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Source: Revue suisse de Zoologie, 123(1) : 35-43

Published By: Muséum d'histoire naturelle, Genève

URL: <https://doi.org/10.5281/zenodo.46287>

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Two additional records of megophryid frogs, *Leptobrachium masatakasatoi* Matsui, 2013 and *Leptolalax minimus* (Taylor, 1962), for the herpetofauna of Vietnam

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Abstract: We record two megophryid species for the first time from Vietnam: *Leptobrachium masatakasatoi* and *Leptolalax minimus*. Acoustic analysis of *L. masatakasatoi* is also reported based on advertisement calls of the male specimen from Son La Province. In addition, data of morphology and natural history of afore mentioned species are provided.

Keywords: Megophryidae - Acoustics - Distribution - New records - Taxonomy - Dien Bien Province - Hoa Binh Province - Son La Province.

INTRODUCTION

The family Megophryidae is one of the most poorly studied group of amphibians in Vietnam. The knowledge about species diversity of this family has remarkably increased from 27 in 2009 to 39 at present (Nguyen *et al.*, 2009; Frost, 2014). A total of nine new species have been described from the country since 2009, namely *Leptolalax applebyi* Rowley & Cao, 2009; *Leptolalax aereus* Rowley, Stuart, Richards, Phimmachak & Sivongxay, 2010; *Leptolalax croceus* Rowley, Hoang, Le, Dau & Cao, 2010; *Leptolalax bidoupensis* Rowley, Le, Tran & Hoang, 2011; *Leptobrachium leucops* Stuart, Rowley, Tran, Le & Hoang, 2011; *Leptolalax nyx* Ohler, Wollenberg, Grosjean, Hendrix, Vences, Ziegler & Bubo, 2011; *Leptolalax firthi* Rowley, Hoang, Le, Dau & Cao, 2012; *Leptolalax botsfordi* Rowley, Dau & Nguyen, 2013; and *Oreolalax sterlingae* Nguyen, Phung, Le, Ziegler & Böhme, 2013 (Rowley & Cao, 2009; Rowley *et al.*, 2010, 2011, 2012, 2013; Ohler *et al.*, 2011; Stuart *et al.*, 2011; Nguyen *et al.*, 2013). In addition, three species were recently recorded for the first time from Vietnam, viz. *Leptobrachium guangxiense* Fei, Mo, Ye & Jiang, 2009; *Leptobrachium promustache* (Rao, Wilkinson & Zhang, 2006); and *Leptolalax eos* Ohler, Wollenberg, Grosjean, Hendrix, Vences, Ziegler & Dubois, 2011 (Bain *et al.*, 2009; Chen *et al.*, 2013; Pham *et al.*, 2014).

We herein report two additional species, *Leptolalax minimus* and *Leptobrachium masatakasatoi*, for the herpetofauna of Vietnam on the basis of a recent amphibian collection from northwestern Vietnam.

MATERIAL AND METHODS

Sampling: Field surveys were conducted in Muong Nhe Nature Reserve of Dien Bien Province, Sop Cop and Cogia nature reserves of Son La Province and Ngoc Son - Ngo Luong Nature Reserve of Hoa Binh Province, Vietnam in April 2012, April 2013, June and July 2013, March 2014, September and October 2014, and January and April 2015 (Fig. 1). Specimens were collected between 19:00 and 24:00. After photographing specimens were anaesthetized in a closed vessel with a piece of cotton wool containing ethyl acetate, fixed in 85% ethanol and subsequently stored in 70% ethanol. Voucher specimens were subsequently deposited in the collections of the Hanoi National University of Education (HNUE), the Institute of Ecology and Biological Resources (IEBR), Hanoi, the Tay Bac University (TBU), Son La Province, and the Muséum d'histoire naturelle (MHNG), Geneva.

Morphological examination: Measurements were taken with a digital caliper to the nearest 0.1 mm. Abbreviations are as follows: SVL: snout-vent length;



Fig. 1. Map showing the survey sites in northwestern Vietnam. (1) Muong Nhe Nature Reserve in Dien Bien Province; and (2) Cobia Nature Reserve; (3) Sop Cop Nature Reserve in Son La Province and (4) Ngoc Son - Ngo Luong in Hoa Binh Province.

EL: eye length, from anterior corner to posterior corner of eye; EN: distance from anterior corner of eye to posterior edge of nostril; HL: head length from posterior corner of mandible to tip of snout; HW: maximum head width, at the angle of jaws; IFE: distance between anterior corners of eyes; IBE: distance between posterior corners of eyes; IN: internarial distance; IUE: minimum distance between upper eyelids; MBE: distance from posterior corner of mandible to posterior corner of eye; MFE: distance from posterior corner of mandible to anterior corner of eye; MN: distance from posterior corner of mandible to posterior edge of nostril; NS: distance from anterior edge of nostril to tip of snout; SL: distance from anterior corner of eye to tip of snout; TYD: maximum tympanum diameter; TYE: distance between anterior margin of tympanum and posterior corner of eye; UEW: maximum width of upper eyelid; FLL: forelimb length, from axilla to tip of third finger; LAL: forearm length, from elbow to base of outer palmar tubercle; HAL: hand length, from base of outer palmar tubercle to tip of third finger; FIL: first finger length; FTL: third finger length, from articulation of proximal and intermediate phalange; HLL: hind limb length, from vent to tip of fourth toe; FL: thigh length, from vent to knee; FOL: foot length, from base of inner metatarsal tubercle to tip of fourth toe; FTL: fourth toe length, from articulation of proximal and intermediate phalange; IMT: length of inner metatarsal tubercle in foot; ITL: inner toe length; TL: shank length; TW: maximum shank width; a.s.l.: above sea level; NR: Nature Reserve. For webbing formula we followed Glaw & Vences (2007).

