HERPETOZOA 13 (1/2): 71 - 87
Wien, 30. Juni 2000

Amphibian biodiversity of Hoang Lien Nature Reserve (Lao Cai Province, northern Vietnam) with description of two new species

Die Biodiversität der Amphibien des Hoang Lien Naturreservates (Lao Cai Provinz, nördliches Vietnam), mit Beschreibung zweier neuer Arten

ANNEMARIE OHLER & OLIVIER MARQUIS & STEVEN SWAN & STÉPHANE GROSJEAN

KURZFASSUNG

Im Rahmen der Erstellung eines Inventares der Fauna und Flora des Hoang Lien Naturreservats im Norden Vietnams wurden von den Autoren in der Zeit von September 1997 bis August 1998 38 Arten von Amphibien gesammelt. Insgesamt sind nunmehr 42 Amphibienarten für dieses Gebiet bekannt, von denen nur 6 als Endemiten bezeichnet werden können. Die Amphibienfauna des Fan Si Pan, des höchsten Berges der Region, zeigt nahe Beziehungen zu den Faunen Yunnans und der nördlichen indochinesischen Halbinsel. Zwei neue Arten aus den Gattungen *Leptolalax* und *Rhacophorus* werden beschrieben. Der Einschluß von *Bombina maxima* in der Arteniste von Vietnam läßt sich nicht aufrechterhalten, da alle bekannten vietnamesichen *Bombina* Exemplare als *B. microdeladigitora* bestimmt wurden. Andererseits sind *Rhacophorus nigropalmatus* und *R. dennysii* in diese Liste aufzunehmen. Allgemeine Hinweise zur Erstellung von Artenlisten für Lokalitäten bzw. Gebiete in Südostasien werden gegeben. Angaben zur Höhenverteilung, Habitatwahl und zum Aktivitätsmuster der gesammelten Arten werden gemacht.

ABSTRACT

Within the framework of establishing an inventory of the fauna and flora of the Hoang Lien Nature Reserve (northern Vietnam), 38 species of amphibians were collected by the authors between September 1997 and August 1998. In total, 42 amphibian species are now recognized for this area. However, only 6 out of these can be considered to be endemic. The amphibian fauna of Fan Si Pan - the highest mountain in the area - shows close relationship to the faunas of Yunnan and the northern Indochinese Peninsula. A new species of the genus *Leptolalax* and a new species of the genus *Rhacophorus* are described. *Bombina maxima* can no longer be constituent part of the list of amphibian species of Vietnam, as all Vietnamese *Bombina* specimens known were identified as *B. microdeladigitora*. On the other hand, *Rhacophorus nigropalmatus* and *R. dennysii* must be added to this list. Altitudinal distribution, habitat selection, and activity pattern are given for the specimens collected. General considerations are made on problems arising from the establishment of lists of species of localities or regions in south-east Asia.

KEY WORDS

Amphibia; *Leptolax pluvialis* nov. sp., *Rhacophorus duboisi* nov. sp.; biodiversity, Hoang Lien Nature Reserve, northern Vietnam, taxonomy

INTRODUCTION

The Hoang Lien Nature Reserve in northern Vietnam (22°08' - 22°23' N, 103° 46' - 104°00' E) covers 24,658 hectares, 11,071 of which are natural forest. The nature reserve contains over 7,000 human inhabitants belonging to various groups of ethnic minorities. To a high degree these people depend upon the natural resources of the forest. The Hoang Lien Nature Reserve lies at the junction of the Palearctic and the Indomalayan biogeographic regions which suggests it is of particular biological interest. It contains Vietnam's highest mountain, Fan Si Pan, which attains the height of 3,143 m.

The results presented here are part of biodiversity surveys of the Hoang Lien Nature Reserve, Sa Pa District, Lao Cai Province, Vietnam (fig. 1), conducted as a part of the Frontier-Vietnam Forest Research Program, between October 1997 and September 1998. This survey involved the study of vegetation types, the collection of biodiversity and ecological data for butterflies, moths, amphibians, birds and mammals, and a socio-economic survey of local communities (TORDOFF et al. 1999) with the emphasis put on forest habitats. Differ-

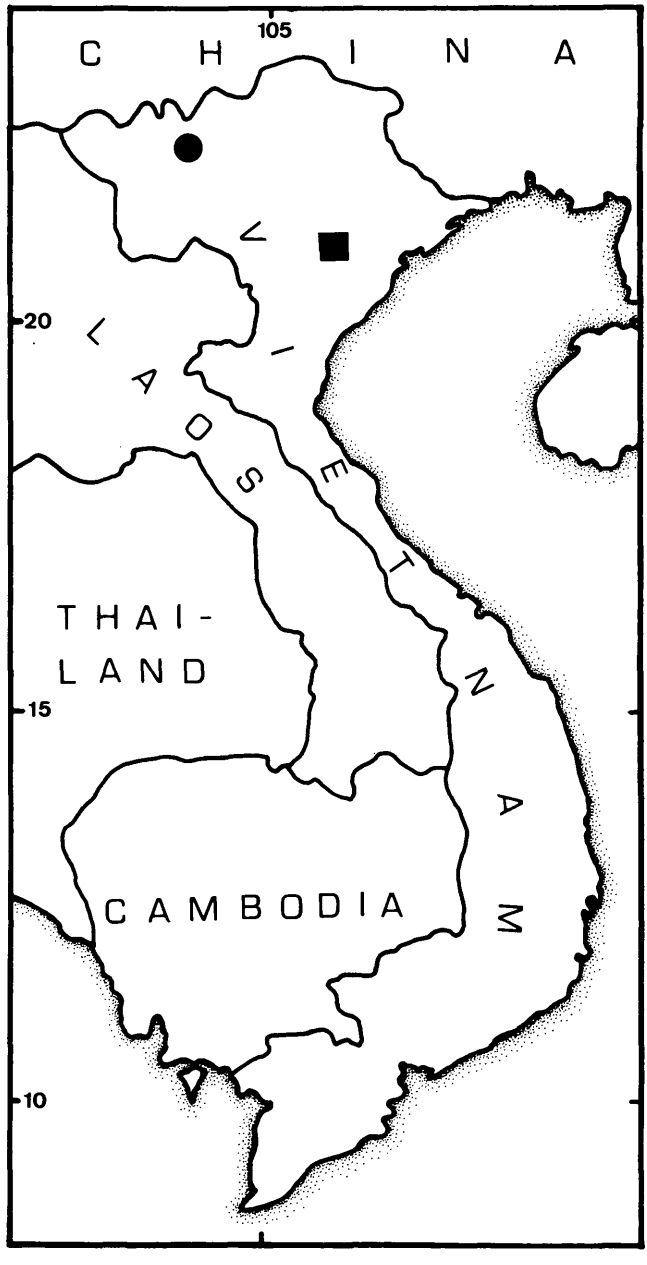

Fig. 1: Map of Vietnam. ■ - Hanoi; ● - the study area in the Fan Si Pan mountains, Hoang Lien Nature Reserve, Sa Pa District, Lao Cai Province.

Abb. 1: Karte von Vietnam. ■ - Hanoi; ● - das Untersuchungsgebiet im Fan Si Pan Gebirge, Hoang Lien Naturreservat, Distrikt Sa Pa, Provinz Lao Cai.

ent habitat types at altitudes above 900 m, mainly between 1,600 and 2,000 m, were explored, because nowadays forests can be found only at high altitudes.

The mountain area near Sa Pa has already been explored in the Nineteen-thirties by the French herpetologist BOURRET (1942), who listed 22 amphibian species from this region, including 11 new, endemic species (50 %). DUBOIS (1983, 1987) described two new endemic amphibian species on the basis of material collected by BOURRET from Sa Pa region: *Leptolalax bourreti* DUBOIS, 1983 and *Paa bourreti* (DUBOIS, 1987), which led to a total of 24 amphibian species including 54 % of endemics.

For the present study, observations and collections of amphibians were carried out by Frontier-Vietnam in four two-months collecting periods distributed over a year (phase 1: 4 October to 10 December 1997; phase 2: 10 January to 14 March 1998; phase 3: 4 April to 5 June 1998; phase 4: 6 July to 4 September 1998). This particular effort shows interesting results concerning the number of species observed, as well as an indication of seasonal activity patterns of the species. In the first part of this paper, a systematic account is given, including description of two new species. In the second part, temporal patterns of collected data are discussed.

MATERIALS AND METHODS

Measurements were taken either with a slide-caliper to the nearest 0.1 mm, or (for measurements smaller than 6 mm) with an ocular micrometer to the nearest 0.01 mm. Data transformation follows OHLER (1996). Webbing formula is given according to MYERS & DUELLMAN (1982).

Institution abbreviations

IEBR	Institute of Ecology and Biological Resources, Hanoi, northern Vietnam;
MO	Muséum d'Orléans, Orléans, France;
MNHN	Muséum national d'Histoire naturelle, Paris, France.

