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Taxonomic Status of the Endemic Andaman Bullfrog *Kaloula baleata ghoshi* Cherchi, 1954 (Anura: Microhylidae) with Notes on Distribution and Natural History

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ABSTRACT.– Taxonomic status of the Andamanese subspecies of *Kaloula baleata* i.e., *Kaloula baleata ghoshi* is re-evaluated based on a comparative analysis of morphological data from members of this species complex from different parts of Southeast Asia. The Andamanese population is shown to be a morphologically distinct, allopatric species deserving specific recognition similar to the recently recognized and named members of this species complex from other parts of Southeast Asia. Thus, the population in the Andaman Islands hitherto considered being a subspecies of *Kaloula baleata* is elevated to species status in the combination *Kaloula ghoshi*. Descriptive notes on morphology, distribution and natural history of this poorly known taxon are presented herein for the first time based on extensive field-surveys conducted in the Andaman Islands.

KEY WORDS: *Kaloula*, Andaman Islands, species complex, subspecies, elevation, allopatry, Java

INTRODUCTION

Kaloula Gray, 1831 is a group of robustly built, Southeast Asian Microhylid frogs that are known from Northeastern India in the West to the Lesser Sunda Islands in the east. In a recent phylogenetic study by Peloso et al. (2015), taxonomic status of the genus has been reassessed and the Indo-Ceylonese taxon *taprobanica* which was attributed to *Kaloula* earlier (e.g. Dutta, 1997, Sengupta et al., 2009) has been shown to be a member of the *Uperodon* clade and has thus been transferred. Currently, 17 species are known within this genus (Frost, 2017). Morphologically, members of *Kaloula* can be divided into the following species groups: the *baleata* group (consisting of *K. baleata*, *K. indochinensis* and *K. latidisca*), *pulchra* group (consisting *K. pulchra* and *K. assamensis*), *verrucosa* group (consisting of *K. verrucosa*, *K. borealis*, *K. rugifera* and *K. nonggangensis*) and the *kalingensis* group (consisting *K. kalingensis*, *K. kokacii*, *K. picta*, *K. walteri*, *K. rigida* and *K. conjuncta*) (Fei et al., 2009; Mo et al. 2015). Two more members, *Kaloula aureata* and *K. mediolineata* are known from Thailand and adjacent parts of Indochina, whose affinities are not known. Of these, members of the *Kaloula baleata* group and *verrucosa* group have been subjected to several phylogenetic studies in the recent past, highlighting the high degree of cryptic diversity within the species complex (Blackburn et al., 2013; Chan et al., 2013; Chan et al., 2014; Mo et al., 2013), leading to the recognition of a few new taxa, some of which have recently been described. Very recently, Chan et al. (2013) remarked on the uncertain taxonomic status of *Kaloula baleata ghoshi* known from

South and Little Andaman Islands. This taxon was described by Cherchi (1954) based on two specimens collected by L. Cipriani from River Tciongare, Little Andaman Island. On-going fieldwork in the Andaman Islands led to the documentation of this taxon from several areas within these islands. In this paper, taxonomic status of the Andamanese population regarded as a subspecies of *Kaloula baleata* till now, is reassessed, whereby, it shown to be a morphologically distinct, allopatric lineage deserving specific recognition.

MATERIALS AND METHODS

Field surveys were carried out in the following islands: Little Andaman, South Andaman, Rutland, Middle Andaman, Long Island and North Andaman during February – June 2015 and July 2017. Specimens of the target species sighted were captured, gently restrained and measured. Three dead individuals encountered during the surveys were collected, preserved in 70% ethanol and are deposited at the Department of Ocean Studies and Marine Biology (DOSMB), Pondicherry University. The following measurements were taken from both preserved and live specimens: snout–vent length (SVL, from tip of snout to anterior margin of cloaca), head length (HL, from posterior edge of mandible to tip of snout), head width (HW, maximum width of head at the angle of the jaws), head depth (HD, maximum depth of head), eye diameter (ED, the greatest horizontal diameter of the orbit), eye–nostril distance (EN, from anterior border of orbit to middle of nostril), eye–snout distance (ES, from anterior border of orbit to tip of snout), upper eyelid width (UEW, maximum width of the upper eyelid), interorbital distance (IO, shortest distance between dorso-medial margins of orbits), inter-narial distance (IN, shortest distance between dorsal margins of nostrils), upper arm length (UAL, on the dorsal surface from the axilla to the elbow), lower arm length (LAL, on the dorsal surface from the posterior margin of the elbow to the base of the outer metacarpal tubercle), palm length (PAL, from the posterior border of the outer metacarpal tubercle to tip of the longest finger), femur length (FEL, from the anterior margin of the hind limb at its insertion point on the body to the knee), tibia length (TBL, from the posterior surface of the knee to the base of the heel), foot length (FOL, from heel to tip of longest toe), inner metatarsal tubercle length (IMTT). Characters were compared against other species, and specifically, against *Kaloula indochinensis* (recently named and geographically closest population of the *Kaloula baleata* species complex) from Vietnam, *K. latidisca* from Peninsular Malaysia, and those from the type locality (Java) of the nominal taxon *Kaloula baleata*. Measurements of type specimens of *Kaloula indochinensis* from Vietnam and *K. latidisca* from Malay Peninsula were used from their original descriptions (Chan et al., 2013; 2014). Measurements of the syntypes of *Kaloula baleata* housed at the Natural History Museum, London were obtained from Bryan L. Stuart. A subset of the above measurements (HL, HW, ED, ES, IO, IN, FEL and TBL) from male specimens were standardized to SVL and subjected to multivariate morphometric analyses. Principal component analysis and hierarchical cluster analysis were carried out using the software package PAST (Hammer et al., 2000) to investigate the grouping of populations from different regions (i.e., Andaman Islands, Vietnam, Peninsular

TABLE 1. Factor loadings of the PCA. Maximum loadings for each character in bold.