Acoustic analysis: Advertisement calls were recorded with a Sony Recorder ICD-UX200F with a Parabolic microphone Telinga Pro-4PIP. Calls were recorded at a distance of approximately 0.2 m and ambient

temperatures at the calling site were taken immediately after recording using an electronic thermal hygrometer Nakata NJ-2099-TH. Calls were analyzed by using Raven Pro, version 1.3 (Cornell Laboratory of Ornithology, Ithaca, New York, U.S.A.) at resolution of 16 bit and frequency of 44.1 kHz. Spectrograms were performed with Hann window type, frame length of 1024 samples, and corresponding 3 dB filter bandwidth of 67.4 Hz; frame overlapped 50% with time-grid resolution of 512 samples and frequency-grid resolution of 46.9 Hz. For each acoustic signal, the following parameters were measured: call duration or call length(s): duration of time between beginning and end of a call; call repetition rate (calls/s): (total number of calls-1)/duration of time between beginning of the first call and end of the last call; inter-call interval(s): duration of time between end of the first call and beginning of the second call; number of notes per call: total number of notes in a call; number of pulses per note: total number of pulses within a note (in some cases); dominant frequency of call (kHz): the emphasized harmonic in the spectrum (after Duellman & Trueb, 1994; Cocroft & Ryan, 1995). The first 10 notes of each call were removed according to Pröhl (2003). We calculated the coefficients of variation ($CV = [SD/mean] \times 100\%$) of the acoustic features measured in calls. We employed the criteria of Gerhardt (1991) and classified as static those acoustic properties with average within individual $CV < 5\%$, dynamic those with $CV > 12\%$, and intermediate with CV from 5-12% within-individual variation.

TAXONOMIC ACCOUNT

Leptobrachium masatakasatoi Matsui, 2013

Masatakasato's Eyebrow Toad

Fig. 2

Material examined (n = 12): TBU PAE. 102, 104; 2 adult males; near Hua Ty Village, 21°19.865'N, 103°36.796'E, elevation 1000 m a.s.l., within Cobia NR; 22 April 2012; collected by A. V. Pham, T. V. Nguyen and K. T. Do. – TBU PAE. 128; 1 adult male; near Hua Ty Village, 21°19.865'N, 103°36.796'E, elevation 1000 m a.s.l., within Cobia NR; 19 April 2013; collected by A. V. Pham, T. V. Nguyen and K. T. Do. – TBU PAE. 114; 1 adult female; near Hua Ty Village, 21°19.865'N, 103°36.796'E, elevation 1000 m a.s.l., within Cobia NR; 19 April 2013; collected by A. V. Pham, T. V. Nguyen and K. T. Do. – TBU PAE. 365; 1 adult male; near Nong Vai Village, 21°20.216'N, 103°34.822'E, elevation 1460 m a.s.l., Co Ma Commune, within Cobia NR; 9 June 2013; collected by A. V. Pham and T. V. Nguyen. – TBU PAE. 418-419, MHNG 2749.7-8; 4 adult females; near Nam Man Commune, 21°01.132'N, 103°34.293'E, elevation 1670 m a.s.l., within Sop Cop NR; 30 April 2013; collected by A. V. Pham and T. V. Nguyen. – IEBR

