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Redescription of a poorly known, insular endemic frog *Minervarya andamanensis* (Stoliczka, 1870) with notes on distribution and natural history

(Amphibia, Anura, Dicroglossidae)

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The poorly known, insular endemic dicroglossid frog *Minervarya andamanensis* (Stoliczka, 1870) from the Andaman archipelago is re-described based on morphological examination of the type specimen, living individuals and newly collected preserved specimens. Analysis of newly generated mitochondrial DNA sequence confirms its position in the *Minervarya* Dubois, Ohler & Biju, 2001 clade and suggests a sister relationship with the recently described *Minervarya muangkanensis*. New data on morphology, natural history and distribution of *M. andamanensis* are presented based on recent surveys conducted in the Andaman archipelago.

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Introduction

Stoliczka (1870), in his report on Indian and Malayan amphibia and reptilia described several new species of reptiles and amphibians. Among them were the new varieties of the taxon *Rana gracilis* Gravenhorst 1829, which he had split into three new, geographically allopatric forms namely *Rana gracilis* var. *andamanensis*, *Rana gracilis* var. *nicobariensis* and *Rana gracilis* var. *pulla* from the Andamans, Nicobars and Penang respectively. Of these, the variety *andamanensis* was based on four specimens ZSIC 2732, 3538, 3539 and BMNH 1947.2.1.23 collected from Port Blair, deposited at the Indian Museum (= Zoological Survey of India) and the Natural History Museum, London respectively (Dutta 1997). Sclater (1892) attributed the varieties *Rana gracilis andamanensis* and *Rana gracilis nicobariensis* to the species *Rana limnocharis* Gravenhorst, 1829. Subsequently, Annandale (1917) studied these specimens and found the syntype series of *Rana gracilis* var. *andamanensis* to be heterotypic, comprising those of the taxa "*Rana limnocharis* var. *andamanensis*" and "*Rana doriae*". By writing "type" opposite to the specimen ZSI 3539, he restricted the name *Rana gracilis* var. *andamanensis* to only one among the four original series of syntypes (ZSI 3539), thus designating it as the lectotype of this taxon. Dutta (1997) remarked that one of the original syntypes BMNH 1947.2.1.23 represents *Limnonectes hascheanus* (Stoliczka, 1870). Dubois (1984) transferred the species *Rana limnocharis* var. *andamanensis* to the (sub)genus *Fejervarya* Bolkay,

1915 of *Limnonectes* Fitzinger, 1843, upon reclassifying the species *Rana limnocharis*. Later, Dubois & Ohler (2000) transferred it to *Fejervarya*, where it remained in the combination *Fejervarya andamanensis* (Stoliczka, 1870). Very recently, the phylogeny based classification of this group has been revised by Sanchez et al. (2018) whereby, *Fejervarya andamanensis*, a member of the south Asian clade, has been attributed to the genus *Minervarya* Dubois, Ohler & Biju, 2001 in the combination *Minervarya andamanensis*. This species is known only based on a few specimens (ex. ZSI 15881-5 fide Annandale 1917: 133) apart from the lectotype and information about its biology, geographic distribution and status remain unknown. This paper presents information on genetics, taxonomy, morphology, biology, acoustics and distribution of this poorly known insular endemic species based on recent studies conducted in the Andaman Islands.

Materials and methods

Field sampling, collection and morphometry

Islands of the Andaman archipelago were surveyed as a part of a larger study on frogs of the Andaman and Nicobar Islands for documenting the distribution of the target species. Especially, forested areas near the type locality (Port Blair, South Andaman) were surveyed for documenting topotypic population. Three dead individuals of this species encountered on roads outside protected areas in South Andaman, Little Andaman and Havelock were collected, preserved in ethanol and deposited in the collections of the Department of Ocean Studies and Marine Biology (DOSMB), Pondicherry University, Port Blair. Living specimens encountered in the field (six males and four females) were captured by hand, gently restrained and measured using digital calipers to the nearest 0.1 mm. After examination and photography, they were released at the site of capture within an hour in order to minimize adverse impacts, if any. The following morphometric characters were

Table 1. Genbank accession numbers (GBN) of the sequences used in the analysis (N.A. = not available).