Character	PC 1	PC 2	PC 3
HL	**0.46**	-0.04	-0.14
HW	**0.46**	0.04	-0.36
ES	0.36	-0.23	**0.57**
ED	0.19	0.48	**-0.50**
IO	0.04	**0.53**	0.43
IN	**0.48**	-0.08	0.07
FEL	-0.21	**0.55**	0.13
TBL	**0.37**	0.34	0.26
Eigenvalue	3.74	2.41	0.83
% variance	46.80	30.10	10.37
Cumulative	46.80	76.90	87.27

Malaysia and Java). Juvenile specimens were excluded from the analysis. Resulting factor scores from the PCA were plotted to examine the distribution of specimens in multivariate morphological space for interpretation of the results, which were independently verified using hierarchical cluster analysis, by building a UPGMA dendrogram from standardised morphometric dataset. Morphological comparisons were made with the syntypes of *Kaloula baleata*; those of the other congeners are based on original descriptions and published literature. One specimen (DOSMB 05040) was also radiographed to examine skeletal characters and its osteology is described. The distribution map of these taxa was prepared in ARC MAP v.10 based on survey locations recorded using Garmin™ GPS MAP 78s (WGS84 datum). Calls of the target species were recorded using the digital audio recorder application in a Samsung Duos G 130 E model mobile phone and analysed using the software packages Adobe™ Soundbooth version CS3 and Adobe Audition version 1.5. Tadpoles of this species observed in stagnant puddles on the ground were collected and reared for observation of growth pattern followed by release at the same site. Larval staging follows Gosner (1960). Measurements of the larvae were done to the nearest millimetre from photographs with a scale placed nearby, using Adobe™ Photoshop version CS3. The following measurements were recorded: total length, head-body length, head-body width, tail length, head-body height and inter-orbital distance. Colour descriptions of the tadpoles were made based on the photographs recorded in life. Later, they were released back at the site of initial observation.

RESULTS

PCA conducted based on the abovementioned standardized measurements, extracted three factors, which, together, explained 87.27 % of variation, observed between samples from the Andaman Islands, Vietnam, peninsular

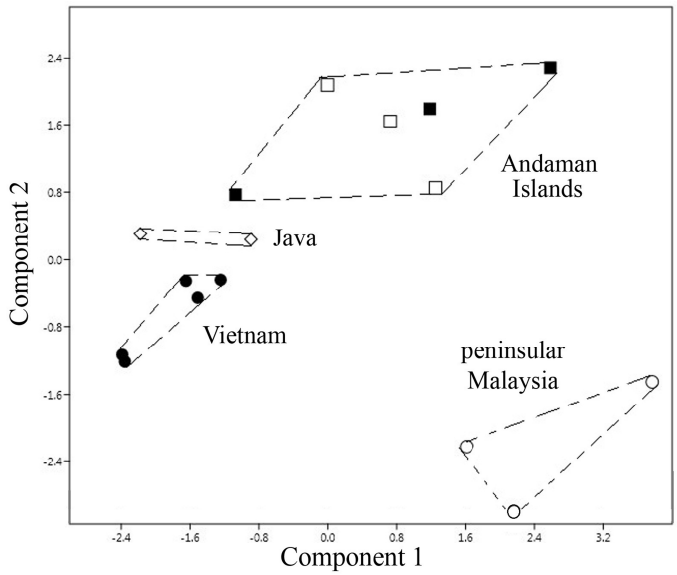

FIGURE 1. Plot of principal component analysis showing morphological distinction of *Kaloula ghoshi* from other congeners of the *K. baleata* complex. Solid black squares represent topotypes

Malaysia and Java. Of these, the first factor explained by cephalic and limb dimensions accounted for 46.8% of variation and the second factor, explained by inter-orbital distance and thigh length accounted for 30.1% of variation; the third factor, explained by eye size and snout length, accounted for 10.37% of variation (Table 1). The first two factors with eigenvalues more than one were plotted against each other. The factor scores plotted in Figure 1 separated the Andamanese, Javan, Vietnamese and Peninsular Malaysian populations out into discrete groups. Similarly, the hierarchical cluster analysis resulted in four distinct clusters, each of which corresponds to the abovementioned four populations respectively (Fig. 2). Based on these results of morphometric analyses and the allopatric distribution, specific status is hereby conferred to the Andaman population as:

***Kaloula ghoshi* Cherchi, 1954 stat. nov.** (Fig. 3A – E)

Kaloula baleata ghoshi Cherchi, 1954

Kaloula pulchra ghoshi (sic!) – Das (1994: 45)

Kaloula baleata (non *Bombinator baleatus* Müller, 1836) – Das et al. (2004: 105, 109) part

Kaloula baleata ghoshi – Das & Dutta (1998); Das (1999); Chandramouli et al. (2015: 49 – 52)

Kaloula baleata goshi (sic!) – Chan et al. (2013: 329); Chan et al. (2014: 569)

Type material.– Two female syntypes, measuring 43.5 and 39.0 mm SVL, collected by L. Cipriani in March 1952 from River Tciongare in Little Andaman Island and deposited at MSNG, Museo Civico di Storia Naturale, Genova, Italy.