Measurement abbreviations and definitions

SVL	Snout-vent length
nm	Not measured

Head

HW	Head width
HL	Head length (from rear of mandible to tip of snout)
MN	Distance from rear of mandible to nostril
MFE	Distance from rear of mandible to front of eye
MBE	Distance from rear of mandible to back of eye
IFE	Distance between anterior margins of eyes
IBE	Distance between posterior margins of eyes
IN	Internarial space
EN	Distance from front of eye to nostril
EL	Eye length
SN	Distance from nostril to tip of snout
SL	Distance from front of eye to tip of snout
TYD	Greatest tympanum diameter
TYE	Distance from tympanum to posterior margin of eye
IUE	Minimum distance between upper eyelids
UEW	Maximum width of upper eyelid

Forearm

HAL	Hand length (from base of outer palmar tubercle to tip of third finger)
FLL	Forelimb length (from elbow to base of outer palmar tubercle)
TFL	Length of third finger (from base of first subarticular tubercle)
PAI-IV	Width of pads of fingers I to IV
WAI-IV	Width of fingers I to IV

Hind limb

FL	Femur length (from vent to knee)
TL	Tibia length
FOL	Foot length (from base of inner metatarsal tubercle to tip of toe IV)
FTL	Length of fourth toe (from base of first subarticular tubercle to tip of toe)
PPI - V	Width of pads of toes I to V
WPI - V	Width of toes I to V
IMT	Length of inner metatarsal tubercle
ITL	Length of inner (first) toe
TFOL	Length from base of tarsus to tip of fourth toe

Webbing

MTTF	Distance from distal edge of metatarsal tubercle to maximum incurvation of web between toes III and IV
TFTF	Distance from maximum incurvation of web between toes III and IV to the tip of toe IV
MTFF	Distance from distal edge of metatarsal tubercle to maximum incurvation of the web between toes IV and V
FFTF	Distance from maximum incurvation of the web between toes IV and V to the tip of toe IV
WTF	Webbing between toes III and IV (from the base of the first subarticular tubercle)
WFF	Webbing between toes IV and V (from the base of the first subarticular tubercle)
WI	Webbing between toes III and IV when folded along toe IV (from the base of the first subarticular tubercle)
WII	Webbing between toes IV and V when folded along toe IV (from the base of the first subarticular tubercle)

SYSTEMATIC ACCOUNT

In the one-year period, 38 species were recorded from Fan Si Pan. These species are listed in table 1. Classification follows DUBOIS (1992) and DUBOIS & OHLER (1998). Two species are new to science, and another one was described as new by DUBOIS & OHLER (1998); 20 species are new to Fan Si Pan, 11 of them are new to this country. The following species deserve a more detailed discussion.

Bombina (*Grobina*) *microdeladigitora* LIU, HU & YANG, 1960

BOURRET's (1942) collection contains three specimens of the genus *Bombina* from Fan Si Pan (MNHN 1948.0112, 1991.2526-2527, 2 adult males, 1 female). This is the only record of *Bombina* from Vietnam. One specimen of this genus was found again in 1998 (MNHN 1999.5606, adult female, SVL 50.9 mm).

BOURRET (1942) reported this species as *Bombina maxima* (BOULENGER, 1905). The description of the latter by BOULENGER was based on a female holotype with moderately webbed feet from Dongchuan Shi [Tong Chuan Fu] (26° 10' N, 103° 02' E; altitude about 1,800 m) in Yunnan. Adult male topotypes (MNHN 1906.0105-0106) have completely webbed feet. Males of Fan Si Pan have half-webbed feet, whereas webbing of the female specimens is very reduced. In China two closely related species occur, *B. maxima* and *B. microdeladigitora*. The latter was described by LIU et al. (1960) from Huangcaoling [Huangtsiao-ling] (24° 28' N, 100° 54' E; atitude 2,240 m), Jing-dong Country [Ching-tung], Yunnan. These species are distinguished mostly in the extent of the webbing, the former being more webbed. Comparison of specimens of BOURRET from Sa Pa, including adult males, with male topotypes of *B. maxima* clearly shows that the specimens from Fan Si Pan belong to the less webbed form. Sexual dimorphism in webbing is important in *Bombina* and should be taken into account in systematic studies. In consequence, *B. maxima* should no longer be understood as an element of the fauna of Vietnam and replaced by *B. microdeladigitora* in this list. Thus, the distribution of the two species is as follows: *B. maxima* is present in northern Yunnan, south-western Sichuan, and Guizhou (China) and *B. microdeladigitora* in Yunnan, Hubei (China), and in northern Vietnam.

Leptolalax bourreti DUBOIS, 1983

BOURRET (1942) reported specimens of *Leptolalax* from Sa Pa under the name *Megophrys pelodytoides* (BOULENGER, 1893). DUBOIS (1983) recognized these specimens as representatives of a new species and described it under *Leptolalax bourreti*. We again collected *L. bourreti* in Sa Pa and also in Tam Dao (MNHN 1996.8620; donated by RENAUD BOISTEL). Moreover, INGER et al. (1999) reported on *L. pelodytoides* (BOULENGER, 1893) from Tam Dao, so this latter species is in fact part of the fauna of Vietnam.

Leptolalax pluvialis nov. sp.

Three adult male specimens of an undescribed species were collected calling under heavy rain, sitting on branches and leaves near a small forest stream. *Leptolalax bourreti* was very abundant in October and November 1997, and was collected in exactly the same locality as *L. pluvialis*, but was rather rare in July, when *L. pluvialis* was collected.

Diagnosis: *Leptolalax pluvialis* nov. sp. can be distinguished from the other species of the genus *Leptolalax* by the following combination of characters: (1) small size (21.3-22.3 mm); (2) ventral

Table 1 (opposite page): List of amphibian specimens collected in the Fan Si Pan mountains (Hoang Lien Nature Reserve, 22°08' - 22°23' N, 103°46' - 104°00' E; altitude 900-2090 m, Sa Pa District, Lao Cai Province, Vietnam) from 1937 to 1942 and from 1997 to 1998. * - not found during 1997 and 1998; *juv* - juvenile(s).

Tab. 1 (gegenüberliegende Seite): Liste der Amphibien-Exemplare, die im Fan Si Pan Gebirge (Hoang Lien Naturreservat, 22°08' - 22°23' N, 103°46' - 104°00' E; Seehöhe 900-2090 m, Distrikt Sa Pa, Provinz Lao Cai, Vietnam) in den Jahren 1937 bis 1942 und 1997 bis 1998 gesammelt wurden. * - 1997 und 1998 nicht gefunden; *juv* - Jungtier.