S. No.	Species	GBN	Locality	Reference
1	*Minervarya sahyadris*	AB530604	India: Aralam	Hassan et al. (2014)
2	*Minervarya gomantaki*	KR781085	Western Ghats	Dinesh et al. (2015)
3	*Minervarya muangkanensis*	AB277300	Thailand: Pilok	Kotaki et al. (2008)
4	*Minervarya muangkanensis*	MG935778	Myanmar: Bago, Dawei	Mulcahy et al. (2018)
5	*Minervarya andamanensis*	MT752940	Havelock, Andaman Islands	this study
6	*Minervarya andamanensis*	AB488899	India: Andaman Island	Kotaki et al. (2010)
7	*Minervarya muangkanensis*	MF166918	N.A.	Suwannapoom et al. (2017)
8	*Minervarya caperata*	AB488894	India: Mudigere	Kotaki et al. (2010)
9	*Minervarya* sp. Nepal	AB488889	Nepal: Chitwan	Kotaki et al. (2010)
10	*Minervarya* sp. hpB	AB167954	India: Mangalore: Bajpe	Kurabayashi et al. (2005)
11	*Minervarya greenei*	AB488891	Hakgala: Sri Lanka	Kotaki et al. (2010)
12	*Minervarya syhadrensis*	AY882956	N.A.	Tandon et al. (unpublished)
13	*Minervarya kirtisinghei*	AY014380	N.A.	Kosuch et al. (2001)
14	*Minervarya asmati*	KP849815.1	N.A.	Howlader et al. (2016)
15	*Minervarya rufecsens*	AB488897	N.A.	Kotaki et al. (2010)
16	*Minervarya neilcoxi*	KY447317	Parambikulam, Kerala	Garg & Biju (2017)
17	*Minervarya manoharani*	KY447313	Chathancod-Bonakkad, Kerala	Garg & Biju (2017)
18	*Minervarya mudduraja*	AB488896	India: Madikeri	Kotaki et al. (2010)
19	*Fejervarya limnocharis*	AF215416	N.A.	Vences (2000)
20	*Fejervarya multistriata*	AB488884	China: Husa	Kotaki et al. (2010)
21	*Fejervarya limnocharis*	AB277301	Malaysia	Kotaki et al. (2008)
22	*Limnonectes doriae*	GU934330	N.A.	Inger & Stuart (2010)
23	*Limnonectes kuhlii*	GU934333	N.A.	Inger & Stuart (2010)
24	*Limnonectes asperatus*	HM067284	Indonesia: Serasan Is.	McLeod (2010)
25	*Limnonectes laticeps*	AB277306	Malaysia	Kotaki et al. (2008)
26	*Fejervarya limnocharis*	AB277302	Indonesia: Java	Kotaki et al. (2008)
27	*Quasipaa boulengeri*	GQ225876	N.A.	Wang et al. (2009)

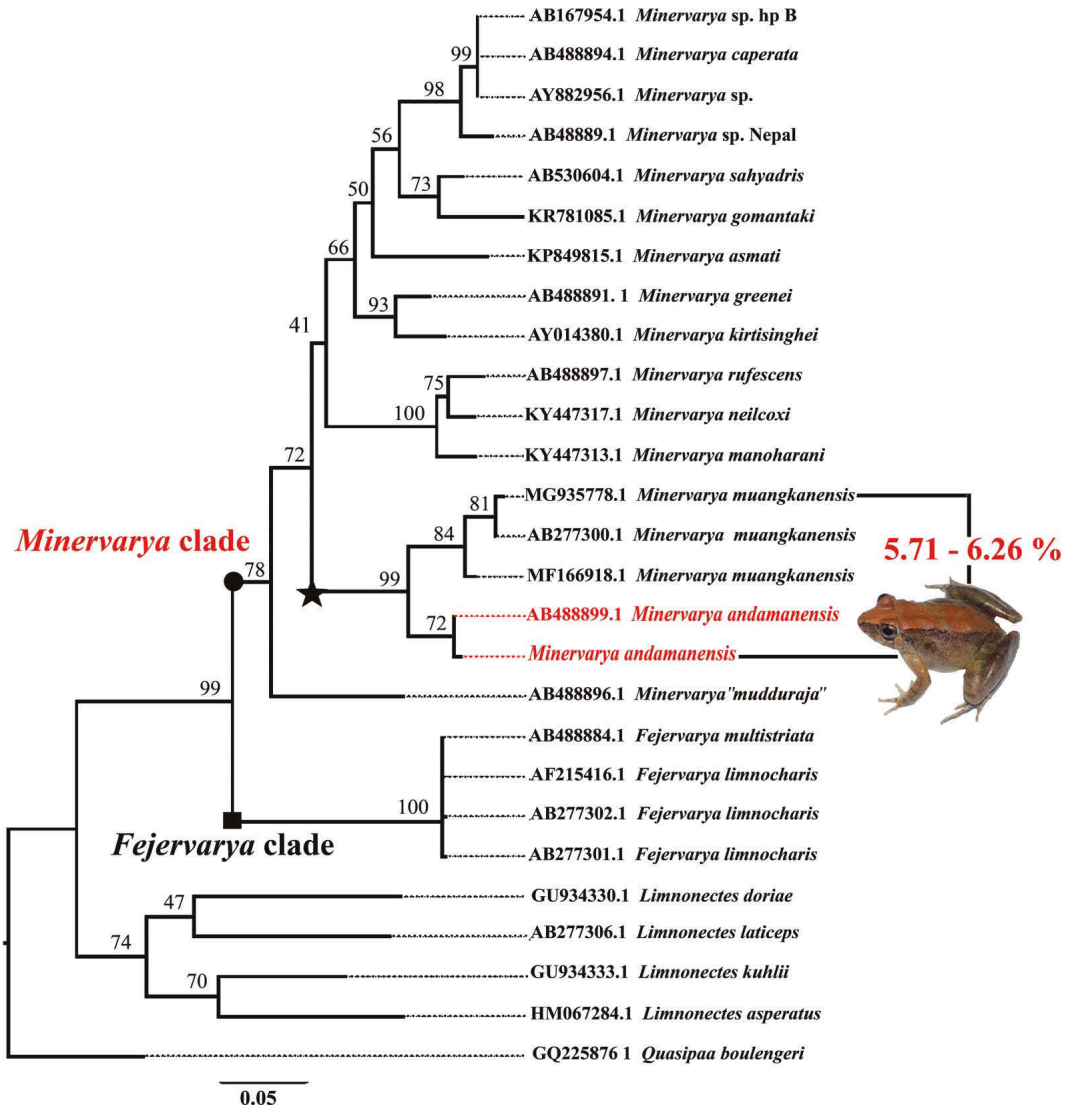


Fig. 1. Maximum likelihood phylogeney of dicroglossid frogs based on 16S rRNA gene showing the position of *Minervarya andamanensis* (scale: substitutions/site).

