

## First Records of *Megophrys daweimontis* Rao and Yang, 1997 and *Amolops vitreus* (Bain, Stuart and Orlov, 2006) (Anura: Megophryidae, Ranidae) from Vietnam

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**Abstract** Two amphibian species, *Megophrys daweimontis* and *Amolops vitreus*, are recorded for the first time from Vietnam, on the basis of a new amphibian collection from Dien Bien and Son La provinces. In addition, acoustic analysis of *A. vitreus* is also provided based on the advertisement calls recorded in Muong Nhe Nature Reserve of Dien Bien Province, Vietnam.

**Keywords** *Amolops vitreus*, *Megophrys daweimontis*, new records, advertisement call, Dien Bien Province, Son La Province.

Based on newly collected amphibians from Dien Bien and Son La provinces, we herein provide records of two amphibian species for the first time from Vietnam: *Megophrys daweimontis* Rao and Yang, 1997, a megophryid species which was described from Mount Dawei, Pingbian County, Yunnan, China, and *Amolops vitreus* (Bain, Stuart and Orlov, 2006), a ranid species which was previously known only from Phou Dendin National Biodiversity Area, Phongsaly Province, Laos. In addition, acoustic analysis of *A. vitreus* is also provided based on the advertisement calls recorded from Dien Bien Province of Vietnam.

Field surveys were conducted in Muong Nhe Nature Reserve (Dien Bien Province) and Copia Nature Reserve (Son La Province), Vietnam in October 2012, March, April, June, August, October and November 2013, and in February 2014 (Figure 1). Amphibians were collected between 19:00 and 24:00. After photographing, specimens

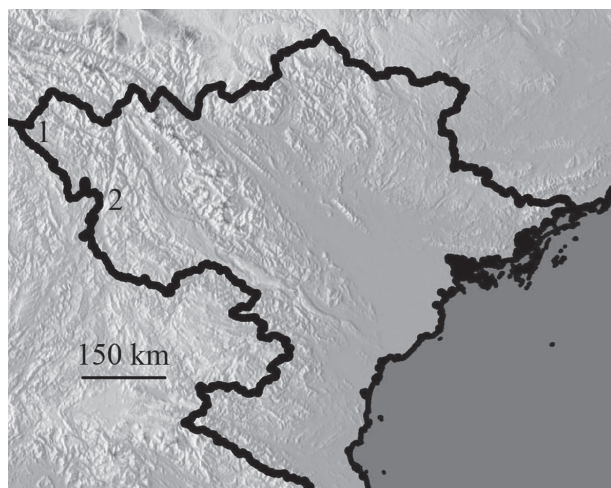
were anaesthetized in a closed vessel with a piece of cotton wool containing ethyl acetate, fixed in 85% ethanol and subsequently stored in 70% ethanol. Specimens were deposited in the Museum of Biology, Hanoi National University of Education (HNUE), Hanoi and Tay Bac University (TBU), Son La Province, Vietnam.

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

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**Figure 1** Map showing the survey sites in northwestern Vietnam: 1) Muong Nhe Nature Reserve in Dien Bien Province and 2) Copia Nature Reserve in Son La Province.

between anterior margin of tympanum and posterior corner of eye; UEW: maximum width of upper eyelid; FLL: forearm length, from elbow to base of outer palmar tubercle; HAL: hand length, from base of outer palmar tubercle to tip of third finger; TFL: third finger length, from articulation of proximal and intermediate phalange; 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; ITL: inner toe length; TFOL: length of tarsus and foot from base of tarsus to tip of fourth toe; TL shank length; TW maximum shank width; a.s.l.: above sea level.

Advertisement calls were recorded with a Sony UX Series Voice Recorder with a Telinga Parabolic microphone. 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 1,024 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: 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 and Trueb, 1994). The first 10 notes of each call were removed. We calculated the coefficients of variation ( $CV = [SD/mean] \times 100\%$ ) of the acoustic features measured in calls bout per individual in order to quantify within-individual variations of the single-note call. We employed the criteria of Gerhardt (1991) and classified as static those acoustic properties with average within individual  $CV < 5\%$  and dynamic those with  $CV > 12\%$ ;  $CV$  from 5%–12% was intermediate level of within-individual variation.

