

## A NEW SPECIES OF *KALOPHRYNUS* (ANURA: MICROHYLIDAE) FROM THE HIGHLANDS OF NORTH-CENTRAL BORNEO

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**ABSTRACT.** – A new species of microhylid of the genus *Kalophrynus* is described from the Kelabit Highlands of Sarawak at the border with Kalimantan. *Kalophrynus eok* new species, is compared with congeners from Borneo and other parts of south-east Asia. The new species is diagnosable in showing the following combination of characters: SVL 26.3 mm in the only specimen known, an adult male; snout obtuse, slightly projecting beyond mandible; head wider than long; fingers and toes basally webbed; a single subarticular tubercle on finger IV; inner and outer metatarsal tubercles present; dorsum brick-red, with dark interorbital bar, shoulder chevron and transverse body bar irregular in outline and fused with each other; and inguinal ocellus absent.

**KEY WORDS.** – *Kalophrynus*, new species, *Kalophrynus eok*, Microhylidae, systematics, new species, Borneo.

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### INTRODUCTION

The genus *Kalophrynus* (Anura: Microhylidae) is at present known to contain 14 nominal species (Iskandar & Colijn, 2000; Dutta et al., 2000), its members distributed from southern China and north-eastern India south to Indo-China and Indo-Malaya (Frost, 1985). Seven of these have been reported from Borneo (Inger & Stuebing, 1997; Inger & Tan, 1996).

The herpetofauna of the remote Kelabit Highlands remains poorly known. Zainuddin (1998) reported on a small collection of frogs, made mostly around the village of Bario, reporting 18 species. We report here an new species of *Kalophrynus*, which does not match any of the seven described species of the genus from Borneo, or from any other part of south-east Asia. The species is allocated to *Kalophrynus* for showing the following characters considered diagnostic for the genus (see Parker, 1934: 19-20; 95; Inger, 1966: 116-117; 126-129): no spine-like dermal projections at heel or elbow; belly lacking brown network on yellow background; undersurface of fingers lack enlarged tubercles; snout short, less than twice eye diameter; inner metatarsal tubercle low, not shovel-shaped; and tympanum visible.

### MATERIAL AND METHODS

The holotype was collected at ca. 0900 h, photographed in life, fixed in formalin ca. 4 h after collection and subsequently washed in water and transferred to 70% ethanol about 2 weeks after collection. The following measurements were taken with Mitutoyo™ dial vernier callipers (to the nearest 0.1 mm) ca. 4.5 months after collection: 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); 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 posterior of the orbital region); eye diameter (ED, horizontal diameter of the eyes); interorbital distance (IO, least distance between upper eyelids); internarial distance (IN, distance between nostrils); eye to snout distance (E-S, distance between anterior-most point of eyes and tip of snout); eye to nostril distance (E-N, distance between anterior-most point of eyes and nostrils); axilla to groin distance (A-G, distance between posterior edge of forelimb at its insertion to body to anterior edge of hindlimb at its insertion to body); body width (BW, greatest width of body); and tympanum diameter (TD, vertical and horizontal). In addition, measurements of digits, taken on the left limbs, from the base to tip. Colour notes on the holotype were taken from Fujichrome Velvia 50 ASA 35 mm slide transparency

film, and compared with colour swatches of F. B. Smith (1975, 1981).