recorded: snout–vent length (SVL, from the tip of the snout to the anterior margin of the cloaca), axilla–groin distance (AG, from the posterior margin of the forelimb at its insertion point on the body to the anterior margin of the hind limb at its insertion point on the body), head length (HL, from the posterior edge of the mandible to the tip of the snout), head width (HW, the maximum width of the head at the angle of the jaws), head depth (HD, the maximum depth of the head), body width (BW, the maximum width of the body at the trunk), eye diameter (ED, the greatest horizontal diameter of the orbit), eye–nostril distance (EN, from the anterior border of the orbit to the middle of the nostril), eye–snout distance (ES, from the anterior border of the orbit to the tip of the snout), eye–tympanum length (ETY, from the posterior border of the orbit to the anterior border of the tympanum), upper eyelid width (UEW, the maximum width of the upper eyelid), interorbital distance (IO, distance between the upper eyelids), internarial distance (IN, distance between the nostrils), tympanum diameter (TYD, the greatest horizontal diameter of the tympanum), upper arm length (UAL, from the axilla to elbow), lower arm

length (LAL, 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 3rd finger), femur length (FEL, from the cloaca to the knee), tibia length (TBL, from knee to heel), foot length (FOL, from inner metatarsal tubercle to the tip of the 4th toe). Webbing formulae follows Savage & Heyer (1997). The lectotype of this species, ZSI 3539, was studied at the Zoological Survey of India, Kolkata. Geographic coordinates of the localities of observation of this species were mapped using a GPS (WGS84 datum). Colour descriptions made here are based on photographs of the focal species recorded using a Canon EOS 500D camera. Call described here was recorded from an adult male (~35 mm SVL) in the natural habitat using a digital audio recorder at ambient air temperature (23 °C) and analysed using the software packages Adobe Soundbooth CS3 and Adobe Audition 1.0. Call description terminologies follow Köhler et al. (2017).

DNA extraction, amplification, sequencing and phylogenetic analysis

Total genomic DNA was extracted using Himedia® MB506 (India) mammalian DNA extraction and purification kit from liver tissues of one specimen (DOSMB 05029) collected from Havelock Island following the manufacturer's protocol. Quality of the extracted DNA was checked spectrophotometrically using Nanodrop. From the extracted genomic DNA, 16S rRNA gene was amplified using the forward and reverse primers 16sAR-L (5'-CGCCTGTTTAT-

Table 2. Pairwise genetic divergences (in %) on 16S rRNA gene between members of *Minervarya*, *Fejervarya* and *Limnonectes* showing distances from the sample of *M. andamanensis* (DOSMB 05029). Intra-specific distance to the sample under investigation is in bold. 1 = *Minervarya sahyadris*; 2 = *M. gomantaki*; 3, 5, 8 = *M. muangkanensis*; 4, 20, 22 = *Fejervarya limnocharis*; 6, 7 = *Minervarya andamanensis*; 9 = *M. caperata*; 10 = *M.* sp. Nepal; 11 = *M.* sp. Hp B; 12 = *M. greeni*; 13 = *M. syhadrensis*; 14 = *M. kirtisinghei*; 15 = *M. asmati*; 16 = *M. rufescens*; 17 = *M. neilcocxi*; 18 = *M. manoharani*; 19 = ; 21 = *F. multistriata*; 23 = *Limnonectes doriae;* 24 = *L. kuhlii*; 25 = *L. asperatus*; 26 = *L. laticeps*; 27 = *Quasipaa boulengeri*.

	1	2	3	4	5	6*	7	8	9	10	11	12	13	14	15	16	17
1																	
2	5.16																
3	11.24	14.32															
4	11.86	14.36	0.50														
5	15.01	18.06	17.00	16.72													
6*	11.83	13.95	6.26	5.71	16.12												
7	11.24	13.34	6.26	5.71	15.48	**0.49**											
8	11.32	13.01	2.02	2.54	17.37	5.17	5.17										
9	6.28	8.14	12.40	13.04	17.45	11.16	10.58	10.27									
10	6.52	9.87	12.65	13.28	16.80	11.41	10.82	12.08	2.52								
11	6.28	8.14	12.40	13.04	17.45	11.16	10.58	10.27	0.00	2.52							
12	8.19	9.84	12.68	13.31	17.74	12.08	11.49	11.81	7.90	9.30	7.90						
13	6.28	8.14	12.40	13.04	17.45	11.16	10.58	10.27	0.00	2.52	0.00	7.90					
14	7.88	10.13	12.73	13.37	14.53	12.43	11.83	12.16	7.62	9.30	7.62	4.35	7.62				
15	8.23	9.12	11.94	11.32	16.60	12.19	11.59	12.33	10.00	9.96	10.00	9.40	10.00	9.08			
16	11.24	13.71	11.24	11.86	15.80	12.79	12.19	11.32	10.92	11.46	10.92	10.02	10.92	11.24	11.59		
17	10.92	14.29	10.63	11.24	16.48	11.86	11.27	11.89	11.78	11.43	11.78	11.17	11.78	12.11	11.27	3.29	
18	11.78	13.95	11.73	12.35	15.40	12.08	11.48	12.11	12.35	12.59	12.35	10.85	12.35	12.38	12.13	4.35	3.81
19	13.10	15.09	13.71	13.07	16.12	12.73	12.13	14.12	11.91	12.46	11.91	11.29	11.91	11.54	10.70	12.85	11.92
20	14.70	17.74	16.68	16.40	0.25	15.80	15.16	17.04	17.13	16.48	17.13	17.41	17.13	14.22	16.28	15.48	16.16
21	14.70	17.74	16.68	16.40	0.25	15.80	15.16	17.04	17.13	16.48	17.13	17.41	17.13	14.22	16.28	15.48	16.16
22	15.01	18.06	17.00	16.72	0.49	16.12	15.48	17.37	16.80	16.80	16.80	17.74	16.80	13.90	16.28	15.80	16.48
23	20.59	23.42	21.53	21.12	21.40	21.29	20.59	20.43	21.23	22.05	21.23	22.00	21.23	21.76	21.64	23.07	23.14
24	20.77	24.35	21.35	21.29	21.35	22.05	21.34	21.16	21.40	20.93	21.40	20.65	21.40	20.54	21.35	21.00	21.64
25	19.35	21.52	22.71	22.29	19.79	21.17	20.48	22.64	20.88	21.58	20.88	20.94	20.88	21.64	22.59	21.29	21.35
26	19.59	22.94	17.43	17.06	21.41	17.43	17.43	16.81	21.94	21.12	21.94	21.41	21.94	20.60	18.68	19.02	19.98
27	16.44	17.91	19.01	18.29	17.43	16.19	15.55	17.96	16.89	17.87	16.89	17.17	16.89	16.44	15.06	17.59	18.29

