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Herpetofaunal Diversity of Ha Giang Province in Northeastern Vietnam, with Descriptions of Two New Species

RAOUL H. BAIN¹ AND NGUYEN QUANG TRUONG²

ABSTRACT

In April and May of 2000, herpetological surveys of Ha Giang Province, Vietnam, near the Chinese border were undertaken. Surveys concentrated on isolated forests of Mount Tay Con Linh II (contiguous with the highest peak in eastern Vietnam, Mt. Tay Con Linh). The 26-day survey yielded 36 species of amphibians and 16 species of reptiles. The collection contains elements of Himalayan as well as Indo-Malayan assemblages and documents a new country record (*Philautus rhododiscus*), eight new records east of the Red River (*Bombina microdeladigitata*, *Megophrys parva*, *Amolops chapaensis*, *Chaparana delacouri*, *Chirixalus gracilipes*, *Philautus odontotarsus*, *Polypedates dugritei*, *Rhacophorus hoanglienensis*), seven species complexes (*Fejervarya limnocharis*, *Hoplobatrachus rugulosus*, *Limnonectes kuhlii*, *Rana chloronota*, *R. maosonensis*, *Polypedates dugritei*, and *P. leucomystax*), three unidentified amphibian species, and two previously undescribed species of cascade ranid (*Rana iriodes*, new species and *Rana tabaca*, new species). *Rana iriodes* differs from *R. daorum* and *Amolops chunganensis* in having an iridescent green-gold dorsum, orange-red dorsolateral folds, a gold-white flank spot, vomerine teeth, and webbing to toe disks. *Rana tabaca*, new species, can be differentiated from other cascade ranids by a combination of characters: mottled brown upper lip, gold lip line below the eye to the arm insertion, shagreened dorsum, dorsolateral folds, and unpigmented eggs. Species accumulation curves indicate that the diversity of the region is still underestimated, which, along with the relatively extensive remnant forest, underscores the importance for a greater faunal understanding and conservation effort for the montane forests of the region.

¹ Center for Biodiversity and Conservation, and Division of Zoology (Herpetology), American Museum of Natural History (bain@amnh.org).

² Institute of Ecology and Biological Resources, Vietnam National Center for Natural Sciences and Technology, Nghia Do, Tu Liem, Hanoi, Socialist Republic of Vietnam (truongqt@iebr.ncst.ac.vn).

INTRODUCTION

The past decade has seen a marked increase in our understanding of the diversity and distribution of Vietnamese herpetofauna (e.g., Darevsky, 1999; Inger et al., 1999; Ohler et al., 2000; Orlov et al., 2001, 2002; Ziegler, 2002; Bain et al., 2003; Ohler, 2003) that has built on the contributions of herpetologists from the first half of the 20th century (e.g., Bourret, 1936, 1937, 1941, 1942; Smith 1931, 1935, 1945). Despite this recent increase in research, an understanding of the diversity and distribution of the Vietnam fauna is still emerging. In northern Vietnam, surveys have concentrated in the Hoang Lien Mountains west of the Red River and the Bak Kan region (today Bac Kan and Cao Bang Provinces) east of the Red River (Bourret, 1942; Smith, 1945; Ohler et al., 2000; Orlov et al., 2001). These areas lie in a transition zone between Palearctic and Paleotropical climates, containing elements of Tibeto-Himalayan and Indo-Malayan assemblages (Inger, 1999; Zhao, 1999; Anonymous, 2000; Averyanov et al., 2003).

In April and May of 2000, as part of a multitaxa survey effort, we undertook herpetological surveys in Ha Giang Province, which lies between the Hoang Lien Mountains and Bak Kan (Nguyen and Carpenter, 2002; Hurley, 2003; Lunde et al., 2003; Vogel et al., 2003). As in mountainous areas west of the Red River, Tay Con Linh II communicates with the Himalayas of southern Yunnan Province, China. Some of the herpetofauna of southern Yunnan have recorded distributions that end on the Vietnam border (Fei, 1999), indicating weak sampling effort in this politically sensitive area. For these reasons, our survey results were expected to include both Tibeto-Himalayan and Indo-Malayan faunal elements found in other mountainous areas of northern Vietnam and southern China.

Survey work was divided between two parcels in Ha Giang Province; one 29 km northeast of Ha Giang City on Mount Muong Cha (1773 m), Du Gia Commune, the other 21 km west of Ha Giang City on Mount Tay Con Linh II (2100 m), Cao Bo Commune (fig. 1). Tay Con Linh II is contiguous with Mount Tay Con Linh (2616 m), the highest

peak in eastern Vietnam. Because Ha Giang Province is located on the border of two northern Indochinese climatic zones the timing of the dry and wet seasons is slightly variable from year to year and from region to region (Institute of Geography, 1989). The climate in Ha Giang Province is temperate, but highly localized montane weather patterns create variable conditions among different regions. In Cao Bo, the dry season is from mid-September until the end of May, and the remainder of the year is rainy. Du Gia experiences a wet season one month earlier. The average annual temperature in Ha Giang City (22°49'N, 104°59'E) is 22.7°C, with monthly averages ranging from a low of 15.4°C in January to a high of 27.8°C in July; yearly rainfall in Ha Giang City is 2430.1 mm, with monthly averages ranging from a low of 31.5 mm in December to a high of 515.6 mm in July; average annual humidity is 84% (Institute of Geography, 1989).

MOUNT MUONG CHA

Initial surveys were carried out between 27 April and 3 May 2000 near the Hmong Village of Khau Ria, in Du Gia Commune, Yen Minh District, below Mt. Muong Cha (22°54'29"N, 105°14'20"E, 600–1100 m elevation). Small-scale livestock and cultivated fields are found below 800 m, while scrub growth with grasses and woody shrubs (maximum height 3 m) are found between 800 and 950 m. Above 1000 m is a patch of disturbed primary forest having trees approximately 30 m high and 50 cm DBH (diameter at breast height), with the occasional 1-m DBH tree. The canopy is approximately 80% closed and the forest contains dense undergrowth with large vines, tree ferns, rhododendrons, and melastomes. Footpaths lead through 10-m² clearings of banana, bamboo, and secondary scrub. Cascading streams are fast moving, alternating among waterfalls, glides, and pools. Pool widths vary between 2 and 10 m, and their limestone, detritus-laden bottoms vary in diameter from 1 and 10 m and in depth from 0.2 to 1.5 m. Seep-like streams on the forest floor are less than 1 m wide, slow, and sandy-bottomed. Above 1100 m is an impassable limestone cliff run-

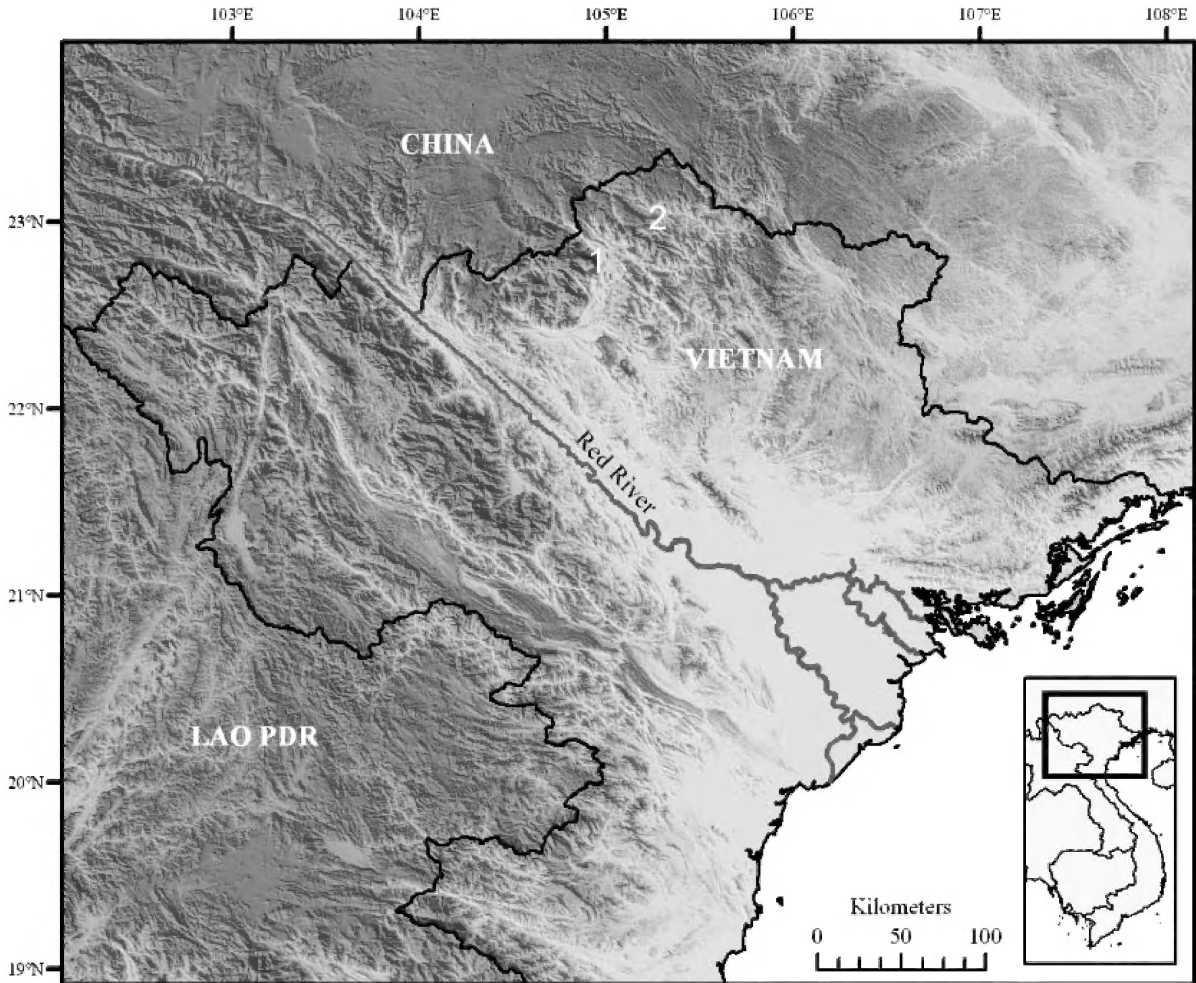


Fig. 1. Map of Vietnam and surrounding countries (inset). Collecting localities within Ha Giang Province, Vietnam: (1) Mt. Tay Con Linh II, (2) Mt. Muong Cha.

ning along the northeast face of Mt. Muong Cha. The southwest slope has a much shallower grade and is almost entirely cultivated.

TAY CON LINH II

The second surveys were carried out in four sites between 6 and 26 May 2000. This was done around Mt. Tay Con Linh II, in Cao Bo Commune, Vi Xuyen District, which lies between two watersheds. Waterways originating on the western side of the mountain flow west, into the Chay River, and those originating on the eastern side flow east, into the Lo River, which eventually joins the Red River.

Site 1: 600 m, Tham Ve Village: This site was on the Nam Ma River (22°45'39"N,

104°52'23"E, 600 m) near the Dao Village of Tham Ve. The Nam Ma is also referred to as the Bac Trao River above the village. Terraced paddies are common, with scattered second growth of woody scrub and ferns, as well as cultivated palms, cinnamon trees, tea, and bamboo. At this elevation the Nam Ma is approximately 20 m wide and fast flowing, with large, smoothly worn boulders among the cascades, glides, and pools. The pools vary in diameter from 1 to 10 m and in depth from 0.1 to 3 m. The river is granite bottomed, but pools contain a layer of sand or mud beneath a thin layer of detritus. A stone and cement bridge was built at this elevation in early 2000. Riparian vegetation is present both on islands in the river and alongside the

banks. There is an occasional large (1 m DBH, 20 m in height) tree along the river. Above 700 m the canopy over the river becomes partially enclosed by scrub vegetation. Taller secondary forest begins between 1020 m (22°45'36"N, 104°51'05"E) and 1200 m elevation (22°45'42"N, 104°15'36"E). This secondary forest includes broadleaf evergreen trees, approximately 20 m high with a 30 cm DBH. Palms, bamboo, and banana, with edge undergrowth of brackens and melastomes, are typical at this elevation.

Site 2: 1400 m camp: This site was within disturbed, primary broad-leaved evergreen forest (22°46'10"N, 104°49'53"E, 1400 m). This forest is characterized by trees with DBH 60 cm (tallest over 30 m), mostly *Camellia* (Theaceae) and *Litsea* (Lauraceae), as well as tree ferns, small buttress trees (DBH 30 cm), and a mixed herbaceous-woody understory of Urticaceae, Vitaceae, and ferns. The slope faces directly south. The soils are micaceous quartz with a rich humus layer, more than 1 m in depth in some places. The formations in this area are largely granitic. Small cascading streams (2–3 m in width) and slower streams with pools are prevalent, as are numerous narrow dry ridges.

Site 3: 1700 m camp: This site was directly upslope from site 2, on a well drained, north-facing ridge top (22°45'27"N, 104°49'35"E, 1700 m). Site 3 is drier and flatter than site 2, semiclosed, premontane mixed evergreen and deciduous forest, with one species of clumping bamboo (10–15 cm DBH). Large trees (Lauraceae, Fagaceae, Theaceae, Meliaceae, and Magnoliaceae) are more evenly spaced, and the herb layer tends to be more homogeneous (including ferns and melastomaceous shrubs). The soils are humus-rich, well-rotted micaceous quartz. There are a few small (2–3 m in width) streams and seasonally dry streambeds that contain seeps and small pools. All waterways are rocky bottomed, with prevalent broad-leaved undergrowth.

Site 4: 2000 m: This site was directly upstream from site 2 (close to 22°46'36"N, 104°49'00"E, 1900 m). It is a montane mixed semideciduous and evergreen cloud forest subject to mists and cloud-borne moisture. This forest is accessed by well-worn hunter paths, which follow through an understory of

Ericaceae with shrub and epiphytic species of *Rhododendron* and *Vaccinium*. Compared to sites 2 and 3, site 4 has many more individual trees of measurable size (greater than 10 cm DBH), but much less diversity in this size class. The family most represented at this elevation is Lauraceae, distantly followed by Ericaceae and Oleaceae (both equally represented) with few and equal numbers of taxa in the Fagaceae, Myrsinaceae, and Araliaceae. Most of the tree trunks support a thick growth of bryophyte mosses. Soils at this site are acidic with thick humus layers. At this site there is no flowing water.

MATERIALS AND METHODS

INSTITUTIONAL ABBREVIATIONS

AMNH	American Museum of Natural History, New York
BMNH	The Natural History Museum, London
FMNH	Field Museum of Natural History, Chicago
IEBR	Institute of Ecology and Biological Resources, Hanoi
MNHNP	Museum National D'Histoire Naturelle, Paris
ROM	Royal Ontario Museum, Toronto

We used opportunistic searching and pitfall traps to sample herpetofauna. Two pitfall trap lines at site 2 were each 50 m long, with buckets (300 mm diameter, 450 mm deep) sunk into the ground at 10-m intervals. A drift fence of plastic sheet 0.5 m in height was buried 50 mm in the substrate. It was positioned to run across the midline of the buckets and scored such that it hung inside of them. Traplines were placed in different microhabitats: one in a flat, open clearing near a small spring, the other running lengthwise along the crest of a well-drained ridge. Traplines were checked at least twice daily and kept as dry as possible. Voucher photographs of live specimens were taken. Collected specimens were euthanised within 24 hours of collection. Amphibians were euthanised using a solution of Chlorotone, and reptiles were euthanised with an injection of Nembutol, according to accepted protocol (Simmons, 2002). All specimens were fixed in a 10% solution of commercial grade formalin, which was buffered with calcium carbonate, and subsequently preserved in 75%

ethanol. Tissue samples were taken from a subset of each species (3–5 specimens) and stored in 95% ethanol. Samples of muscle and liver were taken from amphibians, while those of muscle and heart were taken from reptiles. Tissue samples were subsequently stored below 0°C once out of the field and are now housed in liquid nitrogen vapor at –150°C at the AMNH.

Recordings of frog calls, using a hand-held tape recorder, were made for some specimens. The information recorded for each specimen included date, locality, approximate time of collection, microhabitat, elevation, air temperature, sex (where possible without dissection), and collectors. Each specimen is referable to a field number (AMNH FS-) and an AMNH and/or IEBR catalog number. Those specimens on long-term custodial loan to the AMNH from the IEBR are reported with both an AMNH and an IEBR catalog number (e.g., AMNHxx/IEBRxx). Comparative specimens were examined from AMNH, BMNH, FMNH, IEBR, MNHNP, and ROM collections (appendix 1).

We used primary (where necessary) and secondary sexual characters to record the sex of specimens, and made all measurements using digital calipers to the nearest 0.01 mm. Measurements of amphibians included snout-vent length (SVL); head length (HDL) from tip of snout to the articulation of the jaw; head width (HDW) at greatest width of the jaw; snout length (SNT) from the anterior portion of the eye to the tip of the snout; eye diameter (EYE); interorbital distance (IOD); tympanum diameter (TMP); hand length (HND) from base of the palm to tip of FIII; tibial length (TIB); and foot length (FTL) from distal end of tibia to tip of distal phalanx of III. We determined internal characters (xiphisternum condition, oviduct condition, egg characteristics, terminal phalanx shape) by making small incisions, where necessary.

RESULTS

A summary of the species found is given in table 1, and a summary of ecological data for each species is given in table 2. A combined total of 16 reptile species (14 genera, five families) and 36 amphibian species (20

genera, seven families) were recorded during the 6 days spent at Mt. Muong Cha and the 20 days spent at Mt. Tay Con Linh II (table 1). A cumulative total of 143 hours were spent in direct observation between both mountains. Approximately 55 hours were spent actively searching Mt. Muong Cha, where seven reptile species (seven genera, two families), and 21 amphibian species (16 genera, five families) were recorded. Eleven reptile species (eleven genera, five families) and 30 amphibian species (17 genera, seven families) were recorded at Mt. Tay Con Linh II, logged by a total of 88 hours of active searching and approximately 737 pitfall hours. Pitfall traps yielded 21 captures of one species of reptile (*Acanthosaura lepidogaster*) and three species of frogs (*Leptobrachium chapaense*, *Leptolalax bourreti*, *Megophrys parva*) (table 2). Species accumulation curves (fig. 2) failed to reach a sustained plateau, as novel species continued to be documented up until the last day of the field season.