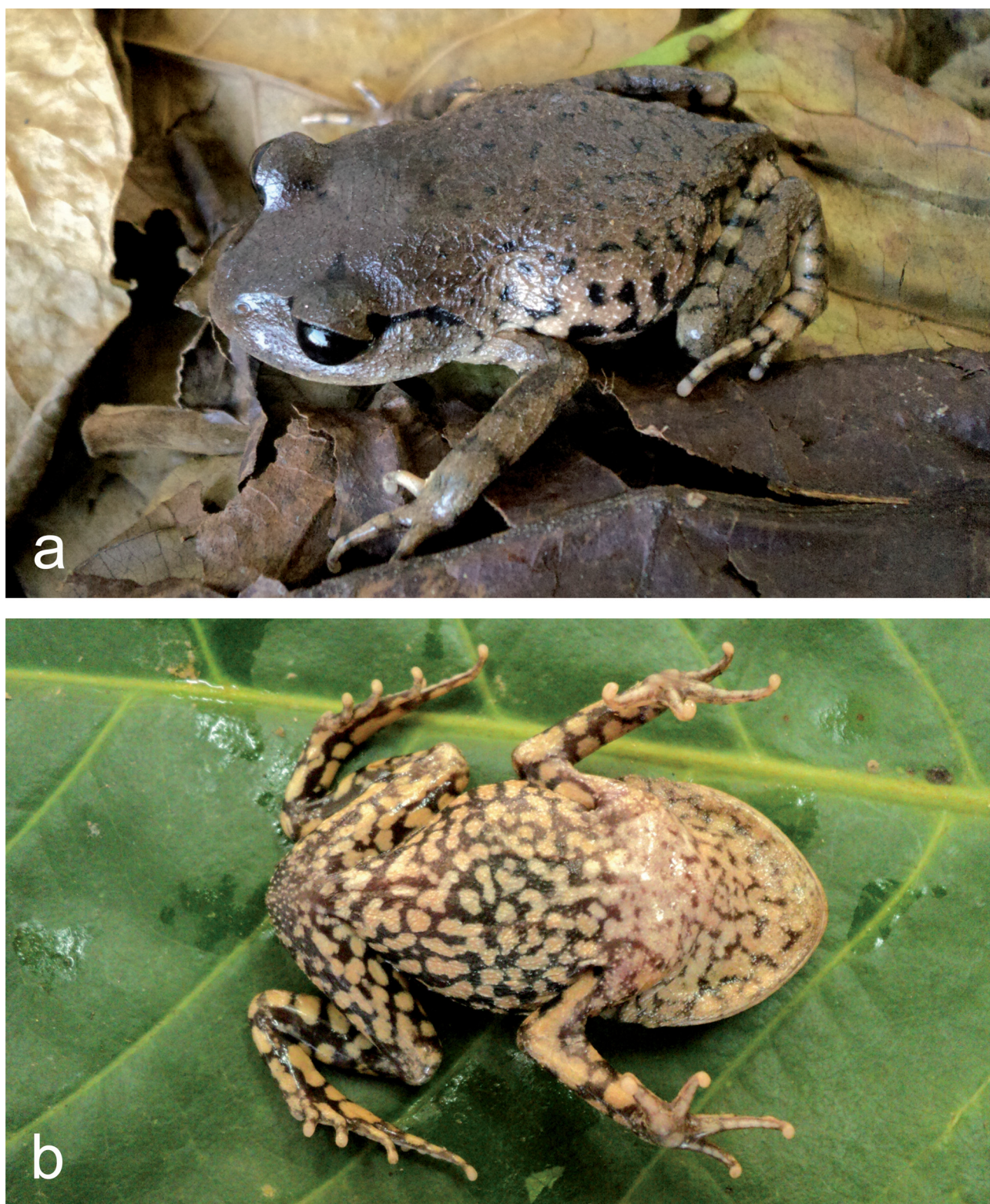


Fig. 2. *Leptobrachium masatakasatoi* from Son La Province, Vietnam (TBU PAE.365, adult male). (a) dorsolateral view. (b) Ventral view. Photos A.V. Pham.

A.2015.17; 1 adult male; near Nam Man Commune, 21°01.132'N, 103°34.293'E, elevation 1670 m a.s.l., within Sop Cop NR; 30 April 2013; collected by A. V. Pham and T. V. Nguyen. – IEBR A.2015.18-19; 2 adult males; near Tuc Pha Village, 20°57.911'N, 103°40.410'E, elevation 1270 m a.s.l., Huoi Mot Commune, within Sop Cop NR; 24 January 2015; collected by S. L. H. Nguyen and A. V. Pham.

Description: Morphological characters of specimens from Son La Province agreed well with the description of Matsui (2013): Body elongate, SVL 52.5-59.1 mm in males (mean \pm SD 55.6 \pm 2.2, n = 7) and 54.7-67.5 mm in females (mean \pm SD 61.0 \pm 5.6, n = 5) (Table 1). Head wider than long (HL 21.8-25.5 mm, HW 22.7-

27.0 mm, HL/SVL 40.0-45.0% HW/SVL 42.0-46.0% in males; HL 23.3-26.7 mm, HW 23.7-27.5 mm, HL/SVL 40.0-45.3%, HW/SVL 40.0-46.6% in females); snout rounded, barely projecting beyond upper jaw (SL 10.0-11.0 mm in males and 10.0-11.8 mm in females), longer than horizontal diameter of eye (EL 7.2-7.9 mm in males and 7.4-9.0 mm in females); canthus sharp, straight; loreal region oblique, moderately concave; nostril lateral, closer to eye than to tip of snout (NS 5.3-6.1 mm, EN 4.4-4.9 mm in males and NS 5.4-6.3 mm, EN 4.5-5.2 mm in females); interorbital space flat, broader than upper eyelid and internarial distance (IUE 6.9-7.8 mm, UEW 5.2-6.3 mm, IN 4.9-5.3 mm in males and IUE 7.4-8.2 mm, UEW 5.5-6.8 mm, IN 5.0-5.9 mm in females);

Table 1. Measurements (in mm) and proportions of *Leptobrachium masatakasatoi* and *Leptolalax minimus* from Vietnam (Min = minimum, Max = maximum, SD = standard deviation, for other abbreviations see Material and Methods)