CAAAAACAT-3') and 16sBR-H (5'-CCGGTCT-GAACTCAGATCACGT-3') respectively (Kocher et al. 1989). Amplifications were performed in a 50 µl reaction with 25 µl of P4600 Sigma-Aldrich® master mix, 2 µl each of forward and reverse primers, 4 µl of DNA template and 17 µl of Milli-Q water with the following procedure: initial denaturation of DNA at 95 °C for 5 m, 35 cycles of: denaturation at 95 °C for 1 m, annealing at 55 °C for 1 m, extension at 72 °C for 1 m and at last, final extension at 72 °C for 10 m. The amplicon was checked by running it through an agarose gel electrophoresis for a clear band of the desired region in the amplified PCR product. The amplified PCR product was purified with Himedia® PCR product purification kit MB512 and sent out for sequencing commercially (Eurofins genomics, Bengaluru, India). The sequence has been deposited in Genbank under the voucher no: MT752940.

The sequences thus obtained were subjected to BLAST search on NCBI, to identify the most similar sequences on the database. Based on the BLAST search, a set of 15 sequences of 16s rRNA of 12 of potentially close species of *Minervarya*, four sequences from the genus *Fejervarya* and four sequences from the genus *Limnonectes* were selected and aligned along with *Quasipaa boulengeri* as the outgroup (Table 1). The sequences were manually edited and aligned with Muscle using MEGA 6. An alignment (537 bp) consisting of the above sequences was developed, exported in FASTA and MEGA formats. The MEGA alignment was then used to determine uncorrected pairwise genetic distances between the samples with MEGA 6 (Tamura et al. 2013). The FASTA alignment was converted to PHYLIP format in the Alignment Transformation Environment (ALTER) website (http://sing.ei.uvigo.es/ALTER/) and was subjected to a maximum likelihood (ML) analysis in RAxML GUI v. 1.3 (Stamatakis 2006, Stamatakis et al. 2008) using the general time reversible model, GTRGAMMA with 1000 bootstrap replicates. The tree file generated was then visualized using Fig Tree v. 1.4.0 (http://tree.bio.ed.ac.uk/software/figtree/).

	18	19	20	21	22	23	24	25	26
12.44									
15.09	15.80								
15.09	15.80	0.00							
15.40	16.12	0.25	0.25						
24.52	22.36	21.05	21.05	21.40					
21.94	19.20	21.00	21.00	21.35	14.70				
20.83	22.23	19.45	19.45	19.79	16.28	12.22			
19.93	19.02	21.06	21.06	21.41	14.74	14.14	16.68		
17.92	16.19	17.10	17.10	16.77	14.39	15.76	14.46	16.69	

Results

The species *andamanensis* was found to be a member of the genus *Minervarya* (Fig. 1), belonging to a well-supported clade (star marked), showing a close relationship with *Minervarya muangkanensis* from Thailand. *Minervarya andamanensis* shows a fairly high genetic divergence of 5.71–6.26 % on 16s rRNA gene from its genetically closest sister species. Intraspecific genetic distance between the two samples of *Minervarya andamanensis* was found to be considerably low (0.5 %), indicating their conspecificity (Table 2).

Systematics

Minervarya andamanensis (Stoliczka, 1870)

Rana gracilis var. *andamanensis* Stoliczka, 1870
Rana limnocharis var. *andamanensis* – Sclater (1892); Annandale (1917)
Rana (*Fejervarya*) *andamanensis* – Dubois (1984)
Limnonectes (*Fejervarya*) *andamanensis* – Dubois (1987)
Limnonectes andamanensis – Das (1999)
Fejervarya andamanensis – Dubois & Ohler (2000)
Minervarya andamanensis – Sanchez et al. (2018)

Material examined. (Zoological Survey of India, Kolkata) ZSI 3539 (lectotype) from Port Blair, South Andaman. (Department of Ocean Studies and Marine Biology, Pondicherry University) DOSMB 05061 from Brookshabad, Port Blair (type locality), South Andaman; DOSMB 05045 from Hut Bay, Little Andaman, DOSMB 05029 from Havelock Island.