#### Taxonomic accounts

*Megophrys daweimontis* Rao and Yang, 1997 Dawei Eyebrow Toad (Figure 2)

Specimens examined. Two adult males collected by D. T. Le: HNUE MNA.120, 22 November 2013; HNUE MNA.361, 18 February 2014, in the Y Ma Ho stream



**Figure 2** *Megophrys daweimontis* from Dien Bien Province, Vietnam (HNUE MNA.361, adult male): A) dorsolateral view and B) ventral view.

(22°20.583' N, 102°12.317' E, elevation 1455 m a.s.l.), the Sin Thau sector, Muong Nhe Nature Reserve, Dien Bien Province; three adult females collected by A. V. Pham and T. V. Nguyen: TBU PAE.71, 72, 13 October 2012; TBU PAE.335, 10 June 2013, near Hua Ty Village, Co Ma Commune, Thuan Chau District, Son La Province (21°20.865' N, 103°34.948' E, elevation 1,390 m a.s.l.).

Morphological characters of specimens from Dien Bien and Son La provinces agreed well with the description of Rao and Yang (1997):

Body slender and small, females bigger than males (SVL 32.6–33.2 mm in males,  $n = 2$  and 45.6–45.8 mm in females,  $n = 3$ , see Table 1).

Head slightly wider than long (HL 11.3 mm, HW 11.3–11.4 mm, HL/SVL 0.34–0.35, HW/SVL 0.34–0.35

in males; HL 15–15.7 mm, HW 15.7–16.4 mm, HL/SVL 0.33–0.34, HW/SVL 0.34–0.36 in females); snout short, projecting beyond jaw, round in profile (SL 3.8–4 mm in males and 4.6–5.5 mm in females), shorter than horizontal diameter of eye (EL 4 mm, SL/EL 0.95–1.0 in males and EL 5.3–5.6 mm, SL/EL 0.87–0.98 in females); nostril lateral, slightly closer to tip of snout than to eye (IN 3.4–3.5 mm, NS 1.7–1.8 mm, EN 2.1–2.2 mm, NS/EN 0.77–0.86 in males and IN 4.6–4.8 mm, NS 1.8–2.4 mm, EN 2.6–3 mm, NS/EN 0.69–0.85 in females); canthus rostralis sharp, well developed; loreal region slightly oblique, interorbital space flat, broader than upper eyelid (IUE 3.4 mm in males and 5.0–5.1 mm in females); UEW 3.4 mm in males and 3.9–4.2 mm in females); anterior interorbital distance about 58%–68% of posterior

**Table 1** Measurements (in mm) and proportions of *Megophrys daweimontis* and *Amolops vitreus* from Vietnam (F = females, M = males, Min = minimum, Max = maximum, SD = standard deviation)