	<i>Leptobrachium masatakasatoi</i>				<i>Leptolalax minimus</i>			
Sex	males (n = 7)		females (n = 5)		males (n = 3)		females (n = 7)	
	min – max	mean \pm SD	min – max	mean \pm SD	min – max	mean \pm SD	min – max	mean \pm SD
SVL	52.5 – 59.1	55.6 \pm 2.2	54.7 – 67.5	61.0 \pm 5.6	26.0 – 29.3	27.3 \pm 1.7	32.7 – 38.0	34.2 \pm 1.7
HL	21.8 – 25.5	23.5 \pm 1.3	23.3 – 26.7	25.0 \pm 1.7	9.9 – 10.9	10.3 \pm 0.6	12.5 – 15.0	13.1 \pm 0.8
HW	22.7 – 27.0	24.6 \pm 1.6	23.7 – 27.5	25.5 \pm 1.8	8.8 – 10.0	9.3 \pm 0.6	11.4 – 14.1	12.2 \pm 0.9
MN	18.3 – 21.0	19.7 \pm 1.0	19.1 – 23	21.1 \pm 1.6	8.6 – 9.9	9.1 \pm 0.7	10.9 – 13.2	11.7 \pm 0.9
MFE	14.8 – 17.5	15.8 \pm 0.9	15.9 – 18.2	16.9 \pm 0.9	6.6 – 7.4	6.9 \pm 0.5	8.5 – 10.5	9.2 \pm 0.6
MBE	8.3 – 9.5	8.9 \pm 0.4	9.6 – 10.6	10.2 \pm 0.5	3.5 – 4.2	3.8 \pm 0.4	4.3 – 6.1	5.0 \pm 0.6
IFE	9.5 – 11.0	10.1 \pm 0.5	9.7 – 12.2	10.8 \pm 1.0	4.6 – 5.0	4.8 \pm 0.2	5.3 – 6.8	5.6 \pm 0.5
IBE	17.0 – 19.4	18.2 \pm 0.8	17.0 – 20.3	19.0 \pm 1.6	7.5 – 8.3	7.9 \pm 0.4	9.0 – 10.9	9.8 \pm 0.6
IN	4.9 – 5.5	5.2 \pm 0.2	5.0 – 5.9	5.3 \pm 0.4	2.5 – 2.9	2.7 \pm 0.2	3.0 – 4.0	3.3 \pm 0.3
SL	10.0 – 11.0	10.5 \pm 0.4	10.0 – 11.8	10.8 \pm 0.8	3.5 – 4.1	3.9 \pm 0.3	4.5 – 5.3	4.9 \pm 0.3
NS	5.3 – 6.1	5.8 \pm 0.3	5.4 – 6.3	5.9 \pm 0.4	1.3 – 1.5	1.4 \pm 0.1	1.6 – 2.2	1.8 \pm 0.2
EN	4.4 – 4.9	4.7 \pm 0.2	4.5 – 5.2	4.8 \pm 0.3	1.6 – 2.1	1.8 \pm 0.3	2.4 – 3.5	2.8 \pm 0.4
EL	7.2 – 7.9	7.6 \pm 0.3	7.4 – 9.0	8.1 \pm 0.7	3.1 – 4.0	3.4 \pm 0.5	4.3 – 4.9	4.6 \pm 0.2
IUE	6.9 – 7.8	7.4 \pm 0.4	7.4 – 8.2	7.8 \pm 0.4	2.8 – 3.3	3.0 \pm 0.3	3.5 – 4.3	3.8 \pm 0.3
UEW	5.2 – 6.3	5.8 \pm 0.4	5.5 – 6.8	6.0 \pm 0.5	2.6 – 2.9	2.8 \pm 0.2	3.2 – 4.1	3.6 \pm 0.3
TYD	2.8 – 4.0	3.2 \pm 0.4	3.5 – 4.0	3.8 \pm 0.2	1.7 – 2.0	1.9 \pm 0.2	2.0 – 2.8	2.3 \pm 0.3
TYE	2.4 – 3.1	2.8 \pm 0.2	2.7 – 3.2	2.9 \pm 0.2	1.3 – 1.5	1.4 \pm 0.1	1.4 – 2.2	1.7 \pm 0.3
FLL	38.2 – 43.7	40.6 \pm 2.1	39.8 – 49.2	45.5 \pm 3.7	17.0 – 21.8	18.7 \pm 2.7	21.5 – 27.0	23.4 \pm 1.8
LAL	17.0 – 18.8	18.1 \pm 0.7	17.0 – 22.0	20.1 \pm 2.1	6.9 – 7.6	7.2 \pm 0.4	8.0 – 11.0	9.0 \pm 1.0
HAL	12.0 – 14.5	13.0 \pm 0.9	12.3 – 15.7	13.8 \pm 1.4	6.3 – 6.7	6.5 \pm 0.2	7.8 – 10.0	8.4 \pm 0.8
FIL	7.0 – 7.5	7.3 \pm 0.2	7.0 – 10.1	8.4 \pm 1.4	2.3 – 3.0	2.6 \pm 0.4	2.7 – 4.3	3.2 \pm 0.5
TFL	7.3 – 9.0	8.0 \pm 0.5	8.1 – 8.8	8.6 \pm 0.3	3.0 – 3.9	3.5 \pm 0.5	4.3 – 5.0	4.6 \pm 0.2
HLL	64.0 – 72.6	68.7 \pm 3.5	64.0 – 78.8	72.4 \pm 5.7	37.0 – 43.0	39.7 \pm 3.1	46.7 – 60.6	50.3 \pm 4.9