There were several species that were found exclusively or primarily in highly disturbed habitat: *Bufo melanostictus*, *Microhyla heymonsi*, *M. pulchra*, *Microhyla* sp., *Fejervarya limnocharis*, *Hoplobatrachus rugulosus*, *Rana guentheri*, *R. taipehensis*, *Philautus odontotarsus*, *Polypedates leucomystax*, *Ptyas korros*, and *Dendrelaphis pictus*. These species all have wide distributions throughout Southeast Asia (see Discussion for comments on *M. sp.*). *Amolops ricketti*, *R. maosonensis*, and *Sinonatrix aequifasciata* were found in waterways adjacent to agriculture, but not distant (~0.5 km) from forest. All of the reptiles recorded on the survey are known from southern China and Indochina.

Although listed as single species here, *F. limnocharis*, *Rana chloronota*, *R. maosonensis*, *H. rugulosus*, *L. kuhlii*, *Polypedates dugritei*, and *P. leucomystax* are all recognized as complexes of cryptic species whose delineation of species boundaries are not clearly understood (Wu and Zheng, 1994; Murphy et al., 1997; Toda et al., 1998a, 1998b; Inger, 1999; Emerson et al., 2000; Orlov et al., 2002; Bain et al., 2003). Below we comment on amphibian species that have significant range extensions, are poorly known, or are

TABLE 1
Continued

	Specimen Number (AMNH, AMNH Field Series, or IEBR)	Mt. Muong Cha				Mt. Tay Con Linh II			
		600–800 m	800–950 m	1000–1100 m	600–1200 m	1400 m	1500 m	1700 m	1900+ m
Rhacophoridae (continued)									
* <i>Philautus odontotarsus</i>	AMNH 163974–163980	5,6	5,6						
<i>Philautus parvulus</i>	AMNH 163901–163903			6,7	6,7	7	7	8	
! <i>Philautus rhododiscus</i>	AMNH 163892/IEBR 59								1
* <i>Polypedates atgritiei</i>	AMNH 163910–163913								
<i>Polypedates leucomystax</i>	AMNH 163981–163988	5	6	7	5				
* <i>Rhacophorus hoanglienensis</i>	AMNH 163767/IEBR 57			7					
<i>Theloderma asperum</i>	Only call recorded			7					
Rhacophorid sp. (#1)	Only call recorded						7	7	7
Rhacophorid sp. (#2)	Only call recorded								8
ORDER SQUAMATA									
Agamidae									
<i>Acanthosaura lepidogaster</i>	AMNH 148555–148560		7	7		7,8	7,8	7	
<i>Physignathus cocincinus</i>	AMNH 148566				?				
Scincidae									
<i>Scincella reevesii</i>	AMNH 148576						8		
Anguidae									
<i>Ophisaurus harti</i>	AMNH FS-15377				?				
ORDER SERPENTES									
Colubridae									
<i>Ahaetulla prasina</i>	AMNH 148561			7					
<i>Amphiesma modesta</i>	AMNH 148575							3	
<i>Amphiesma khasiensis</i>	AMNH 148562, 148563	6	6,8,9						
<i>Calamaria septentrionalis</i>	AMNH R-148564						8		
<i>Dendrelaphis pictus</i>	Not collected								7
<i>Oligodon taeniatus</i>	AMNH FS-15290								
<i>Pareas hamptoni</i>	AMNH 148565								
<i>Pseudoxenodon karlschmidti</i>	AMNH 148567		9						8
<i>Ptyas korros</i>	AMNH 148568	5			6				
<i>Sinonatrix aequifasciata</i>	AMNH FS-15614				4				
<i>Sinonatrix percarinata</i>	AMNH 148569	3,4	3,4						
Viperidae									
<i>Trimeresurus stejegeri</i>	AMNH 148570, 148571					4		4,7,8,9	

*, New record east of Red River; !, new country record.
 Microhabitats/substrates are indicated by numerical codes as follows: 1, temporary forest pools; 2, forest seeps; 3, streams 2–5 m wide; 4, streams >5 m wide; 5, rice paddies; 6, edge of agriculture and second growth; 7, in forest above ground on trees/shrubs; 8, on forest floor; 9, vegetation above or adjacent to streams; ?, microhabitat unknown.

TABLE 2
Ecological Data for Amphibians of Ha Giang

	Open scrub/ stillwater	Open moving water	Edge forest to 1.5 m	Forest pools	Forest seeps	Forest streams	Stream- side forest floor	Stream- side forest to 1.5 m	Stream- side forest >1.5 m	Forest to 2 m	Forest >2 m
ORDER CAUDATA											
Salamandridae											
<i>Tylototriton asperrimus</i>				B			L				
ORDER ANURA											
Bombinatoridae											
<i>Bombina microdeladigitora</i>								B			
Bufonidae											
<i>Bufo melanostictus</i>	B		B								
Megophryidae											
<i>Leptobrachium chapaense</i>				L,M		L,M	M				
<i>Leptolalax bourreti</i>						C,B,L	C,B	C,B			
<i>Megophrys major</i>				L?			C,B			C	
<i>Megophrys palpebralespinosa</i>				L?						C	
<i>Megophrys parva</i>				L?		C,B	C,B				
<i>Ophryophryne microstoma</i>						M				C	
Microhylidae											
<i>Microhyla</i> sp.	J										
<i>Microhyla heymonsi</i>	C,B				C,B						
<i>Microhyla pulchra</i>	C,B				C,B						
Ranidae											
<i>Amolops chapaensis</i>						B,L?			B		
<i>Amolops ricketti</i>		B									
<i>Chaparana delacouri</i>				B,C,L?		B,C,L?					
<i>Fejervarya limnocharis</i>	C,B										
<i>Hoplobatrachus rugulosus</i>	C,B										
<i>Limnonectes kuhlii</i>		B				B,C					
<i>Paa boulengeri</i>				B,C,L?		B,C,L?					
<i>Rana chloronota</i>		B,C	B			B,C		B,C			
<i>Rana guentheri</i>	B,C										
<i>Rana iriodes</i>						B			B		
<i>Rana maasonensis</i>			B								
<i>Rana tabaca</i>						B		B,C			
<i>Rana taipehensis</i>	B										
Rhacophoridae											
<i>Chirixalus gracilipes</i>				B,C,L							
<i>Philautus maasonensis</i>										B,C	
<i>Philautus odontotarsus</i>	B,C		B,C							B,C	
<i>Philautus parvulus</i>			B,C					B,C		B,C	
<i>Philautus rhododiscus</i>										B	C?
<i>Polypedates dugritei</i>				B,C							B,C
<i>Polypedates leucomystax</i>	B,C,L										
<i>Rhacophorus hoanglienensis</i>										B	
<i>Theloderma asperum</i>											C
cf. Rhacophoridae sp. (#1)— 1700 m											C
cf. Rhacophoridae sp. (#2)— 1900 m											C

L, larvae; M, metamorphs; J, juvenile; C, males calling; B, adults in breeding condition (males with secondary sex characters and/or females gravid); ?, unconfirmed identification (see text for details).

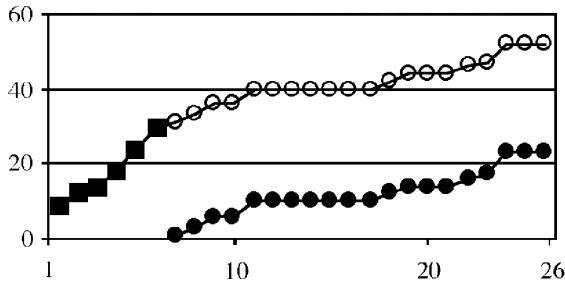


Fig. 2. Species accumulation curve for field-work at Mt. Muong Cha and Mt. Tay Con Linh II. y-axis: number of species; x-axis number of days of survey. Number of novel species found daily on Mt. Muong Cha (■), on Mt. Tay Con Linh II (●), and in total (○).

previously undescribed. We describe two new species of frogs from the *Rana chloronota* complex.

SPECIES ACCOUNTS

AMPHIBIA: CAUDATA
SALAMANDRIDAE

Tylototriton asperrimus Unterstein, 1930

A single adult specimen (AMNH 163989/IEBR 69) was found submerged among the detritus of a 0.5-m-diameter temporary forest pool at 1700 m on Mt. Tay Con Linh II (site 3). Adjacent to the pool, five clutches of larvae in opaque gelatin capsules were found ~5 cm underground. The only other Vietnamese record of this species is from the

Mau Son region, Lang Son Province, in the northeast (Bourret, 1942; Nguyen and Ho, 1996). It is otherwise known from China: Guangxi, Guangdong, Gansu, Sichuan, and Hubei Provinces (Frost, 2002).

MEASUREMENTS (in mm): SVL 58.85, SNT 6.20, HDL 15.34, HDW 16.93, EYE 3.75, IOD 4.75, HND 8.00, TIB 7.80, FTL 10.25.

AMPHIBIA: ANURA
BOMBINATORIDAE

Bombina microdeladigitora Liu, Hu, and Yang, 1960

An adult male was found in a 12-cm-diameter, mud-filled tree hole at 1900 m on Mt. Tay Con Linh II (site 4). This specimen has melanic spines along its chest, chin, and first three fingers. Recorded from the Hoang Lien Mountains, Lao Cai Province, this is the first Vietnam record of *B. microdeladigitora* east of the Red River (Ohler et al., 2000; Orlov et al., 2001). It is otherwise known from China: Yunnan and Hubei Provinces (Ohler et al., 2000).

MEASUREMENTS (in mm, AMNH 163789/IEBR 58): SVL 61.63, SNT 8.38, HDL 28.41, HDW 23.59, EYE 6.60, IOD 3.85, HND 12.35, TIB 27.74, FTL 35.52.

MICROHYLIDAE

Microhyla sp.

Figures 3, 4

A juvenile specimen (tail just resorbed) of an unidentified *Microhyla* species was col-

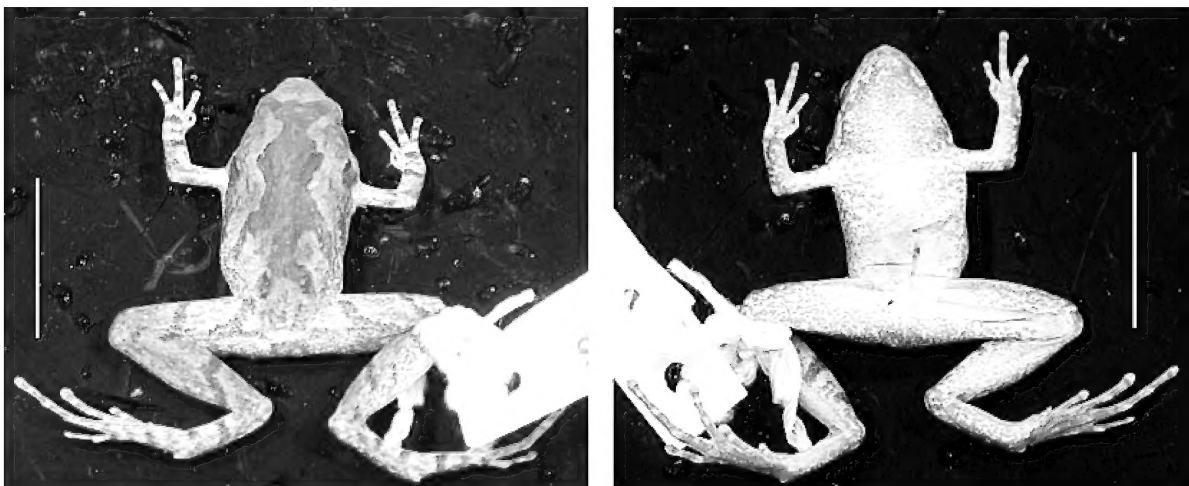


Fig. 3. *Microhyla* sp. (AMNH 163848), juvenile: dorsal view (left), ventral view (right). Scales equal 10 mm.



Fig. 4. Hand of *Microhyla* sp. (AMNH 163848), juvenile. Scale equals 2.5 mm.

lected in a rice paddy in Tham Ve Village (600 m).

It has the following characters: body slender; head rounded, snout bluntly rounded, projecting in profile; tongue spatulate, not notched; tympanum hidden; no vomerine teeth; finger I less than one-half the length of finger II; tips of fingers II–IV and toes II–V slightly expanded (= base of phalange), dorsal surface of digit-tip disks with circum-marginal grooves and faint dorsal median longitudinal grooves producing the appearance of two scutes (as in Bourret, 1942: fig. 9i); tarsus smooth, without folds; foot webbing basal, at level of proximal subarticular tubercle for toes I, II, and preaxial side of III, between first and second subarticular tubercle for toes IV, V, and postaxial side of III; two metatarsal tubercles, inner short and oval, outer tall, projecting; dorsum smooth,

one or two low rounded tubercles on upper eyelid; venter smooth; in preservative dorsum tan with large irregular dark brown medial spot, dark “V” on posterior end; arms banded with two or three transverse bars, legs with two transverse bars; venter dusted brown; chin spotted white, throat dusted darker than chest, belly, and thighs, lightest dusting on medial surface.

This specimen looks superficially like *M. ornata*, but differs in having snout rounded in profile (obtusely pointed in *M. ornata*) and the presence of a median longitudinal groove on the dorsal surface of digits, producing the appearance of two scutes (absent in *M. ornata*) (Parker, 1934). We refrain from naming this species because it is only represented by a juvenile specimen.

MEASUREMENTS (in mm, AMNH 163848): SVL 17.40, HDL 7.79, HDW 5.48, SNT 2.72, TIB 10.23, FTL 14.43, HND 5.28, EYE 2.10, IOD 2.04.

MEGOPHRYIDAE

Leptobrachium chapaense (Bourret, 1937)

Specimens matching the description (Bourret, 1942) and redescription (Lathrop et al., 1998) of *L. chapaense* were found on Mt. Tay Con Linh II. Adults with white on the top quarter of the iris, metamorphs with off-white to yellow on the top quarter of the iris. Dorsum brown, a black line running from the snout to the eye, continuing posterior to the eye, half-way down the supratympanic fold. Red and black marbling on inner thighs (flash colors). White network on brown for entire venter (throat to calves). Tips of toes white.

Adults were found on the forest floor at 1400 m. Tadpoles and metamorphs were abundant in almost every waterway; metamorphs especially in deep pools. Over the course of 21 days of pitfall trapping on Mt. Tay Con Linh II, 13 juvenile *L. chapaense* were collected for only five consecutive days (17–21 May). This suggests that in this region there is a narrow window in which juvenile *L. chapaense* disperse from the streams to the forests.

Leptobrachium chapaense is known from China: central and southern Yunnan; northern Vietnam: Lao Cai, Vinh Phu, Cao Bang,

Thanh Hoa, and Ha Tinh Provinces; Laos: Bokeo Province; Thailand: Chiang Mai Province; Myanmar: Karin region; and India: State of Meghalaya (Dubois and Ohler, 1998; Lathrop et al., 1998; Ziegler, 2002).

MEASUREMENTS (in mm, AMNH 163791): SVL 61.85, SNT 12.64, HDL 30.28, HDW 28.23, EYE 7.44, IOD 7.91, TMP 2.5 (observed), HND 15.50, TIB 22.72, FTL 33.80.

Megophrys parva (Boulenger, 1893)

Found on Mt. Tay Con Linh II on banks of streams and in nearby forest (within 4 m of streams) from 1400 m. Males called strongly from under leaves and the hollows of rocks and logs. This species is known from Nepal east to Yunnan, China, and south to Tenasserim (Myanmar) (Frost, 2002). *Megophrys parva* was recently found in north-western Vietnam (Ohler et al., 2000) and this is the first record of it east of the Red River in Vietnam. It is probably contiguous with other Yunnan populations.

MEASUREMENTS OF FEMALES (in mm, $N = 1$, AMNH 163846): SVL 47.84, HDL 17.29, HDW 16.83, SNT 5.89, TIB 24.23, FTL

32.66, HND 11.74, EYE 5.93, TMP 2.56, IOD 4.53

MEASUREMENTS OF MALES (in mm, $N = 3$, AMNH 163844, 163845, 163847; mean, \pm standard deviation): SVL 38.47 ± 1.82 (40.57, 37.38, 37.46), HDL 15.45 ± 1.20 (16.80, 14.52, 15.03), HDW 13.02 ± 0.58 (13.65, 12.52, 12.90), SNT 5.32 ± 0.02 (5.34, 5.31, 5.30), TIB 20.84 ± 1.54 (22.55, 19.58, 20.38), FTL 29.34 ± 1.92 (31.55, 28.30, 28.17), HND 10.96 ± 0.57 (11.45, 10.33, 11.10), EYE 4.70 ± 0.16 (4.55, 4.67, 4.87), TMP 2.40 ± 0.10 (2.42, 2.30, 2.49), IOD 4.16 ± 0.53 (4.77, 3.88, 3.82); median HDL:HDW 1.17 (1.23, 1.16, 1.17), median TIB:SVL 0.54 (0.56, 0.52, 0.54), median TMP:EYE 0.51 (0.53, 0.49, 0.51), median SNT:HDL 0.35 (0.32, 0.37, 0.35).

RANIDAE

Amolops chapaensis (Bourret, 1937)

Figure 5

This species was common between 800 and 1700 m on Mt. Muong Cha and Mt. Tay Con Linh II. It was found associated with fast-moving water: among cascades, in



Fig. 5. *Amolops chapaensis* (AMNH 163776), male, SVL 89.44 mm.

splash zones, on mossy boulders midstream, along wet, rocky walls, and in streamside forest to 3 m. Males had distended vocal pouches and females were gravid.

This species has been recorded from the type locality in Sa Pa, Lao Cai Province, Vietnam, and from Yunnan Province, China (Fei, 1999). This is the first Vietnam record east of the Red River.

MEASUREMENTS OF FEMALES (in mm; $N = 5$, AMNH 163775–163779; mean, \pm standard deviation, range in parentheses): SVL 89.81 ± 6.67 (79.70–96.78), HDL 32.41 ± 2.68 (28.16–34.34), HDW 27.79 ± 3.29 (22.96–30.75), SNT 13.44 ± 0.55 (12.76–14.1), TIB 51.73 ± 4.23 (45.37–55.75), FTL 69.14 ± 5.55 (60.40–73.95), HND 29.02 ± 3.48 (21.11–32.16), EYE 9.25 ± 0.68 (8.64–10.34), TMP 3.98 ± 0.56 (3.23–4.77), IOD 8.88 ± 1.50 (6.52–10.63); median HDL:HDW 1.15 (1.12–1.21), median TIB:SVL 0.57 (0.56–0.59), median TMP:EYE 0.45 (0.37–0.46) median SNT:HDL 0.41 (0.39–0.45).