	<i>Megophrys daweimontis</i>				<i>Amolops vitreus</i>		Female ( $n = 1F$ )
	Min–Max ( $n = 2M$ )	Mean $\pm$ SD ( $n = 2M$ )	Min–Max ( $n = 3F$ )	Mean $\pm$ SD ( $n = 3F$ )	Min–Max ( $n = 13M$ )	Mean $\pm$ SD ( $n = 13M$ )	
SVL	32.6–33.2	32.9 $\pm$ 0.4	45.6–45.8	45.7 $\pm$ 0.1	35.5–41.7	39.1 $\pm$ 1.7	58.5
HW	11.3–11.4	11.4 $\pm$ 0.1	15.7–16.4	16.1 $\pm$ 0.4	11.1–13.4	12.4 $\pm$ 0.6	19.1
HL	11.3	11.3 $\pm$ 0.0	15–15.7	15.5 $\pm$ 0.4	12–14.5	13.8 $\pm$ 0.7	21.5
MN	9.6–9.7	9.7 $\pm$ 0.1	13.1–13.6	13.4 $\pm$ 0.3	10–12.2	11.4 $\pm$ 0.5	17.5
MFE	7.7–7.8	7.8 $\pm$ 0.1	10.5–11.8	11.2 $\pm$ 0.7	8.3–9.3	8.7 $\pm$ 0.4	13.7
MBE	4.4–4.6	4.5 $\pm$ 0.1	6.2–6.8	6.6 $\pm$ 0.3	3.9–4.9	4.3 $\pm$ 0.4	7.9
IFE	5.7	5.7 $\pm$ 0.0	7.9–8.5	8.3 $\pm$ 0.3	6.8–7.5	7.1 $\pm$ 0.2	10.5
IBE	9.6–9.8	9.7 $\pm$ 0.1	12.3–12.6	12.5 $\pm$ 0.2	9.6–11.5	10.6 $\pm$ 0.5	15.1
IN	3.4–3.5	3.5 $\pm$ 0.1	4.6–4.8	4.7 $\pm$ 0.1	3.8–4.1	3.9 $\pm$ 0.1	7
EN	2.1–2.2	2.2 $\pm$ 0.1	2.6–3	2.8 $\pm$ 0.2	2.9–3.1	3 $\pm$ 0.1	4.5
EL	4	4 $\pm$ 0.0	5.3–5.6	5.4 $\pm$ 0.2	4.6–5.4	5 $\pm$ 0.2	7.2
TYD	2.1–2.2	2.2 $\pm$ 0.1	3.2–3.5	3.3 $\pm$ 0.2	1.8–2.1	1.9 $\pm$ 0.1	3
TYE	1.6–1.7	1.7 $\pm$ 0.1	2.6–2.7	2.7 $\pm$ 0.1	1.2–1.5	1.4 $\pm$ 0.1	2.5
NS	1.7–1.8	1.8 $\pm$ 0.1	1.8–2.4	2.2 $\pm$ 0.3	2.4–3	2.7 $\pm$ 0.2	5
SL	3.8–4	3.9 $\pm$ 0.1	4.6–5.5	5 $\pm$ 0.5	5.6–6.7	6.1 $\pm$ 0.3	9.5
IUE	3.4	3.4 $\pm$ 0.0	5–5.1	5 $\pm$ 0.1	3.4–4.1	3.8 $\pm$ 0.2	5.8
UEW	3.4	3.4 $\pm$ 0.0	3.9–4.2	4 $\pm$ 0.2	2.9–3.4	3.2 $\pm$ 0.2	4.6
FLL	7.5–7.9	7.7 $\pm$ 0.3	9.4–9.8	9.7 $\pm$ 0.2	7.6–10.2	9.3 $\pm$ 0.7	13
HAL	8.7–8.9	8.8 $\pm$ 0.1	11.1–11.5	11.3 $\pm$ 0.2	11.1–13	12 $\pm$ 0.5	17
TFL	4.4–4.5	4.5 $\pm$ 0.1	5.6–6.1	5.8 $\pm$ 0.3	6.6–7.5	7 $\pm$ 0.3	9.8
TL	16.8–17.3	17.1 $\pm$ 0.4	23.7–24.5	24.1 $\pm$ 0.4	23.1–26	24.6 $\pm$ 1	36.2
FOL	13.9–14.5	14.2 $\pm$ 0.4	19.7–20.8	20.2 $\pm$ 0.6	18.6–22.2	20.4 $\pm$ 1.1	30.9
FL	15.4–15.8	15.6 $\pm$ 0.3	22.4–23.5	23 $\pm$ 0.6	19.1–22.2	21.6 $\pm$ 0.9	31.4
FTL	7.8–7.9	7.9 $\pm$ 0.1	10.8–11.9	11.5 $\pm$ 0.6	11.2–13.8	12.4 $\pm$ 0.8	19.7
IMT	1.7–1.8	1.8 $\pm$ 0.1	2.1–2.3	2.2 $\pm$ 0.1	1.5–1.7	1.6 $\pm$ 0.0	2
ITL	2.2–2.3	2.3 $\pm$ 0.1	2.2–2.3	2.2 $\pm$ 0.1	2.9–3.4	3.1 $\pm$ 0.2	4.8
TFOL	22.8–22.9	22.9 $\pm$ 0.1	31.8–33.1	32.3 $\pm$ 0.7	29.8–34	32.2 $\pm$ 1.2	49
TW	4.1	4.1 $\pm$ 0.0	4.5–4.6	4.5 $\pm$ 0.1	3.2–4.2	3.8 $\pm$ 0.3	5.5
HL/SVL	0.34–0.35	0.34 $\pm$ 0.00	0.33–0.34	0.34 $\pm$ 0.01	0.34–0.37	0.35 $\pm$ 0.01	0.37
HW/SVL	0.34–0.35	0.35 $\pm$ 0.01	0.34–0.36	0.35 $\pm$ 0.01	0.3–0.33	0.32 $\pm$ 0.01	0.33
SL/EL	0.95–1	0.98 $\pm$ 0.04	0.87–0.98	0.93 $\pm$ 0.06	1.13–1.33	1.2 $\pm$ 0.05	1.32
NS/EN	0.77–0.86	0.81 $\pm$ 0.06	0.69–0.85	0.78 $\pm$ 0.08	0.77–0.97	0.91 $\pm$ 0.06	0.69
TYD/EL	0.53–0.55	0.54 $\pm$ 0.02	0.6–0.63	0.61 $\pm$ 0.01	0.35–0.42	0.39 $\pm$ 0.02	0.42
FLL/SVL	0.23–0.24	0.23 $\pm$ 0.01	0.21	0.21 $\pm$ 0.00	0.21–0.26	0.24 $\pm$ 0.02	0.22
FL/TL	0.89–0.94	0.92 $\pm$ 0.04	0.95–0.96	0.96 $\pm$ 0.01	0.82–0.93	0.88 $\pm$ 0.03	0.87
FL/SVL	0.47–0.48	0.47 $\pm$ 0.00	0.49–0.51	0.5 $\pm$ 0.01	0.53–0.57	0.55 $\pm$ 0.01	0.54

