

Two new species of *Leptotalax* (Anura: Megophryidae) from northern Vietnam

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Abstract. Two new species of *Leptotalax* are described from two mountain ranges in northern Vietnam (Song Gam and Tam Dao) that are less than 150 km apart. Currently, only two species of *Leptotalax*, *L. pelodytoides* and *L. bourreti*, are described from Vietnam. The two new species are distinguished from other *Leptotalax* by a combination of characters including skin texture, ventral color pattern, presence or absence of spots on the flanks, and lateral fringes on the toes. Furthermore, the new species can be distinguished from the widely distributed and sympatric *L. pelodytoides* by their large size, indistinct color pattern, and an absence of granules under the chin. In addition, one of the new species has a higher cellular DNA content than sympatric *L. pelodytoides*.

Introduction

In this time of growing concern to conserve and document what remains of the global biodiversity, many programs have been established to inventory the remaining biota. We are involved in the fourth year of a collaborative program in Vietnam. Prior to 1993 the amphibian fauna of Vietnam was known almost exclusively from the work of Rene Bourret (1942). More recent investigations in Thailand (Taylor, 1962), Borneo (Inger, 1966), and China (Fei et al., 1991; Ye et al., 1993) have provided a great deal of additional information allowing us to make inferences about the herpetofauna and its distribution in Vietnam. Given the complicated geologic history (Hall, 1996) and concomitant topography of Indochina, it is predictable that a number of isolated species with relatively narrow distributions occur in Vietnam. Our work in two primary forests in northern Vietnam has revealed endemic species of megophryid frogs.

Frogs of the genus *Leptotalax*, a genus composed of ten species, are often found near rocky streams in the moist mountain forests of southeast Asia (Fei et al., 1992; Inger

and Stuebing, 1989; Karsen et al., 1986). They occur from southern China eastward to Burma, and as far south as Borneo (Frost, 1985). All species of *Leptotalax* are relatively small (20-44 mm snout-vent length) compared to some of the other members of the family Megophryidae. Frogs of this genus can be distinguished from other megophryids by their diminished size as well as a combination of the following six characteristics: (1) the presence of an elevated thenar tubercle that is not continuous on to the thumb; (2) chest glands are present but they do not form teats, as in *Megophrys* and *Ophryophryne*; (3) vomerine teeth are absent; (4) eggs are white; (5) the tadpoles possess a subterminal oral disk (characters 1-5, Inger, 1966); and (6) the anterior tip of snout has a vertical white bar. Herein we describe two remarkable new species of *Leptotalax* from northern Vietnam.

Materials and methods

All measurements were taken with digital calipers to the nearest 0.01 mm and rounded to 0.1 mm. Specimens used as comparative material are from a large series of *L. pelodytooides* from Tam Dao National Park, Vietnam (21°27'31"N; 105°38'61"E) (ROM 28675-694) and Pac Ban Village, Na Hang Nature Reserve, Tuyen Quang Province, Vietnam (22°19'94"N; 105°25'79"E) (ROM 28695-708). All figures were drawn with the aid of a Wild dissecting microscope fitted with a drawing tube.

Description of the species

Lepotalax sungi sp. nov.

Figure 1

Materials studied

Holotype. An adult male (ROM 28474) from a stream on the east side of the village of Tam Dao (21°27'31"N; 105°38'61"E), elevation 925 m, Vinh Phu Province, Vietnam; collected on 11 August 1996 by R.W. Murphy.

Paratypes. There are seven paratypes, collected in the vicinity of the holotype. Three gravid females, ROM 28472-73, collected by N. Orlov and R. Bain on 22-27 May 1996 and MVZ 223699, collected by T.J. Papenfuss on 7 May 1996; three adult males, ROM 28471 purchased from local hunters on 6 May 1996, ROM 31153, collected by N. Orlov in June 1997 and AMNH 13038 collected by C. Raxworthy and D. Frost on 2 August 1997; one subadult specimen, ROM 31152, collected by N. Orlov in June 1996.



Figure 1. New species of *Leptolalax*. Above: paratype of *Leptolalax sungi*, ROM 28471, male, 49.8 mm SVL; below: holotype of *Leptolalax nahangensis*, ROM 28715, male, 40.8 mm SVL.