Species / Art	MNHN (without acronym) and MO collection numbers / MNHN- (ohne Akronym) und MO-Sammlungsnummern
Discoglossidae GÜNTHER, 1858	
Bombina (*Grobina*) *microdeladigitora* LIU, HU & YANG, 1960	1948.0112; 1991.2526-2527; 1999.5606 (2 ♂, 2 ♀)
Pelobatidae BONAPARTE, 1850	
* *Leptobrachium* (*Leptobrachium*) *chapaense* (BOURRET, 1937)	1938.0089-0092; 1948.0117-0120 (5 ♂, 3 ♀)
Leptobrachium (*Vibrissaphora*) *echinatum* DUBOIS & OHLER, 1998	1998.0112-0116; 1999.5655-5656 (2 ♂, 3 ♀, 2 *juv*)
Leptolalax bourreti DUBOIS, 1983	1938.0093-0095; 1999.5658-5673, 1999.5677 (9 ♂, 3 ♀, 8 *juv*)
Leptolalax pluvialis n. sp.	1999.5674-5676 (3 ♂)
Megophrys (*Xenophrys*) *jingdongensis* (FEI & YE, 1983)	1999.5686-5691 (6 ♂)
Megophrys (*Xenophrys*) *lateralis* (ANDERSON, 1871)	1938.0098-0099; 0000.8179-8180; 1999.5678-5680 (5 ♂, 2 ♀)
Megophrys (*Xenophrys*) *minor* STEJNEGER, 1926	1999.5699-5700; 1999.5702-5717 (15 ♂, 1 ♀, 2 *juv*)
Megophrys (*Xenophrys*) *pachyprocta* (HUANG, 1981)	1999.5701 (1 ♀)
* *Megophrys* (*Xenophrys*) *palpebralispinosa* BOURRET, 1937	1948.0114-0116 (2 ♂, 1 ♀)
Megophrys (*Xenophrys*) *parva* (BOULENGER, 1893)	1999.5692-5696; 1999.5698 (5 ♂, 1 *juv*)
Megophrys (*Xenophrys*) sp.	1999.5681-5685; 1999.5697 (5 ♂, 1 ♀)
Bufonidae GRAY, 1825	
Bufo melanostictus SCHNEIDER, 1799	1938.0100; 1938.0102; 1938.0104-0105; 1999.5601-5604 (7 ♀, 2 *juv*)
Bufo pageoti BOURRET, 1937	1948.0125; 1999.5561-5562 (2 ♀, 1 *juv*)
Hylidae RAFINESQUE, 1815	
Hyla annectans (JERDON, 1870)	1999.5607-5612; 1999.5614-5615; 1999.5617-5619 (10 ♂, 1 ♀, 3 *juv*)
Ranidae RAFINESQUE-SCHMALTZ, 1814	
Amolops (*Amolops*) *chapaensis* (BOURRET, 1937)	1948.0150-0151; 1999.5756-5760 (2 ♂,1 ♀, 4 *juv*)
Amolops (*Amolops*) *chunganensis* (POPE, 1929)	1999.5799-5813 (15 ♂)
Amolops (*Amolops*) *viridimaculatus* (JIANG, 1983)	1999.5761 (1 ♀)
* *Chaparana* (*Annandia*) *delacouri* (ANGEL, 1928)	1948.0130-0131 (1 ♂, 1 ♀)
Chaparana (*Chaparana*) *fansipani* (BOURRET, 1937)	1948.0139; 1999.5818-5821; 1999.5998 (3 ♂, 1 juv ♂, 2 *juv*)
Chirixalus nongkhorensis (COCHRAN 1927)	1999.5949; 1999.5951-5955 (6 *juv*)
Fejervarya limnocharis (GRAVENHORST, 1829)	1938.0007; 1938.0012; 1999.5718-5753 (13 ♂, 13 ♀, 12 *juv*)
* *Hoplobatrachus rugulosus* (WIEGMANN, 1835)	1938.0022, 1938.0027 (1 ♂, 1 *juv* ♀)
Limnonectes (*Limnonectes*) *kuhlii* (TSCHUDI, 1838)	MO Z.347 (1 *f*); 1999.5754-5755 (1 ♂, 1 ♀)
Paa (*Gynandropaa*) *bourreti* (DUBOIS, 1987)	1948.0128-0129; 1938.0035-0037; 1938.0039; 1985.2999; 1999.5823-5824, 1999.5828-5864, 1999.5995-5997 (17 ♂, 17 ♀ , 15 *juv*)
Paa (*Quasipaa*) *verrucospinosa* (BOURRET, 1937)	1938.0038; 1948.0132-0135; 1999.5822; 1999.5825-5827; 1999.5988-5993 (4 ♂, 3 ♀, 7 *juv*, 1 *larva*)
Philautus carinensis (BOULENGER, 1893)	1999.5895-5915; 1999.5961; 1999.5963-5966; 1999.5975 (6 ♂, 8 ♀, 13 *juv*)
Philautus gracilipes BOURRET, 1937	1948.0156; 1999.5916-5930 (12 ♂, 2 ♀, 2 *juv*)
Philautus jinxiuensis HU & TIAN, 1981	1999.5959-5960; 1999.5962 (2 ♂, 1 ♀)
Philautus odontotarsus FEI & YE, 1998	1999.5931-5948; 1999.5950; 1999.5956-5957 (16♂, 3♀, 3 *juv*)
Rana (*Eburana*) *livida* (BLYTH, 1855)	1999.5791-5798; 5814-5817 (4 ♂, 5 ♀, 2 *juv*)
Rana (*Nidirana*) *chapaensis* BOURRET, 1937	1938.0058-0065; 1948.0144-0147; 1999.5865-5893, 1999.5993; 1999.5999 (22 ♂, 17 ♀, 4 *juv*)
Rana (*Odorrana*) *andersonii* BOULENGER, 1882	1938.0054-0057; 1999.5762-5781 (9 ♂, 5 ♀, 9 *juv*)
Rana (*Odorrana*) *grahami* BOULENGER, 1917	1999.5782-5791 (2 ♂, 3 ♀, 5 *juv*)
Rhacophorus dorsoviridis BOURRET, 1937	1948.0149; 1999.5613, 1999.5616; 1999.5621-5624 (4 ♂, 2 ♀, 1 *juv*)
Rhacophorus duboisi n.sp.	1999.5969-5972 (2 ♂, 2 ♀)
Rhacophorus dugritei (DAVID, 1871)	1999.5973-5974 (2 ♂)
Rhacophorus feae BOULENGER, 1893	MO Z.33 (1 ♂); 1938.0083-0088; 1948.0154-0155; 1999.5967-5968 (7 ♂, 3 ♀)
Rhacophorus cf. *leucomystax* (GRAVENHORST, 1829)	1938.0081; 1999.5976-5985; 1999.5994 (3 ♂, 3 ♀, 6 *juv*)
Theloderma bicolor (BOURRET, 1937)	1938.0082; 1948.0152-153; 1999.5986-5987 (5 ♂)
Microhylidae NOBLE, 1931	
Microhyla butleri BOULENGER, 1900	1999.5629-5643; 1999.5645-5655 (21 ♂, 4 ♀, 1 *juv*)
Microhyla heymonsi VOGT, 1911	1999.5644 (1 *sex undet.*)

Fig. 2: Holotype of *Leptolalax pluvialis* nov. sp., dorsal view of adult male, MNHN 1998.5675, in life (SVL 22.0 mm). Photograph by ANNEMARIE OHLER.

Abb. 2: Holotypus von *Leptolalax pluvialis* nov. sp., Rückenansicht des adulten Männchens MNHN 1998.5675, im Leben aufgenommen (Kopf-Rumpflänge 22,0 mm). Foto ANNEMARIE OHLER.

surface pigmented; (3) dorsum smooth with symmetrical colour pattern; (4) forelegs distinctly bi-coloured; (5) webbing absent; (6) tibia long (TL/SVL 0.516 - 0.559); tibiotarsal articulation reaching nostril.

With only 22 mm SVL, the new species is the smallest of all *Leptolalax* species known (comp. INGER et al. 1995; INGER et al. 1999; FEI 1999). *Leptolax pluvialis* shows dark brown marbling on the ventral surface and can be distinguished by this feature from the following species: *L. hamidi* MATSUI, 1997, *L. arayai* MATSUI, 1997, *L. pictus* MALKMUS, 1992, *L. pelodytoides*, *L. bourreti*, *L. nahangensis* LATHROP, MURPHY, ORLOV & HO, 1998, *L. sungi* LATHROP, MURPHY, ORLOV & HO, 1998, *L. liui* FEI & YE, 1991. In *L. heteropus* (BOULENGER, 1900) and *L. tuberosus* INGER, ORLOV & DAREVSKY, 1999 the dorsal skin bears distinct tubercles, and in *L. ventripunctatus* FEI, YE & LI, 1991 dorsal skin ridges have been described. In *L. pluvialis* the dorsal skin is smooth and flattened tubercles are present on the flanks. In colour pattern and skin structure *L. pluvialis* is most similar to *L. alpinus* FEI, YE & LI, 1991 and *L. gracilis* (GÜNTHER, 1872). In both these species a basal webbing is present on the feet (FEI et al. 1991; INGER 1966), whereas in *L. pluvialis* webbing is absent. The new taxon can also be distinguished by the length of the shanks in that the tibiotarsal articulation reaches the nostril. *Leptolax gracilis* has longer legs (tibiotarsal articulation reaching tip of snout) and in *L. alpinus* the tibiotarsal articulation only reaches the corner of eye. The latter species also shows shorter head length (FEI et al., 1991: HL/ SVL 0.367, head as wide as long), than *L. pluvialis* (HL/SVL 0.386 - 0.413, slightly lengthened head).

Holotype: MNHN 1999.5675, adult male (SVL 22.0 mm) (fig. 2).

Table 2: Measurements (mean ± standard deviation, range) of *Leptolalax bourreti* DUBOIS, 1983, *L. nahangensis* LATHROP, MURPHY, ORLOV & HO, 1998, *L. pelodytoides* BOULENGER, 1893, *L. pluvialis* nov. sp., *L. sungi* LATHROP, MURPHY, ORLOV & HO, 1998, and *L. tuberosus* INGER, ORLOV & DAREVSKY, 1999. SVL - snout-vent length, HW - head width, HL - head length, TL - tibia length. Data source: 1) own measurements; 2) LATHROP et al. 1999; 3) INGER et al. 1999.

Tab. 2: Maße (Mittelwert ± Standardabweichung, Spannweite) von *Leptolalax bourreti* DUBOIS, 1983, *L. nahangensis* LATHROP, MURPHY, ORLOV & HO, 1998, *L. pelodytoides* BOULENGER, 1893, *L. pluvialis* nov. sp., *L. sungi* LATHROP, MURPHY, ORLOV & HO, 1998 und *L. tuberosus* INGER, ORLOV & DAREVSKY, 1999. SVL - Kopf-Rumpflänge, HW - Kopfbreite, HL - Kopflänge, TL - Tibialänge. Datenquellen: 1) eigene Messungen; 2) LATHROP et al. 1999; 3) INGER et al. 1999.

