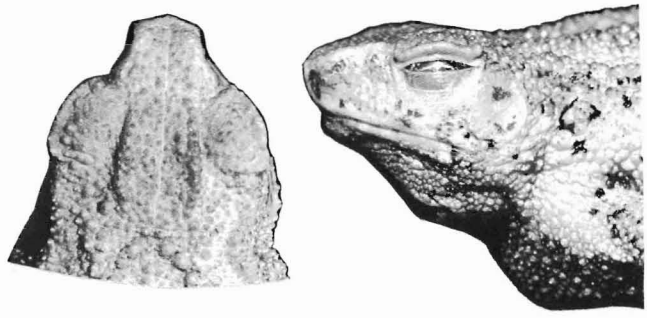

Fig. 3. Head of holotype of *Bufo kumquat* (ZRC 1.3137) in dorsal (2.1) and lateral (2.2) views.

in showing a smaller body size (SVL to 27.5 mm vs to 50.0 mm, in adult males), first two fingers subequal (vs finger II > finger I), tip of toe III reaches median subarticular tubercle of toe IV (vs failing to reach median subarticular tubercle of toe IV), preparatoid crest absent, Fig. 3 (vs present); tympanum pigmented (vs unpigmented); and dorsum pale yellow with scattered dark pigments (vs dark brown to black, typically unpatterned).

It differs from *B. biporcatus* Gravenhorst, 1829 (distribution: the Philippines, Sumatra, Java, Malaya and Peninsula Thailand) in its smaller size (SVL to 27.5 mm in adult males, vs. to 70.0 mm in Javanese and Balinese populations, see Iskandar, 1998: 44); internarial distance greater than tympanum diameter (vs tympanum greater than internarial distance); fingers without nuptial pads (vs finger I with dark nuptial pad); and parotoid gland narrowly elongate, extending to beyond level of axilla (vs small, subtriangular or oval).

Fig. 4. Holotype of *Bufo kumquat* (ZRC 1.3137). Marker = 10 mm.

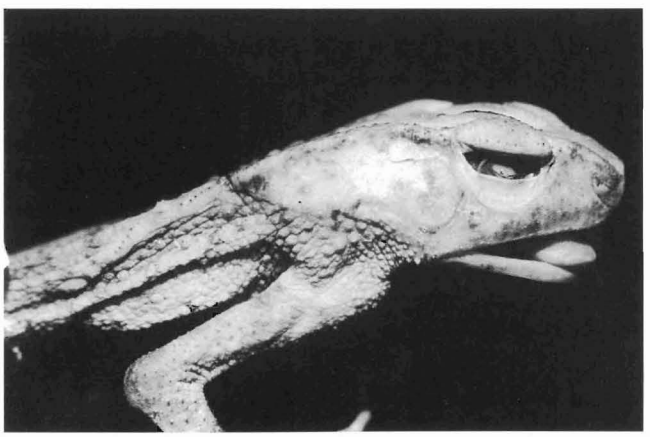

Fig. 5. Head of holotype of *Bufo quadriporcatus* Boulenger, 1887 (BMNH 1947.2.21.94) in lateral view.

The new species differs from *B. divergens* Peters, 1887 (distribution: Borneo) in the following characters: smaller body size of adult males- to SVL 22.4-27.5 mm (vs 28.0-43.0 mm; Inger and Stuebing, 1997: 78); preparatoid crest absent (vs present); elongated (vs oval) metatarsal tubercle; subarticular tubercles not enlarged (vs distinctly enlarged); outer carpal tubercle oval (vs tear-drop shaped); and dorsum with scattered dark pigments (vs typically with dark chevrons).

The new species differs from *B. philippinicus* Boulenger, 1887 (distribution: the Philippines), in lacking nuptial pads (vs nuptial pad consisting of black spinules on the dorsal surfaces of first and second fingers); smaller adult male body size- SVL to 27.5 mm (vs up to 85.6 mm in populations from Busuanga, in the Philippines Archipelago; see Inger, 1954: 227); supraorbital crest fused to parietal (vs distinct) and first and second fingers subequal (vs finger I > finger II).