interorbital distance (IFE 5.7 mm in males and 7.9–8.5 in females, IPE 9.6–9.8 mm in males and 12.3–12.6 mm in females); tympanum distinct, round (TYD 2.1–2.2 mm in males and 3.0–3.5 mm in females), approximately half of eye diameter (TYD/EL 0.53–0.55 in males and 0.6–0.63 in females); tympanum-eye distance (TYE 1.6–1.7 mm in males and 2.6–2.7 mm in females), about 40% of tympanum diameter; tongue round posteriorly; vomerine teeth present, equal in distance from each other and from choanae.

Forelimbs slender, long (FLL 7.5–7.9 mm, FLL/SVL 0.23–0.24 in males; FLL 9.4–9.8 mm, FLL/SVL 0.21 in females), shorter than the length of hand (HAL 8.7–8.9 mm in males and 11.1–11.5 mm in females); relative finger lengths II < I < IV < III; third finger long and thin (TFL 4.4–4.5 mm in males and 5.6–6.1 mm in females); fingers without dermal fringe, free of webbing; tips of fingers swollen; palmar tubercle distinct.

Hindlimbs slightly robust, long, thigh shorter than tibia (FL 15.4–15.8 mm, FL/TL 0.89–0.94, FL/SVL 0.47–0.48 in males and FL 22.4–23.5 mm, FL/TL 0.95–0.96, FL/SVL 0.49–0.51 in females); tibia approximately four times longer than wide in males (TL 16.8–17.3 mm, TW 4.1 mm), five times in females (TL 23.7–24.5 mm, TW 4.5–4.6 mm) and longer than distance from base of internal metatarsal tubercle to tip of toe IV (FOL 13.9–14.5 mm in males and 19.7–20.8 mm in females); toes slender, relative toe lengths I < II < IV < III < V; tips of toes swollen; toes free of webbing; inner metatarsal tubercle poorly distinct, shorter than length of toe I (IMT 1.7–1.8 mm in males and 2.1–2.3 mm in females, ITL 2.2–2.3 mm in all specimens); subarticular tubercles absent.

Skin dorsally smooth, with small warts on flanks; supratympanic fold prominent; two distinct folds on the scapular region extending posteriorly to waist; back with small fold in X-shape; upper eyelid with very small tubercles on outer edge; venter smooth.

Coloration in life: Eyes brown; irises oblique, black; gray blotch in contact with upper lip at base of lores; dorsal surface of head and body olive-brown with a triangular marking between eyes, followed by a X-shaped marking on the back; black marking beneath the vent and behind heel; outer margins of belly with large black blotches; throat, gular sacs, pectoral region and midbelly dark brown with dark marking; dorsal surface of limbs light brown with narrow, dark brown crossbars; lower surface of legs reddish innerly.