Species	Sex	n	SVL	HW	HL	TL
L. bourreti, 1) holo- and paratypes	♂	1	36.1	13.4	14.0	18.2
	♀	2	41.6-42.7	15.9-16.5	16.8-16.9	21.4-22.7
L. bourreti 1) topotypes	♂	8	28.7 ± 1.42 27.2 - 31.8	10.4 ± 0.42 9.9 - 11.1	11.0 ± 0.60 10.0 - 11.7	15.3 ± 0.87 14.6 - 16.8
	♀	1	42.8	15.3	15.9	19.8
L. nahangensis 2)	♂	1	40.8	-	13.5	20.0
	♀	0	-	-	-	-
L. pelodytoides 1)	♂	19	27.4 ± 3.30 22.4 - 36.2	9.2 ± 0.75 8.1 - 10.7	9.8 ± 0.71 8.5 - 10.9	12.5 ± 0.79 11.2 - 13.9
	♀	1	33.4	10.9	11.7	14.7
L. pluvialis 1)	♂	3	21.9 ± 0.51 21.3 - 22.3	8.6 ± 0.50 8.1 - 9.1	8.7 ± 0.15 8.5 - 8.8	11.6 ± 0.27 11.4 - 11.9
	♀		-	-	-	-
L. sungi 2)	♂	3	50.3 ± 2.2 48.3 - 52.7	19.4 ± 0.8 18.9 - 20.3	20.4 ± 0.9 19.3 - 21.0	22.7 ± 0.4 22.8 - 23.1
	♀	3	57.9 ± 1.1 56.7 - 58.9	21.6 ± 0.4 21.2 - 21.9	23.4 ± 0.6 23.0 - 24.1	24.6 ± 1.3 23.6 - 26.1
L. tuberosus 3)	♂	12	26.8 ± 0.42 24.4 - 29.5	-	-	-
	♀	1	30.2	-	-	-

Paratypes: MNHN 1999.5674, MNHN 1999.5676, 2 adult males (SVL 21.3 - 22.3 mm).

Type locality: Fan Si Pan mountain range (22° 19' N, 103° 47' E; 1900 m), Lao Cai Province, Vietnam.

Collection data: The type specimens were collected by ANNEMARIE OHLER under heavy rain in the night of 11 July 1998 near a small mountain stream in montane forest. They were calling on branches and logs about 20 cm above the ground.

Description of holotype, adult male MNHN 1999.5675.

(A) Size and general aspect. - (1) Specimen of small size (SVL 22.0 mm), body moderately slender.

(B) Head. - (2) Head of medium size, narrower (HW 8.1 mm) than long (HL 8.5 mm; MN 6.7 mm; MFE 5.5 mm; MBE 2.2 mm), forehead convex. (3) Snout rounded, slightly protruding, its length (SL 4.02 mm) longer than horizontal diameter of eye (EL 3.31 mm). (4) Canthus rostralis angular, loreal region concave, vertical. (5) Interorbital space convex, slightly larger (IUE 2.79 mm) than upper eyelid (UEW 2.66 mm) but narrower than internarial distance (IN 2.98 mm); distance between anterior margins of eyes (IFE 4.60 mm) about two third of distance between posterior margins of eyes (IBE 7.52 mm). (6) Nostrils oval, without skin flap, closer to eye (EN 1.43 mm) than to tip of snout (NS 2.01 mm). (7) Pupil oval, vertical. (8) Tympanum (TYD 1.65 mm) distinct, rounded; about equal to eye diameter, tympanum-eye distance (TYE 0.68 mm) two fifths of its diameter. (9) Pineal ocellus absent. (10) Vomerine ridge absent. (11) Tongue moderate, cordate, and emarginate. (12) Supratympanic fold distinct, from eye to shoulder.

(C) Forelimbs. - (14) Arm short, thin (FLL 6.22 mm), longer than hand (HAL 5.96 mm), not enlarged. (15) Fingers I, II, and IV rather short and rather strong; finger III long and rather strong (TFL 4.02 mm). (16) Relative length of fingers, shortest to longest: I < II = IV< III. (17) Tips of fingers rounded, not enlarged, without

grooves. (18) Finger II with dermal fringe on the inner side; webbing absent. (19) Subarticular tubercles absent. (20) Prepollex absent; two prominent palmar tubercles, the inner rounded, the outer oval; supernumerary tubercles absent.

(D) Hind limbs. - (21) Shanks about four times longer (TL 11.4 mm) than wide (TW 3.11 mm), longer than thigh (FL 10.9 mm) and distance from base of internal metatarsal tubercle to tip of toe IV (FOL 10.8 mm); heel reaching nare when limb folded forward. (22) Toes rather short and rather strong; toe IV (FTL 6.35) about one third of distance from base of tarsus to tip of toe IV (TFOL 17.2 mm). (23) Relative length of toes, shortest to longest: I < II < V < III < IV. (24) Tips of toes rounded, not enlarged, without grooves. (25) Webbing absent. (WTF nm; WFF nm; WI nm; WII nm; MTTF 3.89 mm; MTFF 3.76 mm; TFTF 6.61 mm; FFTF 6.74 mm). (26) Dermal fringe along toe V absent. (27) Subarticular tubercles absent. (28) Inner metatarsal tubercle rather long and prominent; its length (IMT 1.67 mm) 1.32 times in length of toe I (ITL 2.20 mm). (29) Tarsal fold absent. (30) Outer metatarsal tubercle absent; supernumerary tubercles absent; tarsal tubercle absent.

(E) Skin. - (31) Dorsal and lateral parts of head and body: snout, region between the eyes, side of head and back smooth; flank with flat glandular warts. (32) Dorso-lateral folds absent. (33) Dorsal parts of limbs: forelimbs, thigh, shank and tarsus smooth. (34) Ventral parts of head, body and limbs: throat, chest, belly and thigh smooth. (35) Presence of macroglands: pectoral, femoral, supra-brachial and ventro-lateral glands present.

(F) Coloration. - (a) In alcohol. - (36) Dorsal and lateral parts of head and body: dorsal parts of head and dorsum and upper part of flank grayish-brown with black band between the eyes, a black W-shaped pattern in the shoulder region and a black V in the sacral region; lower part of flank dark grayish-brown; loreal region blackish-brown; tympanic region including tympanum dark brown with white band under the tympanum; upper lip dark brown with white and blackish spots. (37) Dorsal parts of limbs: dorsal parts of forelimb, thigh, shank, and foot gray-brown with blackish bands; posterior part of thigh blackish with small white spots. (38) Ventral parts of head, body and limbs: throat dirty white; margin of throat dark brown with small white spots; chest and belly dirty white with dark brown marbling; thigh brown with some white spots; macroglands white.

(b) In life. - Upper parts of head and dorsum, flanks and tympanic region gray brown with dark brown pattern, particularly in the tympanic and loreal regions; upper lip gray-brown with dark brown and whitish-gray bands. Upper part of fore-arm ochre, lower part gray-brown and dark brown; hind legs with dark brown and gray-brown bands; heels ochre; posterior part of thigh gray-brown with a dark brown zone ventrally. Throat transparent light gray-brown with dark brown margin bearing white spots; chest and belly gray with dark gray marbling; lower part of thigh transparent dark brown with whitish spots. Macroglands whitish gray.

(G) Male secondary sexual characters. - (39) Nuptial spines absent. (40) Vocal sacs: inconspicuous, skin of gular region not modified; inner openings of vocal sacs present located on both sides posteriorly in the mouth floor, distinct; rounded. (41) Other male secondary sexual characters: none.

Advertisement call: not recorded.

Female sexual characters: Not observed.

Variation: The two male paratypes resemble strongly the holotype in coloration and morphology.

Etymology of specific name: From Latin *pluvialis*: created by, related to or originating from the rain.

Leptobrachium (*Vibrissaphora*) *echinatum* DUBOIS & OHLER, 1998

Despite the remarks of HO et al. (1999), this species has to be considered distinct from *Leptobrachium* (*Vibrissaphora*) *ailaonicum* (YANG, CHEN & MA, 1983). In fact the specimens mentioned by HO et al. (1999) are part of the sample which includes the holotype and the paratypes of *L. echinatum* and was collected by our team. Our original field data do not

match the colors in life as published by HO et al. (1999) who just translated and reproduced data of FEI et al. (1995) on *L. ailaonicum*.

