THE RAFFLES BULLETIN OF ZOOLOGY 2002 **50**(2): 465-481

A RECENT SURVEY OF THE AMPHIBIAN FAUNA OF THE CARDAMOM MOUNTAINS, SOUTHWEST CAMBODIA WITH DESCRIPTIONS OF THREE NEW SPECIES

Annemarie Ohler
Laboratoire des Reptiles et Amphibiens, Muséum National d'Histoire Naturelle, 25 rue Cuvier, F-75005 Paris, France

Steven R. Swan
Fauna and Flora International, Indochina Programme Office, PO Box 78, 104B Pho Hue, Hanoi, Vietnam

Jennifer C. Daltry
Fauna and Flora International, Great Eastern House, Tenison Road, Cambridge CB1 2TT, UK

ABSTRACT. – Reported here are the findings of the first field surveys for amphibians in the Cardamom Mountains of Southwest Cambodia, which were conducted in January - March 2000 and February – April 2001. A total of 34 species of anuran were found in these mountains, including new species of *Megophrys, Philautus* and *Rana (Sylvirana)* that are described here. A further 17 species that have not previously been reported from Cambodia were also recorded during these surveys. These results double the size of Cambodia's known amphibian fauna. Species of particular taxonomic interest from the collections are discussed in further detail, and a national checklist of Cambodia's known amphibian fauna is also provided.

KEY WORDS. – Amphibians, new species, *Megophrys, Philautus, Rana (Sylvirana),* Cambodia, taxonomy.

INTRODUCTION

The existing knowledge of the amphibian fauna of Indochina, in terms of both composition and distribution, is highly fragmented. The incompleteness of our knowledge is reflected in the continual discovery of new species from within the region. The past decade has witnessed an intensification of research interest in the Indochinese peninsula, yet only in the last two years have the scattered data on amphibian distribution and taxonomy been collated to provide some nation-wide reviews, e.g., Stuart (1999) for Laos; Inger et al. (1999) for Vietnam. However, of all the Indochinese nations, Cambodia has received the least attention from batrachologists.

Not much is known of Cambodian amphibians because during French occupation little attention was paid to documenting the colony's fauna and a recent history of war has hindered any modern scientific investigation in the field. This conflict persisted up until the very end of the last century and only in the past three years has security stabilised and improved sufficiently to allow relatively safe exploration of Cambodia's forests. Until the present survey, only 18 species were confirmed as present in Cambodia (see Bourret, 1942, for a review; van Dijk, unpublished data), most of these being common and widely distributed throughout Southeast Asia.

The Cardamom Mountains are the dominant topographical feature of Southwest Cambodia, occupying an area of over one million hectares (10,000 km^2). The mountain range has an axis orientated Northwest-Southeast running for approximately 200 km, and an overall altitudinal variation of c. 100 to 1,771 m above sea level - Phnom [Mount] Aural, Cambodia's highest mountain. The mountains include two nominally protected areas: the Phnom Samkos Wildlife Sanctuary and the Phnom Aural Wildlife Sanctuary.

The Cardamom Mountains are characterized by high rainfall for much of the year, with some areas receiving more than 4,000 mm of rain annually (Ashwell, 1997), making the Cardamom Mountains the rainiest place in Cambodia (Weiler, 1998). Humidity and temperature are also high with slight seasonal variation (Ashwell, 1997). Temperatures range from between 25°C and 30°C on average, although at higher elevations temperatures can drop below 15°C at night (Momberg & Daltry, 2000). The dry season lasts from December to March and the rainy season from May to October when the mountains capture the Southwest monsoon arriving offshore from the Gulf of Thailand.

Three distinct basic vegetation types, that are principally a function of altitude, cover the Cardamom Mountains. Dry dipterocarp forest occupies the lowland basins between the mountains, hill evergreen forest covers the lower slopes of

Table 1. Sites surveyed for amphibians in the Cardamom Mountains 2000-2001.

Site	Location	Province	Geo-coordinates	Duration
Phnom Samkos Wildlife Sanctuary	Western Cardamom Mountains	Pursat	12° 15'N 103° 00'E	4 weeks (24/1-27/2/00)
T'Mar Bang District	Central Cardamom Mountains	Koh Kong	11° 50'N 103° 35'E	4 weeks (25/2-27/3/00)
Phnom Aural Wildlife Sanctuary	Eastern Cardamom Mountains	Kampong Speu	12° 00'N 104° 10'E	5 weeks (10/2-21/3/01)
Veal Veng wetland	Central Cardamom Mountains	Pursat	12° 05'N 103° 15'E	1 week (30/3-6/4/01)

the mountains up to 1,200 m, and montane evergreen forest continues above 1,200 m on the upper slopes and mountain summits. Together, the hill and montane evergreen forests of Southwest Cambodia form one of the distinct bio-climatic regions recognised for the country – the Cardamom evergreen forest eco-region (Fontanel, 1972).