	<i>Leptobrachium masatakasatoi</i>				<i>Leptolalax minimus</i>			
Sex	males (n = 7)		females (n = 5)		males (n = 3)		females (n = 7)	
	min – max	mean ± SD	min – max	mean ± SD	min – max	mean ± SD	min – max	mean ± SD
FL	22.3 – 26.0	23.7 ± 1.4	21.3 – 27.0	24.7 ± 2.3	11.7 – 13.9	12.9 ± 1.1	15.0 – 19.4	16.1 ± 1.5
TL	19.0 – 22.0	20.7 ± 1.3	19.7 – 24.8	22.4 ± 2.0	12.0 – 14.3	13.0 ± 1.2	14.4 – 18.3	15.7 ± 1.3
TW	4.5 – 7.2	6.1 ± 1.2	4.9 – 6.7	5.8 ± 0.7	3.3 – 3.5	3.4 ± 0.1	3.0 – 4.5	3.7 ± 0.5
FOL	19.8 – 23.7	22.0 ± 1.5	20.0 – 25.6	22.9 ± 2.2	9.8 – 12.7	11.4 ± 1.5	12.9 – 17.6	14.8 ± 1.6
FTL	10.0 – 11.2	10.3 ± 0.5	10.1 – 12.0	11.2 ± 0.8	5.0 – 6.9	6.1 ± 1.0	7.2 – 9.7	8.0 ± 0.9
IMT	2.6 – 3.2	2.9 ± 0.2	2.7 – 3.7	3.2 ± 0.4	1.2 – 1.3	1.3 ± 0.1	1.2 – 2.0	1.4 ± 0.3
ITL	4.4 – 4.9	4.7 ± 0.2	4.0 – 5.4	4.8 ± 0.7	2.1 – 2.3	2.2 ± 0.1	1.9 – 3.4	2.5 ± 0.5
HL/SVL	0.4 – 0.45	0.42 ± 0.02	0.4 – 0.43	0.41 ± 0.01	0.37 – 0.38	0.37 ± 0.01	0.37 – 0.39	0.38 ± 0.01
HW/SVL	0.42 – 0.46	0.44 ± 0.01	0.4 – 0.44	0.42 ± 0.01	0.34	0.34	0.33 – 0.37	0.36 ± 0.02
SL/SVL	0.18 – 0.2	0.19 ± 0.01	0.17 – 0.19	0.18 ± 0.01	0.13 – 0.15	0.14 ± 0.01	0.13 – 0.15	0.14 ± 0.01
MN/ SVL	0.34 – 0.37	0.35 ± 0.01	0.33 – 0.36	0.34 ± 0.01	0.32 – 0.34	0.33 ± 0.01	0.32 – 0.38	0.34 ± 0.02
MFE/SVL	0.27 – 0.3	0.28 ± 0.01	0.27 – 0.29	0.28 ± 0.01	0.25	0.25	0.25 – 0.28	0.27 ± 0.01
MBE/SVL	0.15 – 0.18	0.16 ± 0.01	0.16 – 0.18	0.17 ± 0.01	0.13 – 0.14	0.14 ± 0.01	0.13 – 0.16	0.15 ± 0.01
IFE/SVL	0.17 – 0.19	0.18 ± 0.01	0.16 – 0.19	0.18 ± 0.01	0.17 – 0.18	0.17 ± 0.01	0.16 – 0.18	0.17 ± 0.01
IBE/SVL	0.31 – 0.36	0.33 ± 0.02	0.3 – 0.32	0.31 ± 0.01	0.28 – 0.29	0.29 ± 0.01	0.27 – 0.3	0.29 ± 0.01
IN/SVL	0.09 – 0.1	0.09 ± 0.005	0.08 – 0.09	0.09 ± 0.004	0.09 – 0.11	0.1 ± 0.01	0.09 – 0.11	0.1 ± 0.01
NS/SVL	0.1 – 0.11	0.1 ± 0.01	0.09 – 0.1	0.10 ± 0.004	0.05	0.05	0.05 – 0.06	0.05 ± 0.01
EN/SVL	0.08 – 0.09	0.08 ± 0.005	0.08	0.08	0.06 – 0.07	0.07 ± 0.01	0.07 – 0.09	0.08 ± 0.01
EL/SVL	0.13 – 0.14	0.14 ± 0.01	0.13 – 0.14	0.13 ± 0.01	0.12 – 0.14	0.13 ± 0.01	0.13 – 0.14	0.13 ± 0.01
UEW/SVL	0.1 – 0.11	0.11 ± 0.01	0.09 – 0.1	0.10 ± 0.004	0.1 – 0.11	0.1 ± 0.01	0.09 – 0.11	0.1 ± 0.01
IUE/SVL	0.13 – 0.14	0.13 ± 0.01	0.12 – 0.14	0.13 ± 0.01	0.11	0.11	0.1 – 0.12	0.11 ± 0.01
TYD/SVL	0.05 – 0.07	0.06 ± 0.01	0.06 – 0.07	0.06 ± 0.004	0.07	0.07	0.06 – 0.08	0.07 ± 0.01
TYE/SVL	0.04 – 0.05	0.05 ± 0.01	0.04 – 0.06	0.05 ± 0.01	0.04 – 0.06	0.05 ± 0.01	0.04 – 0.06	0.05 ± 0.01
FLL/SVL	0.7 – 0.76	0.73 ± 0.02	0.73 – 0.79	0.75 ± 0.03	0.64 – 0.74	0.68 ± 0.05	0.64 – 0.75	0.68 ± 0.04
LAL/SVL	0.3 – 0.34	0.33 ± 0.01	0.31 – 0.34	0.33 ± 0.01	0.26 – 0.27	0.26 ± 0.01	0.24 – 0.29	0.26 ± 0.02
HAL/SVL	0.22 – 0.25	0.24 ± 0.01	0.21 – 0.24	0.22 ± 0.01	0.23 – 0.24	0.24 ± 0.01	0.23 – 0.27	0.25 ± 0.01
F1L/SVL	0.13 – 0.14	0.13 ± 0.004	0.12 – 0.15	0.14 ± 0.01	0.09 – 0.1	0.09 ± 0.01	0.08 – 0.11	0.09 ± 0.01
TFL/SVL	0.14 – 0.15	0.14 ± 0.005	0.13 – 0.16	0.14 ± 0.01	0.12 – 0.13	0.13 ± 0.01	0.13 – 0.15	0.14 ± 0.01
HLL/SVL	1.19 – 1.27	1.23 ± 0.03	1.15 – 1.25	1.19 ± 0.04	1.42 – 1.47	1.45 ± 0.03	1.37 – 1.59	1.47 ± 0.09
FL/SVL	0.41 – 0.45	0.43 ± 0.01	0.39 – 0.42	0.4 ± 0.01	0.45 – 0.49	0.47 ± 0.02	0.45 – 0.51	0.47 ± 0.03
TL/SVL	0.36 – 0.39	0.37 ± 0.01	0.36 – 0.38	0.37 ± 0.01	0.46 – 0.49	0.48 ± 0.02	0.43 – 0.5	0.46 ± 0.02
FOL/SVL	0.38 – 0.42	0.39 ± 0.02	0.37 – 0.38	0.38 ± 0.01	0.38 – 0.44	0.42 ± 0.03	0.39 – 0.47	0.43 ± 0.04
FTL/ SVL	0.17 – 0.21	0.19 ± 0.01	0.18 – 0.19	0.18 ± 0.01	0.19 – 0.24	0.22 ± 0.03	0.21 – 0.26	0.23 ± 0.02
ITL/SVL	0.08 – 0.09	0.08 ± 0.01	0.07 – 0.08	0.08 ± 0.004	0.08	0.08	0.06 – 0.09	0.08 ± 0.01
IMT/SVL	0.05 – 0.06	0.05 ± 0.004	0.05 – 0.06	0.05 ± 0.01	0.04 – 0.05	0.05 ± 0.01	0.03 – 0.06	0.04 ± 0.01

tympanum indistinct (TYD 2.8–4.0 mm in males and 3.5–4.0 mm in females); tympanum-eye distance (TYE 2.4–3.1 mm in males and 2.7–3.2 mm in females); vomerine teeth absent; tongue heart-shaped, notched posteriorly; vocal openings absent.

Forelimb long (FLL 38.2–43.7 mm in males and 39.8–49.2 mm in females), forearm (LAL 17.0–18.8 mm in males and 17.0–22.0 mm in females), longer than the hand length (HAL 12.0–14.5 mm in males and 12.3–15.7 mm in females); relative finger lengths $II < IV < I < III$; fingers without dermal fringe, free of webbing; tips of fingers rounded, slightly swollen; subarticular tubercle indistinct, 1:1:2:2; palmar tubercles two, oval; nuptial pads absent.