One argument of HO et al. (1999) concerns the colour of the iris in *Leptobrachium*. The color of the iris is usually stable in anuran species and has been proven to be a good character for species discrimination (GLAW & VENCES 1997; see also discussion in MATSUI et al. 1999), although often been ignored because it can only be clearly observed when frogs are alive. A major problem in anuran systematics is due to the fact that interspecific variation is often mistaken as intraspecific. Any such systematic analysis is then called to fail [see e. g., morphometric analysis of *Rana* synkl. *esculenta* by KAURI (1959), or works on the *R. pipiens* group, review by DUBOIS 1977]. To understand character distribution, the operational taxonomic unit has to be the population. In all *Leptobrachium* populations studied in the field, eye coloration seems to be stable or variable to a degree which is only discernable using finer methods, such as spectrographs (DUBOIS, GROSJEAN, OHLER and NABITHABATHA, unpublished data). In more than 50 *L. chapaense* (BOURRET, 1937) from Ben En (Tanh Hoa Province, Vietnam) observed by our team, the upper iris was light blue in all cases (GROSJEAN, OHLER, unpublished data; DUBOIS & OHLER 1998); the same color was found in the specimens observed in northern Thailand (DUBOIS & OHLER 1998; MATSUI et al. 1999; DUBOIS, OHLER, NABITHABATHA, unpublished data). In all specimens of *L. echinatum* observed on Fan Si Pan the color of the upper iris can most easily be described as lime green. During field work, life color, especially the color of the iris should be noted by researchers in order to provide access to this useful character in systematics.

Morphometric data of the specimens and sexual characters of the males mentioned by HO et al. (1999) give additional support to the taxonomic conclusions of DUBOIS & OHLER (1998): the range of the number of spines on the upper lip of the five males reported by DUBOIS & OHLER (1998) and HO et al. (1999) is 50 - 61, and does not overlap the range of 22 - 48 reported from 69 *L. ailaonicum* from Yunnan by FEI et al. (1995). These data clearly separate *L. echinatum* and *L. ailaonicum*. The tadpole description by HO et al. (1999) is not based on original data, but is a translation of the description of the tadpole of *L. ailaonicum* by CHEN et al. (1984).

Bufo LAURENTI, 1768

DUBOIS & OHLER (1999) proposed a revision of species of the *Bufo melanostictus* group and the *B. stejnegeri* group (both groups sensu INGER 1972). They proposed to include *B. tienhoensis* BOURRET, 1937 in the synonymy of *B. melanostictus* SCHNEIDER, 1799. Based on the comparison of the holotype and topotypical specimens of *Bufo*

Table 3: Measurements and indexes of treefrogs of the *Rhacophorus dugritei* group (sensu DUBOIS 1987): *Rhacophorus duboisi* nov. sp., *Rh. dugritei* (DAVID, 1871), *Rh. gongshanensis* YANG & SU, 1984, *Rh. omeimontis* STEJNEGER, 1924. SVL - snout-vent lengt, HW - head width, HL - head length, TL - tibia length. Data source: own measurements

Tab. 3: Maße und Indizes von Baumfröschen der *Rhacophorus dugritei* - Gruppe (sensu DUBOIS 1987): *Rhacophorus duboisi* nov. sp., *Rh. dugritei* (DAVID, 1871), *Rh. gongshanensis* YANG & SU, 1984, *Rh. omeimontis* STEJNEGER, 1924. SVL - Kopf-Rumpflänge, HW - Kopfbreite, HL - Kopflänge, TL - Tibialänge. Datenquelle: eigene Messungen.

Species	Sex	n	SVL	HW/SVL	HL/SVL	TL/SVL
Rh. duboisi	♂	2	61.5 - 65.7	0.314 - 0.338	0.315 - 0.333	0.457 - 0.496
	♀	2	71.1 - 74.1	0.337 - 0.364	0.320 - 0.333	0.495 - 0.503
Rh. dugritei	♂	2	38.0 - 40.8	0.358 - 0.385	0.332 - 0.355	0.421 - 0.426
	♀	0	-	-	-	-
Rh. gongshanensis	♂	2	64.7 - 68.0	0.331 - 0.334	0.331 - 0.335	0.468 - 0.472
	♀	2	78.0 - 78.7	0.349 - 0.356	0.326 - 0.329	0.515 - 0.515
Rh. omeimontis	♂	15	50.4 - 69.6	0.298 - 0.355	0.315 - 0.349	0.488 - 0.491
	♀	4	75.5 - 79.4	0.319 - 0.359	0.297 - 0.323	0.466 - 0.520

pageoti BOURRET, 1937 with the type-specimens of *Bufo burmanus* ANDERSSON, 1939, they showed the latter name to be a junior synonym of *B. pageoti*.

Chaparana fansipani (BOURRET, 1937)

This species was described on the basis of a single young male. In our field study, three adult males with developed secondary sexual characters were collected.

Rhacophorus
KUHL & VAN HASSELT, 1822

The genus *Rhacophorus* includes treefrogs of medium to large body size, with vomerine teeth, toe pads bearing circumferential grooves, and development through generalized ranid tadpoles. DUBOIS (1987) divided the genus into two subgenera defined by tadpole morphology. For the subgenus *Rhacophorus* (*Rhacophorus*)

Fig. 3: Holotype of *Rhacophorus duboisi* nov. sp., dorsal view of adult male, MNHN 1998.5971, fixed specimen (SVL 61.5 mm). Photograph by ANNEMARIE OHLER.

Abb. 3: Holotypus von *Rhacophorus duboisi* nov. sp., Rückenansicht des adulten Männchens MNHN 1998.5971, fixiertes Exemplar (Kopf-Rumpflänge 61,5 mm). Foto ANNEMARIE OHLER.

he tentatively proposed 10 species groups, based on external morphology. Taxonomic definitions at the species level also have been modified (LIU & HU 1961) what should be reflected in adjusted distribution patterns. BOURRET (1942) reported on *Rhacophorus feae* BOULENGER, 1893 (*Rh. dennysii* BLANFORD, 1881 group) as a subspecies of *Rh. nigropalmatus* from Sa Pa, but he did not mention *Rh. nigropalmatus* BOULENGER, 1895 [*Rh. reinwardtii* (SCHLEGEL, 1840) group] to occur in Vietnam. He also considered *Rh. dennysi* BLANFORD, 1881 (*Rh. dennysii* group) to be a subspecies of *Rh. nigropalmatus*. INGER et al. (1999) stated that *Rh. nigropalmatus* should be excluded from the fauna of Vietnam, but we collected *Rh. nigropalmatus* (MNHN 1997.5449-5451, IEBR D545, D678, D683) in Ben En (Than Hoa province) as well as *Rh. dennysii* (MNHN 1997.5409) in Ben En (Than Hoa Province) and Huu Lien (Lang Son Province). Both species have to be included in the list of Vietnamese amphibians.

Furthermore, we describe the following new species of this genus collected at Sa Pa.

Rhacophorus duboisi nov. sp.

This new species seems closely related to the *Rh. dugritei* group of DUBOIS (1987), which includes *R. dugritei* (DAVID, 1871) and *R. omeimontis* STEJNEGER, 1924. *Rhacophorus gongshanensis* YANG & SU, 1984 should be added to this group on the basis of adult morphology. With these, *Rh. duboisi* nov. sp. shares the following characters: (1) green and brown dorsum colour; (2) brownish band including canthus rostralis, border of upper eyelid and tympanic fold; (3) webbing on hands half developed. The members of the *Rh. dennysii* group (sensu DUBOIS 1987 - *Rh. dennysii* BLANFORD, 1881, *Rh. feae* BOULENGER, 1893) also resemble the new species in colour pattern, but webbing on their hand is complete and they are of very large body size.

We had the possibility to study the type-material (syntypes and topotypes) of all three species of this group and compare it to *Rh. duboisi* nov. sp. (table 3). The new species can be distinguished from *Rh. dugritei* (syntypes MNHN 5563-5564, Moupin, China) and *Rh. gongshanensis* (topotypes CIB 828033, 0553, 0556, 0723, two adult males two adult females, Yunnan, China) by dorsal color pattern: in *Rh. dugritei*, males are uniformly green, and in *Rh. gonshanensis* both sexes only show a few brown patches on the dorsum and a distinct white line separating dorsal and ventral coloration on forelegs, hindlegs and vent. *Rhacophorus omeimontis* (CIB 561592, 638244-638252, 638254-638260, 740018, 740020, 15 adult males, 4 adult females, Emei Shan, China), which is most similar for color pattern, can be distinguished from *Rh. duboisi* by having a very granular dorsal skin. In this species the tarsal fold is distinct, the digital pad of the third finger is smaller than the tympanum. The dorsal pattern is composed of patches which show a distinct black outline, the flanks show white spots, the posterior surface of shanks is brown with white spots and the ventral side is uniformly light-gray.

Diagnosis: (1) Medium sized *Rhacophorus* (SVL 61.5 - 65.7 mm); (2) brown band on canthus rostralis, upper eyelid and tympanic fold; (3) web on hand present, half developed; (4) digital pad of third finger larger than tympanum; (5) dorsum with small granules; (6) colour of dorsum green and brown, spots arranged in bands, patches without black outline; (7) belly gray-white with small, dense gray spots.

Holotype: MNHN 1999.5971, adult male (SVL 61.5 mm) (fig. 3).