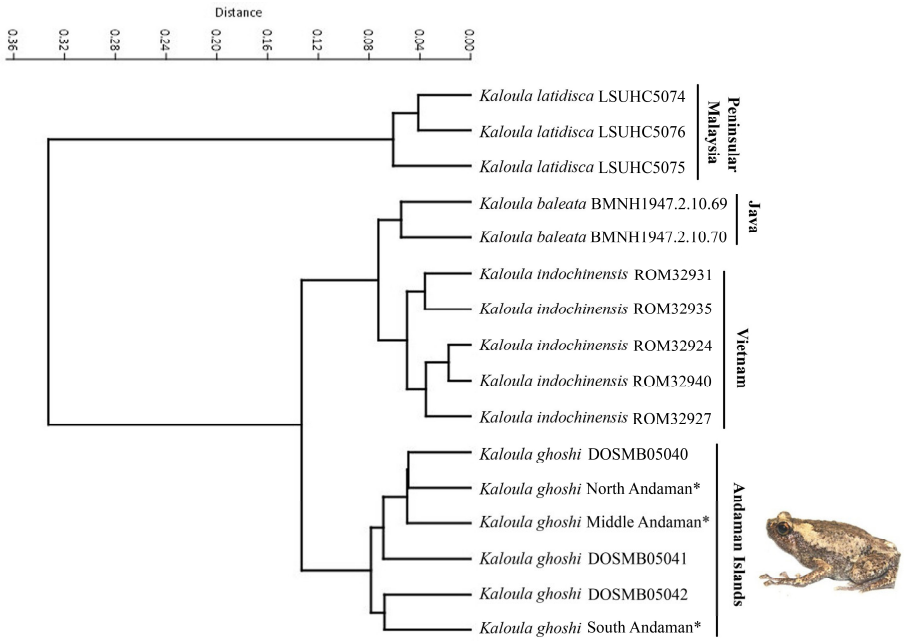

FIGURE 2. UPGMA dendrogram of hierarchical cluster analysis based on standardised measurements of the *K. baleata* complex. * indicates live, uncollected specimens

Material examined.– *Kaloula ghoshi* – DOSMB 05040, DOSMB 05041, DOSMB 05042 – Hut Bay, Little Andaman Island – coll. S.R. Chandramouli – July 2017

Differential diagnosis and comparisons.– (Tables 2, 3)

Kaloula ghoshi is diagnosed and can be differentiated from currently recognized congeners by the combination of following characters: Large body size (mean SVL females – 59.41 mm, males – 51.1 mm) (vs. smaller adult size; 24.5 – 31.5 mm in *Kaloula walteri*; 37.0 – 43.0 mm in *Kaloula kokacii*); presence of horizontally expanded discs on fingers and smaller discs on toes (vs. finger discs not expanded in *borealis*, *pulchra*, *picta*, *verrucosa*, *mediolineata*, *walteri*, *rigida* and *rugifera*); absence of bright coloured inguinal and axillary blotches (vs. present in *K. baleata*, *K. indochinensis*, *K. latidisca* and *K. nonggangensis*); presence of two subarticular tubercles under the fourth toe (vs. three in *K. baleata*); absence of osseous tubercles on the dorsal surface of third fingers (vs. present in *Kaloula nonggangensis*, *verrucosa* and *rugifera*); presence of a conspicuous, horizontally elongate outer metatarsal tubercle (vs. indistinct in *Kaloula conjuncta*, *K. kalingensis*); well-developed but incomplete toe webbing reaching the ante-penultimate subarticular tubercle on 4th toe (vs. complete in *Kaloula nonggangensis*; rudimentary in *K. kalingensis*, *K. picta*, *K. rigida* and *K. mediolineata*). *Kaloula ghoshi* differs from *Kaloula aureata* Nutphand, 1989, *K. pulchra* and *K. assamensis* by its colouration: dorsum brown with a triangular grey patch on the middle and a dark grey