Diagnosis

A large-sized *Leptolalax*, males attaining a snout-vent length (SVL) of 49.8 mm and females being slightly larger (58.9 mm). *Leptolalax sungi* is distinct from all other *Leptolalax* in having a combination of the following characteristics: (1) large size; (2) fingers I and II equal in length; (3) webbing on toes moderate between digits I-IV, basal between IV-V, lateral fringes on toes weakly present; (4) head slightly wider than long; (5) snout acuminate in dorsal view and round in lateral view, extending slightly over lower jaw; (6) tympanum indistinct; (7) supratympanic fold distinct; (8) flanks may have small spots, never with large dark patches; (9) dorsum uniformly light brown or with light spots; (10) venter, smooth and immaculate; (11) a single median subgular vocal sac.

Leptolalax sungi can be distinguished from other species of *Leptolalax* by its large size (females to 58.9 mm SVL; males to 52.7 mm), absence of large spots along flanks, dorsum and limbs covered in coarse granules, and a indistinct tympanum that is obscured by overlying skin. An entirely white venter distinguishes it from all species of *Leptolalax*, except *L. dringi*, *L. hamidi*, *L. arayai* and *L. bourreti* (as taken from the description of *Megophrys pelodytoides*, Bourret, 1942: 209). The chin of *L. hamidi* and *L. arayai* is dusky (Matsui, 1997). In contrast, the chin of *L. sungi* is entirely white. Furthermore, the pattern on dorsum is faint or absent in contrast to discrete spots present on *L. hamidi* (Matsui, 1997). Absence of a glandular area above the insertion of the arm distinguishes it from *L. bourreti*, *L. pelodytoides*, *L. alpinus*, and *L. ventripunctatus*. Furthermore, *L. dringi* has two glandular zones (Dubois, 1980), one behind the tympanum and the other below the eye; neither of which are found on *L. sungi*. Fei et al. (1992) report a longitudinal white gland along the ventrolateral margin of the belly that is present in *L. alpinus* and *L. pelodytoides*, but this is absent in *L. sungi*. The subarticular tubercles on the feet are weakly elevated, and not keratinized, thus distinguishing it from a new species from southern Vietnam recently described by Inger et al. (in press).

Description of holotype

Head broad, width slightly greater than length, length 92% of width. Snout distinctly pointed in dorsal view, and rounded in lateral view (fig. 2), slightly extending beyond mandible. Nostrils situated anterolaterally on snout, closer to tip of snout than to eye. Internarial distance 24% of head width. Canthus sharp, gently curving ventrally in profile. Loreal region vertical, distinctly concave. Eyes large, twice diameter of tympanum, nearly 30% of head length; interorbital width almost twice that of upper eyelid width. Tympanum round, not distinct; diameter less than distance between tympanum and eye. Supratympanic fold distinct, extending from a level dorsal to corner of eye posterovertrally to a point behind articulation of jaw. Vomerine teeth absent; tongue broad, deeply notched. Vocal sac single, median subgular.