Paratypes: MNHN 1999.5972, 1 adult male; MNHN 1999.5969-5970, 2 adult females.

Type locality: Fan Si Pan mountain range (22° 16' N, 103° 50' E; 1900 m), near Sa Pa, Lao Cai Province, Vietnam.

Collection data: The type-specimens were collected by one of the authors (STEVEN SWAN) (phase 3) between April 29 and May 4, 1998 in a pond on the edge of montane forest. They were in breeding condition. A series of this species that had to be deposited in the IEBR collection was not accessible for us to study in July 1999, and thus, cannot be included in the paratype series.

Description of holotype - adult male MNHN 1999.5971.

(A) Size and general aspect. - (1) Specimen of medium size (SVL 61.5 mm), body moderately robust.

(B) Head. - (2) Head of medium size, longer (HL 25.0 mm) than large (HW 20.8 mm; MN 17.3 mm; MFE 12.7 mm; MBE 6.5 mm), flat. (3) Snout pointed, slightly protruding, its length (SL 10.5 mm) longer than horizontal diameter of eye (EL 7.63 mm). (4) Canthus rostralis sharp, loreal region obtusely concave. (5) Interorbital area flat, larger (IUE 7.11 mm) than upper eyelid (UEW 5.53 mm) and internarial distance (IN 6.18 mm); distance between anterior margins of eyes (IFE 11.3 mm) about half the distance between posterior margins of eyes (IBE 19.7 mm). (6) Nostrils rounded, without skin flap, closer to the eye (EN 4.74 mm) than to the tip of the snout (NS 5.40 mm). (7) Pupil horizontal. (8) Tympanum (TYD 4.87 mm) distinct, rounded; two thirds of eye diameter, distance from tympanum to eye (TYE) 0.92 mm. (9) Pineal ocellus absent. (10) Vomerine ridge bearing nine teeth, between choanae in an angle of 70° to body axis, touching choanae and longer than the distance between them. (11) Tongue moderate, spatulate, emarginate. (12) Supratympanic fold indistinct, running from eye to behind tympanum.

(C) Forelimbs. - (13) Arm short, rather thin; fore-arm not enlarged (FLL 15.8 mm), shorter than hand (HAL 21.7 mm). (14) Finger I short and thin, fingers II-IV rather long and thin (TFL 12.3). (16) Relative length of fingers, shortest to longest: I < II < IV< III. (17) Tips of fingers enlarged, with distinct circum-ventral grooves and much wider than finger width (PAI 2.27 mm, WAI 1.49 mm; PAII 4.21 mm, WAII 1.62 mm; PAIII 4.47 mm, WAIII 2.07 mm; PAIV 4.67 mm, WAIV 2.07 mm). (18) Fingers without lateral dermal fringe, webbing present. Webbing formula: I 2 - 2 ½ II 1 - 2 ¾ III 2 - 1 ½ IV. (19) Six subarticular tubercles present, prominent, rounded, single. (20) Prepollex oval; prominent. Two oval and flat palmar tubercles. Supernumerary tubercles present on fingers II - IV.

(D) Hind limbs. - (21) Shank four times longer (TL 30.5 mm) than wide (TW 6.9 mm); longer than thigh (FL 28.7 mm) and distance from base of internal metatarsal tubercle to tip of toe IV (FOL 27.2 mm). (22) Toes rather short and thin; toe IV (FTL 15.0); less than one third the distance from base of tarsus to tip of toe IV (TFOL 40.9 mm). (23) Relative length of toes, shortest to longest: I < II < III <V < IV. (24) Tips of toes enlarged; discs present, with circum-ventral grooves, rather wide compared to toe width (PPI 1.75 mm, WPI 0.97 mm; PPII 2.33 mm, WPII 1.30 mm; PPIII 2.79 mm, WPIII 1.43 mm; PPIV 2.59 mm, WPIV 1.17 mm; PPV 2.53 mm, WPV 1.17 mm). (25) Webbing large; webbing formula: I 0 - 1 II 0 - 1 III 1 - 2 IV 2 - 1 V (WTF 7.11 mm, WFF 7.76 mm; WI 5.92 mm; WII 6.84 mm; MTTF 15.2 mm; MTFF 16.2 mm; FTTF 10.2 mm; FFTF 8.0 mm). (26) Dermal ridge along toe V present; from tip of toe to first subarticular tubercle, poorly developed. (27) Ten subarticular tubercles present, prominent, oval, simple. (28) Inner metatarsal tubercle rather short and indistinct, its length (IMT 2.63 mm) 3.1 times in the length of toe I (ITL 8.16 mm). (29) Tarsal fold absent. (30) Outer metatarsal tubercle absent; supernumerary tubercles present on toes I - V; tarsal tubercle absent.

(E) Skin. - (31) Dorsal and lateral parts of head and body: snout and between eyes granular with horny spinules; side of head smooth; back granular with horny spinules; flanks with glandular warts. (32) Dorso-lateral folds, lateral line system and Fejervaryan line (a dark ventro-lateral line formed by the edge of the musculus pectoralis pars abdominalis which is slightly attached to the skin from the armpit to the groin; see DUBOIS & OHLER submitted) absent. (33) Dorsal parts of limbs: forelimb, thigh, shank and tarsus with glandular warts. (34) Ventral parts of head, body and limbs: throat smooth; chest, belly, and thigh with glandular warts. (35) Macroglands absent.

(F) Coloration. (a) In alcohol. - (36) Dorsal and lateral parts of head and body: dorsal parts of head and dorsum and upper part of flank bluish with copper brown spots bordered with black and some white spots; lower part of flank blackish with white spots; loreal region, tympanic region including tympanum bluish; canthus rostralis, border of upper eyelid and tympanic fold copper brown underlined with

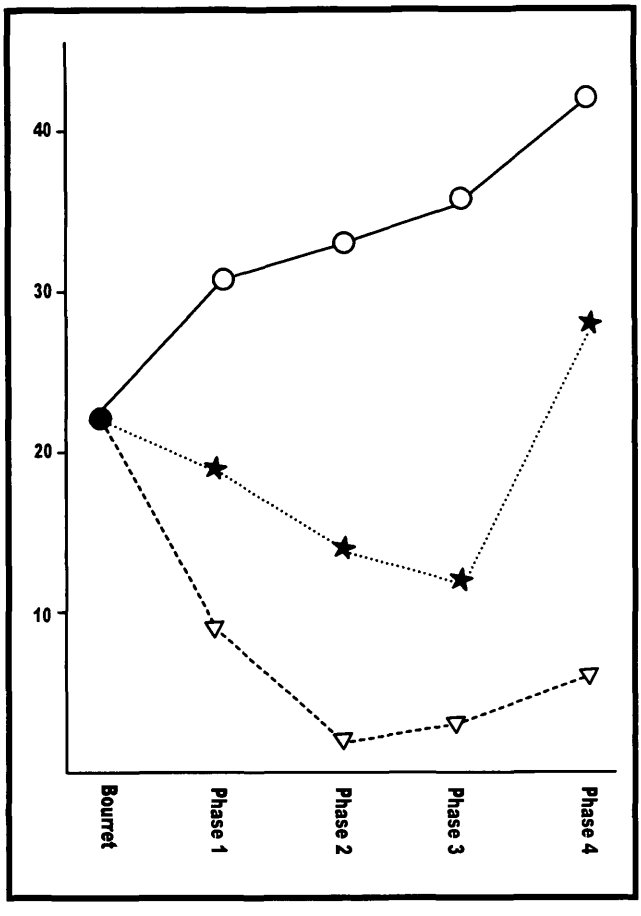

Fig. 4: Progress in discovering the amphibian biodiversity of the Fan Si Pan mountains (Hoang Lien Nature Reserve, Sa Pa District, Lao Cai Province, Vietnam) beginning with the results of BOURRET (1942) (●) through four phases of collecting by the authors. Phase 1 - October-November 1997; phase 2 - January-February 1998; phase 3 - April-May 1998; phase 4 - July-August 1998. Number of species (y-axis) collected during phases 1-4 (★), number of species new to the Fan Si Pan mountains (▽), total number of species known to occur in the Fan Si Pan mountains (○).

Abb. 4: Der Fortschritt in der Aufdeckung der Amphibienbiodiversität des Fan Si Pan Gebirges (Hoang Lien Naturreservat, Distrikt Sa Pa, Provinz Lao Cai, Vietnam) beginnend mit den Ergebnissen von BOURRET (1942) (●) über vier Sammelphasen der Autoren. Phase 1 - Oktober-November 1997; Phase 2 - Jänner-Februar 1998; Phase 3 - April-Mai 1998; Phase 4 - Juli-August 1998. Anzahl der Arten (y-Achse), die während der Phasen 1-4 gesammelt wurden (★), die davon jeweils neu für das Fan Si Pan Gebirge sind (▽), die insgesamt aus dem Fan Si Pan Gebirge bekannt sind (○).

black; upper lip blue with white and black spots. (37) Dorsal parts of limbs: dorsal parts of forelimb, thigh, shank, and foot bluish with copper brown spots bordered with black and some white spots; posterior part of thigh dorsally black with white marbling; ventrally white with small dark spots; vent dorsally underlined with white and ventrally black with white spots. (38) Ventral parts of head, body and limbs: throat, margin of throat and chest gray-brown with light gray spots; belly gray-white with small dense gray spots; thigh with brown and black marbling anteriorly, gray with small darker gray spots posteriorly; webbing marbled with black and white.