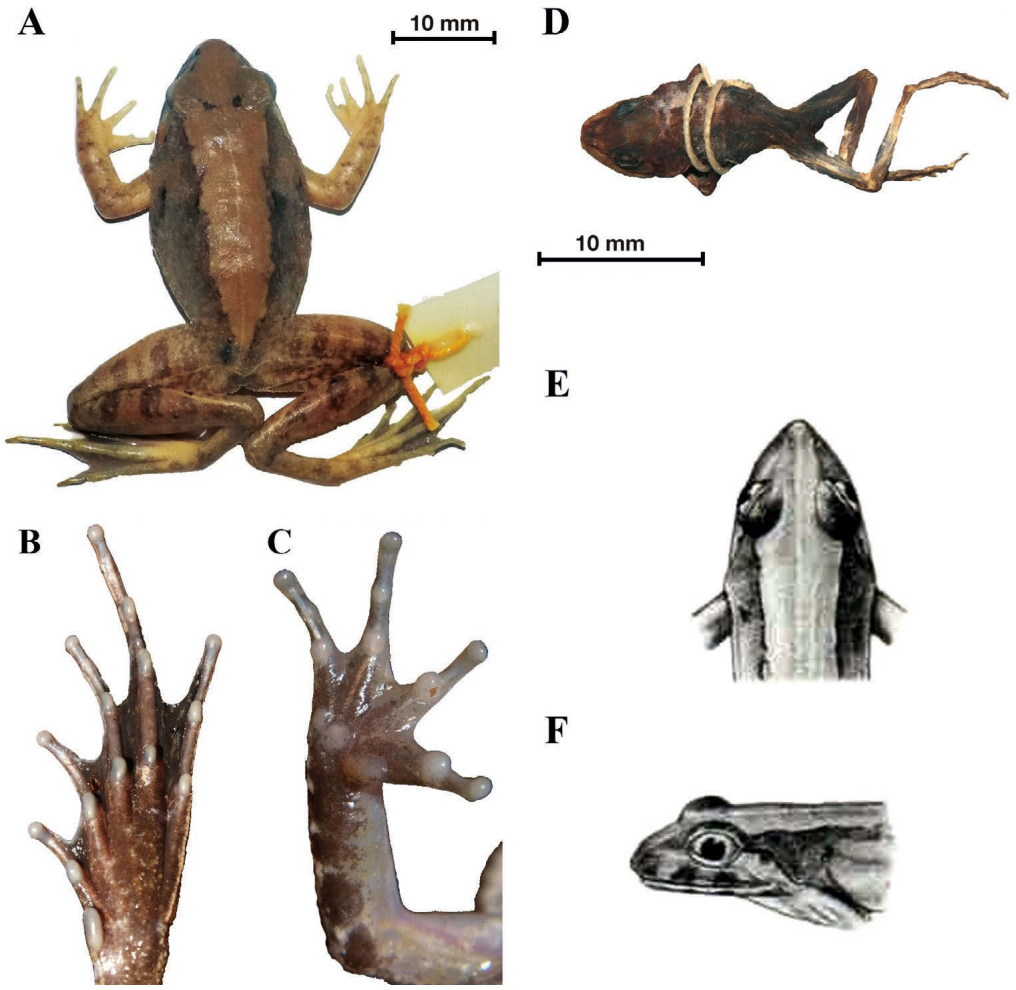


Fig. 2. A. An adult male topotype of *Minervarya andamanensis* DOSMB 05061; **B.** foot; **C.** palm; **D.** lectotype of *Rana gracilis* var. *andamanensis* ZSI 3539; **E–F.** Annandale's (1917) sketch of a specimen of *Minervarya andamanensis* from Baratang collected by B. B. Osmaston.

Lectotype. An unsexed juvenile specimen (SVL 14.4 mm), ZSI 3539 from "Port Blair" by subsequent designation of Annandale (1917). As pointed out by Dubois (1984), presently, the specimen is flattened and in a poor state of preservation. (Fig. 2D).

Differential diagnosis and comparisons. A medium-sized species of *Minervaya* from the Andaman Islands, Bay of Bengal, characterized by: presence of a distinctive, uniform chestnut brown colouration on the dorsum and darker brown to black coloured flanks (vs. absent in all other species of *Minervarya* including its closest sister *M. muangkanensis* except *M. sahyadris*, *M. chilapata*, *M. gomantaki* and *M. krishnan*); absence of rictal glands near lips (vs. present in *M. sahyadris*, *M. chilapata*, *M. gomantaki* and *M. krishnan*); moderate maximum body size of about 53 mm (vs. smaller in *M. sahyadris* (19.2 mm), *M. chilapata* (20.9 mm), *M. gomantaki* (23.8 mm) and *M. krishnan* (21.1 mm)); absence of warts, pustules, series of longitudinal folds or wrinkles on the dorsal skin (vs. present in all other species of *Minervarya* except *M. sahyadris*, *M. chilapata*, *M. gomantaki* and *M. krishnan*); a pair of incomplete but distinct, black-edged glandular folds along the dorso-lateral portion of anterior body (vs. absent in *M. sahyadris*, *M. chilapata*, *M. gomantaki* and *M. krishnan*); a pair of Fejervaryan lines on the sides of belly; paired, dark-coloured external vocal sacs in males; a nuptial pad on first finger of males; digit tips swollen on both

fingers and toes but lacking expanded discs; moderate degree of toe-webbing, leaving three phalanges free on 4th toe; presence of an elongate inner metatarsal tubercle and a rudimentary outer metatarsal tubercle on the feet. Additionally, based on partial 16s rRNA gene, *Minervarya andamanensis* which shows a sister relationship to *M. muangkanensis* can be distinguished from all other species of this genus.