MEASUREMENTS OF MALES (in mm, $N = 9$, AMNH 163780–163788; mean, \pm standard deviation, range in parentheses): SVL 76.70 ± 1.30 (74.68–79.03), HDL 29.94 ± 2.48 (27.39–31.47), HDW 23.40 ± 1.12 (21.16–24.71), SNT 11.70 ± 0.65 (10.92–12.82), TIB 44.87 ± 1.52 (43.38–48.20), FTL 60.50 ± 1.23 (58.8–61.97), HND 24.04 ± 1.33 (22.03–25.84), EYE 8.41 ± 0.66 (7.57–9.17), TMP 3.86 ± 0.33 (3.18–4.31), IOD 7.18 ± 0.48 (6.61–8.07); median HDL:HDW 1.29 (1.19–1.43), median TIB:SVL 0.58 (0.56–0.61), median TMP:EYE 0.44 (0.41–0.55), median SNT:HDL 0.40 (0.36–0.43).

Rana chloronota (Günther, 1875)

In Ha Giang, *Rana chloronota* was common on Mt. Muong Cha between 800 and 950 m. It was always closely associated with fast-moving streams and cascades, either on overhanging vegetation or on rocks within the stream or on the banks. At Muong Cha, this species was found both within the forest and at its edge. *Rana chloronota* was also found among large boulders on the Nam Ma on Mt. Tay Con Linh II (600 m), with little or no cover from vegetation.

Rana chloronota is a complex of several

species across its wide range (Bain et al., 2003). This grouping is based on morphological similarity around the diagnosis of *Rana chloronota*: (1) body dorsoventrally compressed; (2) SVL males 41–53 mm (mean 46 mm), females 80–100 mm (mean 92 mm); (3) vomerine teeth in rows oblique to choanae; (4) lip stripe white; (5) head broad, snout rounded in dorsal view, bluntly rounded in profile; (6) tympanum round, distinct, TMP:EYE of males 0.43–0.85 (mean 0.57) greater than females 0.37–0.60 (mean 0.48); (7) supratympanic fold weak; (8) dorsal skin smooth, flanks weakly granular, dorsolateral folds absent, venter smooth; (9) dorsum green, sometimes with black spots; forelimbs and hindlimbs brown, with transverse bars; (10) median callous pad on finger III to proximal tubercle; furrow on medial edge of fingers II, III; (11) disks on fingers and toes greatly enlarged ($>2\times$ base of phalanges); (12) feet fully webbed to disks, weak lateral fringes on I and V to terminal phalanges, webbing brown; (13) subarticular tubercles and inner metatarsal tubercle distinct, conical; (14) terminal phalanges T-shaped; (15) xiphisternum large, deeply notched posteriorly; (16) male with velvety nuptial pads on thumb, paired gular pouches, pectoral spines absent; (17) eggs white. Numbered characters follow Bain et al. (2003). Based on the similarity of two previously undescribed cascade ranid species from Ha Giang to this diagnosis, we put them in the *Rana chloronota* complex. They are described below.

Rana chloronota sensu stricto is found in southern China, Vietnam (Gia Lai, Nghe An, Ha Tinh, Tuyen Quang, Bak Thai, and Vinh Phu Provinces), Laos (Khammouan Province), and India (Darjeeling, Assam) (Inger et al., 1999: 19–20; Ziegler, 2002: ; Bain et al., 2003).

Rana iriodes, new species

Figures 6A, B, 7–9

HOLOTYPE: AMNH 163925/IEBR 70 (AMNH Field Series 15556), a mature male from Mt. Tay Con Linh II, Cao Bo Commune, Vi Xuyen District, Ha Giang Province, Vietnam (site 2: 22°46'10"N, 104°49'53"E, elevation 1400 m) found on 10 May 2000 by Q.T. Nguyen and R.H. Bain.



Fig. 6. Three frog species from Ha Giang Province, Vietnam: (A) paratype of *Rana iriodes*, new species (AMNH 163928), adult male, SVL 42.80 mm; (B) paratype of *Rana iriodes*, new species; (C) paratype of *Rana tabaca*, new species (AMNH 163915), adult male, SVL 59.18 mm; (D) paratype of *Rana tabaca*, new species (AMNH 163920), adult female, SVL 103.40 mm; (E) *Polypedates dugritei* (AMNH 163910), adult male, in profile; and (F) posterior view showing transmedial white line, SVL 40.50 mm.

The holotype was on a wet, mossy rock near a stream. The holotype had leg muscle and liver removed shortly after it was euthanised.

PARATYPES: One mature male (AMNH

163928) and one gravid female (AMNH 163926) collected with holotype on 10 May 2000 by Q.T. Nguyen and R.H. Bain. Specimens were collected along mossy rocks and

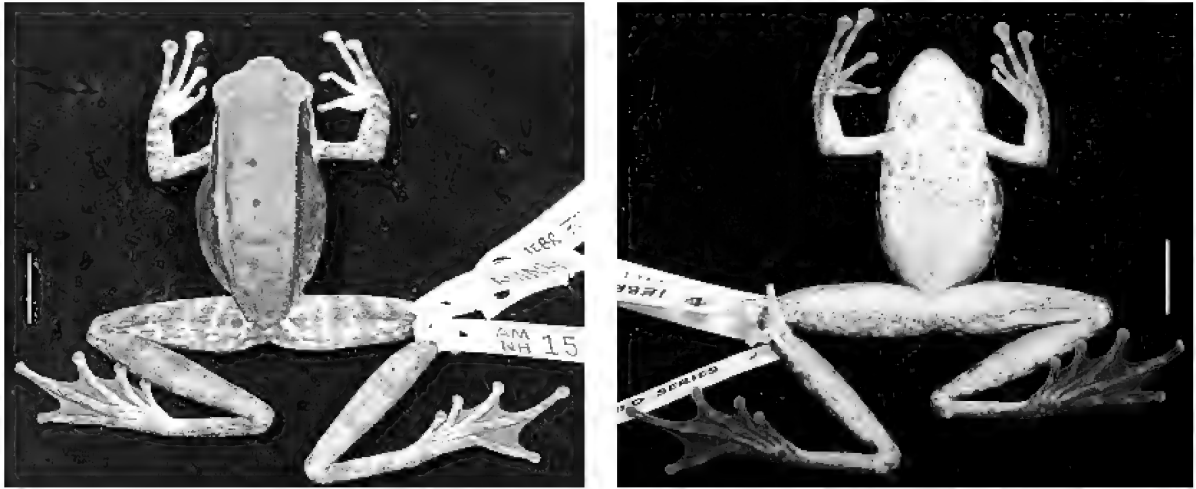


Fig. 7. Holotype of *Rana iriodes*, new species (AMNH 163925/IEBR 70), adult male from Mt. Tay Con Linh II: dorsal view (left), ventral view (right). Scales equal 10 mm.

small branches overhanging a stream. Mature male (AMNH 163924/IEBR 69) collected from Mt. Tay Con Linh II, Cao Bo Commune, Vi Xuyen District, Ha Giang Province, Vietnam (ca. 1 km south-southwest of 22°45'27"N, 104°49'35"E, 1700 m) on 19 May 2000 by P.R. Sweet and R.H. Bain. This specimen was found at small, rocky-bottomed forest pools, about 10 m from the nearest stream.

DIAGNOSIS: *Rana iriodes* is characterized by a combination of the following characters: SVL of males 39–43 mm (mean 40.32 mm), female 62; vomerine teeth loosely grouped along crescent-shaped ridge between choanae; golden lip stripe extends to form rough



Fig. 8. Head of *Rana iriodes*, new species (AMNH 163925/IEBR 70), holotype in profile. Scale equals 2.5 mm.

line across flank; dorsum iridescent green or green-gold; dorsolateral folds weak, iridescent gold or orange-red; flanks with white glandular spot; no lateral furrows on fingers; web full to toe disks on toes I, V, and post-axial sides of II and III, reaching disks as a fringe on all other toes; no external metatarsal tubercle; males with paired gular pouches, nuptial spines absent; eggs not pigmented.

DESCRIPTION OF HOLOTYPE: AMNH 163925/IEBR 70, a mature male, SVL 39.40 mm, HDW:HDL 0.94, HDL:SVL 0.34; pupil broadly oval; snout short, rounded in dorsal view, broadly rounded in profile, protruding beyond margin of lower jaw; eye prominent, EYE:SNT 0.57; eyelid broader than interorbital distance. Top of head flat; canthus rostralis rounded; loreal region concave; lip flared just anterior to orbit; nostril about three-fourths distance from eye to tip of snout; weak supratympanic fold curving posteroventrally from posterior corner of eye to level above insertion of arm; tympanum round, distinctly visible, separated from eye by distance less than tympanum diameter, TMP:EYE 0.68; choanae ovoid; vomerine denticulous processes weakly developed medially along crescent-shaped ridge between choanae, a few loosely grouped teeth; tongue cordiform, distinctly notched posteriorly, free for approximately two-thirds its length.

Forearms robust; fingers moderately short,



Fig. 9. Hand (**left**) and foot (**right**) of *Rana iriodes*, new species (AMNH 163925/IEBR 70), holotype. Scales equal 5 mm.

slender, HND:SVL 0.32, relative lengths of fingers I < II < IV < III, median callous pads to proximal tubercle on fingers II, III, IV, no lateral furrows on edges of fingers; disks on tips of fingers greatly expanded (>2× base of phalange), relative pad size I < II < IV < III, pad width of finger III greater than TMP, ventral circummarginal grooves present; terminal phalanges T-shaped; subarticular tubercles conical. Hindlimbs moderately robust; TIB:SVL 0.65; FTL:SVL 0.88; relative toe lengths I < II < III = V < IV; inner tarsal fold absent; web full to base of toe disk on toes I, V, and postaxial sides of II and III, reaches disks as a fringe on all other toes; web full to beyond subarticular tubercle on preaxial side of II, and to level of distal subarticular tubercle of IV and preaxial side of III, lateral fringes on preaxial side of I and postaxial side of V to terminal phalanges; toes long, slender, with large, rounded triangular disks (>2× base of phalange), pad size of all toes equal to each other, smaller than those of fingers, with ventral circum-

marginal grooves; subarticular tubercles prominent and conical; inner metatarsal tubercle ovoid, long; outer metatarsal tubercle absent.

Skin on dorsum, sides, venter, and around anus smooth; dorsolateral folds weak; anus unmodified, directed posteriorly, at upper level of thighs.

COLOR IN LIFE (in preservative): Dorsum iridescent light green (livid blue) with some black spots; green loreal spot (livid blue); black stripe (dark gray), from loreal region across tympanum to insertion of arm, continues as thin line below dorsolateral folds; gold lip stripe (white) extends beyond tympanum to form rough line across flank; tympanum dark brown; iris gold for ventral two-thirds, dorsal one-third red with some gold flecks; iridescent orange-red dorsolateral stripe (thin, gray); flanks iridescent gold-green with some brown and yellow marbling (gray, white), two gold-white spots on left posterior flank, one on right (white); dorsal limbs tan (light brown) with dark brown transverse

bars (dark brown); posterior surface of thighs yellow with black marbling (brown); webbing marbled white on dark brown (gray on brown); venter with iridescent gold-white irregular spots (off-white with irregular gray spots on throat and chest, legs creamy yellow with light brown mottling toward knees).

MALE SECONDARY SEX CHARACTERS: Holotype with greatly enlarged forearms and paired gular pouches; a white, velvety nuptial pad along base of finger I; nuptial spines absent.

MEASUREMENTS OF HOLOTYPE (in mm) (AMNH 163925/IEBR70): SVL 39.40, SNT 5.15, HDL 13.53, HDW 12.72, EYE 2.96, IOD 4.03, TMP 1.86, HND 12.85, TIB 25.59, FTL 34.76.

VARIATION OF PARATYPES: *Rana iriodes* exhibits sexual dimorphism: females are larger than males, SVL 61.88 mm (mean of male paratypes 41.0 mm [38.80, 43.24 mm]); females with smaller TMP:EYE (female 0.35, mean paratype males 0.54 [0.57, 0.51]); females with larger EYE:SNT (female 0.94, mean paratype males 0.67 [0.68, 0.66]); females with smaller FTL:SVL (female 0.69, mean paratype males 0.86 [0.90, 0.82]). Females have unpigmented eggs. The xiphisternum of females is large and deeply notched posteriorly. Some specimens with iridescent light green-gold on the dorsum (livid blue in preservative). The dorsolateral stripe sometimes appears as iridescent gold (thin, gray stripe in preservative). AMNH 163928 (male) has red-brown arms with irregular brown transverse bars and some gold patches above the eye; other specimens with green or gold flecks on limbs, with more gold extending to ventral thighs (dark brown bars on light brown limbs in preservative). In preservative, ventral mottling varies from absent to gray on throat and chest. All paratypes only have one glandular gold-white spot on each flank.

MEASUREMENTS OF MALE PARATYPES (in mm, AMNH 163924, 163928): SVL 38.80, 43.24; SNT 5.40, 5.79; HDL 15.07, 13.95; HDW 13.51, 14.10; EYE 3.70, 3.83; IOD 4.26, 4.37; TMP 2.14, 1.96; HND 13.87, 12.70; TIB 26.52, 25.40; FTL 34.89, 35.35; HDL:HDW 1.11, 0.98, TIB:SVL 0.68, 0.59, SNT:HDL 0.36, 0.42.

MEASUREMENTS OF FEMALE PARATYPE (in

mm, AMNH 163926): SVL 61.88, SNT 8.15, HDL 22.10, HDW 20.29, EYE 7.70, IOD 5.42, TMP 2.72, HND 19.29, FPL 2.62, TIB 36.72, FTL 42.90.

COMPARISONS: *Rana iriodes* superficially resembles other Asian cascade ranids, but can be differentiated from them by its gold or orange-red dorsolateral folds and glandular gold-white flank spot: *R. andersonii*, *R. bacboensis*, *R. chloronota*, *R. hainanensis*, *R. hejiangensis*, *R. jingdongensis*, *R. junlianensis*, *R. kwangwuensis*, *R. livida*, *R. margaritae*, *R. morafkai*, *R. schmackeri*, *R. sinica*, and *R. tiannanensis* (dorsolateral folds and flank spots absent); *Amolops chunganensis*, *R. banaorum*, *R. chalconota*, *R. exiliversabilis*, *R. graminea*, *R. hosii*, *R. leporipes*, *R. nasuta*, *R. frankieni*, and *R. versabilis* (dorsolateral folds present, but none with gold or orange-red; flank spots absent); *Huia nasica*, *R. archotaphus*, *R. grahami*, *R. hmongorum*, and *R. megatympanum* (dorsolateral fold present or absent, never gold or orange-red; flank spots absent); *R. daorum* (white glandular dorsolateral folds, glandular white flank spot). The absence of a furrow on the medial edge of fingers II and III differentiates *R. iriodes* from other cascade ranids in which this character has been noted: *R. archotaphus*, *R. bacboensis*, *R. banaorum*, *R. chalconota*, *R. chloronota*, *R. daorum*, *R. graminea*, *R. hmongorum*, *R. hosii*, *R. livida*, *R. morafkai*, *R. megatympanum*, and *R. frankieni* (absent in *Amolops chunganensis* and *Huia nasica*; undescribed in other cascade ranids).

Rana iriodes most closely resembles *R. daorum* and *A. chunganensis*. It can further be differentiated from *R. daorum* by its vomerine teeth (absent in *R. daorum*), size (*R. daorum* male SVL 32–38, *R. iriodes* 39–43 mm), and male TMP:EYE (0.18–0.38 for *R. daorum*, 0.47–0.75 for *R. iriodes*). It can further be differentiated from *Amolops chunganensis* by its color (*A. chunganensis* red-brown, *R. iriodes* iridescent light green with black spots), lip stripe (white in *A. chunganensis*, yellow in *R. iriodes*), webbing on toe IV (reaches just beyond distal subarticular tubercle in *A. chunganensis*; full to distal subarticular tubercle, then to the disk as fringe for *R. iriodes*).

Character states for the condition of finger

furrows was obtained by direct observation of specimens (appendix 1) and from the original description of *R. trankieni* (Orlov et al., 2003). All other character information on *R. exiliversabilis* and *R. nasuta* is from Fei et al. (2001), on *R. trankieni* from Orlov et al. (2003), and *R. versabilis* from Liu and Hu (1962). Refer to table 3 and Bain et al. (2003: table 12) for detailed comparisons of regional cascade ranids.

ETYMOLOGY: The specific name is from the Latin *iriodes*, meaning iridescent. This refers to the iridescent nature of the skin in life.

DISTRIBUTION: This species is currently known only from Mt. Tay Con Linh II in northeastern Vietnam: Ha Giang Province, Vi Xuyen District, Cao Bo Commune.

REMARKS: Neither tadpoles nor vocal recordings were collected for this species. Male specimens exhibit gular pouches that are either loose and baggy (distended) or tight, appearing as folds of skin at the corner of the jaw.

***Rana tabaca*, new species**
 Figures 6C, D, 10–13

HOLOTYPE: AMNH 163923/IEBR 68 (AMNH Field Series 15217), a mature male from a stream near the Hmong Village of Khau Ria, in Du Gia commune, Yen Minh District, below Mount Muong Cha, Ha Giang Province, Vietnam (22°54'27"N, 105°13'59"E, ca. 800 m elevation) found on 28 April 2000 by Q.T. Nguyen and R.H. Bain.

PARATYPES: Four mature males (AMNH 163914/IEBR 64; AMNH 163915; AMNH 163916/IEBR 65; AMNH 163917/IEBR 66) and one gravid female (AMNH 163920) collected with holotype by Q.T. Nguyen and R.H. Bain. A subadult female (AMNH 163922/AMNH FS-15258) was also collected on the same stream as the holotype (above 900 m elevation) by Q.T. Nguyen and R.H. Bain. Two males (AMNH 163918, 163919) and one subadult female (AMNH 163921/IEBR 67) were collected between 24 and 25 May 2000 from the Bac Trao River, near Tham Ve Village, below Mt. Tay Con Linh II District, Ha Giang Province, Vietnam (22°45'39"N, 104°52'23"E, 600 m) by R.H. Bain.

DIAGNOSIS: *Rana tabaca* is characterized

by a combination of the following characters: SVL of males 52–60 mm (mean 55.60 mm), adult female 103 mm; upper lip spotted brown between tip of snout and eye, lip stripe golden, extends below eye to insertion of arm; dorsal skin shagreened, dorsolateral folds present on males and subadult females; dorsum varies from dark brown with green-gold marbling to olive brown with red-brown spots; web full to disk on all toes except IV, webbing on IV full to distal subarticular tubercle, reaching disk as a fringe, postaxial fringe on V to proximal subarticular tubercles, continuing to the base of metatarsal as a thin ridge; no external metatarsal tubercle; males with paired gular pouches, nuptial spines absent; eggs not pigmented.