(b) In life. - Dorsal part of head, body and legs dark olive green with brown spots; ventral parts fleshy with brown spots; iris dark gold.

(G) Male secondary sexual characters. - (39) Small indistinct white nuptial spines present as a long band on finger I and prepollex and a small patch on finger II. (40) Vocal sacs absent. (41) Other male secondary sexual characters: canthus rostralis and tympanic fold more clearly underlined in males than in females.

Female sexual characters: Adult female (MNHN 1999.5970) with large (Ø 2.5 mm) creamy-whitish ovocytes.

Variation: The four specimens are very similar. Males have slightly darker throats than females.

Etymology of specific name: We have the pleasure to dedicate this frog to ALAIN DUBOIS in recognition of his help regarding our work on Vietnamese frogs.

BIODIVERSITY OF FAN SI PAN

To our present knowledge, the Hoang Lien Nature Reserve (altitudinal range: 940 - 2300 m) counts 42 species of amphibians. This is 18 species more than were known before this study. When compared, northern Vietnamese lowland forests (altitudinal range: 30 - 100 m) (OHLER unpublished data) and Hoang Lien Nature Reserve have only five species in common: *Bufo melanostictus*, *Fejervarya limnocharis*, *Rhacophorus leucomystax*, *Microhyla butleri*, *Microhyla heymonsi*. INGER et al. (1999) gave a list of 47 species for the central highlands of Vietnam. The Hoang Lien Nature Reserve and the area studied by INGER et al. (1999) have four species in common: *Bufo melanostictus*, *Megophrys lateralis* (ANDERSON, 1871), *Limnonectes kuhlii* (TSCHUDI, 1838), *Rhacophorus leucomystax* (GRAVENHORST, 1829). INGER et al.'s (1999) study includes intermediate altitudes of 700 - 1,200 m, thus, showing a higher number of species than Fan Si Pan. The difference is due to the presence of lowland species, such as *Rana erythraea* (SCHLEGEL, 1827) and *Hoplobatrachus rugulosus* (WIEGMANN, 1835) in INGER et al.'s (1999) list which are absent in our collection from Fan Si Pan. These data suggest that the Vietnamese fauna shows a high degree of both latitudinal and altitudinal differentiation.

Based solely on BOURRET's (1942) collection, the Fan Si Pan Mountain must be called a hotspot of Amphibian evolution as more than 50% of the species known from the area until most recently are considered endemic. According to our present study, this evaluation has to be relativised because now only 14 % (6 out of 42 species) can be considered endemic. Most of the new species for Fan Si Pan are also known from outside this region or outside Vietnam. Many are known from, the southernmost province of China, Yunnan, which is the geographical continuation of northern Vietnam. It is, therefore, not surprising to find many species on both sides of the frontier. The distribution range of some species of Fan Si Pan extends as far as Myanmar [*Philautus carinensis* (BOULENGER, 1893), *Rhacophorus feae*].

Even if the outstanding richness of endemic species cannot be maintained any longer as the characteristics of Fan Si Pan, the high degree of species diversity in a limited area is noteworthy. Many genera and species groups have several representatives in this region. As many as seven species of the genus *Megophrys*, five species of the genus *Rhacophorus*, and four species of the genus *Philautus* are known from here.

Our discovery of the diversity of amphibian species in the Hoang Lien Nature Reserve progressed in a rather regular manner all over the year (fig. 4). In phase 1, we collected more species new to this place than in other phases, but it was in phase 3 when two of the three species new to science were discovered. Discovery of taxa new to the Sa Pa region continued even in phase 4. From the sequence of the discovery of new taxa it seems that the total number of species of the area is not yet attained. Four of the 22 species (18.2 %) collected by BOURRET (1942) have not yet been observed since. From an estimation based on this proportion, one might expect the presence of about eight more species, which would mean a total of about 50 species.

Table 4: Altitudinal range, vegetation type (Ag - agriculture, Sc - scrub, Sm - submontane forest, Mo - montane forest), and activity pattern from October through August (OB - mere observation, RA - species observed in reproductive activity) of frogs in the Fan Si Pan mountains, Hoang Lien Nature Reserve, Sa Pa District, Lao Cai province, Vietnam.

Tab. 4: Vertikale Verbreitung, Vegetationstyp (Ag - Landwirtschaft, Sc - Buschwald, Sm - submontaner Wald, Mo - montaner Wald) und Aktivitätsmuster von Oktober bis August (OB - bloße Beobachtung, RA - Beobachtung von Fortpflanzungsaktivitäten) von Fröschen im Fan Si Pan Gebirge, Hoang Lien Natureservat, Distrikt Sa Pa, Provinz Lao Cai, Vietnam.

Species	Altitude (m) Höhe (m)	Vegetation type Vegetationstyp				Activity Pattern from October through August Aktivitätsmuster von Oktober bis August										
		Ag	Sc	Sm	Mo	O	N	D	J	F	M	A	M	J	J	A
Bombina microdeladigitoria	~ 2050				●											OB
Leptobrachium echinatum	1600-2090		●		●	RA	RA								OB	OB
Leptolax bourreti	1150-2090	●	●	●	●	RA	RA		OB	OB					OB	
Leptolax pluvialis	~ 1850				●										RA	
Megophrys jingdongensis	1660			●											RA	RA
Megophrys lateralis	1500		●									RA	RA			
Megophrys minor	1660-2040		●	●	●					OB					RA	RA
Megophrys pachyprocta	- 1800														OB	
Megophrys parva	1660-1780		●	●								OB				RA
Megophrys sp.	~ 1700			●												RA
Bufo melanostictus	940-1260	●	●							OB					OB	OB
Bufo pageoti	2020-2030				●							OB				
Hyla annectans	1260-2090	●	●	●	●	OB	OB			OB					RA	RA
Amolops chapaensis	~ 1900				●										OB	
Amolops chungaensis	~ 1900				●	OB									RA	
Amolops viridimaculatus	~ 1750			●		OB										
Chaparana fansipani	1270-1800		●	●			RA					OB				OB
Chirixalus nongkhorensis	1210-1660		●	●						OB						
Fejervarya limnocharis	800-1700	●	●				OB			OB						
Limnonectes kuhlii	~ 1250		●				OB									
Paa verrucospinosa	1280-1900		●	●	●	OB	OB		OB	OB		OB	OB		OB	OB
Paa bourreti	1570-2050		●	●	●							OB	OB			
Philautus carinensis	1260-2020	●	●	●	●					RA						
Philautus gracilipes	1540-1770		●	●						OB					RA	OB
Philautus jinxiuensis	1850				●										RA	RA
Philautus odontotarsus	1250-1500	●	●												RA	RA
Rana andersonii	1500-1790	●	●	●		OB									OB	OB
Rana chapaensis	1600-1900		●	●	●					OB					RA	RA
Rana grahami	1150-2040		●	●	●	OB	OB								OB	
Rana livida	1100-1900			●	●	RA	RA									
Rhacophorus dorsoviridis	~ 1900				●							RA	RA			
Rhacophorus duboisi	1210-1890			●	●							RA	RA			
Rhacophorus dugritei	1890-2300			●	●							RA	RA			
Rhacophorus feae	1230-1800		●			OB	OB									
Rhacophorus cf. *leucomystax*	1260-1680	●	●	●			OB			OB					RA	
Theloderma bicolor	1210-1890			●	●											OB
Microhyla butleri	~ 1260	●	●												RA	RA
Microhyla heymonsi	~ 1150	●								OB						

VARIATION OF SEASONAL ACTIVITY

A major problem of field work is the choice of the most suited sampling time. Amphibians are known to have seasonal phases of activity which appear most clearly expressed in the temperate zone. Tropical regions are often considered to have a more stable climate and, in consequence, seasonal variation in amphibian activity should be less pronounced. The climate on Fan Si Pan is not tropical, but montane subtropical with a rather cold wet season (November to January) and a short dry season (February and March). The climate is humid due to rainfall distributed over great parts of the year (TORDOFF et al. 1999).