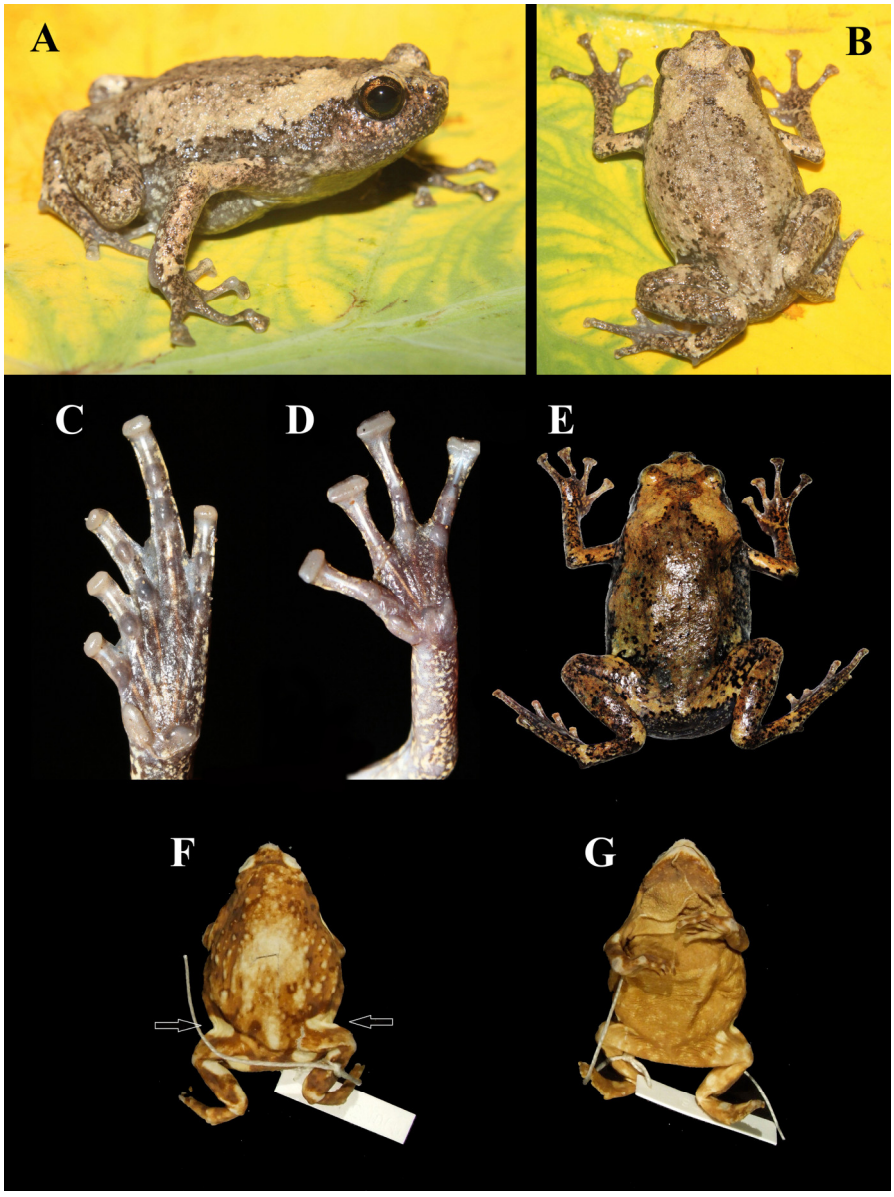

FIGURE 3. Lateral (A) and dorsal (B) views of an adult male *Kaloula ghoshi* Cherchi, 1954 from Little Andaman Island (type locality); foot (C); palm (D) and dorsal body (E) of *Kaloula ghoshi*; Dorsal (F) and ventral (G) views of a syntype BMNH 1947.2.10.69 of *K. baleata* from Java (arrows point at the bright inguinal blotch)

venter with white speckled markings in *Kaloula ghoshi* (vs. golden brown dorsum with yellow markings and white venter in *K. aureata*; dull olive brown dorsum with distinct longitudinal stripes in *Kaloula assamensis* and dark brown dorsum with

TABLE 2. Morphological variation between *Kaloula ghoshi* and other members of the *K. baleata* complex (mm). Values of $p \leq 0.05$ in bold.

	K. ghoshi **(Andaman) n = 9**		***K. baleata*** **(Java) n = 2**	***U*** **(p)**	***K. latidisca*** **(pen. Malaysia) n = 3**	***U*** **(p)**	***K. indochinensis*** **(Vietnam) n = 7**		***U*** **(p)**
	M (7)	F (2)	M (2)		M (3)		M (5)	F (2)	
SVL	37.4-59.73 (51.1±7.53)	40.07-59.41 (49.74±13.6)	40.7-42.0 (41.4±0.91)		49.2-54.4 (52.5±2.89)		46.2-50.3 (48.06±1.91)	46.5-52.9 (49.7±4.2)	
HL:SVL	0.24-0.28 (0.26±0.02)	0.25 (0.25±0)	0.23-0.26 (0.25±0.02)	6.5 (0.62)	0.28-0.37 (0.34±0.05)	5.5 (0.15)	0.23-0.24 (0.24±0)	0.24-0.27 (0.26±0.02)	**13 (0.04)**
HW:SVL	0.31-0.36 (0.34±0.01)	0.26 (0.26±0)	0.31-0.33 (0.32±0.01)	8.5 (1)	0.33-0.37 (0.35±0.02)	5 (0.13)	0.29-0.31 (0.3±0.01)	0.31-0.36 (0.34±0.03)	30.5 (0.95)
ES:HL	0.28-0.42 (0.37±0.05)	0.32-0.35 (0.34±0.02)	0.38 (0.38±0)	8 (0.9)	0.43-0.45 (0.45±0.01)	**0 (0.01)**	0.41-0.44 (0.42±0.01)	0.41 (0.41±0)	**5.5 (0.006)**
ED:HL	0.38-0.47 (0.44±0.03)	0.36-0.38 (0.37±0.02)	0.44-0.48 (0.46±0.03)	3.5 (0.22)	0.29-0.33 (0.31±0.02)	**0 (0.01)**	0.27-0.37 (0.31±0.04)	0.29-0.32 (0.31±0.02)	**1 (0.001)**
IO:HL	0.44-0.52 (0.48±0.03)	0.36-0.38 (0.37±0.01)	0.48-0.49 (0.49±0.01)	7.5 (0.81)	0.35-0.43 (0.4±0.04)	4 (0.09)	0.46-0.5 (0.48±0.02)	0.44-0.46 (0.45±0.02)	30 (0.91)
IN:HL	0.27-0.34 (0.3±0.02)	0.24-0.26 (0.25±0.02)	0.19-0.21 (0.2±0.01)	**0 (0.04)**	0.35-0.43 (0.4±0.04)	**0 (0.01)**	0.22-0.29 (0.26±0.03)	0.27-0.29 (0.28±0.01)	16 (0.1)
FEL:SVL	0.33-0.39 (0.37±0.02)	0.43 (0.43±0)	0.31-0.35 (0.33±0.03)	**0.5 (0.05)**	0.38-0.43 (0.41±0.03)	6.5 (0.2)	0.33-0.39 (0.37±0.02)	0.37-0.42 (0.39±0.03)	**7.5 (0.01)**
TBL:SVL	0.32-0.35 (0.34±0.01)	0.38 (0.38±0)	0.31 (0.31±0)	2 (0.12)	0.34-0.39 (0.36±0.02)	7.5 (0.3)	0.32-0.35 (0.34±0.01)	0.35-0.37 (0.36±0.02)	**8 (0.01)**

yellow dorsolateral bands and a yellow-white venter in *Kaloula pulchra*).