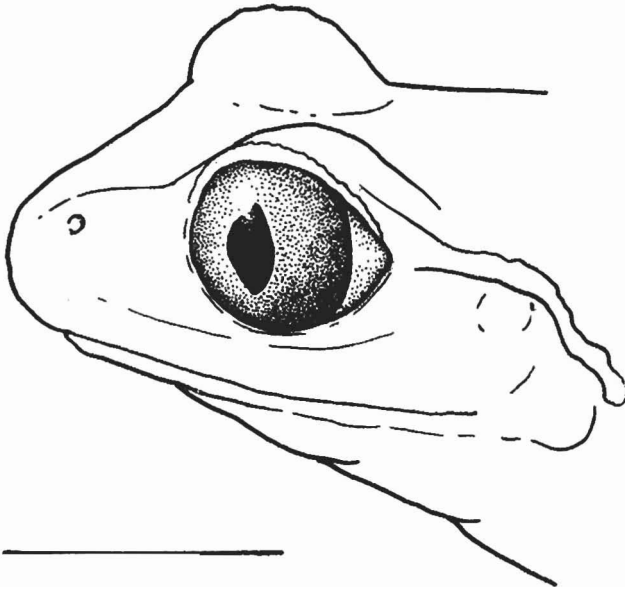


Figure 2. Head of *Leptolalax sungi* (ROM 28471) in lateral view. Scale = 5 mm

Hand length (from base of thenar tubercle to tip of digit III) 30% of SVL, relative lengths of fingers I = II = IV < III (fig. 3); fingers terminate in swollen tips. Webbing absent; large, distinct inner metacarpal tubercle, separated anteriorly from a smaller, conspicuous outer metacarpal tubercle by a slight furrow. Foot length (from base of inner metatarsal tubercle to tip of digit IV), nearly equal to that of tibia, 42% of the SVL. Webbing basal between toes I-IV, absent between IV and V; lateral fringes weak. Subarticular tubercles absent; callous ridge weakly present on ventral side of toes III-V, inner metatarsal tubercle pronounced, elliptical; outer metatarsal tubercle absent.

Skin on dorsum uniformly granular with distinct tubercles dispersed on dorsum, flanks and head; upper eyelid granular, lateral margin with a low distinct granular margin extending on to canthus; no distinct conical tubercle(s) on eye; ridges or dorsolateral folds on back absent; flanks granular with a few larger tubercles near waist; belly, throat, and ventral surface of thighs smooth; chest gland oval, low, and medial to axilla, length larger than that of diameter of tympanum. White gland at terminal end of supratympanic fold absent. Femoral gland present; situated closer to knee than to anus.

Color in life

Uniformly light brown on dorsum with scattered, orange tubercles on back, flanks, head, extending anteriorly to eyes, and especially concentrated in areas adjacent to anus. Ventral margin of supratympanic fold, vertical bars on upper lip, transverse bars on limbs, and ventral surfaces of forearm and foot dark brown. Transverse bars on femur distinct