At Fan Si Pan, frogs were reproductively active all over the year (table 4). However, the periods of reproductive activity differed among congeneric species. Examples: *Leptolax bourreti* was found breeding in October-November, *L. pluvialis* in July. *Philautus carinensis* was found to breed mainly in October-November, while three other members of the genus showed this activity in July. In doing so, *Ph. odontotarsus* FEI & YE, 1998 and *Ph. jinxiuensis* HU & TIAN, 1981 shared more open habitats and call positions, whereas *Ph. gracilipes* BOURRET, 1937 found simultaneously was rather a forest dweller and chose call positions different from the two other *Philautus* species. The most common species was *Paa verrucospinosa* (BOURRET, 1937); individuals exhibiting the morphological attributes of sexual activity were found all over the year. Some species such as *Leptolalax pluvialis* which seem to have very short activity phases were found during one of four visits only, although the identical collection site was inspected during the other visits as well. A more detailed quantitative analysis on the ecological and ethological aspects of this amphibian community including field observations is part of a master's degree diploma (SWAN in prep.).

The present paper presents results of the most comprehensive batrachological exploration of a single site in Vietnam so far. Nonetheless, from some species only a single adult or some young specimens were collected, so that no information on their reproductive period can be given.

As shown in figure 4, collecting over successive phases led to an increasing number of species over the one-year period. This is due to differential activity patterns of the species from Fan Si Pan. None of the collecting phases provided results representative for the whole batrachofauna of this region. Finally, even after one year of data collecting, no definite information on the total number of amphibian species could be made. Concerning the choice of various phases of field work, our data indicate clearly that an increase of visits to a site will increase diversity of species observed and will lead to more and better data on a particular site.

ACKNOWLEDGMENTS

We are grateful to the Frontier staff and research assistants for collecting the frog specimens in northern Vietnam and sending them to us for study and to the Institute of Ecology and Biological Resources (Hanoi) for the permit to export the specimens. We thank ALAIN DUBOIS (Paris) and HEINZ GRILLITSCH (Vienna) for comments on the manuscript and ROGER BOUR (Paris) for advise concerning the figures. This is publication N° 00-25 of PPF «Faune et flore du sud-est asiatique». Publication N° 00-24 see DEUVE (2000).

REFERENCES

BOULENGER, G. A. (1905): Description of a new batrachian of the genus *Bombinator* from Yunnan.- Ann. Mag. Nat. Hist., London; (7) 15: 188-189.

BOURRET, R. (1937): Notes herpétologiques sur l'Indochine Française XIV-XV.- Annexe Bull. Gén. Instr. Publique, Hanoi; 1937: 1-80.

BOURRET, R. (1942): Les batraciens de l'Indochine; Hanoi (Institut océanographique de l'Indochine).

CHEN, H.-J. & LI, F.-L. & HENG, X. (1984): Preliminary observations on ecology of *Vibrissaphora ailonica*.- Acta Herpetol. Sinica, Chengdu; 3: 41-45.

DEUVE, TH. (2000): Un nouveau genre de Trechinae aphaenopsien et une nouvelle *Eustra* microphtalme découverts dans un karst du Laos (Coleoptera, Trechidae, Paussidae).- Rev. française d'Entomologie, Paris, (N. S.), 22 (in print).

DUBOIS, A. (1977): Les problèmes de l'espèce chez les amphibiens anoures.- Mém. Soc. zool. France, Paris; 39: 161-284.

DUBOIS, A. (1983): Note préliminaire sur le genre *Leptolalax* DUBOIS, 1980 (Amphibiens, Anoures), avec diagnose d'une espèce nouvelle du Vietnam.-

Alytes, Paris; 2: 147-153.

DUBOIS, A. (1987): Miscellanea taxinomica batrachologica (I).- Alytes, Paris; ("1986") 5: 7-95.

DUBOIS, A. (1992): Notes sur la classification des Ranidae (Amphibiens Anoures).- Bull. mens. Soc. linn. Lyon; 61: 305-352.

DUBOIS, A. & OHLER, A. (1998): A new species of *Leptobrachium* (*Vibrissaphora*) from northern Vietnam, with a review of the taxonomy of the genus *Leptobrachium* (Pelobatidae, Megophryinae).- Dumerilia, Paris; 4: 1-32.

DUBOIS, A. & OHLER, A. (1999): Asian and Oriental toads of the *Bufo melanostictus*, *Bufo scaber* and *Bufo stejnegeri* groups (Amphibia, Anura): list of available and valid names, and redescription of some name-bearing types.- J. South Asian Zool., Colombo; 4: 133-180.

DUBOIS, A. & OHLER, A. (submitted): Systematics of *Fejervarya limnocharis* (GRAVENHORST, 1829) (Amphibia, Anura, Ranidae). Nomenclatural status and type-specimens of the nominal species *Rana limnocharis* GRAVENHORST, 1829.- Alytes, Paris.

FEI, L. (ed.) (1999): Atlas of the amphibians of China. Zhengzhou (Henan Science and Technology Press), pp. (i-ii) + 1-432.

FEI, L. & YE, C. & JIANG, J. & CHEN, S. & CAI, C. & TANG, Z. & CAI, M. & GAO, J. & WEI, G. (1995): Study on the classification and phylogenetic relationship of *Vibrissaphora* (Amphibia, Pelobatidae).- Acta Herpetol. Sinica, Chengdu; 4-5: 65-71.

FEI, L. & YE, C.-Y. & LI, S.-S. (1991): Two new species of pelobatid toads of genus *Leptolalax* from Yunnan Province of China (Amphibia, Anura).- Acta Biologica Plateau Sinica, Xi'ning; 11: 45-54.

GLAW, F. & VENCES, M. (1997): Anuran eye colouraion: definitions, variation, taxonomic implications and possible functions. In: BÖHME, W. & BISCHOFF, W. & ZIEGLER, T. (eds.): Herpetologica Bonnensis. Proc. 8th General meeting Societas Europaea Herpetologica. 23-27 August 1995. SEH, Bonn: 1-416.

HO, C. T.& LATHROP, A. & MURPHY, R. W. & ORLOV, N. (1999): A redescription of *Vibrissaphora ailonica* with a new record in Vietnam.- Russian J. Herpetol., Moscow; 6: 48-54.

INGER, R. F. (1966): The systematics and zoogeography of the Amphibia of Borneo.- Fieldiana Zool., Chicago; 52: 1-402.

INGER, R. F. (1972): *Bufo* of Eurasia. pp. 102-118 + 357-360, 1 tab. In: BLAIR, W. F. (ed.): Evolution of the genus *Bufo*. Austin & London (Univ. Texas Press).

INGER, R. F. & ORLOV, N. & DAREVSKY, I. (1999): Frogs of Vietnam: a report on new collections.- Fieldiana. Zoology, Chicago; 92: i-iv+1-46.

KAURI, H. (1959): Die Rassenbildung bei europäischen *Rana*-Arten und die Gültigkeit der Klimaregeln.- Ann. Soc. Tartuensis ad res naturae investigandas constitutae, Lund; 2: 1-171.

LATHROP, A. & MURPHY, R. W. & ORLOV, N. & HO, C. T. (1998): Two new species of *Leptolalax* (Anura: Megophryidae) from northern Vietnam.- Amphibia-Reptilia, Leiden; 19: 253-267.

LIU, C.-C. & HU, S.-C. (1961): Chinese tailless amphibians. Shanghai (Science Press), pp. i-xvi + 1-364, pl. 1-6 + 1-28.

LIU, C.-C. & HU, S.-Q. & YANG, F.-H. (1960): Amphibia of Yunnan collected in 1958.- Acta Zool. Sinica, Peking; 12: 149-174.

MATSUI, M. & NABHITABHATA, J. & PANHA S. (1999): On *Leptobrachium* from Thailand with a description of a new species.- Japanese J. Herpetol., Kyoto; 18: 19-29.

MYERS C. W. & DUELLMAN W. E. (1982): A new species of *Hyla* from Cerro Colorado, and other tree frog records and geographical notes from Western Panama.- American Mus. Novit., New York; 2752: 1-32.

OHLER, A. (1996): Systematics, morphometrics and biogeography of the genus *Aubria* (Ranidae, Pyxicephalinae).- Alytes, Paris; 13: 141-166.

SWAN, S. (in prep.): Amphibian biodiversity of Vietnamese rainforest communities: ecological and populational aspects. Master's Degree Diploma, Open University, Milton Keynes.

TORDOFF, A. & SWAN, S. & GRINDLEY, M. & STURUA, H. (1999): Hoang Lien Nature Reserve: Biodiversity survey and conservation evaluation 1997-8.- Frontier-Vietnam Forest Research Programme Report No. 13. London (Society for Environmental Exploration).

DATE OF SUBMISSION: October 7th, 1999

Corresponding editor: Heinz Grillitsch

AUTHORS: Dr. ANNEMARIE OHLER, OLIVIER MARQUIS, STEPHANE GROSJEAN, Laboratoire des Reptiles et Amphibiens, Muséum national d'Histoire naturelle, 25 rue Cuvier, F-75005 Paris, France; STEVEN SWAN, Frontier-Vietnam, PO Box 242, Hanoi GPO, Vietnam.