Ecological notes: Specimens were found at the banks of rocky streams, between 20:00 and 22:00. The

surrounding habitat was mixed secondary forest of small hardwood and shrub.

Distribution: This species was previously known only from the Mount Dawei, Yunnan Province, southern China (Rao and Yang, 1997). The newly recorded locality in northern Vietnam is approximately 180 km distant from the type locality in China.

Remarks. The size of male specimens of *M. daweimontis* from Vietnam was smaller than those from China (SVL 32.6–33.2 mm versus 34–37 mm).

***Amolops vitreus* (Bain, Stuart and Orlov, 2006)**  
Vitreous Cascade Frog (Figure 3)

Specimens examined. Six adult males collected by D. T. Le and N. T. Bui: HNUE MNA.229, 232, 234, 331, 332, 17 October 2013, in the Nam Pac swamp of Muong Nhe Nature Reserve, Dien Bien Province (22°13.633' N, 102°22.317' E, elevation 846 m a.s.l.). Seven adult males collected by A. V. Pham and T. V. Nguyen: TBU PAE.153, 154, 16 March 2013; TBU PAE.295, 298, 18 April 2013; TBU PAE.361, 362, 9 June 2013; TBU PAE.517, on 1



**Figure 3** *Amolops vitreus* (HNUE MNA.232, adult male) from Dien Bien Province, Vietnam: A) dorsolateral view and B) ventral view.

August 2013 and one adult female: TBU PAE.296, 18 April 2013, in Co Ma Commune, Copia Nature Reserve, Son La Province (21°20.216' N, 103°34.822' E, elevation 1,465 m a.s.l.).

Morphological characters of specimens from Dien Bien and Son La provinces agreed well with the description of Bain *et al.* (2006):

Size moderate, habitus slender, the female bigger than males (SVL 35.5–41.7 mm in males,  $n = 13$  and 58.5 mm in the single female, see Table 1).

Head narrow, longer than wide (HL 12–14.5 mm, HW 11.1–13.4 mm, HL/SVL 0.34–0.37, HW/SVL 0.3–0.33 in males; HL 21.5 mm, HW 19.1 mm, HL/SVL 0.37, HW/SVL 0.33 in the female); snout obtusely pointed in dorsal view, projecting beyond lower jaw, round in profile (SL 5.6–6.7 mm in males and 9.5 mm in the female), longer than horizontal diameter of eye (EL 4.6–5.4 mm, SL/EL 1.13–1.33 in males and EL 7.2 mm, SL/EL 1.32 in the female); nostril lateral, round, slightly closer to eye than to tip of snout (IN 3.8–4.1 mm, NS 2.4–3 mm, EN 2.9–3.1 mm, NS/EN 0.77–0.97 in males and IN 7 mm, NS 5 mm, EN 4.5 mm, NS/EN 0.69 in the female); canthus rostralis distinct, loreal region oblique, shallowly concave, interorbital space flat, broader than upper eyelid (IUE 3.4–4.1 mm in males and 5.8 mm in the female; UEW 2.9–3.4 mm in males, 4.6 mm in the female); anterior interorbital distance about 67% of posterior interorbital distance (IFE 6.8–7.5 mm in males and 10.5 mm in the female; IBE 9.6–11.5 mm in males and 15.1 mm in the female); tympanum distinct, rounded (TYD 1.8–2.1 mm in males, 3 mm in the female), equal to one third of eye diameter (TYD/EL 0.35–0.42 in males and 0.42 in the female); tympanum-eye distance (TYE 1.2–1.5 mm in males, TYE 2.5 mm in the female), approximately 70% of tympanum diameter; vomerine teeth strongly developed, on two oblique ridges, equal in distance from each other and from choanae; tongue deeply notched posteriorly; males with vocal sac openings distinct at corners of mouth.

Forelimbs robust, short (FLL 7.6–10.2 mm, FLL/SVL 0.21–0.26 in males; FLL 13 mm, FLL/SVL 0.22 in the female), about 80% of the hand length (HAL 11.1–13 mm in males, HAL 17 mm in the female); relative finger lengths  $I < II < IV < III$ ; tips of all four fingers expanded with circummarginal grooves; finger I with indistinct circummarginal groove, without dermal fringe, free of webbing; width of finger III disc about 1.5 times width of phalanx; subarticular tubercle formula: 1, 1, 2, 2; palmar tubercles two, oval; males with nuptial pad on finger I.