Description.– (based on the examined live and preserved specimens; Table 4)

A large species of *Kaloula* (mean SVL – 50.8 mm); with a depressed and rounded habitus. Head large (HL:SVL – 0.25); broader than long (HL:HW – 0.78); snout with a flattened anterior tip, not projecting beyond mandible. Eyes large and protruding; a little less than half the length of the head (ED:HL – 0.42) and slightly longer than the snout (ES:ED – 0.86). Canthus rostralis short but well-defined; nostrils closer to the snout tip than to eyes. Inter-narial region flat, inter-orbital region slightly concave; inter-narial distance less than inter-orbital distance (IN:IO – 0.64). Upper eyelids half as broad as inter-orbital distance. A weak, indistinct supra-tympanic fold commencing from post orbital region fails to reach the mandible; tympanum hidden. Upper arm longer than lower arm (UAL:LAL – 0.76); palm longer than lower arm, two distinct metacarpal tubercles present at the base of the palm, inner one slender and elongate; outer larger and heart-shaped. Fingers free of webbing; finger-tips broadened to discs with a flat anterior end; relative length of fingers – IV>III>II>I. Thigh a little less than half the length of the body (FEL:SVL – 0.43); shank shorter than the thighs (TBL:SVL – 0.38). Toes with broadened discs at the terminus; their relative lengths – IV>III>V>II>I. Webbing on toes moderate: webbing formula: $I_{0.5-1}II_{0.5-1.5}III_{1-2}IV_{2-1}V$. Inner metatarsal tubercle vertically elongated; outer metatarsal tubercle smaller than inner, but horizontally elongated; tarsal ridge absent.

Skin smooth to feebly pustular dorsally; with small granules situated along the dorso-lateral region; venter perfectly smooth and glossy; gular region with larger granules, especially in the vocal sacs of males.

TABLE 3. Comparison of morphological traits between members of the *Kaloula baleata* species complex (mm) (+ indicates presence and – indicates absence of the character).

	Kaloula ghoshi	***Kaloula baleata***	***Kaloula latidisca***	***Kaloula indochinensis***
Mean SVL±SD	50.8±8.14	41.35±0.91	53.5±2.89	48.52±2.54
Range (n)	40.07-59.73 (9)	40.7-42.0 (2)	49.2-54.4 (3)	46.2-52.9 (7)
Expanded finger discs	+	+	+	+
Inguinal blotches	–	+	+	+
Axillary blotches	–	+	+	+
Subarticular tubercles under toe 4	2	3	3	2
Toe webbing	I $_{0.5–1}$ II $_{0.5–1.5}$ III $_{1–2}$ IV $_{2–1}$ V	I $_{0.5–1}$ II $_{0.5–2}$ III $_{1–2}$ IV $_{2–1}$ V	I $_{1–2}$ II $_{1–3}$ III $_{2–3.5}$ IV $_{4–2}$ V	I $_{1–1}$ II $_{1–2}$ III $_{0.5–1}$ IV $_{3–1}$ V

Variation.– Sexual size dimorphism not pronounced (largest male SVL 59.73; largest female SVL – 59.41). Large, smooth nuptial pads present at the base of the dorsal surface of the first finger in males (vs. absent in females); gular vocal sac indicated by dark colour and granular skin texture in males (vs. absent in females).

Colouration in life.–Dorsum bight orange-brown with dark brown flanks and a large dark brown hourglass shaped marking in the middle, extending from the inter-orbital region till the groin, broadening posteriorly; venter light grey with white marbled pattern. Lateral regions with two dark grey bands, each running along the flanks from sides of the snout till the groin. Gular vocal sac dark grey coloured in males. Limbs bear dark grey bands. No bright spots on the axillary and inguinal regions in both males and females.

Natural history.– It is nocturnal, semi-arboreal in habits and can often be seen on the ground among leaf litter, surface of tree trunks and in tree holes in primary evergreen, secondary and littoral forests. To a certain extent, it also occurs close to human habitation. This was observed in southern parts South and Little Andaman Islands. *Kaloula ghoshi* was observed to use tree holes at a height of upto 7ft above the ground level as a refuge for roosting. Courtship and breeding activities commence with the onset of southwest monsoon by late May and last till the end of the monsoon in September. Sporadic showers during the post-monsoon period were found to trigger intermittent calling and courtship activities in this species. Males call from puddles and other such stagnant water bodies on the ground (Fig. 4A). Females are about as large as males and amplexus in this species is axillary (Fig. 4B). Eggs of dull grey colour are laid in clumps in shallow, stagnant water bodies (Fig. 4C). *Xenochrophis tytleri* (Blyth, 1863) was observed in the breeding pools of this taxon and could be a potential predator.

Description of call.– (Fig. 5) The call described here was recorded from a topotypical male in Hut Bay, Little Andaman Island on 12 May 2015 at 2130 h

TABLE 4. Measurements of *Kaloula ghoshi* from the Andaman Islands and *K. baleata* syntypes (BMNH) from Java (in bold). * indicates live, uncollected specimens