Description of a topotype DOSMB 05061
(Fig. 2A–C)

An adult male measuring 31.8 mm SVL; body moderately robust (AG : BW 1.18), with a relatively slender habitus. Head as long as broad (HL : HW 0.99), snout obtusely pointed to rounded in dorsal and lateral views; canthal fold well-marked; nostrils situated on the fold midway between eye and snout tip (EN : ES 0.6). Eyes large, about 33 % of HL with a rhomboidal pupil. Upper eyelids wider than the inter-orbital space (IO : UEW 1.49); inter-narial space wider than the distance between the upper eyelids (IO : IN 0.89). A pair of glandular dorso-lateral folds extends from the post-orbital region till halfway through the body losing prominence in the posterior region. A pair of prominent supra-tympanic folds extends downwards from behind the eyes till axilla. Tympanum distinct, about less than half the size of the eye; (TYH : ED 0.44). Upper arms short (UAL : SVL 0.24); as long as the lower arm (UAL : LAL 1.02); palm slightly longer (UAL : PAL 0.92). One inner and two small outer palmar tubercles present; relative length of fingers: III > I > II > IV; finger tips swollen, but not dilated. Thighs robust; half as long as the body (FEL : SVL 0.53); shank longer than thigh (FEL : TBL 0.84). Toes partially webbed, webbing formula: I 0–1 II ½–2 III 1–2 IV 2–0 V; tips swollen but not dilated, lacking circum-marginal grooves or dorso-terminal grooves; their relative lengths: IV > III > V > II > I.

Variation. Females (mean SVL 47.5 mm ± 4.7; range 32.8–52.9; n = 4) larger than males (mean SVL 34.8 mm ± 3.8; range 30.5–39.5; n = 6); males with a clearly demarcated pair of external vocal sacs in the gular region and thick, fleshy white nuptial pads on the dorsal surface of first finger (vs. absent in females) (Table 3).

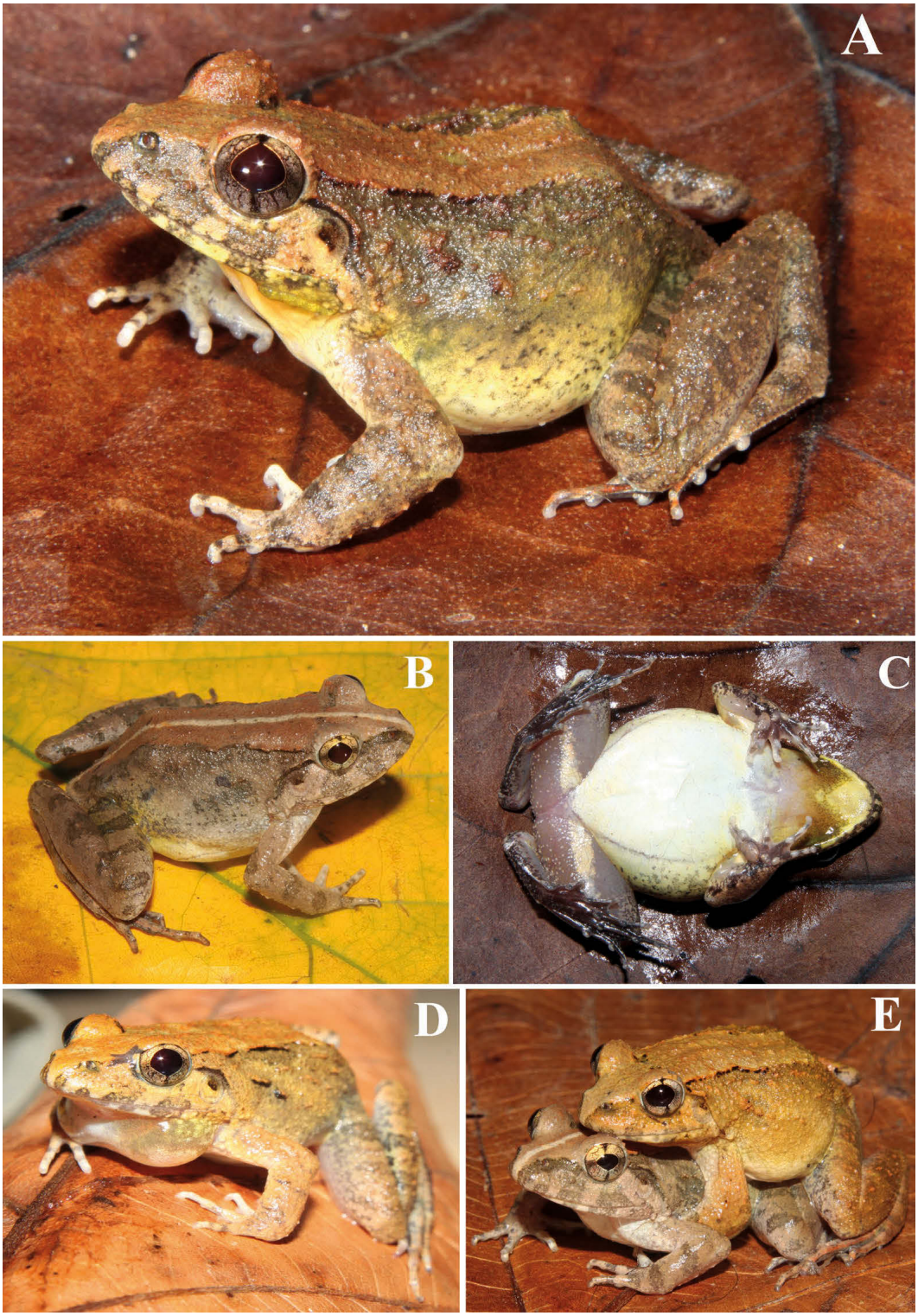
Colouration in life (Fig. 3A–C)**.** Dorsum unpatterned, uniform chestnut brow in colour. Lateral regions (flanks) darker in colour varying in intensity from black (n = 7) in some specimens to light brown (n = 3). Dorso-lateral folds bordered with black margins. Fore and hind-limbs feebly barred with dark and light brown. Lips with large dark spots below the eyes. Tympanum bicoloured, with the upper part being dark and the lower part being creamy white. Venter uniform white; thighs grey; undersurface of the throat white in females and the vocal sacs indicated by dark patches in males. Occasionally (in three of ten individuals), a bright yellow mid-dorsal stipe passing through the chestnut brown colour and a small, black transverse band on the upper eyelid is seen on some specimens.