Comparative materials examined are listed in Appendix I. Sources of additional data on character states and distribution of congeneric species of *Kalophryalus* include the following works: Alcala & Brown (1998), Berry (1975), Boulenger (1882, 1912), Bourret (1942), Dring (1979, 1983), Dutta et al. (2000), Fei et al. (1999), Inger (1954, 1966), Inger & Stuebing (1989, 1997), Iskandar (1998), Kiew (1984a, b), Matsui et al. (1996), Nieden (1923), Parker (1934), M. A. Smith (1922), Taylor (1962), van Kampen (1923) and Yang & Su (1980). Museum abbreviations, where available (indicated with an asterisk), follow Leviton et al. (1985). These include: The Natural History Museum, London, U.K. (BMNH\*); Museum of the Department of Biology, La Sierra University, Riverside, California, U.S.A. (LSUHC); Museum Zoologicum Bogoriense, Cibinong, Java, Indonesia (MZB\*); Sarawak Biodiversity Centre Zoological Museum, Semenggoh, Sarawak, Malaysia (SBC); Sarawak Museum, Kuching, Sarawak, Malaysia (SM\*); Sabah State Museum, Kota Kinabalu, Sabah, Malaysia (SSM); Museum of Zoology, Universiti Kebangsaan Malaysia, Sabah Campus, Kota Kinabalu, Sabah, Malaysia (UKMS; see below); "Borneensis" Collection, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia (UMS, which also houses the erstwhile UKMS collection); the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore, Singapore (ZRC; the abbreviation used in Leviton et al., 1985, is USDZ\*); Zoological Survey of India, National Zoological Collection, Kolkata (formerly Calcutta), West Bengal, India (ZSI\*).

## SYSTEMATICS

### *Kalophryalus eok*, new species

(Figs. 1, 2)

**Material examined.** – Holotype - Adult male, SBC A.00310 (field number ID-7474; holotype) from Long Re (03° 42' 2"N; 115° 32' 06"E), east of Barito along forest trail to Kalimantan border, Sarawak, East Malaysia (Borneo), coll. A. Haas & I. Das, 9 Sep. 2001.

**Diagnosis.** – A small (SVL 26.3 mm in the only specimen known, an adult male) species of *Kalophryalus*, diagnosable from congeneric species in showing the following combination of characters: snout obtuse, slightly projecting beyond mandible; head wider than long; fingers and toes basally webbed; a single subarticular tubercle on finger IV; inner and outer metatarsal tubercles present; dorsum brick-red, with dark interorbital bar, shoulder chevron and transverse body bar irregular in outline and fused with each other; and inguinal ocellus absent.

**Description of holotype (adult male).** – A small species of *Kalophryalus*, SVL 26.3 mm; body elongate, with a narrow waist; head broader than long (HW/HL ratio 1.32); snout obtusely pointed when viewed dorsally and laterally;

projecting slightly beyond mandible; nostrils dorso-laterally positioned, nearer tip of snout than to orbit of eye (E-N/E-S ratio 0.78); internarial distance greater than distance from anterior margin of eye to nostril (IN/E-N ratio 1.05); eye small (ED/HL ratio 0.55); its diameter less than eye to nostril distance (ED/E-N ratio 1.38); interorbital width greater than upper eyelid width (IO/UE ratio 2.05); canthus rostralis distinct; loreal region vertical; upperjaw edentate; a 'W'-shaped notch (= symphysial knob) on anterior edge of mandible; mouth extends to posterior corner of eye; tongue elongate, smooth, with rounded tip; pupil horizontal; tympanum distinct; supratympanic fold absent.

Fingers basally webbed, the inner and outer margins of finger IV with skin fringes; relative length of fingers (measurements in parentheses, in mm): 3 (4.0) > 2 (2.1) > 1 (1.4) > 4 (1.2); finger tips rounded but not dilated; subarticular tubercles prominent, rounded, numbering one on first, second and fourth fingers, two on third finger; fleshy palmar tubercles; portion of finger IV projecting from palm longer than terminal phalanx of finger III; smooth nuptial pads present on upper surfaces of fingers II and III; no enlarged glands on lower arm.

Toes webbed basally to below level of basal subarticular tubercle of toe IV and level of subarticular tubercle of toe



Fig. 1. Lateral view of holotype of *Kalophryalus eok*, new species (SBC A.00310), in life.



Fig. 2. Ventral view of holotype of *Kalophryalus eok*, new species (SBC A.00310), in life.

III; relative length of toes (measurements in parentheses, in mm): 4 (6.4) > 3 (4.2) > 5 (3.7) > 2 (2.4) > 1 (0.6); toe tips rounded; subarticular tubercles prominent, rounded, numbering one on first and second toes; two on third and fifth toes; and three on fourth toe; rounded inner and outer metatarsal tubercles.