DESCRIPTION OF HOLOTYPE: AMNH 163923/IEBR 68, a mature male, SVL 53.40 mm, HDW:HDL 0.93, HDL:SVL 0.40; pupil broadly oval; snout short, rounded in dorsal view, bluntly rounded in profile, protruding beyond margin of lower jaw; eye very prominent, EYE:SNT 1.03; eyelid broader than interorbital distance; top of head flat; canthus rostralis rounded; loreal region concave; lip flared just anterior to orbit; nostril about three-fourths distance from eye to tip of snout; weak supratympanic fold straight posteroventrally from posterior corner of eye to distal portion of tympanum; tympanum round, distinctly visible, separated from eye by distance less than tympanum diameter, TMP:EYE 0.62; choanae ovoid; vomerine dentigerous processes prominent, postero-medial to choanae, each bearing numerous teeth; tongue cordiform, distinctly notched posteriorly, free for approximately two-thirds its length.

Forearms robust; fingers moderately short, slender, HND:SVL 0.21, relative lengths of fingers II < I < IV < III, median callous pads to proximal tubercle on fingers II, III, IV, furrows on either edge of finger III and medial edge of II; disks on tips of fingers expanded (>2× base of phalange), relative pad size I = II < IV < III, pad width of finger III less than TMP, ventral circummarginal grooves present; terminal phalanges T-shaped; subarticular tubercles conical. Hindlimbs moderately robust; TIB:SVL 0.66; FTL:SVL 0.87; relative toe lengths I < II < III = V < IV; inner

TABLE 3
Comparisons of Some Adult Southeast Asian Cascade Ranids

	SVL (mm)		Vomerine teeth	Lip stripe	Lip bands	Head	Snout	TMP:EYE	
	M	F						M	F
<i>R. exiliversabilis</i>	43–52	52–62	+	Light yellow	–	2	2	~0.50	~0.50
<i>R. iriodes</i>	39–43	62	+	Gold	–	1	1	0.57	0.36
<i>R. nasuta</i>	57–63	73	+	Yellow	–	4	3	~0.50	~0.50
<i>R. tabaca</i>	52–59	103	+	Gold	Spotted	1	1	0.66	0.50
<i>R. trankieni</i>	76, 77	?	+	–	–	4	3	0.54	?
<i>R. versabilis</i>	74	79	+	Yellow-brown stripe	–	2	1	0.50	?

	Dorsum skin	DL	Dorsum color (in life)	Flank color (in life)	Day
<i>R. exiliversabilis</i>	S	Narrow, eye–hip	Olive-brown, light brown, gray or green; ± dark blue or black-brown spots	Black line under DL, warts light yellow	–
<i>R. iriodes</i>	S	Weak	Green ± black spots	Gold-green with yellow and black marbling; white glandular spot	?
<i>R. nasuta</i>	S	Weak	Dark brown, green or olive	Brown marble on light yellow	?
<i>R. tabaca</i>	Sh	+ on ♂, subad ♀	Dark brown or olive; ± green-gold marbling, ± red-brown spots	Marbled or spotted yellow and black	?
<i>R. trankieni</i>	S	Distinct	Green with red-brown spots	Gray with dark spot	?
<i>R. versabilis</i>	S	Distinct, thick	Brown or green with sparse green spots	Black line under DL, underneath lighter brown	–

	Limbs	Finger length	Disk	OT	PHAL	Web	Egg	Gular pouches	Spines
<i>R. exiliversabilis</i>	+	II < IV < I < III	1/2	+	?	4	?	–	+
<i>R. iriodes</i>	+	I < II < IV < III	2	–	1	4	1	+	–
<i>R. nasuta</i>	+	II < IV < I < III	1/2	+	?	1	1	+	–
<i>R. tabaca</i>	+	I < II < IV < III	2	–	1	4	1	+	–
<i>R. trankieni</i>	+	IV < II < I = III	1	–	?	1	?	+	–
<i>R. versabilis</i>	+	II < IV < I < III	1	–	?	1?/4?	1	–	–

SVL, snout–vent length; Head, head shape in dorsal view: (1) rounded, (2) bluntly pointed, (4) narrowly long (longer than wide); Snout, snout profile (all species have protruding snouts): (1) broadly round, (2) obtusely pointed, (3) strongly protruding; TMP:EYE, tympanum diameter:eye diameter; Dorsum skin: (S) smooth, (Sh) shagreened; DL, dorsolateral folds; Day, different day and night color; Limbs, arm and leg banding: Disk, finger disk: (1) disk <2× base of phalanges, (2) disk >2× base of phalanges; OT, outer metatarsal tubercles; PHAL, shape of distal phalanges: (1) T-shaped; Web: (1) complete to disk; (4) to disk as a fringe; Egg, egg color: (1) wholly unpigmented; Spines, ventral spines on male.

Codes and abbreviations follow Bain et al. (2003).

tarsal fold absent; web full to base of toe disks, except toe IV, webbing on IV full to distal subarticular tubercle, reaching disk as a fringe, preaxial fringe on toe I and postaxial fringe on V to proximal subarticular tubercles, on V continuing to the base of meta-

tarsal as a thin ridge; toes long, slender, with rounded triangular disks (>2× base of phalange), pad size of all toes equal to each other, smaller than those of fingers, each with ventral circummarginal grooves; subarticular tubercles prominent and conical; inner meta-

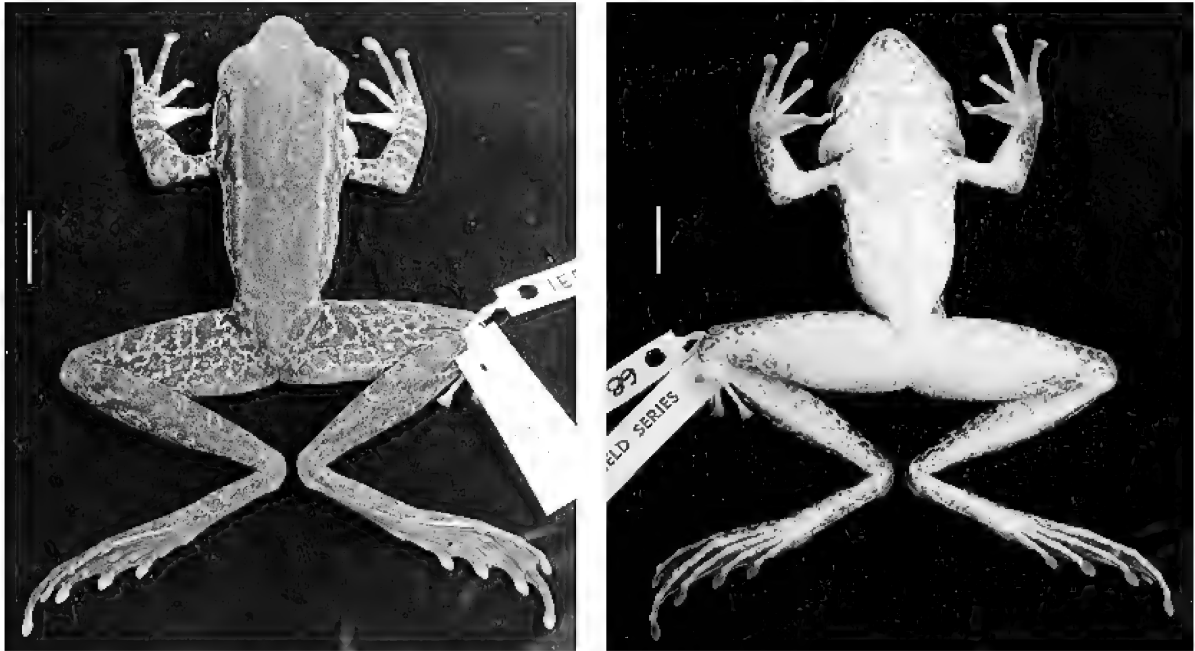


Fig. 10. Holotype of *Rana tabaca*, new species (AMNH 163923/IEBR 68), a male from Mt. Muong Cha, Ha Giang Province, Vietnam: dorsal view (left), ventral view (right). Scales equal 10 mm.

tarsal tubercle ovoid, long; outer metatarsal tubercle absent.

Skin on dorsum shagreened, becoming more granular on flanks; venter and around anus smooth; dorsolateral folds present; anus unmodified, directed posteriorly, at upper level of thighs.

COLOR IN LIFE (in preservative): Dorsum dark brown with green-gold marbling (livid blue with light gray spots); snout spotted brown (dark brown on light brown); upper lip spotted brown (black) from tip of snout to anterior of eye, lip stripe gold from below

eye to insertion of arm (white); iris entirely gold; dorsolateral stripe yellow (light gray); flanks brown (gray) with black and yellow network (dark gray and off-white); dorsal limbs brown (tan) with black spots and transverse bands (brown), fingers I, II tan (off-white); posterior surface of thighs yellow with black marbling; webbing marbled white on dark brown (light gray on dark gray); venter iridescent gold-white (white), throat mottled brown to anterior third of belly (light brown on creamy white), light brown mottling on thigh.

MALE SECONDARY SEXUAL CHARACTERS: Greatly enlarged forearms and paired subgular vocal pouches; large white, velvety nuptial pad extends along base of finger I; nuptial spines absent.

MEASUREMENTS OF HOLOTYPE (in mm): SVL 53.40, SNT 8.20, HDL 21.44, HDW 19.98, EYE 8.48, IOD 4.90, TMP 5.34, HND 11.29, TIB 35.40, FTL 46.58.

VARIATION OF PARATYPES: Adults exhibit sexual dimorphism: females are larger (SVL female, 103.4 mm; males 53.62–59.38 mm, mean 56.43 mm); females with smaller HDL: HDW (1.10 for female; males 1.14–1.58, median 1.22); females with smaller TMP:



Fig. 11. Head of *Rana tabaca*, new species, holotype (AMNH 163923/IEBR 68), in profile. Scale equals 5 mm.



Fig. 12. Hand and foot of *Rana tabaca*, new species (AMNH 163923/IEBR 68), holotype: (A) hand; (B) arrows indicate furrows on preaxial side of fingers II, III; (C) foot. Scales equal 5 mm.

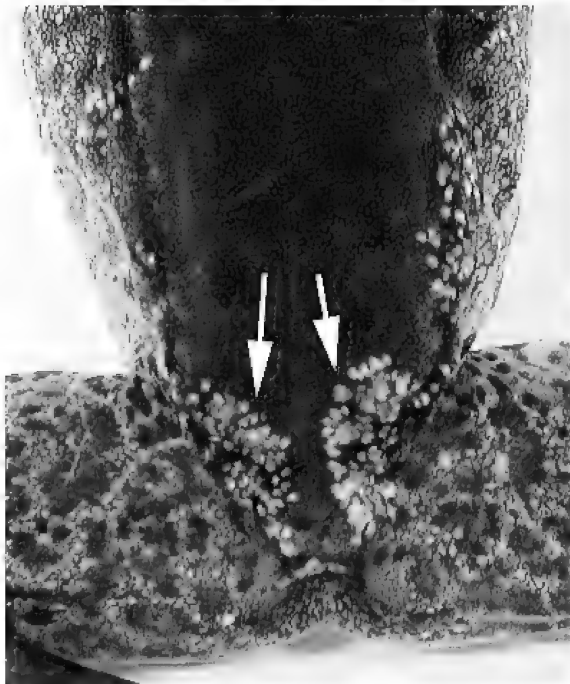


Fig. 13. Dorsal view of posterior pelvic region of a female *Rana tabaca*, new species (AMNH 163921/IEBR 67), paratype. Arrows point to groups of cutaneous masses on posterior part of the dorsum.

EYE (0.50 for female; males 0.62–0.70, mean 0.63); females with smaller EYE:SNT (0.74 in female; males 0.78–0.97, mean 0.85); females with no dorsolateral folds (present in males). Females have unpigmented eggs. The xiphisternum of the adult female is large and deeply notched posteriorly. The subadult female from Du Gia (AMNH 163922) bears a strikingly resemblance to males: dorsolateral folds present and TMP:EYE is 0.63. Male paratypes all have prominent eyes (EYE:SNT 0.78–0.97, mean 0.85), but only the holotype has an eye that is larger than the snout. The supratympanic fold is more strongly developed and curved in paratypes than in the holotype. Dorsum varies from dark brown with various amounts of green-gold marbling to olive brown with red-brown spots (dark brown with light brown marbling in preservative). Cao Bo specimens (AMNH 163918, 163919, 16321) are brown with no green (dark brown in preservative); flanks sometimes with spots, rather than network; mottling on throat to upper one-third of the belly varies among paratypes from faint to very dark (as a network of light

brown on creamy white in preservative). All Cao Bo specimens possess subcutaneous masses on each side of the dorsum just above the insertion of the leg (fig. 13).

MEASUREMENTS OF MALE PARATYPES ($N = 6$, AMNH 163914–163919; mean, \pm standard deviation, range in parentheses): SVL 55.97 ± 3.13 (53.62–59.38), SNT 9.12 ± 0.46 (8.52–9.74), HDL 24.03 ± 2.66 (21.64–26.58), HDW 19.42 ± 0.82 (18.40–20.26), EYE 7.88 ± 0.24 (7.64–8.26), IOD 4.90 ± 0.24 (4.50–5.08), TMP 5.25 ± 0.37 (4.71–5.76), HND 12.82 ± 1.53 (11.00–15.63), TIB 33.72 ± 2.27 (30.8–36.64), FTL 44.79 ± 3.01 (42.00–48.74). median TIB:SVL 0.62 (0.52–0.68), median SNT:HDL 0.38 (0.33–0.45).

MEASUREMENTS OF FEMALE ADULT PARATYPE (AMNH 163920): SVL 103.40, SNT 15.98, HDL 40.00, HDW 36.36, EYE 11.80, IOD 9.72, TMP 5.96, HND 28.16, FPL 2.88, TIB 68.66, FTL 86.52.

COMPARISONS: *Rana tabaca* superficially resembles several other Asian cascade ranids, but can be differentiated from them by a combination of characters. *Rana tabaca* has an upper lip that is spotted brown from tip of snout to anterior of eye, lip stripe gold from below eye to insertion of arm: *Amolops chunganensis*, *Huia nasica*, *Rana archotaphus*, *R. chloronota*, *R. daorum*, *R. graminea*, *R. hosii*, *R. leporipes*, *R. livida* (white lip stripe from tip of snout, snout not spotted); *R. chalconota*, *R. exiliversabilis*, *R. hmongorum*, *R. iriodes*, *R. morafkai*, and *R. nasuta* (yellow lip stripe from tip of snout, snout not spotted); *R. hejiangensis* and *R. junlianensis* (yellow lip stripe from tip of snout with brown lip bars); *R. versabilis* (yellowish-brown lip stripe, snout with white asperities); *R. grahami*, *R. jingdongensis*, and *R. kwangwuensis* (yellow-green marbling from tip of snout, some with brown marks); *R. andersonii*, *R. bacboensis*, *R. hainanensis*, *R. margaretae*, *R. schmackeri*, *R. sinica*, *R. tiannanensis*, and *R. trankieni* (no lip stripe). The postaxial fringe on toe V that extends to the base of the metatarsal as a thin ridge separates *R. tabaca* from *Huia nasica*, *R. bacboensis*, *R. banaorum*, *R. chalconota*, *R. chloronota*, *R. daorum*, *R. hosii*, *R. graminea*, *R. hmongorum*, *R. iriodes*, *R. margaretae*, *R. morafkai*, *R. megatympnum*, and *R. sinica*

(if present, fringe ends at the proximal subarticular tubercle); *A. chunganensis*, *R. grahami*, *R. kwangwuensis* (fringe ends at proximal subarticular tubercle or half-way to base of metatarsal); *R. hejiangensis*, *R. sinica* (no lateral fringe or ridge on toe V). *Rana tabaca* most closely resembles *R. bacboensis*, *R. megatympnum*, and *R. tiannanensis*. *Rana tabaca* further differs from *R. bacboensis* by its dorsolateral folds (absent in *R. bacboensis*) and unpigmented eggs (completely melanic in *R. bacboensis*). *Rana tabaca* further differs from *R. tiannanensis* by its shagreened dorsum (rough in *R. tiannanensis*). *Rana tabaca* further differs from *R. megatympnum* by its slightly larger males (*R. tabaca* SVL mean 55.60 mm, maximum 59.38 mm; 52.3 mm, maximum 55.2 mm for *R. megatympnum*), and its more moderate TMP: EYE (0.59–0.79 [mean 0.66] in *R. tabaca* males, 0.96–1.54 [mean 1.20] for *R. megatympnum*).

Character states for the condition of finger furrows and lateral fringes on the toes were obtained by direct observation of specimens (appendix 1) and from the original description of *R. trankieni* (Orlov et al., 2003). Character information on *R. exiliversabilis* and *R. nasuta* is from Fei et al. (2001), on *R. trankieni* from Orlov et al. (2003), and on *R. versabilis* from Liu and Hu (1962). Refer to table 3 and Bain et al. (2003: table 12) for detailed comparisons of regional cascade ranids.

ETYMOLOGY: The specific name is derived from the Latin *tabacum*, meaning tobacco. The dark brown of *R. tabaca* is close to the color of *thuoc lao*, a tobacco common in northern Vietnam.

DISTRIBUTION: This species is currently known only from Ha Giang Province in northern Vietnam: Mt. Tay Con Linh II, Cao Bo Commune, Vi Xuyen District, and Mt. Muong Cha, Du Gia commune, Yen Minh District.

REMARKS: Males were calling a single, loud, high birdlike chirp. They were found on streamside rock ledges and low-lying foliage and on branches 1–3 m over the stream. A female was seen in a small crevice under rocks. Males and females easily scale the rocks among the cascades they inhabit. Tadpoles remain unknown.