Calls. The call of *Minervarya andamanensis* is composed of a multi-pulsed note consisting of five to eight interrupted pulses uttered in succession within duration of 8–17 s, at a rate of 0.66 pulses/s. Each pulse lasts for a mean duration of 0.3 s ± 0.03 (range 0.25–0.48 s, n = 21) with a mean inter-pulse interval of 0.74 s ± 0.29 (range 0.27–2.1 s, n = 17). Mean frequency of the call was around 3 kHz, with a maximum frequency of about 7 kHz. The call syllables resemble a duck's "quack– quack– quack" sound (Figs 3D, 4).

Distribution. This species is endemic to the Andaman Islands and has been documented during the present study from the following Islands: South Andaman (the type locality; 11.720706° N, 92.733613 E, 362 m asl.), Middle (12.6393° N, 92.958° E, 17 m asl.), North (13.1556° N, 93.0191° E, 512 m asl.) and Little Andaman (10.71245° N, 92.5416° E, 70 m asl.), Interview (12.888° N, 92.667° E, 46 m asl.), Baratang (12.2397° N, 92.8055° E, 40 m asl.), Rutland Island (11.4427° N, 92.6659° E, 135 m asl.) among the Great Andamans and Havelock (12.0103° N, 92.9603° E, 62 m asl.), John Lawrence (12.1141° N, 93.02737° E, 3 m asl.) and Henry Lawrence (12.2098° N, 93.07551° E, 10 m asl.) Islands within the Ritchie's Archipelago (Fig. 5).

Table 3. Measurements of *Minervarya andmanensis* (Stoliczka, 1870) in mm.

Character	Males (n = 6)		Females (n = 4)	
	Range	(Mean ± SD)	Range	(Mean ± SD)
SVL	30.5–39.5	34.8 ± 3.8	32.8–52.9	47.5 ± 4.7
HL	11.4–14.3	12.4 ± 1.1	12.6–18.1	15.8 ± 2.3
HW	12.0–13.8	12.8 ± 0.8	12.5–18.6	15.4 ± 2.5
ED	3.5–5.4	4.3 ± 0.6	4.2–5.8	5.1 ± 0.7
UEW	2.9–3.5	3.2 ± 0.3	3.6–4.9	4.1 ± 0.7
TYD	1.9–2.7	2.4 ± 0.3	1.8–3.4	2.7 ± 0.6
UAL	5.9–7.9	7.2 ± 0.7	7.5–10.8	8.9 ± 1.5
LAL	6.2–9.0	7.2 ± 1.0	7.7–12.4	9.2 ± 2.2
PAL	6.9–8.9	8.2 ± 0.7	8.1–11.3	9.8 ± 1.3
FEL	14.9–19.0	17.3 ± 1.7	17.3–28.1	22.7 ± 4.6
TBL	18.4–21.7	19.3 ± 1.2	20.6–29.8	24.3 ± 3.9
FOL	16.5–20.1	17.9 ± 1.5	20.1–27.3	23.7 ± 2.9