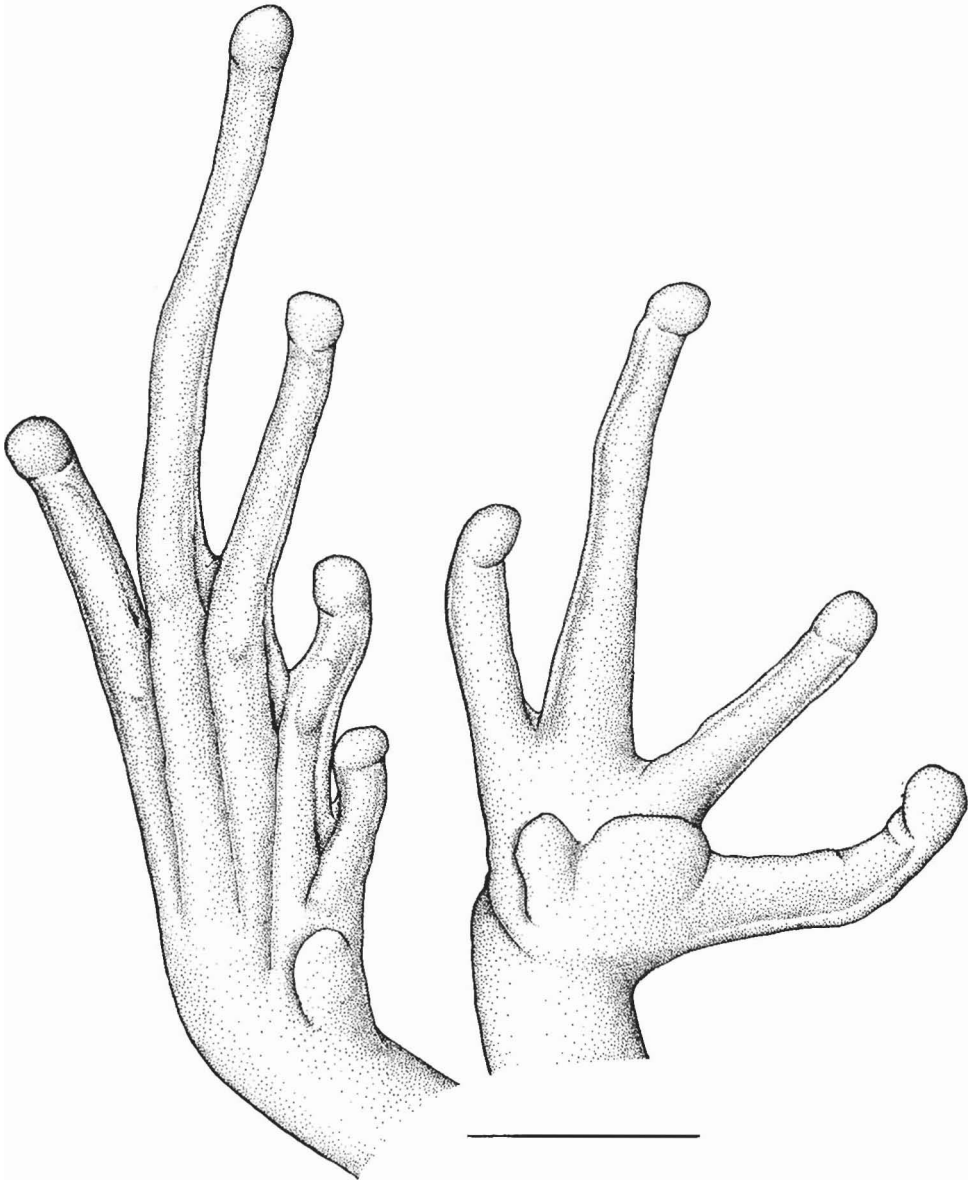


Figure 3. Foot and hand of *Leptolalax sungi* (ROM 28474) in ventral view. Scale = 5 mm.

on anterior surface, with diffuse mottling posteriorly. Flanks covered with diffuse black flecks. Belly, ventral surface of thighs, and throat creamy-white, with mottling confined to margin of lower jaw, ventral surface of forearm, tibio-tarsus and feet. Toe tips of some specimens imbued with red. Iris almost iridescent gold-green with only slight mottling along outer margin.

Color in preservative

Light to dark brown-gray above and on sides; interorbital bar and canthus dark brown to black, distinct dark bar below eye, extending to ventral edge of upper lip; distinct light, vertical bar at tip of snout; very thin white, granular ridge along margin of canthus and upper eyelid; ventral margin of supratympanic fold dark brown. Femoral gland white; numerous white pustules adjacent to vent.

Measurements of holotype (in mm)

SVL, 48.3; tibia, 23.1; hand, 13.9; foot, 20.3; head length, 17.6; head width, 19.1; snout length, 5.6; interorbital distance 9.4; eye length, 5.4; upper eyelid length, 4.2; eye-nostril distance, 3.4; eye-tympanum, 3.4; tympanum diameter, 2.9; nostril-tip of snout, 2.3; quadratojugal-tip of snout, 21.0.

Etymology

The specific name is a patronym for Prof. Dr. Cao Van Sung, Director of Vietnam's Institute of Ecology and Biological Resources, in recognition of his outstanding, unflinching, indefatigable, innovative efforts to protect and conserve Vietnam's biota.

Variation and remarks

Variation in measurements is given in table 1. Females are slightly larger, and more robust than males. There are no indications of secondary sexual characters (nuptial excrescences or pads) in males. The color on the dorsum is light brown, consistently having an inverted triangle between the eyes. The remainder of the dorsum may be composed of conspicuous mottling (in preservative) as seen in all specimens, except ROM 28471 and ROM 31153, in which the mottling is absent. Transverse bars on limbs may be distinct (MVZ 223699; ROM 28473; ROM 28474; ROM 31152), broken (ROM 28472), or absent (ROM 28471 and ROM 31153). The formation of the callous ridges underneath the toes may be weak and unclear (ROM 28471; ROM 28474; ROM 31152) or distinctly present (ROM 28472-3; ROM 31153; MVZ 22399).

Distribution and ecology

All six specimens collected by us and Dr. Theodore Papenfuss came from the vicinity of a single stream passing through the east side of the village of Tam Dao; the seventh specimen was purchased from local collectors and we are unsure of its precise origin. Despite equivalent amounts of time searching alternative streams, all of our efforts failed to produce specimens in these sites. Of the six specimens collected by us, one, the holotype, was collected on the side of the stream ravine, about 1 meter off the ground while poised on a small log. The remaining five frogs were found on the paved road or foot path that is adjacent to the eastern-most stream in the village of Tam Dao. All

Table 1. Measurements (in mm) of adult *Leptolalax sungi*. For each measurement the mean \pm one standard deviation are provided above the range (in parentheses).