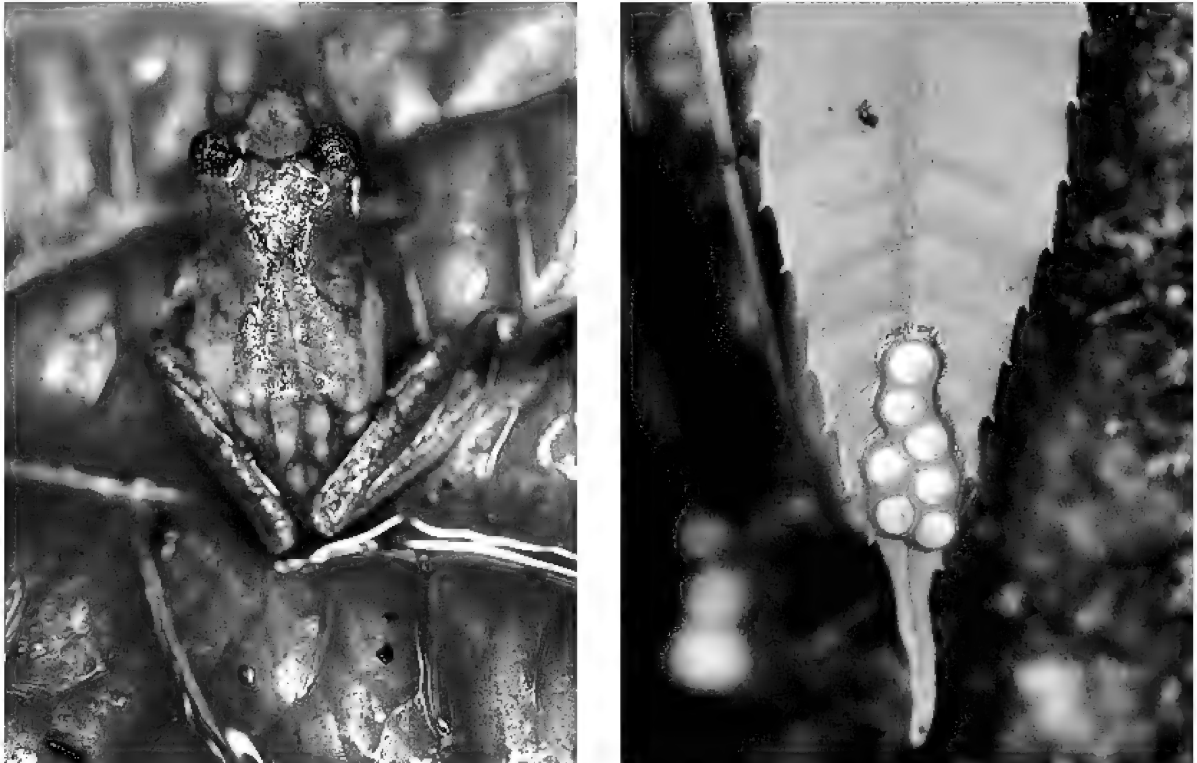


Fig. 14. *Chirixalus gracilipes*: dorsal view of gravid female (AMNH 163899) (left), SVL 29.50 mm; egg clutch (right). Individual eggs vary from 2.5–2.8 mm in diameter.

RHACOPHORIDAE

Chirixalus gracilipes (Bourret, 1937)

Figures 14, 15

Philautus gracilipes Bourret, 1937: “Chapa”, Tonkin [Vietnam].

Chirixalus gracilipes is known from the Hoang Lien Mountains in northwestern Vietnam (Bourret, 1937) and southern Yunnan Province (Fei, 1999), but this is the first record of it east of the Red River. These specimens match the original description exactly, however Bourret (1937) describes the hands as “less than two-thirds webbed”, whereas we prefer to describe the fingers as fleshy with lateral flaps, but not webbing.

Calling males, gravid females, and several aerial clutches of eggs and larvae were found at 1700 m. Clutches were deposited on leaves overhanging forest pools, which varied from rocky to muddy bottomed. Clutches were found from ground level up to 4 m. One clutch was found on leaves, but directly in the pool. Clutch size varies from two to eight. Initial identification of eggs was based

on proximity to calling males, as well as egg size and shape, visible through gravid females (fig. 14). Comparison of DNA sequence data confirmed that the eggs and larvae are conspecific with adult specimens of *C. gracilipes* (J. Faivovich, unpubl.). The right ovary of one female (AMNH 163900) holds more than 20 eggs (complete count not possible in order to keep specimen intact).

Eggs are creamy yellow with brown melanistic pole, each encased in a gelatinous capsule that sticks the eggs to the leaf and each other (fig. 14). Eggs are between 2.5 and 2.8 mm in diameter, whereas the gelatinous casings range from 4.5 to 10 mm in diameter. Larvae within the gelatinous egg-mass clutches were found between stage 1 and stage 24 of development (Gosner, 1960). Tadpoles beyond stage 20 were large and active, causing the casings to droop to the edge of the leaf (fig. 15). At stage 24, tadpoles are depressed, oval in dorsal view; snout round in dorsal and lateral views; eyes in dorsal position, dorsolateral orientation; nares three-fourths to tip of snout, aperture oval, directed



Fig. 15. *Chirixalus gracilipes* clutch with tadpoles visible.

anterodorsally; oral disk ventral, elliptical, emarginated at the corners and appears suctional; at this stage the labial teeth are still forming, although the jaw sheath is present and strongly keratinized in a typical shape (see Altig and McDiarmid, 1999: fig. 3.9A); tail is moderately high, originates near dorsal tail-body junction, tip weakly pointed. In preservative, body gray with light brown, irregular dusting, tail fin almost totally without pigment.

MEASUREMENTS (in mm) OF ONE TADPOLE AT STAGE 24: body length 4.08, lateral height

2.04; dorsal height 2.37; interorbital distance 1.42; internares distance 1.26; tail length 8.38; maximum tail muscle height 1.02; tail muscle width 0.67 (all tadpole measurements follow Altig and McDiarmid, 1999).

The generic placement of this small, distinct species is problematic. *Philautus* is a large (177 species), widely distributed (south and southeast Asia) genus with historically ambiguous diagnosable characters. This has made it a taxonomically confusing group, as assignment of small rhacophorid species has been scattered among *Philautus*, *Chirixalus*

(21 species), and *Rhacophorus* (56 species) (Bossuyt and Dubois, 2001; Frost, 2002). At the time of its description, the placement of *gracilipes* into *Philautus* rather than *Chirixalus* was based on the following characters: digit tips dilated into “regular-sized” disks for *Philautus*, “large-sized” disks for *Chirixalus*; external metatarsals separated by a furrow or by a narrow web in *Philautus*, absent in *Chirixalus*; “webbing” of two external fingers gives the appearance that they are opposable to the internal fingers in *Chirixalus*, not in *Philautus* (Bourret, 1937, 1942; Liem, 1970). Although no phylogeny for *Philautus* has been proposed, Dring (1979) described the direct aerial development of the type species, *Philautus aurifasciatus*, and it has since been recognized as the diagnosable character for the genus (Bossuyt and Dubois, 2001). Even in the absence of larval data, workers continue to assign small rhacophorid species to *Philautus* if they are not diagnosable as *Chirixalus* (i.e., do not have two external fingers “opposable” to the internal digits) (Bossuyt and Dubois, 2001). Assignment of species to *Chirixalus* is also problematic, as it has been shown to be paraphyletic (Wilkinson et al., 2002).

Because tadpoles of *C. gracilipes* exhibit characters not seen in direct aerial developers (i.e., strongly keratinized jaw sheath, expanded oral disk, and coiled gut), the species cannot be considered part of *Philautus*. Bossuyt and Dubois (2001) followed Inger et al. (1999: 23–24) in removing *C. palbebralis* from *Philautus* when faced with the same situation. In the absence of a known phylogeny of the two genera, we follow the provisional taxonomy of Bossuyt and Dubois (2001) and place *gracilipes* in *Chirixalus*, since it is not a member of *Philautus*, but we recognize that this is a provisional arrangement pending major revisionary work. This is consistent with Bossuyt and Dubois’ (2001) placement of *gracilipes* in the *C. palbebralis* group (sensu Fei, 1999). The need for these taxonomic stop-gap measures highlights the necessity for a rigorous systematic study of *Rhacophorus*, *Chirixalus*, and *Philautus*, the latter of which is also suspected to be paraphyletic (Bossuyt and Dubois, 2001).

MEASUREMENTS OF FEMALES (in mm, $N = 3$, AMNH 163893, 163899, 163900; mean,

\pm standard deviation, range in parentheses): SVL 27.75 ± 1.24 (26.37, 28.08, 28.79), HDL 10.05 ± 0.83 (9.44, 9.72, 10.99), HDW 9.23 ± 0.81 (8.30, 9.56, 9.82), SNT 4.22 ± 0.31 (3.93, 4.55, 4.17), TIB 15.35 ± 0.29 (15.54, 15.49, 15.02), FTL 21.01 ± 0.45 (20.50, 21.18, 21.35), HND 9.46 ± 0.46 (9.51, 8.98, 9.89), EYE 3.48 ± 0.30 (3.14, 3.56, 3.73), TMP 1.44 ± 0.21 (1.20, 1.58, 1.55), IOD 4.36 ± 0.36 (4.33, 4.74, 4.02); median HDL:HDW 1.11 (1.14, 1.12, 1.14), median TIB:SVL 0.55 (0.55, 0.52, 0.59), median TMP:EYE 0.41 (0.44, 0.42, 0.38), median SNT:HDL 0.42 (0.47, 0.38, 0.42).

MEASUREMENTS OF MALES (in mm, $N = 5$, AMNH 163894–163898; mean, \pm standard deviation, range in parentheses): SVL 22.76 ± 0.97 (21.66–23.80), HDL 8.89 ± 0.65 (8.06–9.66), HDW 7.73 ± 0.54 (7.16–8.56), SNT 3.67 ± 0.19 (3.38–3.86), TIB 13.06 ± 0.22 (12.80–13.41), FTL 17.56 ± 0.55 (16.96–18.04), HND 8.11 ± 0.71 (7.51–9.28), EYE 3.34 ± 0.25 (3.11–3.74), TMP 1.26 ± 0.24 (0.95–1.49), IOD 3.62 ± 0.21 (3.50–3.99); median HDL:HDW 1.15 (1.08–1.24), median TIB:SVL 0.58 (0.55–0.62), median TMP:EYE 0.38 (0.30–0.48), median SNT:HDL 0.41 (0.36–0.47).

Philautus maosonensis Bourret, 1937

This species was collected while calling on vegetation between 0.5 and 2 m off the ground in the forest near (but not directly adjacent to) any water source. This frog called alone or in syncopated choruses. Choruses can be as dense as one individual male per 4 m². Males were found calling on tops of leaves, though never on the topmost leaf of the plant. The color of these specimens is uniformly brown during the day (orange-peach at night), thighs brown, except flash colors, which are yellow; tips of some fingers yellow; venter mottled white on black. This species has been reported in Mau Son, Lang Son, and Cao Bang Provinces on the north-east border with China, and from Tam Dao in Vinh Phu Province (Bourret, 1937; Inger et al., 1999; Orlov et al., 2002).

MEASUREMENTS OF MALES (in mm, $N = 6$, AMNH 163904–163909; mean, \pm standard deviation, range in parentheses): SVL 30.60 ± 2.42 (25.97–32.88), HDL 12.15 ± 0.83

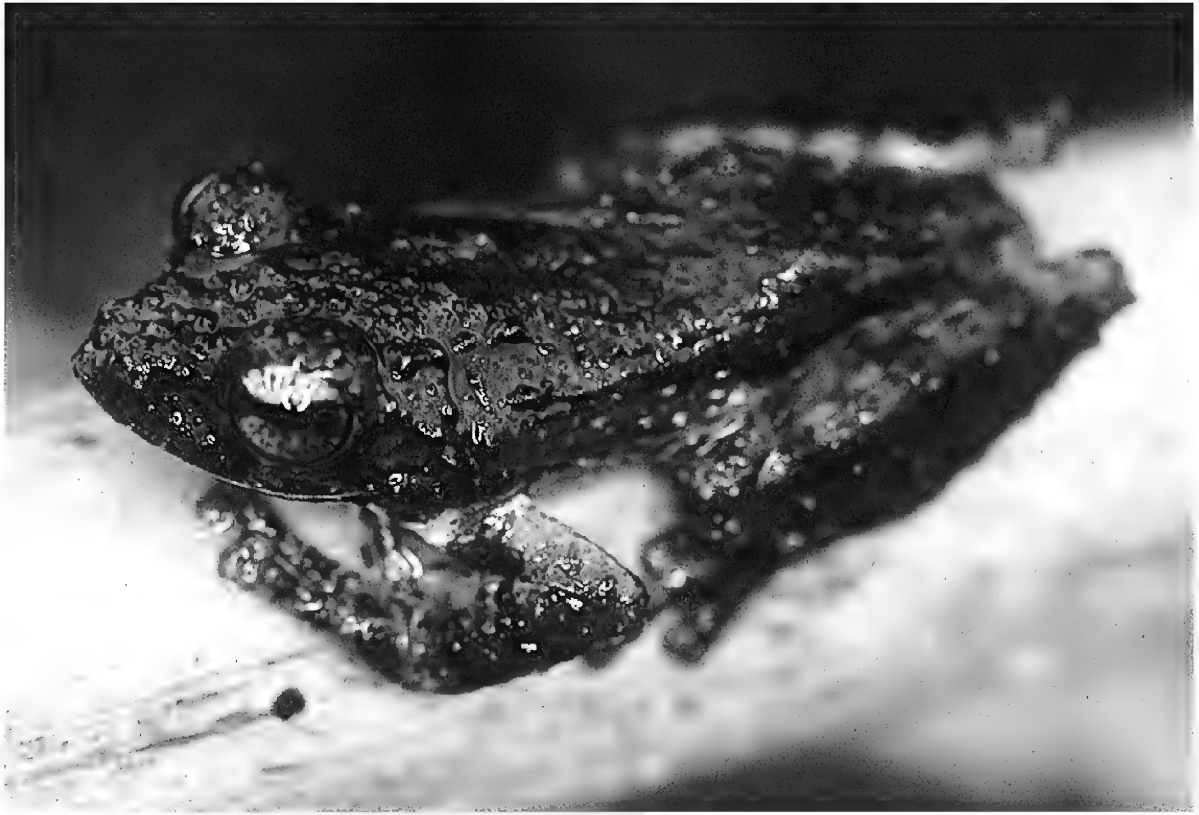


Fig. 16. *Philautus odontotarsus*.

(11.18–13.44), HDW 10.92 ± 0.78 (9.43–11.54), SNT 4.73 ± 0.57 (3.69–5.16), TIB 15.42 ± 0.99 (13.53–16.46), FTL 22.02 ± 1.80 (18.79–23.98), HND 10.09 ± 0.85 (9.11–11.58), EYE 4.65 ± 0.35 (4.15–5.23), TMP 1.79 ± 0.21 (1.57–2.06), IOD 3.71 ± 0.34 (3.30–4.14); median HDL:HDW 1.12 (1.03–1.23), median TIB:SVL 0.50 (0.49–0.52), median TMP:EYE 0.39 (0.37–0.42), median SNT:HDL 0.39 (0.29–0.46).

Philautus odontotarsus Ye and Fei, 1993

Figure 16

This species was found at the forest edge, beside large wet rice paddies at 600 m. It was found atop vegetation and branches less than 2 m above the ground.

Philautus odontotarsus is part of a taxonomically problematic group including *Rhacophorus appendiculatus*, *R. bissaculus*, *R. cavirostris*, and *R. verrucosus* (see discussions in Inger et al., 1999: 39–40; Orlov et al., 2001: 39–40; Frost, 2002; Orlov et al., 2002: 97–98). Although *Philautus odonto-*

tarsus has been reported from Lao Cai Province (Ohler et al., 2000), this is the first stated record east of the Red River. In addition to the Lao Cai specimens (Ohler et al., 2000), these specimens are possibly conspecific with unidentified specimens from Tam Dao (Inger et al., 1999: 40) and specimens reported as *Rhacophorus verrucosus* from Lao Cai (Orlov et al., 2001).

We base our identification on the specimens' similarity with the original description of *P. odontotarsus* and the proximity of Ha Giang Province to its type locality (Ye and Fei, 1993). The type locality of *P. odontotarsus* is in Yunnan Province, China, but the type locality of other frogs of the group is much farther away: *R. appendiculatus*, the Greater Sunda Islands; *R. bissaculus*, Phu Kading, Loei Province, Thailand; *R. cavirostris*, Sri Lanka; and *R. verrucosus*, Myanmar. We include a translation of the original description of *P. odontotarsus* from Chinese in appendix 2.

Our specimens are identified as *P. odon-*

totarsus based on the following characters: male SVL between 28 and 35 mm; vomerine teeth present in short oblique rows; relative finger lengths $I < II < IV < III$; finger tips with expanded disks; disks with circummarginal grooves; disk on I small; disk on III smaller than tympanum diameter; fingers with lateral fringes and basal webbing; five to six saw-teeth tubercles on outer edge of forearm; no outer metatarsal tubercle; saw-teeth tubercles on tarsus along outside of toe V to tibiotarsal joint; skin rough; dorsum with irregularly shaped tubercles, more on upper eyelids; dorsum olive and gray; flanks grayish-green; back of forelimbs with black-brown transverse bars; flash colors orange-red; chest and belly with scattered spots; males with creamy white nuptial pad at the base of finger I.

Our specimens differ from the original description in female size (SVL 43 mm for the Chinese population, 34.2 and 35.64 for Ha Giang specimens), male TMP:EYE (0.50–0.66 for Chinese populations, 0.34–0.47 for Ha Giang specimens), and foot webbing (in Chinese population web full to toe tips, except toes I and V; for Ha Giang specimens web full to between distal subarticular tubercle and disk for toes I, V, and postaxial sides of toes II and III, web basal [below subarticular tubercle] for preaxial side of II, web full to between medial and distal subarticular tubercles for toe IV, and the postaxial side of III, web reaching all disks as a fringe, except for preaxial side of II). We agree with Inger et al. (1999: 40) and Orlov et al. (2000: 39–40) that our identification is uncertain and that a stable identification (both generic and specific) requires a detailed analysis of this group of species from India, Myanmar, Thailand, Indochina, and China.

Philautus odontotarsus is known from China: Tibet Autonomous Region, and Yunnan, Guizhou, Hainan, Guangxi Provinces; and Vietnam: Lao Cai, Ha Giang Provinces (Fei, 1999; Ohler et al., 2000; this paper).

MEASUREMENTS OF FEMALES (in mm, $N = 2$, A-163977, 163978): SVL 34.2, 35.64; HDL 11.94, 13.35; HDW 11.49, 12.77; SNT 5.31, 6.09; TIB 17.44, 17.48; FTL 22.69, 24.36; HND 10.0, 9.83; EYE 4.67, 4.97; TMP 1.59, 2.79; IOD 4.18, 3.96); HDL:HDW 1.04, 1.05; TIB:SVL 0.49, 0.51, TMP:EYE 0.34, 0.56, SNT:HDL 0.44, 0.46.

MEASUREMENTS OF MALES (in mm, $N = 4$, A-163975, 163976, 163979, 163980; mean, \pm standard deviation, range in parentheses): SVL 31.59 ± 1.01 (30.58–32.84), HDL 11.68 ± 0.50 (11.13–12.19), HDW 10.82 ± 0.41 (10.45–11.39), SNT 5.25 ± 0.68 (4.44–5.99), TIB 16.61 ± 0.76 (15.48–17.05), FTL 22.12 ± 0.66 (21.14–22.59), HND 9.71 ± 0.96 (8.36–10.57), EYE 4.45 ± 0.48 (4.01–4.96), TMP 1.74 ± 0.13 (1.59–1.90), IOD 3.57 ± 0.08 (3.48–3.65). median HDL:HDW 1.08 (1.05–1.13), median TIB:SVL 0.53 (0.51–0.55), median TMP:EYE 0.39 (0.34–0.47), median SNT:HDL 0.45 (0.39–0.54).