A
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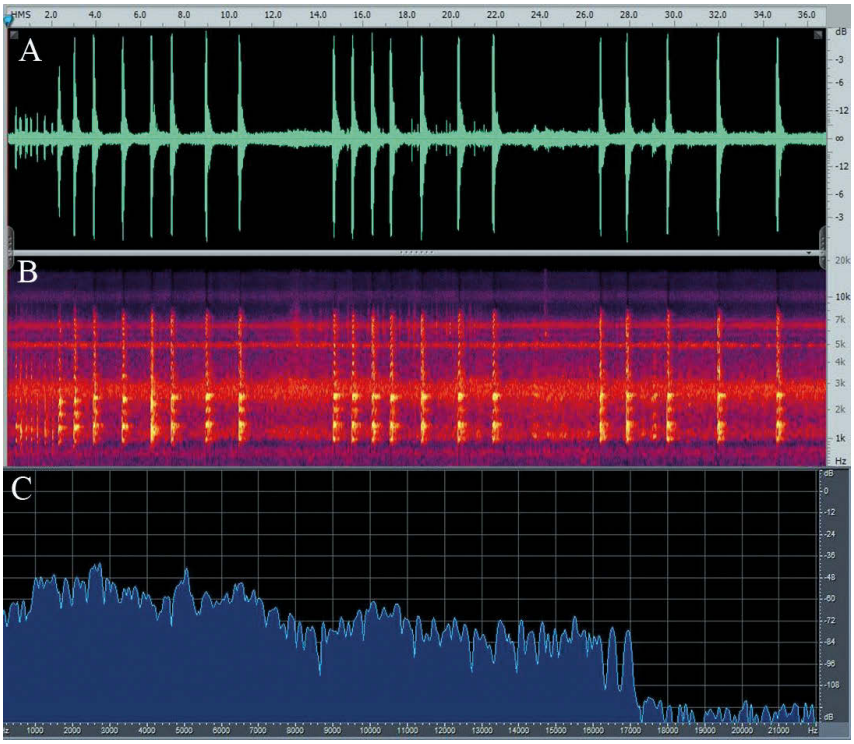

Fig. 4. A. Oscillogram, **B.** spectrogram and **C.** power spectrum of the call of *Minervarya andamanensis*

Natural history. *Minervarya andamanensis* was observed to be one of the most widespread frog species within the Andaman archipelago. This species was found in both pristine and human-impacted landscapes. It has been observed on the forest floor in lowland evergreen, secondary evergreen and littoral forests and also in paddy fields. Further basic data on ecology of this species were presented by Chandramouli et al. (2015). Breeding activities were observed to commence with the southwest monsoon (late May–September) and last till the end of the northeast monsoon (October–December). This species takes part in communal breeding along with *Limnonectes* cf. *hascheanus*, with both these species calling and engaging in courtship activities in the same pool. Males call from stagnant puddles to attract females. Amplexus is axillary (Fig. 3E) and may last a little longer even after the eggs have been laid on the surface of water. Eggs are small (1.5 mm mean diameter) yolky and partially pigmented, with dirty white and grey colour, laid in clutches of about 180–200.

Comparisons with sympatric dicroglossids

From other sympatric dicroglossid frogs, it can be distinguished as follows: dorsum uniform chestnut brown in colour (vs. brown with large black spots and a 'W' shaped marking in *Limnonectes* cf. *hascheanus*); presence of long, uninterrupted but incomplete glandular dorso-lateral folds extending from post orbital region till about mid-body (vs. short, interrupted and numerous folds present in all the other species); digit tips swollen but not dilated (vs. tips pointed and not swollen in *Fejervarya moodiei* and *Minervarya* sp.) and laterally positioned nostrils (vs. dorsal in *Fejervarya moodiei*). Additionally, from *Ingerana charlesdawini*, *M. andamanensis* can be distinguished by its dorsal colouration, larger body size, presence of incomplete dorso-lateral folds and paired vocal sacs (vs. absence of incomplete dorsolateral folds, smaller body size and single median vocal sac in *I. charlesdarwini*) and call characteristics.

◁ **Fig. 3. A.** An adult male without vertebral stripe; **B.** an adult female with vertebral stripe; **C.** ventral view of male *Minervarya andamanensis*; **D.** an adult male *Minervarya andamanensis* calling and **E.** a pair in amplexus.

Discussion

Despite being a species that had been known since a long time, data on its natural history and distribution were virtually absent till now. In fact, after the partial sketches of a specimen from Baratang Island in the Andamans (Fig. 2E,F) provided by Annandale (1917), this species was illustrated for the first time only recently (Chandramouli et al. 2015), after a century and a half since its description. The present study has filled in some of the gaps in knowledge on this species, by providing taxonomic clarity and field observed information on natural history and distribution. Currently, the status of this species is considered to be 'Least Concern', as per the IUCN criteria (Das & Vijayakumar 2004). However, although locally widespread, owing to the narrow and restricted distribution in comparison to other congeners and the taxonomic confusions that had prevailed all along, it would be essential to make a reassessment and revise the conservation status of this species based on new data.

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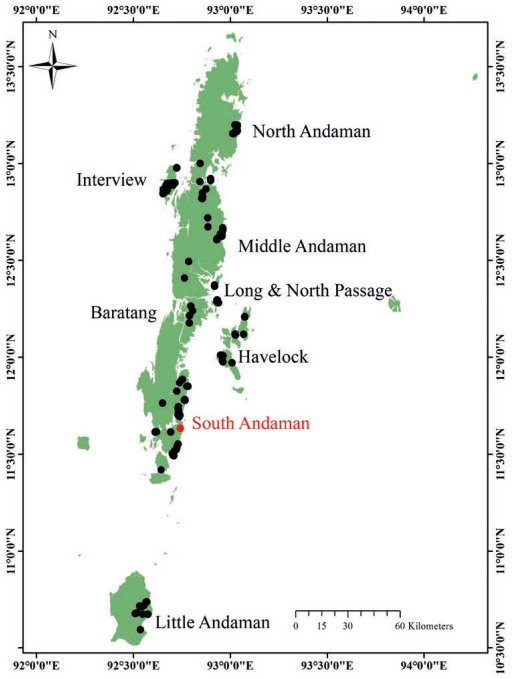

Fig. 5. Map of the Andaman archipelago showing the distribution and type locality (South Andaman, in red) of *Minervarya andamanensis*.

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