The present paper summarises the findings of amphibian surveys of the Cardamom Mountains in the Southwest of Cambodia. The surveys were conducted during the dry seasons of 2000 (January to March) and 2001 (February to April), as part of a larger biodiversity study of these remote mountains requested by the Cambodian Government for the purposes of conservation management planning (Daltry & Momberg, 2000). As the most extensive amphibian surveys to have been carried out in Cambodia to date, our work makes a significant contribution to the existing knowledge of amphibian distributions in Indochina.

METHODS

Amphibians were surveyed in four localities within the Cardamom Mountain range, details of which are given in Table 1. During the 2000 dry season, the Phnom Samkos Wildlife Sanctuary and T'Mar Bang District, Koh Kong Province, in the Central Cardamom Mountains were surveyed. The Phnom Samkos Wildlife Sanctuary occupies 3,338 km^2 of the western end of the Cardamom Mountain range. Phnom Samkos itself is the highest point in the sanctuary and the second highest in the country attaining an altitude of 1,717 m. The highest elevation of the T'Mar Bang survey area in the Central Cardamom Mountains is c. 1,200 m and the area is located within a newly proposed protected area. However, at the time of the survey, the second site was under logging concession. During 2001, the Phnom Aural Wildlife Sanctuary was the focus of field surveys. The Phnom Aural Wildlife Sanctuary encompasses 2,537 km^2 of the far eastern end of the Cardamom Range including Cambodia's highest mountain, Phnom Aural at 1,771m. One week was spent at the fourth study site, the Veal Veng wetland, which lies between the Phnom Samkos Wildlife Sanctuary and the second survey site in T'Mar Bang District. The wetland is a highly modified mosaic of inundated habitats at an elevation of 560 m.

The majority of survey effort was focused on aquatic habitats at night, usually between 19:00 and 23:00 hours. Because this work was carried out as part of a wider conservation initiative, only a limited number of voucher specimens were taken (1 to 10 specimens) to represent the full range of species encountered. Frogs were caught by hand and specimens fixed in c. 4% formalin and stored in c. 70% ethanol. Voucher specimens from our surveys are deposited in BMNH (Natural History Museum, London, United Kingdom) and MNHN (Muséum national d'Histoire naturelle, Paris, France) (see Table 2). Historical museum material examined for this study is listed as an Appendix. Specimens were measured using callipers and a graded rule under a binocular microscope. In order to facilitate comparisons, the description's methodology and plan were the same as those used in previous works on Asian anurans (Dubois & Ohler, 1998, 1999, 2000; Ohler & Dubois, 1999; Ohler et al., 2000; Veith et al., 2001). The webbing formula is given according to Myers & Duellman (1982). The relevant synonymy for each species reported on is listed in Table 8.

The present paper cites several recent records based on the unpublished data of Peter Paul van Dijk, who is currently preparing a field guide to the amphibian species of Southeast Asia. Through van Dijk's kind generosity, we were able to include the specimens he has studied in Table 8. Other data come from various authors in particular from Bourret. In 1942 he published an important book on the frog fauna of southeast Asia, the only consistent review even today. However, it included little new information, as most of the data (including Bourret's own data) had already been published elsewhere (see Bourret, 1942). Therefore, while Bourret (1942) is an excellent source, it nevertheless remains a secondary source, and we prefer instead to cite primary sources for the relevant synonymies (see Table 8) and cite this book only when original data are published there.

Voucher specimens were deposited in BMNH (Natural History Museum, London, United Kingdom) and MNHN (Muséum National d'Histoire Naturelle, Paris, France).

The following abbreviations are used for measurements: SVL: Snout-vent length. *Head:* HW: Head width; HL: Head length (from the back of the mandible to the tip of snout); MN: Distance from the back of the mandible to the nostril; MFE: Distance from the back of the mandible to the front of the eye; MBE: Distance from the back of the mandible

Table 2. List of amphibian species encountered during the 2000-2001 surveys of the Cardamom Mountains, Pursat, Koh Kong and Kampong Speu Provinces, Southwest Cambodia.