Hindlimb slender, long (HLL 64.0–72.6 mm in males and 64.0–78.8 mm in females); foot longer than tibia (TL 19.0–22.0 mm in males and 19.7–24.8 mm in females); FOT 19.8–23.7 mm in males and 20.0–25.6 mm in females); tibiotarsal articulation reaching to posterior margin of tympanum when limb addressed along body; relative toe lengths $I < II < V < III < IV$; tips of toes slightly swollen; webbing formula $II-III1-1III1-2IV2-1V$; inner metatarsal tubercle distinct, shorter than length of toe I (IMT 2.6–3.2 mm in males and 2.7–3.7 mm in females); ITL 4.4–5.4 mm in males and 4.0–5.4 mm in females); subarticular tubercles indistinct, 1: 1: 2: 3: 2.

Skin. Dorsal surface with fine network of ridges, tubercles present in the posterior region of sacrum, more distinct in anterior part of vent; upper lip without spines in males; supratympanic fold present, from posterior edge of eye to axilla; flanks granular; throat and chest asperities; belly and ventral surfaces of limbs smooth except for granular thigh.

Coloration in life. Dorsal surface light brown or brown-reddish, with dark spots on medial side of upper eyelid, distinct or indistinct in some individual, back with irregularly black spots; supratympanic fold edged in black below; flanks light brown reticulated with large black spots; anterior part of thigh with large dark spots; dorsal limbs light brown with dark crossbars; ventral surface with irregular brown and cream markings.

Acoustic properties (Fig. 3): Calls emitted by the male (IEBR A.2015.19) from Sop Cop NR were recorded at a temperature of 8°C and a relative humidity of 83%. The calls were composed of a single pulsed note, lasting for 0.161–0.244 s (0.199 ± 0.019 ; $n = 27$), repeated at a rate of 1.115–1.218 calls/s (1.166 ± 0.073 ; $n = 2$) and inter-call intervals of 0.259–1.184 s (0.61 ± 0.277 ; $n = 24$). Each note consisted of multipulse. Frequency band of calls ranged between 0.224 and 2.015 kHz (from 0.314 ± 0.05 to 1.771 ± 0.145 ; $n = 26$). The dominant frequency, presenting at about 0.861–1.206 kHz (1.097 ± 0.098 ; $n = 26$). Rise time of calls (mean CV = 9.31%), call repetition rate (mean CV = 6.23%), inter-call interval (mean CV = 45.35%) and dominant frequency (mean CV = 8.87%) were the most stereotyped proper-

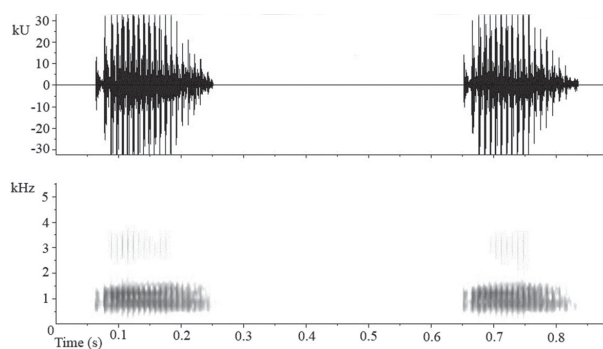


Fig. 3. Advertisement call of *Leptobrachium masatakasatoi* (IEBR A.2015.19, adult male). (a) A 0.8-sec waveform of relative amplitude. (b) Corresponding 0.8-sec spectrogram.

ties. Time of calls, call rate, and dominant frequency can be considered static properties, while inter-call interval can be considered dynamic properties. In comparison with other species of *Leptobrachium* from Vietnam, advertisement calls of *L. masatakasatoi* intensively overlap with those of *L. leucops* and *L. pullum* in both temporal and spectral properties (Stuart *et al.*, 2011; Tran, 2013). All three species emit calls of a single pulsed note, with a dominant frequency at around 1.0 kHz (*L. masatakasatoi* 0.861–1.206 kHz, *L. leucops* 1–1.6 kHz, and *L. pullum* 0.99–1.38 kHz).

Calling behavior: Calling males were found on stream banks in the secondary forest. The smallest distance in between two calling individuals was from 1 to 2 m. This species is quite sensitive for surrounding disturbances such as light or sounds. The calling individuals stayed silence for a long time when they recognized disturbances.

Ecological notes: Specimens of *L. masatakasatoi* were found on the edge of small streams and on forest paths between 20:00 and 24:00. The surrounding habitat was evergreen forest of small hardwood and shrub at elevations between 1000 and 1670 m.

Distribution: This species was previously known only from Laos (Matsui, 2013).

Leptolalax minimus (Taylor, 1962)

Small Asian Toad

Fig. 4

Leptobrachium minimum Taylor, 1962: 320.

Leptolalax (Lalos) minimus. – Delorme, Dubois, Grosjean & Ohler, 2006: 67.