Philautus rhododiscus Liu and Hu 1962
Figure 17–19

A single specimen was found at 0545 hours on a tent at the 1400 m camp on Mt. Tay Con Linh II (site 2). This represents the first record of this species outside of China (Guangxi, Fujian Provinces) (Fei, 1999). The specimen from Ha Giang matches the original description precisely (Liu and Hu, 1962); diagnosis: toes with disks orange-red on the ventral side, tea-brown dorsally; dorsum with white tubercles interweaved as a network. A translation of the original description of *P. rhododiscus* is in appendix 3.

We enhance the description, based on AMNH 163892/IEBR 59, an adult male. Palmar tubercle appears to have a free edge. Relative toe length $I < II < V = III < IV$, which agrees with the illustration in the original description (Liu and Hu, 1962: fig. 11a, b). Webbing reaches the base of every toe disk as a fringe, except for toe V, where it reaches subarticular tubercle (reaches second articulation on toe IV of holotype). Preaxial fringe on toe I runs from the base of the disk to the top of the subarticular tubercle; toe V without a postaxial fringe. The dorsal longitudinal, pointy ridges are as in the description of the holotype. The Ha Giang specimen exhibits spinules on every dorsal and lateral surface (torso, head, appendages, and digits), except the tympanum. The dorsum is olive brown with long black spots on the appendages, middorsal, and sacral areas. Venter is black with a white marbled network. Chin is dark black with white spots. White nuptial pad on the thumb.

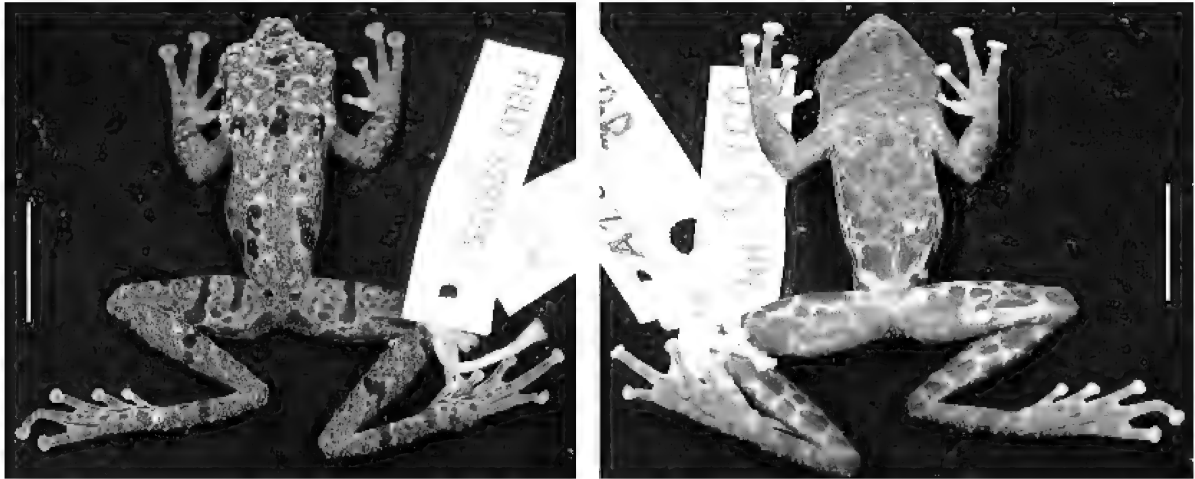


Fig. 17. *Philautus rhododiscus* (AMNH 163892/IEBR 59), male: dorsal (**left**) and ventral (**right**) views. Scales equal 10 mm.

MEASUREMENTS OF MALE (in mm, $N = 1$, AMNH 163892/IEBR 59): SVL 26.60, HDL 11.70, HDW 8.30, SNT 4.00, EYE 1.90, IOD 2.85, TMP 1.85, HND 8.4, FPW 1.72, TIB 14.9, FTL 20.25, TPW 1.19.

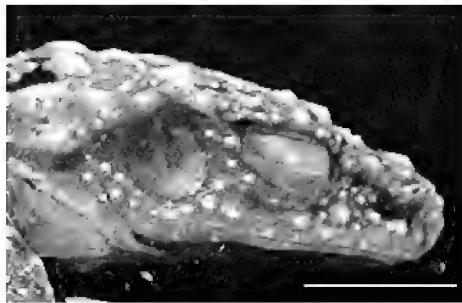


Fig. 18. Head of *Philautus rhododiscus* (AMNH 163892/IEBR 59), male. Scale equals 5 mm.

Polypedates dugritei David, 1872 “1871”

Figures 6E, F, 20–22

Polypedates dugritei David, 1872 “1871”.

Rhacophorus hui Liu, 1945.

Rhacophorus pleurostictus batangensis Vogt, 1924.

Hyla bambusicola (Barbour, 1912).

Polypedates davidi Sauvage, 1877.

Four male specimens referable to *P. dugritei* were found at 1700 m (fig. 6E, F). All were calling atop broadleaves or bamboo 1–3 m above temporary forest pools (in the

same microhabitat as *Chirixalus gracilipes*). No females or foam nests were found. *Polypedates dugritei* is known from southern Sichuan, Guizhou, Hubei, and Yunnan Provinces, China, and the Hoang Lien Mountains of northwestern Vietnam (Wu and Zheng, 1994; Fei, 1999; Ohler et al., 2000; Orlov et al., 2001). The specimens from Ha Giang are the first recorded east of the Red River.

The series from Ha Giang closely matches the brief original description (David, 1872 “1871”) and a subsequent amplification of the description based on Hoang Lien Mountain specimens (Orlov et al., 2001). The color in life (and in preservative) of Ha Giang *P. dugritei* is as follows: dorsum light green (livid blue), dorsum, flanks, and limbs heavily spotted red-brown to digit tips, each spot with thick black border (brown with black border); red-brown band on supratympanic fold present or absent; axillary region, flanks, posterior and anterior surface of thighs thickly marbled black and white; inner thighs tinged red; white line along lateral edge of toe V continuous with the lateral margin of the tarsus and across anus, thin black line immediately below transmedial white line (fig. 6F); a similar, but less distinct line on the lateral edge of finger IV along the forearm to the flanks; thick black on white marbling across the entire venter (black on white), chin with more brown mottling (gray), chest yellow-white (dull white); web-

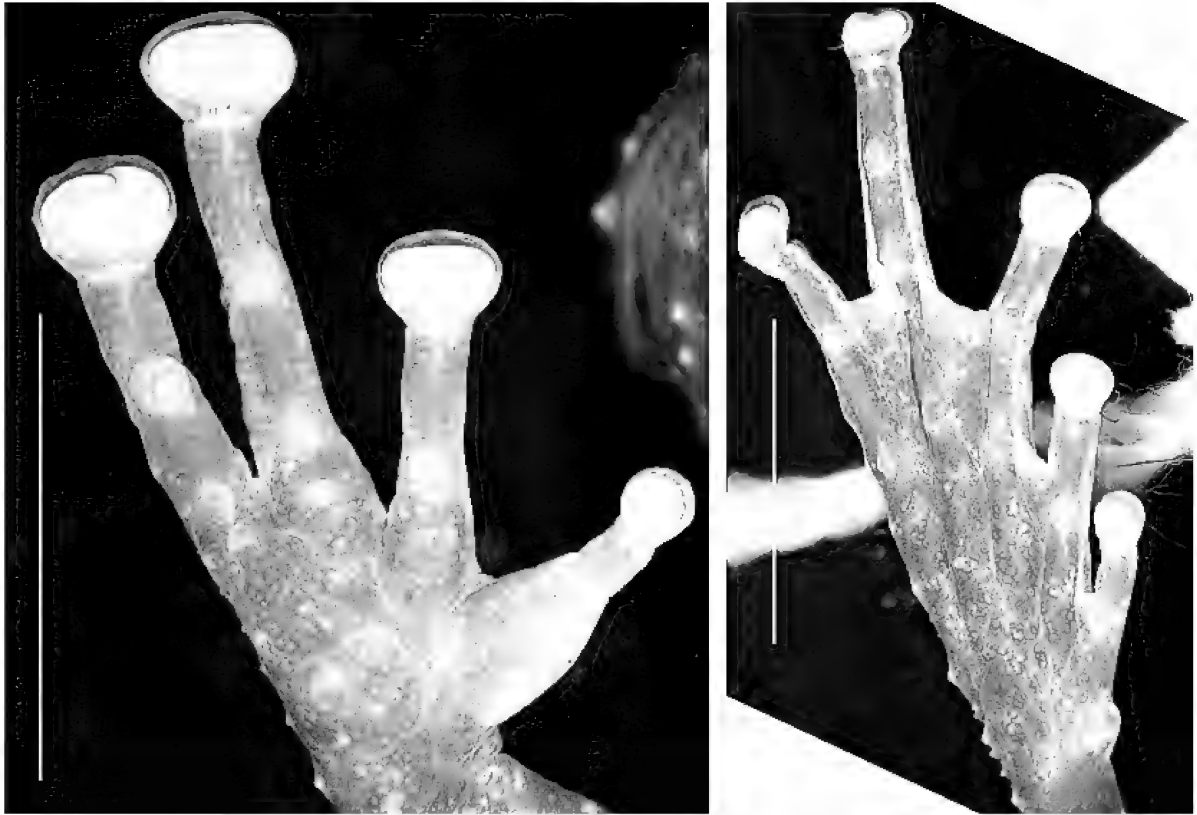


Fig. 19. *Philautus rhododiscus* (AMNH 163892/IEBR 59), male: hand (left) and foot (right). Scales equal 5 mm.

bing and tips of feet red; dorsal one-third of iris gold, orange-red ventral two-thirds.

Specimens of *P. dugritei* from Ha Giang were compared with specimens from the Hoang Lien Mountains and syntypes from Mouping, China (appendix 1) (figs. 20–22). All three series closely match each other in shape, although the Hoang Lien Mountain specimens are the smallest of all published accounts of *P. dugritei*, its synonyms, and similar species (table 4). Tubercles on the hands and feet of the syntypes are very pronounced (fig. 21). The inner metatarsal tubercle is high and sharply projecting in the syntypes, low and ovoid in the Vietnamese specimens (fig. 22). Orlov et al. (2001: 23) commented on the possible conspecificity of *P. dugritei* from the Hoang Lien Mountains with *P. puerensis* (He, 1999). The description of *P. puerensis* closely matches that of the syntypes and Vietnamese series of *P. dugritei*, except that *P. puerensis* has a glandular wart at end of the lip that forms a tri-

angle with supratympanic fold and the supratympanic fold continues from the eye to connect to a weak, obscured fold on the flank (not found in *P. dugritei*). We did not examine the type series of *P. puerensis*, but in light of the marked similarity between the two species, we include a translation of the original description of *P. puerensis* in appendix 4.

Polypedates dugritei shows a high level of sympatric variation (Pope and Boring, 1940; Liu, 1950; Wu and Zheng, 1994; Fei, 1999; Ohler et al., 2000; Orlov et al., 2001), including: (1) vomerine teeth vary from being absent to distinctly present; (2) red-brown dorsal spots vary from lightly scattered to a dense mosaic; (3) red-brown coloration of supratympanic fold present or absent; (4) venter varies from immaculate to marbled to deeply mottled brown; (5) white transmedial line along lateral edge of toe V continuous with the lateral margin of the tarsus, across anus, and continuous with lateral edge of fin-



Fig. 20. Syntypes of *Polypedates dugritei*: clockwise from top left: MNHNP 1994.2641, male, SVL 42.40 mm; MNHNP 1994.2361, female, SVL 55.92 mm; MNHNP 1994.2362, female, SVL 59.24 mm; and MNHNP 5563, male, SVL 39.80 mm.

ger IV along the forearm (created when individual sits still [fig. 6F]) present or absent; (6) inner three toes orange-red or not; (7) groups of adults with distinct size differences. Some differences are also noted across allopatric populations: the size range of *P. dugritei* is 32–47 mm for males and 46–66 mm for females (table 4), and specimens are described as being rough, with tubercular skin (Liu, 1950; Fei, 1999), whereas the syntypes and Vietnamese specimens are smooth, with or without tubercles.

Wu and Zheng (1994) reported that four Chinese populations of *P. dugritei* within 100 km of each other exhibit two distinct karyotypic patterns. They described a new species, *P. zhaojuensis* from Sichuan and Hubei Provinces, based on differences in the karyotype (*P. zhaojuensis* with secondary constriction in the middle of long arm of chromosome 10; *P. dugritei* with satellite on the terminal end of arm 10), and snout coloration (yellowish-brown in *P. zhaojuensis*).

This suggests that *P. dugritei* is a complex of species and would account, at least in part, for its widespread range and highly variable nature (Pope and Boring, 1940; Liu, 1950; Ohler et al., 2000; Orlov et al., 2001). The confusion that this variation presents is also evidenced by the five junior synonyms of *P. dugritei*. A thorough investigation of all known specimens (including types of junior synonyms) is necessary to help resolve this confusion.

MEASUREMENTS OF MALE *POLYPEDATES DUGRITEI* (in mm, $N = 4$ males, AMNH 163910, 163911, 163912/IEBR 62, 163913/IEBR 63; mean, \pm standard deviation, range in parentheses): SVL 42.59 ± 2.87 (40.11–46.63), HDL 15.50 ± 0.77 (14.43–16.10), HDW 15.92 ± 0.70 (15.13–16.75), SNT 7.11 ± 0.40 (6.67–7.64), EYE 5.02 ± 0.63 (4.26–5.79), IOD 5.28 ± 0.33 (4.93–5.65), TMP 2.39 ± 0.19 (2.20–2.57), HND 13.85 ± 0.92 (13.18–15.20), TIB 18.03 ± 0.58 (17.43–18.80), FTL 28.39 ± 1.35 (26.61–29.68);

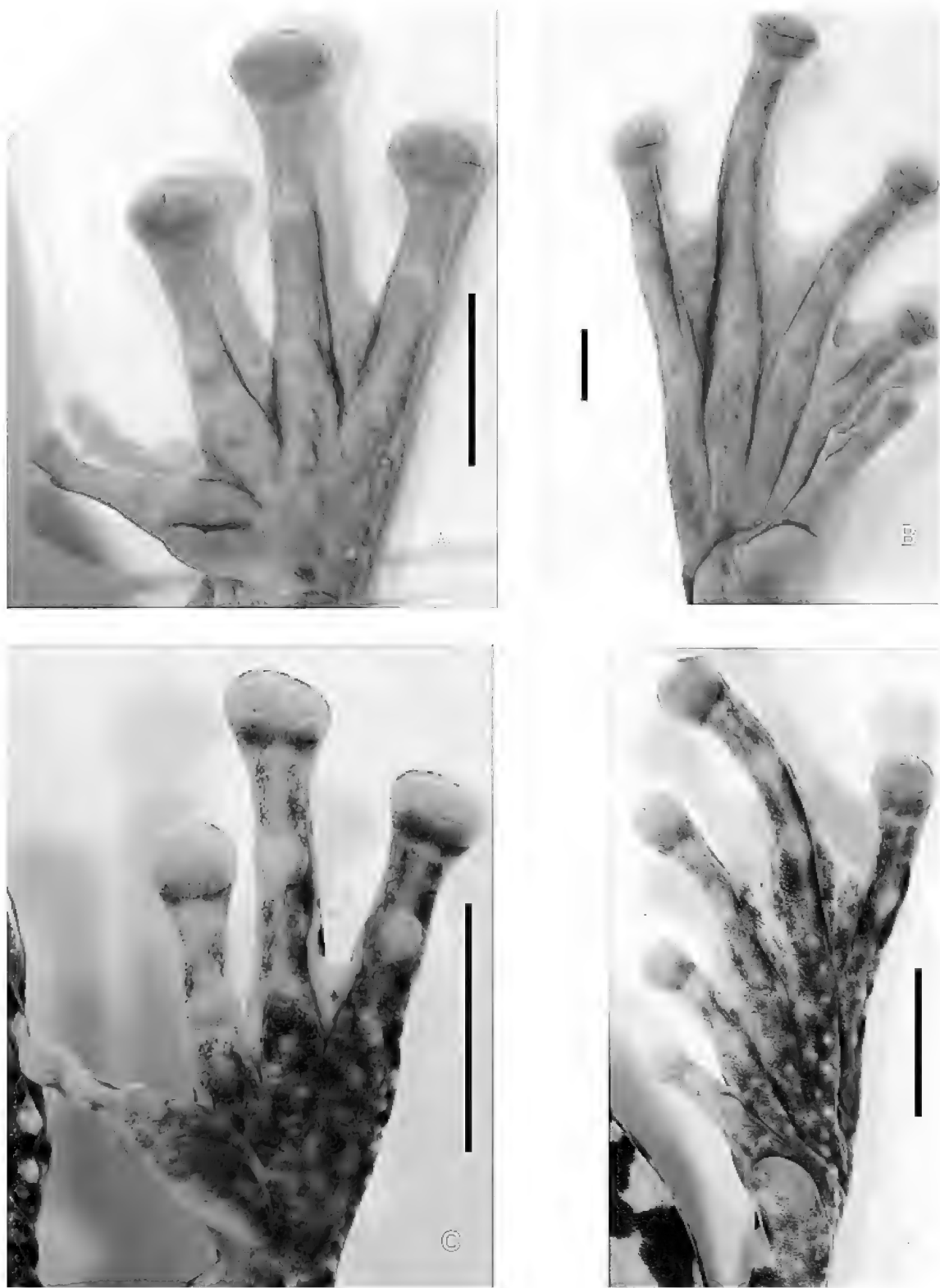


Fig. 21. Hands and feet of *Polypedates dugritei*: hand (A) and foot (B) of MNHNP 1994.2361, syntype; hand (C) and foot (D) of AMNH 163910. Scales equal 5 mm.