Dorsum granular, especially on eyelids and upper surfaces of limbs; no supratympanic fold extends from posterior angle of eye to base of forelimbs; abdomen and inner side of thighs have large, flattened glandular structures.

**Colour.** – In life, brick-red dorsally, with a sepia interorbital band, fused posteriorly with an irregular, inverted V-shaped scapular mark which is followed by an irregular transverse band across midbody of the same colour; venter flesh color, sides of throat peach red; pectoral and abdominal regions with scattered cream spots; nuptial pads on fingers II and III cream; no inguinal ocellus; and flattened glandular structures of the venter, especially on gular region and lower surfaces of thighs and tibia cream coloured.

**Measurements (in mm).** – SVL 26.3; HL 5.3; HW 7.0; HD 5.5; BW 9.5; TBL 11.8; TD (vertical) 1.9; TD (horizontal) 1.8; ED 2.9; UE 2.2; IN 2.2; IO 4.5; E-S 2.7; E-N 2.1; A-G 11.7.

**Etymology.** – *eok*, Kelabit for tiny, in allusion to the small size.

**Ecological notes.** – The holotype and only known specimen was found calling from a water-filled node of a fallen bamboo, across a forest path within a primary submontane forest at an elevation of ca. 1,050 m above mean sea level. It was collected around 0900 h, following a night of torrential rainfall. Its call can be described as a single, low pitched note, emitted ca. every 3 secs. The following species of frogs were found sympatric with the new species: *Limnonectes leporinus*, *L. kuhlii*, *Rana hosii*, *R. chalconota*, *R. aff. signata*, *Staurois natator*, *Nyctixalus pictus*, *Philautus* sp., *Leptobrachium montanum* and *Microhyla berdmorei*.

**Remarks.** – The new species from the Kelabit Highlands is compared with all known congeners, listing only opposing suites of characters for congeners: *Kalophrynus baluensis* Kiew, 1984 (distribution: endemic to Gunung Kinabalu, Sabah, East Malaysia), subarticular tubercles on toes weakly developed; toe V with a single subarticular tubercle; toes unwebbed; raised dermal fold in interorbital region; inguinal ocelli yellow, bordered with black; and dorsum light brown with a dark brown patch, comprising closely-located blotches, running from snout to inguinal region; *K. bunguranus* (Günther, 1895) (distribution: Great Natuna Island, Indonesia; the record from Limbang, Sarawak in Parker, 1934: 100, in need of confirmation), snout and eye diameter subequal; parotoid glands present; toes one-third webbed; inguinal ocellus present and raised fold in interorbital region; *K. heterochirus* Boulenger, 1900 (distribution: Borneo), dorsum unpatterned dark brown, with or without bluish-white inguinal spots; dorsum smooth;