Material examined (n = 10): TBU PAE.493; 1 adult male; near Hua Ty Village, 21°20.866'N, 103°34.948'E, elevation 1390 m a.s.l., Co Ma Commune, within Copia NR; 22 July 2013; collected by A. V. Pham and T. V. Nguyen. – TBU PAE.566; 1 adult female; near Kha

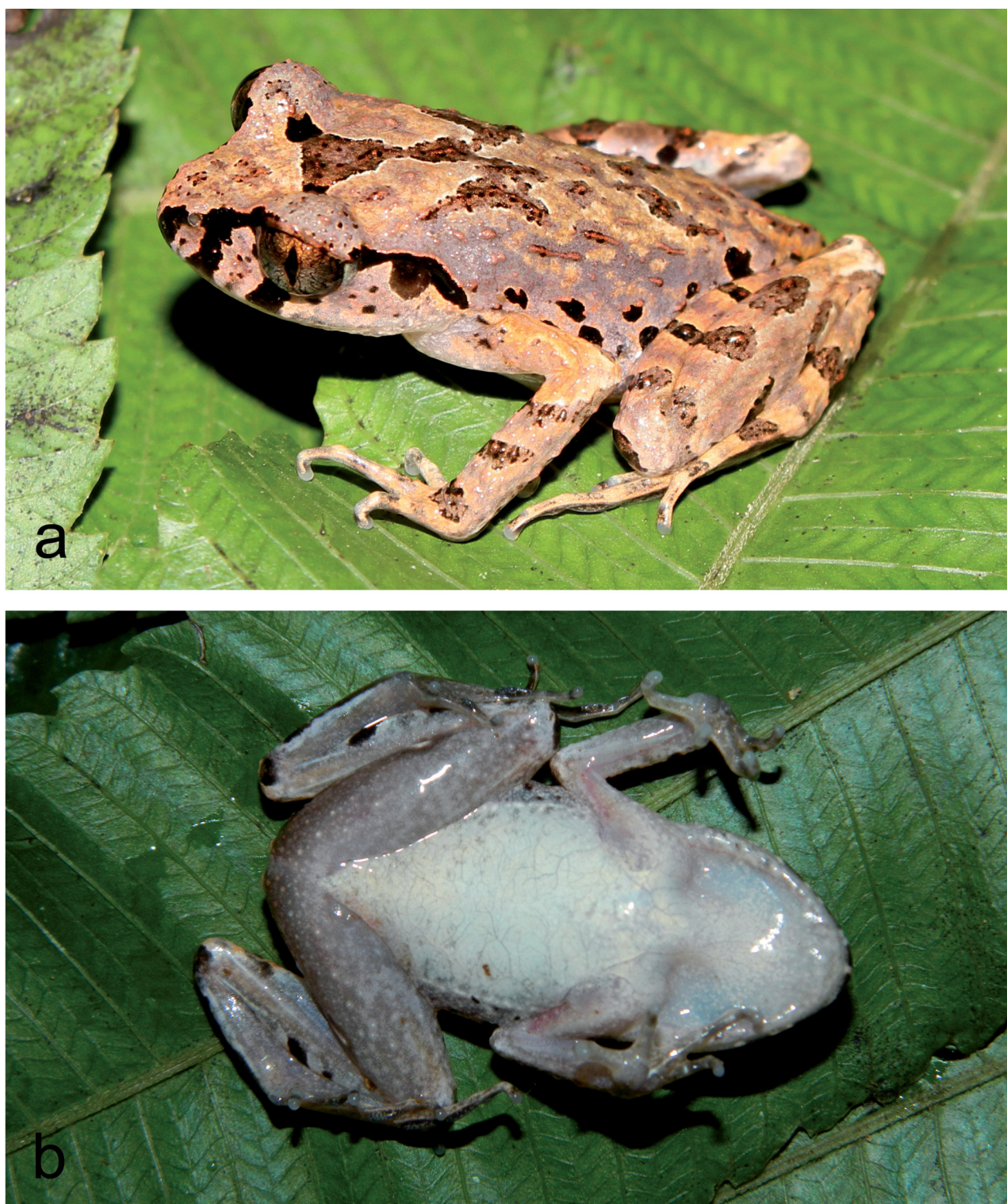


Fig. 4. *Leptolalax minimus* (IEBR A.2015.22) from Dien Bien Province, Vietnam. (a) dorsolateral view. (b) ventral view. Photos T. Q. Nguyen.

Village, 21°00.365'N, 103°25.913'E, elevation 1190 m a.s.l., Pung Banh Commune, within Sop Cop NR; 2 March 2014; collected by A. V. Pham and D. A. Vi. – IEBR A.2015.20; 1 adult male; near Kha Village, 21°00.365'N, 103°25.913'E, elevation 1190 m a.s.l., Pung Banh Commune, within Sop Cop NR; 20 September 2014; collected by T. Q. Nguyen, A. V. Pham, H. N. Ngo, T. V. Nguyen, H. V. Tu. – MHNG 2749.9; 1 adult female; near Kha Village, 21°00.365'N, 103°25.913'E, elevation 1190 m a.s.l., Pung Banh Commune, within Sop Cop NR; 21 September 2014; collected by T. Q. Nguyen, A. V. Pham, H. N. Ngo, T. V. Nguyen, H. V. Tu. – HNUE MNA.159; 1 adult female; Suoi Do stream, near Nam San village, 22°12.050'N, 102°20.483'E, elevation 1370 m a.s.l., within Muong Nhe NR; 18 February 2013; collected by D. T. Le and H. P. Vu. – HNUE MNA. 335; 1 adult female; Suoi Do stream, near Nam San village, 22°12.050'N, 102°20.483'E, elevation 1370 m a.s.l., within Muong Nhe NR; 22 March 2014; collected by D. T. Le and H. P. Vu. – IEBR A.2015.21; 1 adult male; Hang Doi mountain, near Nam Po village, 22°09.017'N, 102°26.533'E, elevation 910 m a.s.l., within Muong Nhe NR; 11 September 2014; collected by T. Q. Nguyen, D. T. Le, C. T. Pham, and H. N. Ngo. – IEBR A.2015.22, MHNG 2749.10; 2 adult females; Hang Doi mountain, near Nam Po village, 22°09.017'N, 102°26.533'E, elevation 910 m a.s.l., within Muong Nhe NR; 11 September 2014; collected by T. Q. Nguyen, D. T. Le, C. T. Pham, and H. N. Ngo. – IEBR A.2015.23; one adult female; Mu stream, Tu Do Commune, 20°41.597'N, 105°22.107'E, elevation 313 m a.s.l., within Ngoc Son-Ngo Luong NR; 4 October 2014; collected by C. T. Pham and H. N. Ngo.