	Sex	SVL	HL	HW	ES	ED	IO	IN	FEL	TBL
DOSMB 05040	M	37.4	10.47	12.89	4.33	4.6	5.14	3.21	16.27	16.07
South Andaman*	M	45.89	11.29	15.17	3.14	4.34	5.49	3.11	15.95	12.83
DOSMB 05041	M	49.85	14.09	17.69	4.69	6.16	6.18	3.85	22.78	19.8
Middle Andaman*	M	53.1	12.94	18.46	4.74	6.12	6.73	4.35	24.43	19.9
Middle Andaman *	M	55.3	14.4	19.2	5.99	6.02	6.87	4.31	21.35	21.5
North Andaman*	M	56.44	13.36	20.3	5.41	6.33	6.91	4.35	27.18	23.18
DOSMB 05042	M	59.73	14.36	18.38	5.61	6.33	6.36	4.13	25.4	22.08
Rutland*	F	59.41	15.1	15.5	5.3	5.78	5.68	3.99	25.84	22.73
South Andaman*	F	40.07	10.02	10.42	3.21	3.61	3.61	2.40	17.23	15.23
BMNH1947.2.10.69	**M**	**42.0**	**10.8**	**13.8**	**4.1**	**4.7**	**5.2**	**2.1**	**14.9**	**13.0**
BMNH1947.2.10.70	**M**	**40.7**	**9.5**	**12.6**	**3.6**	**4.6**	**4.7**	**2.0**	**12.5**	**12.8**

at an ambient air temperature of 29.1°C. Calls of *Kaloula ghoshi* consist of a series of pulses uttered in succession within duration of 55 s. Calls were composed of five notes, each of which comprise of 7 – 25 pulses, with syllables resembling the sound of a grunt. Mean amplitude of the call was -8 db with a dominant frequency of 1 kHz. Each pulse lasted for a mean duration of 0.4 s (range: 0.32 – 0.64 s), with the inter-pulse interval ranging between 0.24 – 0.53 s (mean 0.3 s).

Osteology: based on DOSMB 05040.– (Fig. 6) Skull broader than long; frontoparietals broad and robust with a median suture; nasals relatively short; orbital cavity large; longer than broad; maxillae and vomers edentate; vertebra bears seven presacal vertebrae, of which the last three are relatively larger. Pectoral girdle firmisternal in architecture; coracoids non-overlapping; very robust with widely expanded proximal and distal ends with a relatively slender medial region. Sternum cartilaginous clavicles absent. Suprascapula slender than coracoids. Humerus broader proximally, narrower distally; longer than radio-ulna. Finger tips with widely expanded terminal phalanges; phalangeal formula – 2-2-3-3. Sacral vertebra of the pelvic girdle well developed with widely dilated sacral diapophysis; ilia long; extending a little beyond the level of the sacral diapophysis; urostyle long; lacking lateral dilations or expansions. Femur longer than tibiofibula; tarsus shorter than the foot; phalangeal formula of the toes – 2-2-3-4-3; terminal phalanges expanded, but relatively narrower than finger tips.

Larval description.– Larvae of *Kaloula ghoshi* of stage 33 are described in this section. The tadpoles measure about 11 mm in total length (range: 10.58 – 11.23 mm; mean – 10.93±0.29). Head-body nearly rounded in shape when viewed dorsally, slightly longer than broad (HBL:HBW – 1.23) and broader than deep (HBW:HBH-1.85); markedly distinct from the tail; streamlined and tubular when viewed laterally. Oral disc lacking keratinised