finger IV with three subarticular tubercles; and no outer metatarsal tubercle; *K. interlineatus* (Blyth, 1855) (distribution: south-eastern China, Myanmar, northern Thailand, Cambodia and Vietnam; this taxon was elevated to the rank of species by Matsui et al., 1996), male SVL to 47.7 mm; outer metatarsal tubercle absent; and dorsal pattern comprising a narrow dark line commencing from tip of snout; *K. intermedius* Inger, 1966 (distribution: Borneo), finger IV with two subarticular tubercles; and dorsum brown or purplish-brown, unpatterned or with obscure dark markings; *K. menglianicus* Yang & Su, 1980 (distribution: south-eastern China), toes free; a dark stripe from nostril to anterior corner of mouth, and along sides, from corner of eyes, across flanks, to inguinal region; and dorsum with scattered dark blotches; *K. minusculus* Iskandar, 1998 (distribution: Java, Indonesia), several parallel black stripes on dorsum and paired axillary glands present; *K. nubicola* Dring, 1984 (distribution: Borneo), subarticular tubercles on digits indistinct or absent; males with enlarged glands on lower arm and venter pale orange with blue markings; *K. orangensis* Dutta et al., 2000 (distribution: Assam State, north-eastern India), SVL 35–38 mm; supratympanic fold present; fingers free of web; a black ocellus in inguinal region and dorsum reddish-brown or cream, with a deep brown inverted V-shaped mark; *K. palmatissimus* Kiew, 1984 (distribution: Peninsular Malaysia), tympanum indistinct; outer metatarsal tubercle absent; webbing on toe IV to beyond median subarticular tubercle; and sole of feet with supernumerary spicules; *K. pleurostigma* (Tschudi, 1838) (distribution: southern China, Thailand, the Malay Peninsula, Natuna Island, Sumatra, Borneo, the Philippines islands including Leyte, Mindanao, Maripipi, Bohol and Camiguin), SVL to 52.0 mm; black ocellus in inguinal region; venter pale with scattered black pigmentation; finger IV with two subarticular tubercles; and webbing on toe IV to median subarticular tubercle; *K. punctatus* Peters, 1871 (distribution: north-western Borneo and perhaps Pulau Sipura in the Mentawai Archipelago, the latter record in need of confirmation; see Dring et al., “1989” 1990), snout length and eye diameter subequal; tympanum partially obscured; toe V projecting beyond toe III; outer metatarsal tubercle indistinct; and dorsum brown with oblique pale lines on sides of head and flanks; *K. robinsoni* Smith, 1922 (distribution: Peninsular Malaysia), SVL to 18.0 mm; a series of tubercles along dorsolateral region; snout length and eye diameter subequal; and subarticular tubercles indistinct; and *K. subterrestris* Inger, 1966 (distribution: Borneo), dorsum dark brown with scattered pale spots; and pale inguinal spot present.

#### ACKNOWLEDGEMENTS

We thank Esther Bala for assistance and company in the field, the Bala family of Pa’ Umor for hospitality, and our respective institutions, the Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak and the Institute für Spezielle Zoologie und Evolutionsbiologie mit Phyletischem Museum, for supporting our researches. Curators of the following institutions permitted us to examine comparative material:

Edwin Nicholas Arnold, Barry Thomas Clarke and Colin John McCarthy (BMNH), Boo Liat Lim and Norsham Yaakob (DWNP), Larry Lee Grismer (LSUHC); Pak Boeadi and Ir. Mumpuni (MZB), Eileen Yen and Margarita Naming (SBC), Anna Wong (SSM), Charles Moi Ung Leh (SM), Kelvin Kok Peng Lim, Peter Kee Lin Ng and Chang Man Yang (ZRC) and J. R. B. Alfred and Shyamal Kumar Chanda (ZSI). Finally, we would like to thank Robert F. Inger and an anonymous reviewer for commenting on the manuscript.