Description: Morphological characters of specimens from Vietnam agreed well with the descriptions of Taylor (1962) and Ohler *et al.* (2011): SVL 26.0–29.3 mm in males (mean \pm SD 27.3 \pm 1.7 mm, n = 3) and 32.7–38.0 mm in females (mean \pm SD 34.2 \pm 1.7 mm, n = 7) (Table 1).

Head longer than wide (HL 9.9–10.9 mm, HW 8.8–10.0 mm, HL/SVL 47.0–38.0%, HW/SVL 34.0% in males; HL 12.5–15.0 mm, HW 11.4–14.1 mm, HL/SVL 37.0–39.0%, HW/SVL 33.0–37.0% in females); snout protruding, longer than eye diameter (SL 3.5–4.1 mm, EL 3.1–4.0 mm in males; SL 4.5–5.3 mm, EL 4.3–4.9 mm in females); nostrils oval, on lateral side, closer to the tip of snout than to eye (NS 1.3–1.5 mm, EN 1.6–2.1 mm in males; NS 1.6–2.2 mm, EN 2.4–3.5 mm in females); canthus rostralis distinct, loreal region concave; interorbital distance wider than upper eyelid width and internarial distance (IUE 2.8–3.3 mm, UEW 2.6–2.9 mm, IN 2.5–2.9 mm in males; IUE 3.5–4.3 mm, UEW 3.2–4.1 mm, IN 3.0–4.0 mm in females); eye large, pupil vertical; tympanum round, distinct (TYD 1.7–2.0 mm in males and 2.0–2.8 mm in females), greater than distance to posterior corner of eye (TYE 1.3–1.5 mm in males and

1.4–2.2 mm in females); vomerine teeth absent; tongue notched posteriorly.

Forelimb: Forearm rather thin (LAL 6.9–7.6 mm in males, 8.0–11.0 mm in females), longer than hand (HAL 6.3–6.7 mm in males; HAL 7.8–10.0 mm in females); relative finger lengths I<II<IV<III, tips of fingers not enlarged into discs; fingers free of webbing; subarticular tubercles distinct, 1:1.2:2; palmar tubercles round, in contact with each other, inner one very large.

Hindlimb: Thigh short (FL 11.7–13.9 mm in males and 15.0–19.4 mm in females); tibia three times longer than wide (TL 12.0–14.3 mm, TW 3.3–3.5 mm in males; TL 14.4–18.3 mm, TW 3.0–4.5 mm in females); relative toe lengths I<II<V<III<IV; webbing rudimentary between toes I and II and between IV and V, slightly developed between toes II and III, III and IV, webbing formula II–III1–2 ½ III2–3IV3–2V, dermal fringes well developed but absent along outer edge of toe V; subarticular tubercles round, indistinct, 1:1.2:3:2; inner metatarsal tubercle prominent; outer metatarsal tubercle absent.

Skin. Dorsal head smooth, dorsum and upper part of flanks with tubercles and glandular folds; supratympanic fold distinct; dorsolateral fold absent; dorsal surface of limbs with tubercles and glandular folds; ventral surface smooth.

Coloration in life. Upper part of iris dark golden, lower part grey; dorsal surface of head and body brown grey with a triangular marking between eyes, some grey spots in middle of back; dorsolateral region with some small dark spots; dorsal surface of fore and hindlimbs brown grey with dark bars; tympanic region dark brown; upper lip brown with dark bars; posterior part of thigh dark brown with white spots and a large femoral gland on each side; throat and chest transparent grey; border of throat grey with white spots; belly white.

Remarks: The female specimens from Vietnam are slightly larger than those from Thailand and Laos (SVL 32.7–38.0 mm versus 31.6–37.3 mm) (see Ohler *et al.*, 2011).

Ecological notes: Specimens of *L. minimus* were collected between 19:00 and 22:00 on stones at stream banks or on leaves, about 0.3–0.6 m above the forest floor, near rocky streams. The surrounding habitat was mixed evergreen forest or secondary forest of small hardwood, bamboo and shrub.

Distribution: This species was previously known only from Thailand and Laos (Ohler *et al.*, 2011).

DISCUSSION

Leptobrachium masatakasatoi was recently described by Matsui (2013) from Houaphan Province, northeastern Laos. The newly recorded localities in northern Vietnam are approximately 20 km distant from the type locality in Laos. *Leptolalax minimus* was described by Taylor (1962)

from Chiang Mai Province, northern Thailand. This species was recently recorded from Khammouan, Luang Prabang, and Savannakhet provinces in Laos by Ohler *et al.* (2011). The newly recorded localities in Vietnam are approximately 180 km distant from the type locality in Thailand. The new records of *L. masatakasatoi* and *L. minimus* increased the species number of the genus *Leptobrachium* to 10 and of the genus *Leptolalax* to 16 in Vietnam.

ACKNOWLEDGEMENTS

We are grateful to the directorates of Muong Nhe, Copia, Sop Cop, and Ngoc Son - Ngo Luong nature reserves for support of our field work and issuing relevant permits. We thank T. V. Nguyen, H. V. Tu, K. T. Do, D. A. Vi, M. A. Lau, T. A. Sung (Son La), K. L. Toan, L. A. Sung (Dien Bien), H. P. Vu and H. N. Ngo (Hanoi) for their assistance in the field. Thanks to E. Sterling (New York) and K. Koy (Berkeley) for providing the map. We thank two anonymous reviewers for their helpful comments. This research is supported by the National Foundation for Science and Technology Development (NAFOSTED, Grant No. 106-NN.05-2014.34). Field work in northwestern Vietnam was funded by the National Geographic Society (Grant No. 9492-14) and the Rufford Small Grants Foundation (Grant No. 14877-1). Research of A. V. Pham in Son La Province was supported by the Tay Bac University (Grant No. TB 2015-12).

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