Character	Female (<i>n</i> = 3)	Male (<i>n</i> = 3)
snout-vent length	57.9 \pm 1.1 (56.7-58.9)	50.3 \pm 2.2 (48.3-52.7)
tibia length	24.6 \pm 1.3 (23.6-26.1)	22.7 \pm 0.4 (22.8-23.1)
hand length	14.5 \pm 0.3 (14.3-14.9)	13.5 \pm 0.4 (13.2-13.9)
foot length	22.6 \pm 1.7 (20.8-24.1)	20.2 \pm 0.2 (20.0-20.4)
occipital region to tip of snout	18.5 \pm 1.0 (17.5-19.5)	17.6 \pm 0.4 (17.3-18.0)
head length	23.4 \pm 0.6 (23.0-24.1)	20.4 \pm 0.9 (19.3-21.0)
head width	21.6 \pm 0.4 (21.2-21.9)	19.4 \pm 0.8 (18.9-20.3)
snout length	7.3 \pm 0.6 (6.9-8.0)	6.0 \pm 1.8 (4.2-7.7)
interorbital distance	10.5 \pm 0.8 (10.0-11.4)	9.6 \pm 0.3 (9.4-9.9)
eye length	7.1 \pm 0.1 (6.9-7.2)	6.1 \pm 0.8 (5.4-6.9)
upper eyelid width	5.5 \pm 0.1 (5.4-5.6)	4.6 \pm 0.5 (4.2-5.2)
eye-nostril distance	5.2 \pm 0.3 (4.9-5.5)	5.2 \pm 0.6 (4.7-5.9)
eye-tympanum distance	3.8 \pm 0.5 (3.4-4.3)	3.3 \pm 0.2 (3.0-3.4)
tympanum diameter	3.5 \pm 0.5 (3.1-4.0)	2.5 \pm 0.4 (2.1-2.9)
nostril-tip of snout distance	2.6 \pm 0.5 (2.1-3.0)	2.1 \pm 0.2 (1.9-2.3)

specimens except a gravid female (ROM 28472) were collected on rainy nights, the latter was found on a warm dry evening.

Leptolalax nahangensis sp. n.

Figure 1

Material studied

Holotype. An adult male (ROM 28715) from the entrance of a cave, 7 km east of the village of Pac Ban (22°19'94"N; 105°25'79"E), elevation 314 m, Na Hang Nature Reserve, Tuyen Quang Province, Vietnam; collected on 1 June 1996 by A. Lathrop.

Table 2. Measurements (in mm) of males of *Leptolalax nahangensis* and *L. pelodytoides* from two different localities. Except SVL, each measurement is given as a ratio with the mean \pm one standard deviation above the range (in parentheses).

Character	Males		
	<i>L. nahangensis</i> <i>n</i> = 1	<i>L. pelodytoides</i>	
		Pac Ban <i>n</i> = 10	Tam Dao <i>n</i> = 10
SVL	40.8	27.05 \pm 2.8 (24.3-33.4)	28.6 \pm 0.8 (27.1-29.8)
tibia length/SVL	0.49	0.50 \pm 0.02 (0.46-0.53)	0.50 \pm 0.02 (0.47-0.52)
hand length/SVL	0.33	0.26 \pm 0.02 (0.24-0.28)	0.26 \pm 0.01 (0.26-0.33)
foot length/SVL	0.46	0.45 \pm 0.03 (0.39-0.49)	0.47 \pm 0.01 (0.45-0.49)
occipital region-tip of snout/head width	0.96	1.01 \pm 0.04 (0.95-1.09)	1.03 \pm 0.03 (0.97-1.08)
head length/SVL	0.40	0.37 \pm 0.02 (0.36-0.40)	0.36 \pm 0.06 (0.32-0.38)
snout length/head length	0.30	0.33 \pm 0.03 (0.30-0.39)	0.35 \pm 0.02 (0.31-0.39)
interorbital distance/head width	0.50	0.54 \pm 0.04 (0.49-0.61)	0.53 \pm 0.06 (0.45-0.63)
eye length/head length	0.37	0.37 \pm 0.02 (0.35-0.41)	0.41 \pm 0.09 (0.34-0.65)
eye-tympanum distance/tympanum	0.50	0.62 \pm 0.11 (0.42-0.81)	0.81 \pm 0.06 (0.71-0.91)
tympanum diameter/eye length	0.49	0.42 \pm 0.05 (0.44-0.64)	0.42 \pm 0.06 (0.32-0.40)