Hindlimbs very long, thigh shorter than tibia (FL

19.1–22.2 mm, FL/TL 0.82–0.93, FL/SVL 0.53–0.57 in males; FL 31.4 mm, FL/TL 0.87, FL/SVL 0.54 in the female); tibia approximately six times longer than wide (TL 23.1–26 mm, TW 3.2–4.2 mm in males and TL 36.2 mm, TW 5.5 mm in the female), longer than distance from base of internal metatarsal tubercle to tip of toe IV (FOL 18.6–22.2 mm in males and FOL 30.9 mm in the female); toes thin, relative toe lengths  $I < II < III < V < IV$ ; tips of toes round, enlarged; webbing formula  $I1/3-1/2II0-1III0-1/3IV1/3-1/2V$ ; inner metatarsal tubercle distinct (IMT 1.5–1.7 mm in males, 2 mm in the female), outer metatarsal tubercle distinct, round; subarticular tubercles round, formula 1, 1, 2, 3, 2.

Skin dorsally and ventrally smooth, except granular on posterior surface of thigh; humeral gland absent; supratympanic fold absent; rictal glands two, anterior gland continuous with upper lip; dorsolateral fold weak, glandular, from posterior corner of upper eyelid to near vent; ventral surface translucent.

Coloration in life: Upper eyelids dark green without any stippling or spots; side of head dark brown, from tip of snout, continuing as a narrow streak below edge of dorsolateral fold; white upper lip stripe present, extending from tip of snout to posterior of arm insertion; rictal glands yellowish cream; a narrow yellowish gray stripe on edge of canthus, from tip of snout along margin of upper eyelid continuing above edge of dorsolateral fold; dorsum grayish green with dark brown stippling and large brown spots that concentrate near sacrum; upper portion of flank grayish green with brown spots as on dorsum; lower half of flank creamy white, with brown mottling; dorsal surface of limbs light brown with narrow, dark brown crossbars, interspersed with small dark brown spots; posterior portion of thigh creamy white with brown longitudinal markings near vent; ventral surface cream, with a few, brown, very lightly stippled markings on lower jaw, throat, gular sacs, pectoral region, and outer margins of belly; ventral surface of hindlimbs creamy-yellow, with loosely grouped dark brown stippling; nuptial pad white; outer metatarsal tubercle white; foot webbing gray with white network, and white outer margin.

Ecological notes: Specimens were found on the ground, on shrubs and ferns near the wetland area or at stream banks, between 19:00 and 24:00, ca. 1.5–2 m above the water surface and about 1–2 m from the stream.