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## APPENDIX I

### List of comparative material examined

- Kalophrynx baluensis* Kiew, 1984. ZRC uncat., Gunung Kinabalu, Sabah, East Malaysia (Borneo).
- Kalophrynx bunguranus* (Günther, 1895). BMNH 1947.2.11.38-41 (four syntypes of *Diplopelma bunguranus* Günther, 1895), Natuna Besar, Riau Province, Indonesia.
- Kalophrynx heterochirus* Boulenger, 1900. BMNH 1909.8.18.6-7 (paratypes), "Borneo"; SSM 2174-75. Gunung Lumaku, Sipitang, 4,670 m, Sabah, East Malaysia (Borneo); SSM 2211, SFI Mendolong, 860 m, Sabah, East Malaysia (Borneo); LSUHC 4077, Lambir Hills, Sarawak, East Malaysia (Borneo); SBC A.2, Gunung Meraja, Bau, Sarawak, East Malaysia (Borneo); SM uncat. (three specimens), Gunung Pueh and Gunung Dulit, Sarawak, East Malaysia (Borneo); MZB 2179, Kalimantan Tengah Province, Indonesia (Borneo).
- Kalophrynx interlineatus* (Blyth, 1854). ZSI 9853 (holotype of *Engystoma? interlineatum* Blyth, 1854), "Pegu, Burma" (= Bago, Myanmar).
- Kalophrynx intermedius* Inger, 1966. SBC A.275, Gunung Kawa, Bau, Sarawak, East Malaysia (Borneo); UBD 448 and 473, Batu Apoi, Temburong District, Brunei Darussalam (Borneo).
- Kalophrynx minusculus* Iskandar, 1998. MZB 367 (holotype), "Cigeunteur, Ujung Kulon, West Java" (in Indonesia).
- Kalophrynx orangensis* Dutta et al., 2000. ZSI A9087 (holotype), ZSI S9088-91 (four paratypes of *Kalophrynx orangensis* Dutta et al., 2000), "Orang National Park (26°30'N; 92°15'E), Darrang District, Assam, north-eastern India".
- Kalophrynx palmatissimus* Kiew, 1984. BMNH 1982.1508 (holotype), Pasoh, Negri Sembilan, West Malaysia; DWNP A.0969, Salleh and Engkabang trail, Kepong, Selangor, West Malaysia; MZB 3824, Lembah Auai, Sumatera Barat Province, Indonesia (Sumatra).

*Kalophrynx pleurostigma* (Tschudi, 1838). MZB 139, Lembanghari, Melawi, Kalimantan Barat Province, Indonesia (Borneo); MZB 3450, Dirgahayu Rimba, Taman Bukit Barisan Selatan, Bengkulu Province, Indonesia (Sumatra); MZB 6190, Maruwai, Kalimantan Tengah Province, Indonesia (Borneo); MZB 504, Pulau Nusa Kambangan, Jawa Selatan, Indonesia (Java); ZRC 1.1763-64; ZRC 1.1705; ZRC 1.2935, Bukit Timah, Singapore; ZRC 1.3288, Seletar Forest, Singapore; ZRC 1.1753, Endau Rompin Base Camp, Sungai Kinchin, Pahang, West Malaysia; ZRC 1.1201, Sungai Madek, Johor, West Malaysia; ZRC 1.2733, Danum Valley Field Centre, Lahad Datu, Sabah, East Malaysia (Borneo); SSM 1602, 1643, 1653, 1688, Hutan Simpan, Ulu Tongod, Telupid, Sabah, East Malaysia (Borneo); SSM 2267, Purulon, Crocker Range National Park, Sabah, East Malaysia (Borneo); SSM 591, Batu Putih, Kinabatangan, Sabah, East Malaysia (Borneo); SSM 714 and 718, Kampung Lawa, Mandou, Telipok, Sabah, East Malaysia (Borneo); SSM 2546, Hutan Simpan, Bukit Silam, Lahad Datu, Sabah, East Malaysia (Borneo); SSM 1305, Gunung Lumaku, Sipitang, Sabah, East Malaysia (Borneo); SSM 1323 and 1373, Gunung Tawai, Telupid, Sabah, East Malaysia (Borneo); SSM 2575, Hutan Simpan, Baturong/Kunak, Sabah, East Malaysia (Borneo); UBD 41, 48, 197, 232, 361 and ZRC 1.3157, Batu Apoi, Temburong, Brunei Darussalam (Borneo); ZRC 1.3170-71, Bako National Park, Sarawak, East Malaysia (Borneo); SM 2.1.1.c-b (six specimens), Kuching, Sarawak, East Malaysia (Borneo); SM uncat., Pa Brayong, Sarawak, East Malaysia (Borneo).

*Kalophrynx robinsoni* Smith, 1922. BMNH 1923.5.14.29 (holotype), Kuala Teku, Pahang, West Malaysia.

*Kalophrynx subterrestris* Inger, 1966. ZRC 1.3172, Telok Assam trail, Bako National Park, Sarawak, East Malaysia (Borneo); SSM 2403, Muruk Miao, Sabah, East Malaysia (Borneo).