It differs from *B. parvus* Boulenger, 1887 (distribution: Myanmar, Thailand, the Malay Peninsula, Sumatra and Java) in the following characters: preparatoid crest absent (vs present); smaller body size of adult males- to SVL 27.5 mm (vs to 35.0 mm; Iskandar, 1998: 47); vocal sac yellow with scattered dark grey pigmentation (vs uniformly grey); flanks with scattered dark pigmentation (vs with a distinct dark band); subarticular tubercle not enlarged (vs distinctly enlarged); parotoid gland elongated (vs short, rounded); and first two fingers subequal (vs finger I > finger II).

Finally, *Bufo kumquat*, new species differs from *B. claviger* Peters, 1863 (distribution: Nias in the Mentawei Archipelago and Sumatra, Republic of Indonesia) is the following characters: smaller maximum adult body size to SVL 39.7 mm (vs to 81.0 mm; van Kampen, 1923); parotoid gland elongated (vs small, oblong or rounded); parietal crest narrow (vs thickened); and first two fingers subequal (vs finger I > finger II).

COMPARATIVE MATERIAL

Bufo claviger.- ZRC 1.3827, Bengkulu, Sumatra.

Bufo divergens.- UBD 475, Batu Apoi, Temburong District, Brunei Darussalam; ZRC 1.2720, Nyabau Forest Reserve, Bintulu, Sarawak, East Malaysia; ZRC 1.3149-51. Lambir Hills, Sarawak, East Malaysia.

Bufo parvus.- ZRC 1.110. Bettotan, Sabah, East Malaysia; ZRC 1.3100-03. Pulau Redang, Trengganu, West Malaysia; ZRC 1.3291. Gombak Field Studies Centre, Selangor, West Malaysia; ZRC 1.99. Tebing Tinggi, Kelantan, West

Table 1. Data on measurements (in mm) taken on the type series of *Bufo kumquat*, new species.

	ZRC 1.3137	ZRC 1.3138	ZRC 1.3139	ZRC 1.3140	ZRC 1.3141	ZRC 1.3142	ZRC 1.3584
sex	male	male	male	male	male	female	male
SVL	27.2	25.0	26.4	25.5	27.5	39.7	22.4
BW	17.7	13.2	13.7	13.4	14.8	19.8	12.0
TBL	10.7	9.8	11.4	11.0	11.5	15.9	8.9
HL	5.3	4.4	5.2	4.9	5.5	8.5	3.5
HD	5.0	4.4	4.9	4.8	5.0	6.8	4.9
HW	7.9	6.1	7.5	7.0	7.6	8.7	6.3
IO	4.7	4.1	4.1	4.4	4.0	5.1	3.7
IN	2.4	2.3	2.4	2.1	2.4	3.1	1.7
UE	2.0	1.8	2.1	1.9	2.0	2.6	1.8
ED	2.7	2.4	2.9	2.7	2.7	3.2	2.2
E-N	2.5	1.8	2.2	1.7	1.9	2.9	2.0
E-S	3.6	2.7	2.9	2.8	2.8	4.2	2.7
E-T	0.3	0.5	0.4	0.5	0.6	0.7	0.3
HTYD	1.9	2.0	1.0	1.8	2.2	2.5	1.5
VTYD	2.3	2.4	2.0	2.5	2.2	2.8	1.9
TOL	3.6	3.3	4.1	4.1	3.6	5.7	2.8
TOW	1.7	1.4	1.5	1.5	1.3	2.5	2.0
SORB	1.7	3.0	3.5	4.4	4.0	5.5	2.3
PARL	6.9	6.5	5.4	7.2	7.7	10.3	0.4

Malaysia; ZRC 1.100-02. Kuala Tahan, Pahang, West Malaysia; ZSI 15196-97 (syntypes of *Bufo parvus*), "..within a radius of fifty miles from the town of Malacca" (= Melaka, West Malaysia).

Bufo quadriporcatus.- BMNH 1947.2.21.94, formerly BMNH 86.12.28.41 (holotype of *Bufo quadriporcatus*). "Malacca" (= Melaka, West Malaysia); ZRC 1.2899-2900. Kota Tinggi, Johore, West Malaysia; ZRC 1.3166. Nee Soon, Singapore; ZRC 1.2909-12. Nee Soon, Singapore; ZRC 1.3293. Nee Soon, Singapore; ZRC 1.3167. Nee Soon, Singapore; ZRC 1.3144. Pontian, Johore, West Malaysia.

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