Diagnosis

A large sized *Leptolalax* having (1) finger I < II, (2) basal webbing on all toes, (3) head as wide as long, (4) snout bluntly rounded in profile, extending slightly over lower jaw, (5) tympanum distinct, half the eye length, (6) supratympanic fold distinct, terminating dorsal to axilla, (7) flanks with a line of several large spots, (8) dorsum lavender-brown with large, irregular mottling, (9) venter smooth, with light speckling on throat and chest, (10) vocal slits.

Leptolalax nahangensis can be differentiated from most other *Leptolalax* by its larger size, SVL of male holotype 40.8 mm (SVL of males in mm: *L. dringi* 24.2-28.5 [Dubois, 1987]; *L. ventripunctatus*, 25.5-28 [Fei et al., 1992]; *L. alpinus* 24-26.4 [Fei et al., 1992]; *L. bourreti* 36.2 [Dubois, 1983]; *L. heteropus*, 24.2-28.5 [Dubois, 1983]; *L. pictus* 30-35 [Malkmus, 1992]; *L. arayai* 30 mm [Matsui]; *L. hamidi* 28-31 [Matsui]). *Leptolalax nahangensis* can further be distinguished from those species that do not have shoulder glands (*L. sungi* and *L. gracilis*). The absence of lateral fringes on the toes differs *L. nahangensis* from *L. heteropus*, *L. alpinus*, *L. bourreti*, *L. sungi* and *L. pelodytoides*. The ventral color pattern of *L. nahangensis* differs it from those species with immaculate venters, *L. sungi* and *L. dringi*, and *L. bourreti* (as described as *Megophrys pelodytoides*

in Bourret [1942]), and from the color pattern found in *L. pelodytoides* as illustrated in fig. 4. The color pattern in *L. pelodytoides* is confined to speckling on the chin that surrounds large white pustules. The legs of *L. pelodytoides* are dark brown with scattered white spots, whereas, in *L. nahangensis* the color pattern consists of light mottling on the chin, extending to the throat, and the ventral surface of the legs are white and posterior thighs light brown with white spots. Measures of cellular DNA content for sympatric *L. pelodytoides* (5.13 ± 0.05 pg) are much less than that seen in *L. nahangensis* (5.46 pg) (see remarks below).

Description of holotype

Head broad, width nearly equal to length; snout rounded in dorsal view, bluntly rounded in profile, extending slightly beyond mandible (fig. 5); nostrils situated dorsolaterally on snout, 2.5 times closer to tip of snout than to eye; internarial distance 25% of head width; canthus round, flat in lateral view; loreal region oblique and concave. Eyes moderately large, twice that of tympanum, 40% of head length; interorbital distance 1.5 of upper eyelid width. Tympanum round, distinct; twice that of distance from tympanum to eye. Supratympanic fold distinct, extending from corner of eye to a point dorsal to shoulder. Vomerine teeth absent; tongue triangular in shape, deeply notched, not broad. Vocal slits present.

Hand length 33% of SVL; relative length of fingers $I < II < IV \ll III$; digits terminate in slightly swollen tips (fig. 6). Large thenar tubercle, not continuous with thumb, separated by slight furrow from smaller outer metacarpal tubercle. Fingers III and IV bear a distinct ridge ventromedially; finger II with a less distinct ridge. Foot length nearly equal to that of tibia, 46% of SVL. Webbing basal between all toes, lateral fringes absent; sharp callous ridge present ventrally on toes III-V; II with a distinctly truncate ridge ventromedially forming a large subarticular tubercle; inner metatarsal tubercle pronounced, elliptical; no outer metatarsal tubercle.

Skin on dorsum smooth, with small pustules and minute tubercles uniformly distributed; dorsolateral fold absent; upper eyelid smooth with several pustules on posterior corner; flanks smooth, large tubercles near waist absent; belly, throat, and ventral surface of thighs smooth; chest gland oval, low, and medial to axilla, length less than that of diameter of tympanum. White gland at terminal end of supratympanic fold present. Femoral gland 50% closer to tibia articulation than to vent; a single pair of pustules adjacent to vent.