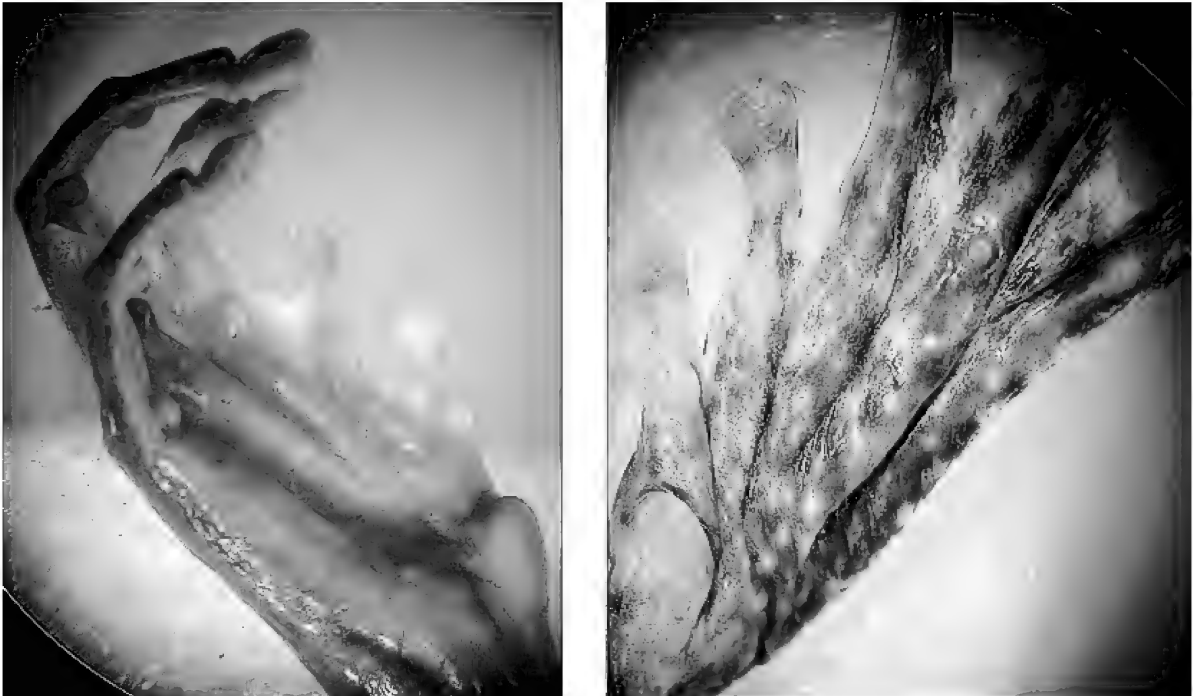


Fig. 22. Feet of *Polypedates dugritei*: (left) foot of MNHNP 5663, male syntype, with taller tubercles (especially the metatarsal tubercle) than those from Vietnam, as shown in the foot of AMNH 163910 (right).

TABLE 4
Published Snout-Vent Lengths (in mm) of *Polypedates dugritei*, Its Junior Synonyms (*Rhacophorus bambusicola* and *Rhacophorus pleurostictus batangensis*), and *Polypedates puerensis*. Measurement means with ranges are shown for series.

		<i>P. dugritei</i>							
		Sichuan			Vietnam		<i>R.</i>	<i>R. p.</i>	<i>P.</i>
	Holotype	Syntypes	Near Shaping, Opien	Sichuan, Yunnan, Hubei ^a	Ha Giang	Hoang Lien	<i>bambusicola</i> Sichuan	<i>batangensis</i> Sichuan	<i>puerensis</i> Yunnan
Males	43	43	45	44	43	37	40	39	41
	(N = 1)	42.5–43.5 (N = 4)	44–47 (N = 7)	(N = ?)	40–47 (N = 4)	32–42 (N = 23)	34–43 (N = 10)	(N = ?)	35.5–41 (N = 9)
Females		60.5	66	61		50	51	52	52, 55.2
		58–62.5 (N = 3)	(N = 1)	(N = ?)		46–53 (N = 5)	(N = 1)	(N = ?)	(N = 2)
Source	David, 1872	Pope and Boring, 1940	Liu, 1950	Fei, 2000	this paper	Orlov et al., 2001	Liu, 1950; Liu 1945 (as <i>R. hui</i>)	Vogt, 1924	He, 1999

^aMeasurements represent a summary of specimens from Sichuan, Yunnan, and Hubei provinces.

median HDL:HDW 0.97 (0.93–1.02), median TMP:EYE 0.48 (0.44–0.53), median SNT: HDL 0.46 (0.44–0.48), median TIB:SVL 0.42 (0.40–0.45).

Rhacophorus hoanglienensis Orlov et al.,
2001

This single specimen was collected on a broad leaf 2 m above the ground in the forest. This is only the second specimen and the first female recorded for this species and is the first record east of the Red River (Orlov et al. 2001). Some additional color information for this specimen: dorsum orange-red with irregular black and brown spotting; white line runs from the supra-tympanic fold, over the eyelid, across the canthus rostralis to tip of snout; brown line running between the eyes; inner thigh black with white speckling, white increases along sides; webbing gray; venter evenly dark brown to tibia.

MEASUREMENTS (in mm, $N = 1$, AMNH 163767/IEBR 57): SVL 57.89, HDL 21.45, HDW 22.06, SNT 8.85, EYE 7.17, IOD 7.84, TMP 3.45, HND 17.38, TIB 31.8, FTL 40.20.

Theloderma asperum (Boulenger, 1886)

Calling males referable to *Theloderma asperum* were recorded from 1000 m on Mt. Muong Cha and from 1400 to 1700 m on Mt. Tay Con Linh II. Calls were made from high in the canopy and could be heard from several kilometers away, either alone or in choruses. Each call consists of a repeating two-note “peep-peep” (at ~180 beats/minute), with a 2-second intermittent silence. Choruses could be heard either within a small forest area (~100 m²) or several kilometers across valleys. Individuals would begin to call independently, and then proximal individuals would call together in synchrony and eventually fall into syncopation with distant groups. In this way, a cluster of frogs dispersed throughout the canopy on one side of a valley would call during the 2-second rest of the group on the other side of the valley, and vice versa. This continued for up to 30 minutes uninterrupted. The calls were heard more often at 1400 m (on Tay Con Linh II) than at higher elevations, and calling was undeterred during a full moon. Although not

measured, several discrete pitches of calls were heard across valleys. No vouchers were collected, but calls were recognized by one of us (R.H.B.) as identical to those of *Theloderma asperum* from Tam Dao, Vinh Phu Province (referred specimens currently housed in the ROM).

Rhacophoridae spp.

Two species of Rhacophoridae were heard calling from trees. One species was heard calling from a small hardwood (DBH 5 cm) several hundred meters from any type of water at 1700 m elevation. Although the call was persistent, it stopped as soon as the moon rose. At 1900 m, another species was heard calling in foliage close to the ground. Two males were calling in syncopation with a single “peep”. No specimens of either species was recovered.

DISCUSSION

An understanding of Vietnam’s herpetofaunal diversity and distribution is still only emerging, owing in part to historically disparate survey efforts and a recent recognition of “hidden” diversity within species complexes.

Research efforts in Vietnam over the past 10 years have resulted in several new records and the discovery of 19 previously undescribed species of reptiles (2 snakes, 15 lizards, 3 turtles) and 28 species of frogs (Frost, 2002; Uetz, 2002; Ziegler, 2002; Bain et al., 2003; Ohler, 2003; Orlov et al., 2003; Stuart and Parham, 2004). The current number of amphibians now known from Vietnam is 157, a 57% increase since Inger et al. (1999) (Ohler et al., 2000; Orlov et al., 2002, 2003; Ziegler, 2002; Bain et al., 2003; Ohler 2003). Estimating the country’s herpetofaunal diversity remains a dynamic process, and survey efforts have resulted in more detailed records of species geographic ranges. Results from recent surveys in northwestern Vietnam, for example, suggested both a lower level of endemism and higher overall diversity of amphibian species of Mt. Fan Si Pan (13% endemic [7/52 species]; Ohler et al., 2000; Orlov et al., 2001) than was previously thought (54% endemic [13/24 species]; Bourret, 1942). Our discovery of *Rhacophoro-*

rus hoanglienensis in Ha Giang again lowers the proportion of endemic amphibians in Fan Si Pan to 12% (6/52).

At the same time, the recognition of species complexes in the region reveal not only cryptic diversity, but sets of species with much more limited ranges than was previously thought (e.g., *Paramesotriton*: Chan et al., 2001; *Fejervarya*: Toda et al., 1998a, 1998b; Veith et al., 2001; *Limnonectes*: Emerson et al., 2000; Evans et al., 2003; *Rana*: Murphy et al., 1997; Fei et al., 2001; Li et al., 2001; Matsui et al., 2002; Ziegler, 2002; Bain et al., 2003; Orlov et al., 2003; *Polypedates*: Orlov et al., 2002; *Takydromus*: Lin et al., 2002; *Dixonius*: Ota et al. 2001; *Emoia*: Emilio et al., 1996; *Naja*: Wüster and Thorpe, 1992; and *Cuora*: Stuart and Parham, 2004). For at least some of these complexes, sympatric occurrence of multiple cryptic species is common, as with *R. chloronota* (Bain et al., 2003) and now *R. iriodes* and *R. tabaca*. This is indicative of an underestimated level of diversity and a history that is not yet fully understood. We recorded the presence of *Fejervarya limnocharis*, *Hoplobatrachus rugulosus*, *Limnonectes kuhlii*, *Rana chloronota*, *R. maosonensis*, *Polypedates dugritei*, and *P. leucomystax*, all known to be species complexes.

Most of the amphibian and reptile species recorded from Ha Giang fall within expected ranges, being previously recorded from adjacent Yunnan Province, China, or the Vietnamese provinces of Lao Cai, Lai Chau, Tuyen Quang, and Cao Bang (Pope, 1931, 1935; Bourret, 1936, 1942; Liu and Hu, 1961; Nguyen and Ho, 1996; Lathrop et al., 1998; Fei, 1999; Inger et al., 1999; Ohler et al., 2000; Orlov et al., 2001). In our surveys of Ha Giang, 27% (10/36) of the amphibians recorded are common to highly disturbed habitats throughout southeast Asia: *Bufo melanostictus*, *Microhyla heymonsi*, *M. pulchra*, *M. sp.*, *F. limnocharis*, *H. rugulosus*, *R. guentheri*, *R. taipehensis*, *Philautus odontotarsus*, and *P. leucomystax* (although the range of *M. sp.* is unknown, it was found in a wet rice paddy, indicating that it is probably commensal with agricultural habitats of the region). All of these species, except for *P. odontotarsus* and *R. guentheri* are found in lowlands. Two snakes recorded from dis-

turbed habitats, *Dendrelaphis pictus* and *Ptyas korros*, also have wide ranges in southeast Asia. Two amphibians, *Amolops ricketti* and *R. maosonensis*, and two reptiles, *Sinonatrix aequifasciata* and *S. percarinata*, were found in streams and rivers adjacent to agricultural habitats. *Rana maosonensis* is found in the highlands of northern Vietnam and *A. ricketti*, *Sinonatrix aequifasciata* and *S. percarinata*, are found in the highlands of northern Indochina and southern China. Several species were found both in the forest and along the edge of second growth: *Chaparana delacouri*, *L. kuhlii*, *R. chloronota*, *Philautus parvulus*, and *Amphiesma khasiensis*. The remaining 55% (20/36) of amphibian and 56% (9/16) of reptile species were found only in the forest: *Tylototriton asperrimus*, *Bombina microdeladigitata*, *Leptobranchium chapaense*, *Leptolalax bourreti*, *Megophrys major*, *M. palpebralespinosa*, *M. parva*, *O. microstoma*, *Amolops chapaensis*, *Paa boulengeri*, *Rana iriodes*, *Rana tabaca*, *Chirixalus gracilipes*, *Philautus maosonensis*, *P. rhododiscus*, *Polypedates dugritei*, *Rhacophorus hoanglienensis*, *Theloderma asperum*, *Rhacophoridae sp. (no.1)*, *Rhacophoridae sp. (no.2)*, *Acanthosaura lepidogaster*, *Scincella reevesii*, *Ahaetulla prasina*, *Amphiesma modesta*, *Calamaria septentrionalis*, *Oligodon taeniatus*, *Pareas hamptoni*, *Pseudoxenodon karlschmidti*, and *Trimeresurus stejnegeri*.

The reported diversity is lower than that of other montane surveys for Indochina (Ohler et al., 2000, 2002; Orlov et al., 2001). There are approximately 108 amphibian species and 154 reptile species (111 snakes, 39 lizards, 14 turtles) known from northern Vietnam (Inger, 1999; Ohler et al., 2000; Orlov et al., 2001, 2002, 2003; Frost, 2002; Uetz, 2002, Bain et al, 2003), indicating that our results from Ha Giang represent approximately 33% of the known amphibian fauna and 10% of the reptile fauna of the region. This, coupled with the sharp slope of the species accumulation curve (fig. 2), indicates that these are only preliminary results and that the area is still under-surveyed, particularly for reptile diversity. Our relatively short survey time occurred during the earliest part of the rainy season. An extended stay during the rainy season and at the higher elevational zones at any time of the year would increase

the number of recorded reptiles and breeding amphibians. Discussions with local hunters indicated the presence of other species (e.g., *Hyla simplex* and *Polypedates dennysii*) that were not found during this survey.

CONSERVATION NOTES

The discrepancy between the observed and expected numbers of species is also partly due to local extirpations from hunting and habitat loss. Discussions with hunters and farmers from Tham Ve Village indicated that local people hunt turtles, lizards (*Physignathus cocincinus* adults and eggs), and amphibians (*C. delacouri*, *H. rugulosus*, and *P. boulengeri*) for food, and they hunt venomous snakes (*T. stejnegeri*) for alcohol drinks. Locals indicated that pythons and cobras have been extirpated from the area. Turtles are still hunted for food, but they are very rarely found.

Montane forests in Ha Giang Province have long been isolated by lowland cultivation. Regional population growth and the demand for wildlife products for local and international trade put increased pressure on the forest (Wege et al., 1999). Furthermore, people living near Mount Tay Con Linh II currently suffer from two to four months of food shortages per year, which greatly increases hunting and harvesting pressure on the forest (Birdlife International, 2001). Currently, Mt. Tay Con Linh II has no national protection, although ongoing investigations by the Ministry of Agriculture and Rural Development include the proposal of a 40,344-ha nature reserve incorporating Mt. Tay Con Linh I and Mt. Tay Con Linh II (Birdlife International, 2001). It lies within the Northern Indochina Subtropical Forest Ecoregion, an ecosystem currently underrepresented in Vietnam's protected area network and apparently heavily degraded in adjacent regions of China (Wege et al., 1999). Efforts to protect this area and create corridors between other montane forests would result in an extensive and contiguous montane forest tract otherwise unknown to this region.

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APPENDIX 1

SPECIMENS EXAMINED

See table 1 for specimens from Ha Giang, including new species.

Amphibia (Anura): family Megophryidae: *Lepidolalax pelodytoides* ($N = 7$): VIETNAM: **Quang Nam Province**: Tra My District, AMNH 163658–163664. *Megophrys parva* ($N = 3$): THAILAND: **Surathani Province**: FMNH 216096. **Chang Mai Province**: FMNH 213942, 213943.

Family Ranidae: *Amolops chunganensis* ($N = 93$): CHINA: **Fujian Province**: Kuantun Village, Ch'ungan Hsien, 4500–5000 ft a.s.l., AMNH 30497 (holotype); AMNH 28832, 30139–30141, 30395–30478, 30480–30483 (paratypes); Yenping, AMNH 28419, 30820–30821 (paratypes). *Huia nasica* ($N = 2$): VIETNAM: **Ha Tinh Province**: Huong Son Nature Reserve, Huong Son District, AMNH 161169, 161170. *Paa boulengeri* ($N = 2$): CHINA: **Sichuan Province**: Mount Omei, AMNH 49738, 49739. *Paa yunnanensis* ($N = 3$): CHINA: **Yunnan Province**: Yunnanfu, AMNH 5428, 5429, 30847. *Rana archotaphus* ($N = 1$): THAILAND: **Chiang Mai Province**: Doi Inthanon National Park, Dawn Tak Them, FMNH 214074 (holotype). *Rana bacboensis* ($N = 1$): VIETNAM: **Nghe An Province**: Con Cuong Region, AMNH A161248 (paratype). *Rana banaorum* ($N = 35$): VIETNAM: **Gia Lai Province**: ROM 39944 (holotype), 39899–39901, 39928, 39929, 39931, 39936, 39941, 25084–25086, 25100, 25102, 25103, 39700, 39702–39705, 39716–39720, 39912, 39913, 39915, 39916, 39920–39922, 39924–39926 (paratypes). *Rana chalconota* ($N = 10$): MALAYSIA: **Sarawak**: 4th Division, Bintulu District, AMNH 90527, 90528, 90530, 90531; THAILAND: **Songkla Province**: Haddyai (Hat Yai), Khohona Mountain, AMNH 107901–107905, 107909. *Rana chloronota* ($N = 77$): CHINA: **Hong Kong**: ROM 39241–39245; INDIA: **Darjeeling**: BMNH 1947.2.28.4, 1947.2.28.6, 1947.2.28.12 (syntypes); ROM 14057, 14058; **Assam**: FMNH 72416, 74158; LAO PDR: **Khammouane Province**: Nakai District, FMNH 256493; VIETNAM: **Bak Kan Province**: Ba Be National Park, ROM 26348–26356, 26367, 26360–26366, 26368; **Gia Lai Province**: ROM 26420, 26422, 26424, 26425, 26427, 26428; **Lang Bien Plateau**: FMNH 83223; **Nghe An Province**: Con Cuong Region, ROM 26401–26403, 26405, 39260–39262, 39264–39271, 39276, 39277, 39272–39275; **Quang Binh Province**: Minh Hoa, Cha Lo, AMNH A161233; **Tuyen Quang Province**: Na Hang Nature Reserve, Pac Ban, ROM 39278–

39284, 39755, 39757, 39759, 39760, 39767; **Vinh Phu Province**: Tam Dao Hill Station, AMNH 161481–161485. *Rana daorum* ($N = 45$): VIETNAM: **Lao Cai Province**: Sa Pa and vicinity, near O Qui Ho Pass, ROM 26381 (holotype); 38500, 38503, 38507, 38512, 38516, 38517, 26382–26397, 38501, 38502, 38504–38506, 38508–38511, 38513–38515, 38518–38525, 38527–38529 (paratypes). *Rana graminea* ($N = 25$): CHINA: **Hainan Island**: Five Finger Mountains, BMNH 1947.2.27.96, 1947.2.27.97 (syntypes); **Fujian Province**: Ch'ungan Hsien, AMNH A29973–29991, 28612; Yenping, AMNH A28543–28545. *Rana hmongorum* ($N = 1$): VIETNAM: **Lao Cai Province**: Sa Pa and vicinity, AMNH 161480 (paratype). *Rana hosii* ($n = 8$): MALAYSIA: **Sarawak**: 4th Division, Bintulu District, AMNH A90550–90556; 3rd Division, Kapit District, AMNH A90557. *Rana livida* ($N = 2$): MYANMAR: Tenasserim, BMNH 1889.3.25.48 (neotype), BMNH 1889.3.25.47. *Rana megalympanum* ($N = 16$): VIETNAM: **Tuyen Quang Province**: Na Hang Nature Reserve, Pac Ban, ROM 39237–39240 (paratypes); **Nghe An Province**: Con Cuong Region, ROM 39684 (holotype), 26398–26400, 39263, 39685–39689, 39691, 39690 (paratypes). *Rana morafkai* ($N = 27$): VIETNAM: **Gia Lai Province**: ROM 39932 (holotype), 39930, 39934, 39947, 39949, 25094–25097, 25099, 25101, 25104–25106, 25108–25111, 39904–39911, 39937 (paratypes).