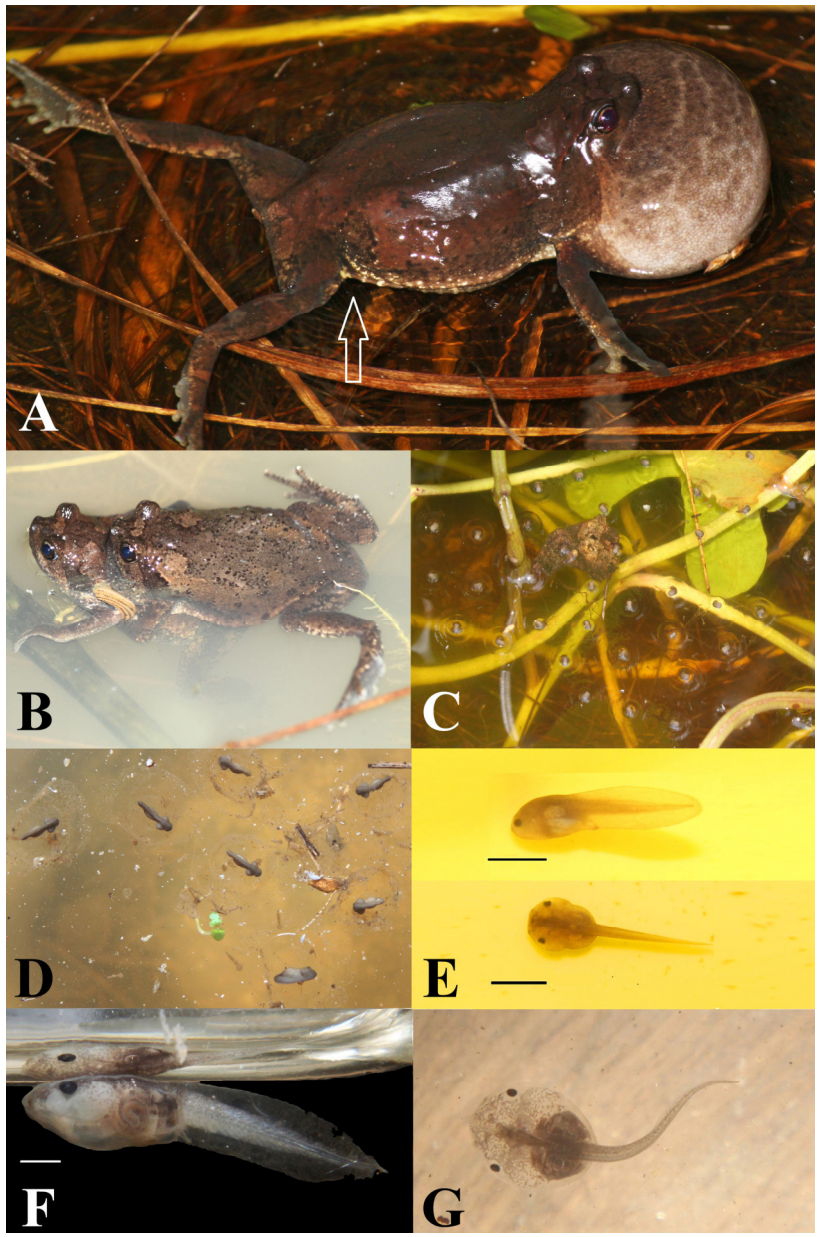

FIGURE 4. (A) a calling male *Kaloula ghoshi* Cherchi, 1954 (arrow points at the absence of a bright inguinal blotch); (B) pair of *K. ghoshi* in amplexus; (C-D) Eggs and freshly emerged larvae of *K. ghoshi*; (E) stage 25 larvae of *K. ghoshi* in lateral and dorsal views; (F-G) lateral and dorsal views of a stage 33 larva of *K. ghoshi* (scalebars – 2 mm)

mouthparts. Eyes distinct; lateral in position, situated nearly at 1/4th of the HBL; separated widely from each other (IO – 2.49 mm ±0.34). Caudal musculature well

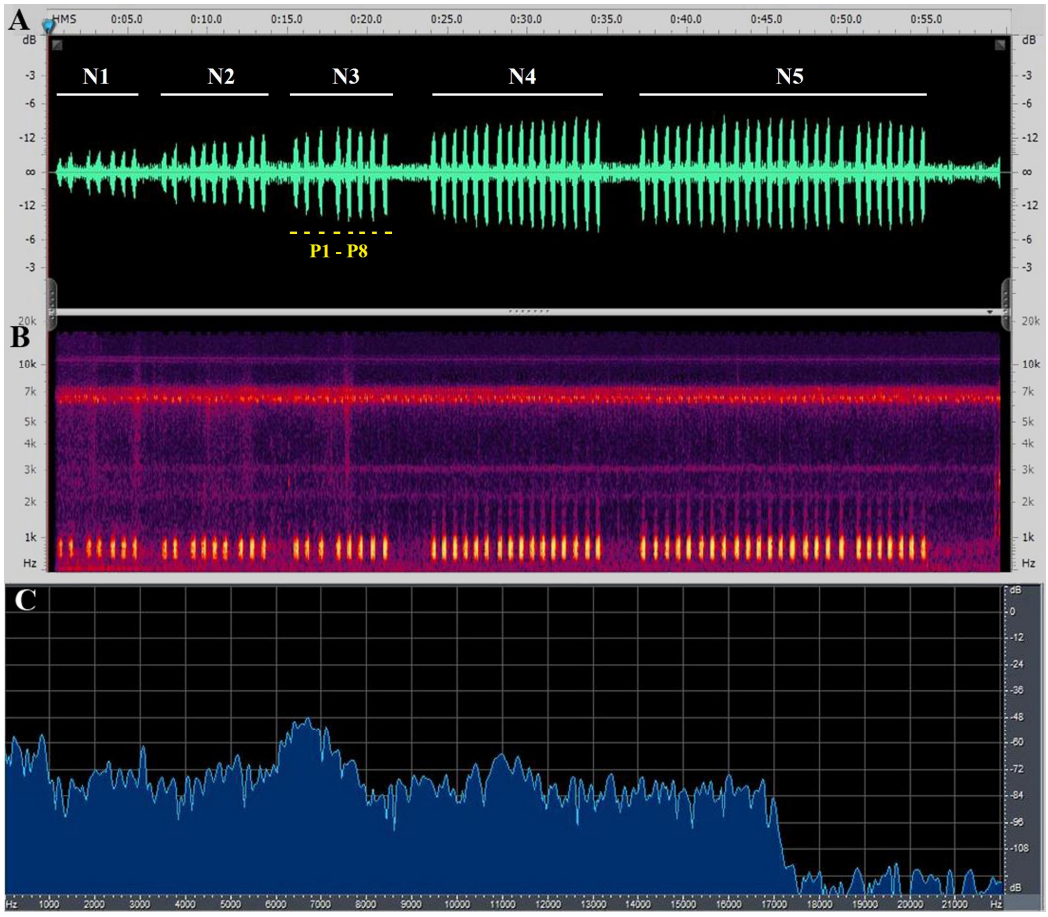

FIGURE 5. Spectrogram (A), oscillogram (B) and power spectrum (C) of the call of *Kaloua ghoshi*. N1 – N5 indicate notes; P1 – P8 indicate pulses within note 3 of the call.

developed; dorsal and ventral portion of the tail-fin equally well developed. Overall pigmentation very sparse and patchy, most parts of the body being translucent; Anterior portion of the head-body and tail spotted with light brown colour; posterior part of head-body with intense pigmentation. Highly coiled gut visible through the abdomen when viewed laterally and ventrally.

Distribution.– Within the Andaman archipelago, *Kaloula ghoshi* Cherchi, 1954 was observed to be a fairly widespread species, and was recorded from the following islands during the present study: Little Andaman (type locality), Rutland (Bada Khadi), South Andaman (Mt. Harriet National Park, Chidiyatapu and Wandoor), Long Island, Middle Andaman (Cutbert Bay) and North Andaman Island (Saddle Peak) from an altitudinal range of 4 to about 300 m asl (Fig. 7).