Color in life

Dorsum and limbs brownish lavender; flanks light gray-lavender; upper eyelids gray. Dorsum covered with irregular, diffuse dark gray and black spots. Flanks with a series of large well defined black spots. Limbs and digits with transverse dark bars. Forearm and heels yellow-orange; belly pinkish-white. Supratympanic fold flanked and accen-



Figure 4. Ventral color patterns of adult males of (left) *Leptolalax nahangensis* (holotype), ROM 28715 and (right) *L. pelodytooides* (28700) from Pac Ban, Tuyen Quang Province, Vietnam. Drawings are not to scale, and the outline for each species is the same with the color pattern superimposed.

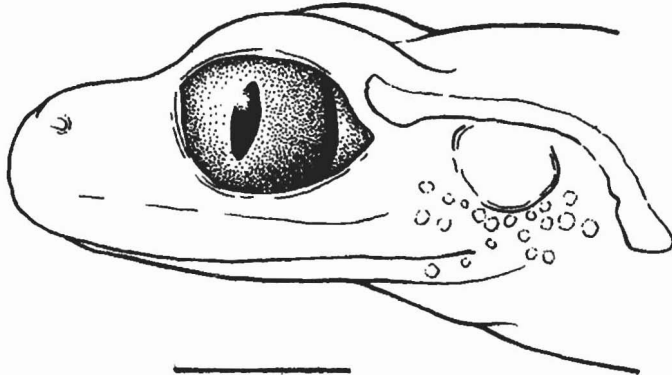


Figure 5. Head of *Leptolalax nahangensis* (ROM 28715) in lateral view. Scale = 5 mm.

tuated in black. A pair of vertical bars on upper lip, one below eye and loreal region. Canthus rostralis black, extending over tip of snout producing a light vertical bar at tip of snout. Tympanum black, or partly so. Iris gold uniformly distributed with minute black, reticulations.

Color in preservative

Dark brown-gray above and on sides; interorbital bar, canthus dark brown to black, vertical bars on upper lip black; vertical bar at tip of snout distinct, lighter than color on dorsum; ventral margin of supratympanic fold dark brown. Limbs light gray to brown-gray with distinct transverse bars. Ventral surfaces of thighs and belly creamy-white, light mottling ventral surface of forearm, tibio-tarsus, feet, and from margin of lower jaw to chest. Femoral gland and pustules adjacent to vent white.

Measurements of holotype (in mm)

SVL, 40.8; tibia, 20.1; hand, 13.3; foot, 18.6; head length, 15.0; head width, 15.6; snout length, 5.0; interorbital distance 7.8; eye length, 6.1; upper eyelid length, 4.7; eye-nostril distance, 3.8; eye-tympanum, 1.5; tympanum diameter, 3.0; nostril-tip of snout, 1.5; quadratojugal-tip of snout, 16.5.

Etymology

The species name is derived from the type locality and in recognition of the unfailing support of the government officials, nature reserve officers, and people of Na Hang Nature Reserve. It is likely that the species range is limited to Na Hang Nature Reserve; our collecting efforts in Ba Be National Park failed to produce specimens even though the site was only 30 km east.