Family Rhacophoridae: *Chirixalus doriae* ($N = 6$): CHINA: Hainan Island, Nodua, AMNH 26756, 26775–26777, 32942, 32943; *Chirixalus vittatus* ($N = 2$): THAILAND: Southeastern Siam, Nong Khov, AMNH 24938, 24939. *Philautus maosonensis* ($N = 1$): VIETNAM: **Vinh Phu Province**: FMNH 254253. *Polypedates dugritei* ($N = 14$): CHINA: **Sichuan Province**: Mouping [=Baoping County], MNHNP 5563, 1994.2361, 1994.2362, 1994.2641 (syntypes); VIETNAM: **Lao Cai Province**: Sa Pa Vicinity, ROM 38642, 38645–38648, 38654, 38658, 38661–38662, 38666. *Rhacophorus hoanglienensis* ($N = 1$): VIETNAM: **Lao Cai Province**: Fan Si Pan Mountain, ROM 37997 (holotype).

Reptilia (Sauria): Family Agamidae: *Acanthosaura lepidogaster* ($N = 12$): CHINA: **Hainan Island**: Nodua, AMNH 30885; **Fujian Province**: Yenping, AMNH 33003–33013.

Family Scincidae: *Scincella reevesii* ($N = 17$): CHINA: **Hainan Island**: Nodua, AMNH 30204–30220.

Reptilia (Serpentes): Family Colubridae: *Amphiesma craspedogaster* ($N = 3$): **Fujian Prov-**

ince: Yenping, AMNH 33398, 34550, 34557. *Amphiesma popei* ($N = 3$): CHINA: **Hainan Island:** Nodda, AMNH 27765, 27767, 27768 (paratypes). *Pseudoxenodon karlschmidti* ($N = 3$): CHINA: **Fujian Province:** Chungan Hsien, AMNH 34658 (holotype), 34659, 34660 (paratypes). *Sinonatrix*

aequifasciata ($N = 5$): CHINA: **Fujian Province:** Fuching Hsien, AMNH 33818–33821, 33823. *Sinonatrix percarinata* ($N = 6$): CHINA: **Sichuan Province:** Mount Omei, AMNH 62653; **Fujian Province:** Yenping: 33366–33369, 33371.

APPENDIX 2

TABLE 5

Measurements of Male *Philautus odontotarsus* (in mm)

Percentage of SVL in parentheses. Means and ranges are given for Cai Yang River specimens. From Ye and Fei (1993).

	Holotype CIB 57311	Near Cai Yang River ($N = 9$)	Mouth of the Cai Yang River ($N = 10$)
SVL	30.8	30 28.1–30.8	34 32–35.5
HDL	10.8 (35.1)	10.8 10.0–11.5 (36)	11.6 10.6–12.2 (34.1)
HDW	10.8 (35.1)	10.7 9.9–11.2 (35.7)	11.3 10.7–12.2 (33.2)
Arm–HND	15 (48.7)	15.9 15.0–17.0 (53)	15.6 14.8–16.0 (52)
Leg–FT	46 (149.4)	48.4 46.0–50.0 (161.3)	50.8 48.0–54 (149.4)
TIB	15 (48.7)	15.2 14.5–15.5 (50.7)	16.3 15.6–17.6 (47.9)

Arm–HND, total length of front appendage; Leg–FT, total length of hind appendage; refer to Materials and Methods for all other abbreviations.

DESCRIPTION OF *PHILAUTUS ODONTOTARSUS*

Translated from the Chinese (Ye and Fei, 1993). *Note:* Osteological comments have been omitted and the associated table from the original description is shown here as table 5.

“The holotype (CIB 57311, Chengdu Institute of Biology) is an adult male from Laiyanghe, Mengla County, altitude 1000 m, Yunnan, China, 9 June 1957, collected by Do Wah Ching; eight male paratypes from the same locality on 28 May 1957; and 10 males collected at the mouth of the Cai Yang River and nearby areas at 1300 m a.s.l. on 15–18 June 1956.

“It is similar to *P. microtympnum*, but the new species is smaller (mean snout-vent length males 32 mm, females 43 mm); the tympanum is relatively larger (tympanum diameter one-half to two-thirds the eye diameter), and closer to the eye; hindlimbs are shorter (tibiotarsal articulation reaches between the eye and nares); saw-tooth-shaped fringes on the forearm and tarsus are always present; dorsum is more rough (with small warts). *Philautus microtympnum* snout vent length 50 mm in males, 57.5–61 mm in females; tympanum is small (about one-third the eye diameter), and further from the eye than *P. odontotarsus*; not every specimen has saw-tooth-shaped fringes on the appendages; dorsum smoother, with fewer warts.

“DESCRIPTION: The new species has a mean snout-vent length of 32 mm (28–35 mm); head length about equal to head width; snout sharp, sloping; canthus rostralis oblique, sloping to snout from nares; snout tip slightly protruding above lower lip; loreal region concave; nares closer to snout tip; interorbital distance is greater than or equal to the eyelid length; tympanum diameter approximately one-half to two-thirds the eye diameter, tympanum almost immediately posterior to corner of eye; tongue small, significantly notched posteriorly, but underneath with some ripplelike papillae; vomerine teeth in short, oblique rows, widely spaced, beginning at the posterior edges of the choanae.

“Long forearms; relative finger lengths III > IV > II > I; finger tips with expanded disks, with circummarginal grooves, disk on I small, disk on III smaller than or equal to tympanum diameter; fingers with lateral fringes and basal webbing; sub-articular tubercles large, palmar tubercles smaller, palms with small warts, outer palmar tubercle bifurcates; five to six saw-teeth on outer fringe of forearm; hindlimbs thin, long, tibiotarsal articulation reaches eye or to nares, overlap when adpressed; tibial length one-half snout-vent length; foot shorter than the tibia; toes with expanded disks, circummarginal grooves; relative toe length III = V; web full to toe tips, except toes I and V;

lateral sides of metatarsals without fringes; base of foot with small tubercles in a row, padding of foot flat; no outer metatarsal tubercle; saw-teeth on fringe of tarsus along outside of toe V to tibiotarsal joint (hence the etymology).

“Skin rough; top of head, dorsum and tops of arms and legs with irregularly shaped tubercles, large and small in size; upper eyelids with more tubercles; supratympanic fold flat and straight; some specimens with larger warts on back of head; forearm and heel with saw-toothed tubercles; below anal region with scattered round tubercles or warts; throat, chest, inner thighs and especially belly with obvious flat, round tubercles.

“In life dorsum tan or olive, flanks grayish-green; ‘YY’ pattern on dorsum between the eyes; back of forelimbs with blackish-brown horizontal bars; flash colors orange-red; belly grayish-red; chest and belly with some darker zebra pattern; lower lip border olive.

“Males with creamy white nuptial pad at base of finger I; a single internal vocal sac, vocal slits elliptical; linea masculinae present.

“HABITAT: Found between 250 and 1500 m a.s.l. in shrubbery. At night adults rest on leaves, branches, vines, or grass. Their call sounds like ‘dung-dut’. Eggs and tadpoles remain unknown. Currently known from Tibet, Yunnan, Guizhou, Hainan, and Guangxi.

“REMARKS: Liu and Hu (1959: 526) recorded samples that they called *Rhacophorus cavirostris*. In these Yunnan samples, the snout is sharp, not rounded, the TMP is greater than finger III. Frost (1985) recorded *R. cavirostris* from Sri Lanka and China, indicating that it was related to *R. microtympanum*. Upon further study, we think that the Chinese samples are not the same as those from Sri Lanka.”

Fei (1999) included additional information in his subsequent enhancement of the description: finger I obviously much smaller than all other fingers; webbing one-half on toes, dips down to the top of distal subarticular tubercle on either side of IV; dorsum with dark brown stripes; belly sometimes unevenly scattered with darker spots.

APPENDIX 3

DESCRIPTION OF *PHILAUTUS RHODODISCUS*

Translated from the Chinese (Liu and Hu, 1962). *Note:* The associated table from the original description is shown here as table 6.

“Type specimen is Chengdu Institute of Biology no. 601818, an adult male. Type locality is Yaoshun City, Guangxi Province, China. Elevation 1350 m a.s.l. Collected on 8 May 1960.

“DIAGNOSIS: Toes with disks tinged orange-red on the ventral side, tea-brown dorsally; dorsum covered with white tubercles interweaved as a network.

“DESCRIPTION OF THE TYPE: Snout-vent length of male 26.5 mm; head depressed, head length greater than head width; snout slopes upward towards the tip, straight in profile, not protruding beyond lower jaw; nostrils nearer tip of the snout, flare convexly; canthus rostralis evident, loreal region almost rectangular in shape; interorbital distance greater than internasal distance; tympanum evident, much larger than finger disk III; tongue long, narrow deeply notched posteriorly; vomerine teeth absent.

“Arm and hand length about one-half snout-vent length; disks at tips of fingers, with circum-marginal grooves separating dorsal from ventral sides, wide and compressed; fingers without webbing, finger I very short, small, relative finger lengths I < II < IV < III, base of finger I with evident nuptial pad; two palmar tubercles evident, projecting. Tibiotarsal articulation extends be-

TABLE 6

Measurements of *Philautus rhododiscus* (in mm)

Percentage of SVL in parentheses. From Liu and Hu (1962).

	Holotype CIB 60181	Female (N = 1)
SVL	26.5	29.5
HDL	9.5 (35.9)	10.5 (35.6)
HDW	8.5 (32)	9.5 (32.2)
SNT	3.5 (13.2)	4 (13.5)
IND	2.8 (10.6)	2.5 (8.5)
IOD	3 (11.2)	3.5 (11.8)
Eyelid	2.5 (8.3)	3 (10.1)
EYE	3.4 (12.8)	4 (13.5)
TMP	2.5 (9.4)	5 (10.1)
Arm-HND	13.5 (50.9)	14 (41.5)
Arm W	2.5 (9.4)	2.3 (7.8)
HND	8 (30.2)	8.5 (28.8)
Disk of III	1.5 (5.7)	2 (6.8)
Leg-FT	43.5 (164)	47 (159)
TIB	14.3 (53.9)	15 (50.8)
Tibia W	3.3 (12.4)	3.6 (12.2)
Tarsus	19.2 (72.5)	20.4 (69.2)
Foot	12.3 (46.4)	13.5 (45.5)

IND, inter-nares distance; Eyelid, length of upper eyelid; Arm-HND, total length of front appendage; Arm W, arm width; Leg-FT, total length of hind appendage; Tibia W, tibia width; refer to Materials and Methods for all other abbreviations.

tween eye and snout, tibia more than one-half snout-vent length; legs overlap when adpressed; tibial width 23% of length; toe tips similar to finger tips, length of toe III = V, space between toes equals width of two disks; webbing half developed, on toe IV web reaches second articulation, on inside of V reaches the base of the disk, no webbing on the outside of V; subarticular tubercles distinct; inner metatarsal tubercle egg-shaped, no outer metatarsal tubercle.

“Skin rough; tubercles on head and eyes evident; dorsum covered with needlelike small tubercles in a network; skin of the hands and feet smooth; lateral side of the head with small tubercles, tympanum with tubercles; supratympanic fold not evident; belly to base of hindlimb with some tubercles, otherwise smooth.

“COLOR IN LIFE: Tips of digits orange-red, dorsal parts of digits tea-brown with one or two white dots on the hands; black spots between the nostrils and eyes; upper part of shoulder and thigh each with a pair of black spots; limbs barred; anus deep

brown; edge of jaw, flanks scattered with small white stripes and dots; throat darkly mottled; chest mottled brown; belly brownish-black scattered with gray-white network; tubercles on hands and feet gray-white color; pupil purple, iris red-brown; color of fixed specimens fade rapidly.

“Types were collected from the insides of dark basins, others collected on May 28, 1960 also form large basins. Collected female with snout-vent length 29.5 mm; neck thick, coarse; fold evident; stripes the same, but with only one black dot on the dorsum; more than 10 very large eggs per side, animal pole deep brown and vegetative pole light brown, other eggs small without color, which differentiates this species from other tree frogs. Male a little smaller; forearm robust, nuptial pad gray-white; no vocal sac.”

Fei (1999) added the following information: female SVL 28 mm; tympanum almost touching eye; disk of III much smaller than tympanum; tea brown on anterior portion of dorsum; venter marbled; distributed in Guangxi and Fujian Provinces.

APPENDIX 4

DESCRIPTION OF *POLYPEDATES PUERENSIS*

Translated from the Chinese (He, 1999). *Note:* The associated table from the original description is shown here as table 7.

“This paper records a new species of the family Rhacophoridae from Yunnan, China.

“HOLOTYPE: YU 96606, an adult male, Banshan, Puer County, Yunnan, China, altitude 2000 m, May 11, 1996. The geographical situation is 22°54'N, 101°21'E.

“ALLOTYPE: YU 96604, an adult female, May 11, 1996. Paratypes: Eight adult males and an adult female, May 11, 1996. Allotype and paratype specimens were collected from the same locality as the holotype. All the types are kept in the Department of Biology, Yunnan University, Kunming.

“DIAGNOSIS: The new species is closely related to *Polypedates dugritei* David, but differs from the latter by having: (1) no tubercles as sawtooth on the outer margin of arms and tarsus; (2) the outer metatarsal tubercles absent; (3) 4th digital web not reaching its tip; (4) the tibiotarsal articulation obviously not reaching the tympanum; (5) dorsum of body with less rounded or semirounded, brownish-red spots.

“DESCRIPTION: Mean of snout-vent length males 40.5 mm, females 53.6 mm; head width greater than head length; snout of male slightly sharper than females, protrudes slightly beyond upper lip, angles significantly, easily seen; loreal triangular,

concave, lips flaring; internares distance about equal to interorbital distance; tympanum round, relatively small, tympanum diameter less than eye diameter, but distance between eye and tympanum small; pupils horizontal, oval; supratympanic fold starts posterior to eye, continuing straight then connects to weak, obscured fold on flank; glandular wart at end of lip, forming a triangle with supratympanic fold; vomerine teeth white, in two unconnected groups, almost forming a straight line, but outer edges slightly crescent-shaped, close to choanae; tongue deeply notched posteriorly.

“Forearm and hand about one-half snout-vent length, for female 29.7 mm (55.4% of snout-vent length); disks enlarged with obvious indents on top, circummarginal groove present, disk on finger I very small; relative lengths of fingers III > IV > II > I; hands webbed, more developed on females than males, males maximum web development about one-third, females about two-thirds; subarticular tubercles on every finger to base; inner palmar tubercle is especially large, significantly tall, 4 mm for females, 3.2 mm for males; no external tubercle.

“Legs shorter for males 51.4 mm (126.9% of snout-vent length), females 150% snout-vent length; tibiotarsal articulation obviously does not reach tympanum, heels just meet each other when adpressed; tibia 37–42% of snout-vent length; feet larger than tibia; relative lengths of toes IV > III = V > II > I. Webbing one-half to two-thirds on

TABLE 7
Measurements of *Polypedates puerensis* (in mm)

Percentage of SVL in parentheses. Means and ranges are given for male paratypes. From He (1999).

	Males		Females	
	Holotype CIB 96606	Paratypes (N = 8)	Allotype CIB 96604	Paratype (N = 1)
SVL	41.1	40.5 35.5–41	52	55.2
HDL	14.1 (34.3)	14.1 13–14.5 (34.8)	16.7 (32.1)	17.5 (31.7)
HDW	17.5 (42.6)	16.2 13.7–18 (40)	20 (38.5)	21.3 (38.6)
SNT	6.8 (16.5)	6.4 5.5–7.0 (15.8)	8 (15.4)	9 (16.3)
IND	4.5 (10.9)	4.3 3.7–4.7 (10.5)	5.2 (10)	5.9 (10.7)
IOD	4.8 (11.7)	4.4 4.1–4.5 (10.9)	5.9 (11.4)	7.5 (13.6)
Eyelid	3.2 (7.8)	3.3 2.7–3.5 (8.1)	4.1 (7.9)	5 (9.1)
EYE	4.5 (10.9)	4.5 4.2–5.0 (11.1)	5.8 (11.2)	6.4 (11.6)
TMP	2.7 (6.6)	2.5 2.0–3.0 (6.2)	3.5 (6.7)	3.3 (6)
Arm–HND	20.5 (49.9)	19.1 18.0–21 (47.2)	29.3 (56.3)	30.1 (54.5)
Leg–FT	54 (131.4)	51.4 47–54 (126.9)	78 (150)	81.5 (147.6)
TIB	15.2 (37)	15.4 14.7–16 (38)	21.8 (41.9)	22.9 (41.5)
Tarsus	16.7 (40.7)	16.4 14–17.5 (40.5)	25.3 (48.7)	25.3 (45.8)

IND, inter-nares distance; Eyelid, length of upper eyelid; Arm–HND, total length of front appendage; Leg–FT, total length of hind appendage; refer to Materials and Methods for all other abbreviations.

toes, barely reaching tips, does not reach to tip of toe V; foot tubercles completely round, base with insignificant tubercles, internal metatarsal tubercle smaller, almost oval, obviously smaller than that of the hand; no outer metatarsal tubercle.

“Dorsum with small dense warts, more densely distributed on chin and throat than belly, larger on thighs and around anus; weak fold on flank; other parts of legs and sides of arms with smooth skin; forearms and outside of legs to tips of toes without sawtooth projections or warts.

“COLOR IN LIFE: Snout, head, dorsum, limbs all green or dark green with brown-red spots outlined in dark brown rings, density of spots different for each frog, female spots more densely distributed and obvious, male spots sparsely distributed and

not obvious. YU 96605 (female) has white belly without any pattern; side, legs, and arms with larger spotting pattern in brown-black.

“COLOR IN ALCOHOL: Dorsum gray-brown, venter white; patterns still visible, but less obvious.

“SECONDARY SEX CHARACTERS: Base of male fingers I, II with white nuptial pads, I very large, II very small; single external vocal sac.

“HABITAT: Found at 2293 m a.s.l. with Fagaceae, Lauracaceae, and Thecaceae. Frogs found between 1990 and 2000 m in swampy areas where *Juncus* sp. and Cyperaceae are found. Breeding occurs among grass and ponds, where eggs are laid in a milky white foam nest, diameter 10 cm × 13 cm × 10–12 cm. Fertilized eggs were visible inside the nests.”

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