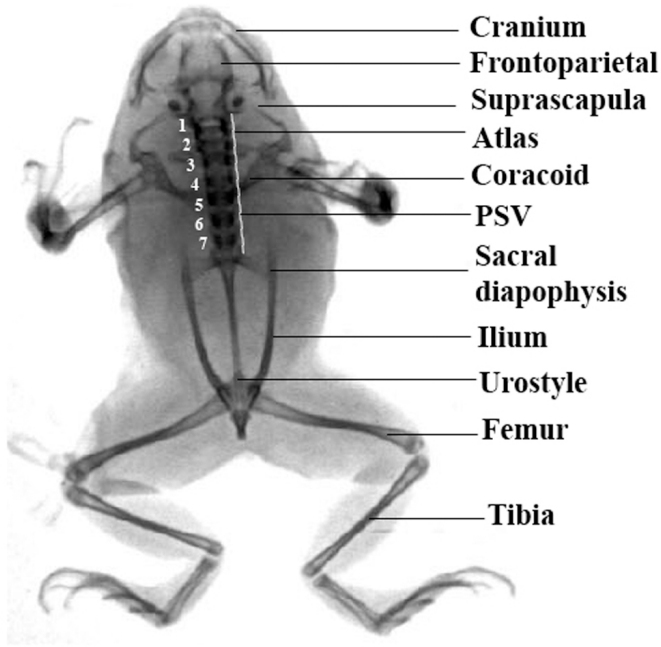

FIGURE 6. Osteology of *Kaloula ghoshi* Cherchi, 1954 based on DOSMB 05040. (PSV – presacral vertebrae)

DISCUSSION

Taxonomic complexity within the family Microhylidae, was appreciably demonstrated recently by Pesolo et al. (2015). Blackburn et al. (2013) revealed the presence of a large number of cryptic taxa within members of the genus *Kaloula* Gray, 1831. Following Blackburn et al. (2013) a series of recent taxonomic works have been carried out on *Kaloula*, leading to several new species descriptions (Chan et al., 2013; Chan et al., 2014; Mo et al., 2013). In each of the above cases, taxonomic status of specific geographic populations of widely distributed species complexes were reassessed, revealing the presence of cryptic species within each of the species groups. Among the currently recognized *Kaloula* species, members of the *Kaloula borealis* complex were shown to exhibit a relatively wide distribution spanning from south-western to north-eastern part of China (Mo et al., 2013). Similarly, the *baleata* complex shows a wide distribution with several members confined to specific localities across the mainland and insular regions of Southeast Asia, namely, *Kaloula ghoshi* in the Western extremity – Andaman Islands, *K. indochinensis* – Vietnam, *K. latidisca* – Peninsular Malaysia to *K. baleata* – Java in the Lesser Sunda Islands in the East.

Most of the above species were recognised and named recently based on molecular data supplemented by morphological evidences. Although genetic data is presently lacking for the Andaman population, elevation of *Kaloula ghoshi* to specific status is justifiable based on the morphological differences highlighted above in conjunction with its allopatric distribution. To the north of its range,

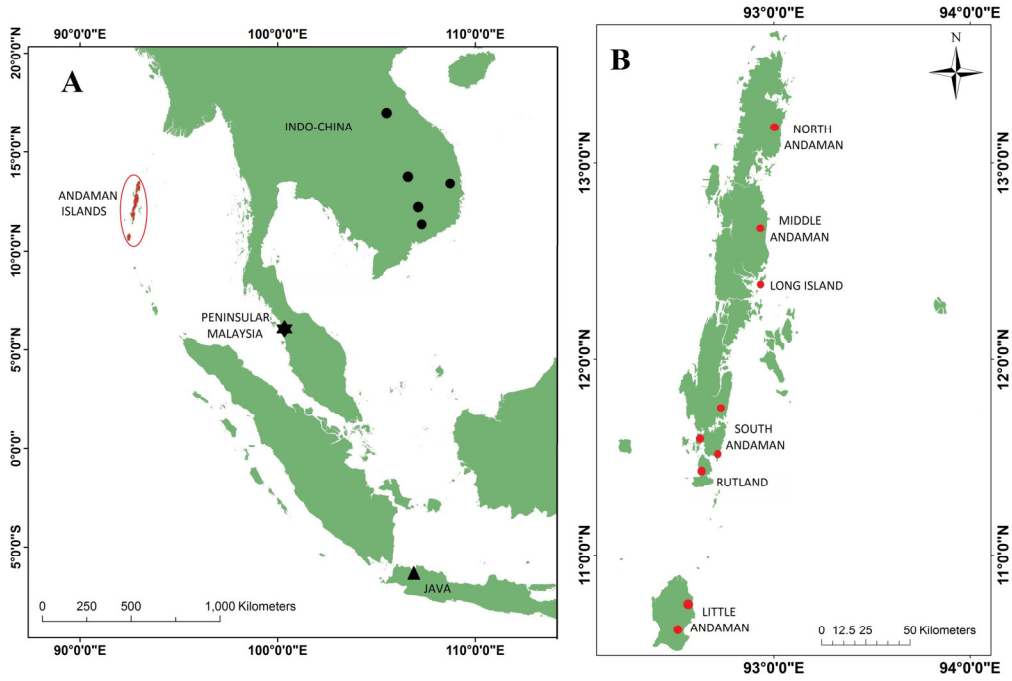

FIGURE 7. Geographic distribution of (A) members of the *Kaloula baleata* complex (red - *K. ghoshi*; black dots – *K. indochinensis*; black star – *K. latidisca* and black triangle – *K. baleata*); (B) locality records of *K. ghoshi* in the Andaman Islands during the present study.

Kaloula pulchra and *K. assamensis* occupy the East Indian and Burmese regions (Sengupta et al., 2009). The absence of any *Kaloula* species to the south of its range in the Nicobar Islands, and the subsequent presence of the nominotypical *Kaloula baleata* in the island of Java, provide ample evidence for reproductive isolation of the Andaman population and hence, support its elevation to the status of a distinct species.

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