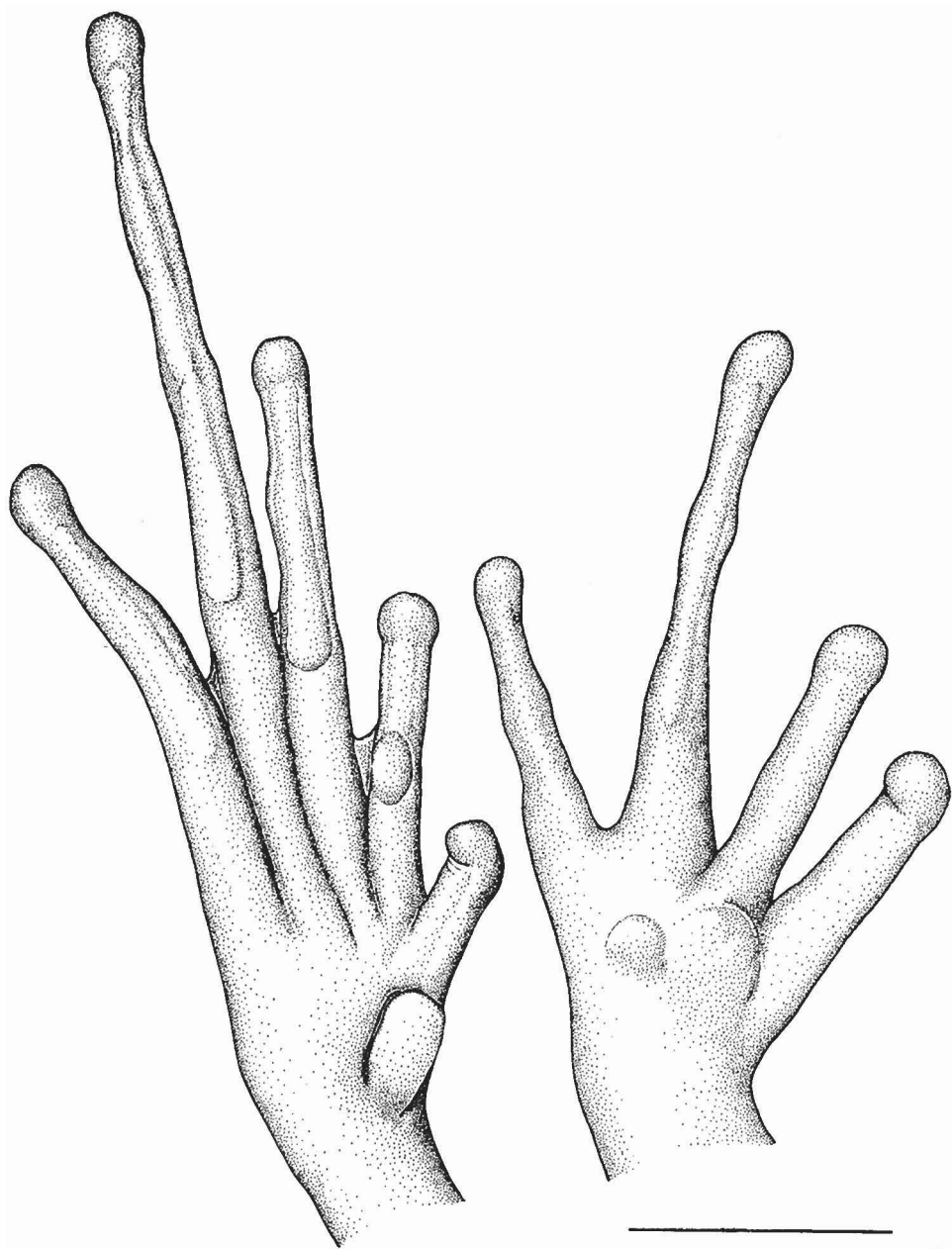


Figure 6. Foot and hand of *Leptolalax nuhangensis* (ROM 28715) in ventral view. Scale = 5 mm.

Remarks

Cellular DNA content levels have been used as a quick and inexpensive method to identify cryptic species (Murphy et al., 1997). Among Vietnamese megophryids, DNA

content levels are consistent within a species and show very little variation even between populations. An example of this can be observed among three populations of *Megophrys lateralis* (Tam Dao 6.94 ± 0.15 pg; Pac Ban, 6.98 ± 0.05 pg, Khe Moi, 6.92 ± 12 pg [\pm represents standard deviations]). In light of this, the difference observed between *L. nahangensis* (5.46 pg) and *L. pelodytoides* (5.13 ± 0.05 pg) is noteworthy.

Distribution and ecology

The holotype was collected after a rainstorm at the very early part of the rainy season in northern Vietnam. The frog was located by its call; it was found in a dry stream bed on top of a large boulder amongst a bed of other large rocks. After nearly 24 hours of heavy rains, this dry river bed was full with shallow running water. The call, unlike that of *L. pelodytoides*, was a single, loud chirp, produced at an interval of approximately 30 seconds. The call of *L. pelodytoides* is composed of a series of several chirps, as though dragging a finger over a comb.

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