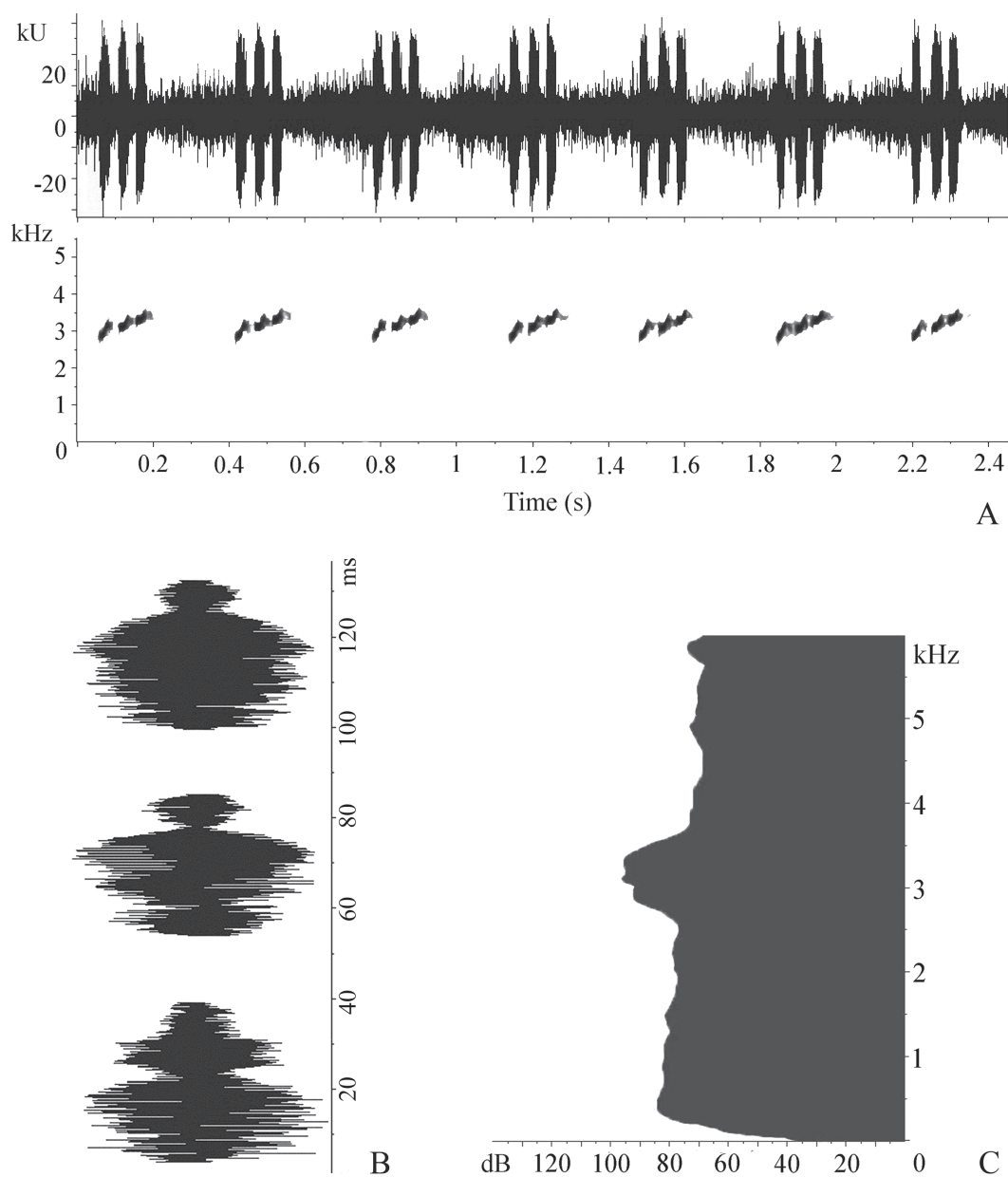
Distribution: This species has been reported from Phou Dendin National Protected Area, Phongsaly Province, northeastern Laos (Bain *et al.*, 2006). The newly recorded locality of this species in Vietnam is approximately 20 km

eastern from the type locality in Laos.

Acoustic properties (Figure 4): Calls emitted by two males (HNUE MNA.232, 234) from Muong Nhe Nature Reserve were recorded at an air temperature of 17°C and a relative humidity of 92%. The calls were composed of multi-note, lasting for 5.389–23.175 s ( $14.282 \pm 12.577$  s,  $n = 2$ ). Each note consisted of 3 pulses ( $n = 42$ ), delivered at a rate of 17.14–20.55 pulses/s ( $18.5 \pm 0.8$ ;  $n = 42$ ), inter-note intervals of 0.175–0.25 s ( $0.2 \pm 0.022$  s;  $n = 41$ ). The intensity of notes was from 114 dB to 116 dB ( $115.4 \pm 0.5$  dB,  $n = 42$ ). The dominant frequency of the primary calls was 2.62 and 3.69 kHz (from  $2.68 \pm 0.05$

kHz to  $3.65 \pm 0.03$  kHz,  $n = 42$ ). Analysis call types of the adult males showed the most of pulse were created by a main structure (large subpulse) and an auxiliary structure (small subpulse).

Rise time of calls (mean CV = 88.06%), rise note duration (mean CV = 4.04%); dominant frequency (mean CV = 0.77%) were the most stereotyped properties. According to the criteria of Gerhardt (1991), dominant frequency and call duration can be considered static properties, while rise time can be considered dynamic properties.



**Figure 4** Advertisement call of *Amolops vitreus* (HNUE MNA.232, male): A) a 2.4 s waveform of relative amplitude (above) and corresponding 2.4 s spectrogram (below), B) two peaks per pulse in a note, and C) the power spectrum of a call.

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