SPECIES	Number of specimens	Collection number
MEGOPHRYIDAE Bonaparte, 1850		
Leptolalax sp.	1	MNHN 2001.0204
Megophrys (Xenophrys) auralensis, new species	10	BMNH 2000.0077, MNHN 2001.0205-0213
BUFONIDAE Gray, 1825		
Bufo macrotis Boulenger, 1887	3	BMNH 2000.0074-0075, MNHN 2001.0201
Bufo melanostictus Schneider, 1799	2	MNHN 2001.0202-0203
Bufo parvus Boulenger, 1887	2	BMNH 2000.0072-0073
RANIDAE Rafinesque-Schmaltz, 1814		
Chirixalus doriae Boulenger, 1893	4	MNHN 2001.0219-0222
Chirixalus vittatus (Boulenger, 1887)	2	BMNH 2000.0144, MNHN 2000.0223
Fejervarya limnocharis (Gravenhorst, 1829)	4	BMNH 2000.0108-0111
Hoplobatrachus chinensis (Osbeck, 1765)	2	BMNH 2000.0092-0093
Limnonectes (Elachyglossa) gyldenstolpei (Anderson, 1916)	7	BMNH 2000.0112-0114, BMNH 2000.0125, MNHN 2001.0224-0226
Limnonectes (Elachyglossa) kohchangae (Smith, 1922)	18	BMNH 2000.0115-0124, MNHN 2001.0227-0234
Occidozyga lima (Gravenhorst, 1829)	4	BMNH 2000.0094-0096, MNHN 2001.0235
Paa (Eripaa) fasciculispina (Inger, 1970)	8	BMNH 2000.0102-0107, MNHN 2001.0236-0237
Philautus cardamonus, new species	3	BMNH 200.0149-0151
Philautus parvulus (Boulenger, 1893)	7	BMNH 2000.0145-0148, MNHN 2001.0238-0240
Phrynoglossus martensii Peters, 1867	8	BMNH 2000.0097-0101, MNHN 2001.0241-0243
Polypedates cf. leucomystax (Gravenhorst, 1829)	3	BMNH 2000.0152-0154
Rana (Hylarana) erythraea (Schlegel, 1837)	4	BMNH 2000.0126, MNHN 2001.0244-0246
Rana (Hylarana) macrodactyla (Günther, 1859).	5	BMNH 2000.0127-0128, MNHN 2001.0247-0249
Rana (Hylarana) taipehensis van Denburgh, 1909	1	BMNH 2000.0129
Rana (Sylvirana) faber, new species	15	BMNH 2000.0134, BMNH 2000.0136-0141, MNHN 2001.0256-0263
Rana (Sylvirana) mortenseni Boulenger, 1903	9	BMNH 2000.0133, BMNH 2000.0135, BMNH 2000.0143, MNHN 2001.0250-0255
Rhacophorus bipunctatus Ahl, 1927	3	BMNH 2000.0157-0159
Rhacophorus bisacculus Taylor, 1962	2	BMNH 2000.0155-0156
Theloderma asperum (Boulenger, 1886)	1	MNHN 2001.0264
MICROHYLIDAE Günther, 1858		
Kalophrynus interlineatus Blyth, 1855	1	MNHN 2001.0214
Kaloula pulchra Gray, 1831	1	BMNH 2000.0078
Micryletta inornata (Boulenger, 1890)	1	BMNH 2000.0079
Microhyla annamensis Smith, 1923	1	BMNH 2000.0086
Microhyla berdmorei (Blyth, 1856)	3	BMNH 2000.0080-0082
Microhyla butleri Boulenger, 1900	7	BMNH 2000.0089-0091, MNHN 2001.0215-0218
Microhyla heymonsi Vogt, 1911	1	BMNH 2000.0083
Microhyla ornata (Duméril & Bibron, 1841)	2	BMNH 2000.0087-0088
Microhyla pulchra (Hallowell, 1861)	2	BMNH 2000.0084-0085

to the back of the eye; IFE: Distance between the front of the eyes; IBE: Distance between the back of the eyes; IN: Internasal space; EN: Distance from the front of the eye to the nostril; EL: Eye length; SN Distance from the nostril to the tip of the snout; SL Distance from the front of the eye to the tip of the snout; TYD: Greatest tympanum diameter; TYE: Distance from tympanum to the back of the eye; IUE: Minimum distance between upper eyelids; UEW: Maximum width of inter upper eyelid. *Forearm:* HAL: Hand length (from the base of the outer palmar tubercle to the tip of the toe); FLL: Forelimb length (from the elbow to the base of the outer tubercle); TFL: Third finger length (from the base of the first subarticular tubercle); PAI - IV Width of pads of fingers I to IV; WAI - IV Width of fingers I to IV. *Hindlimb:* FL: Femur length (from vent to knee); TL: Tibia length; FOL: Foot length (from the base of the inner metatarsal tubercle to the tip of the toe); FTL: Fourth toe length (from the base of the first subarticular tubercle); 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: Inner toe length. *Webbing:* MTTF: Distance from the distal edge of the metatarsal tubercle to the maximum incurvation of the web between third and fourth toe; TFTF: Distance from the maximum incurvation of the web between third and fourth toe to the tip of fourth toe; MTFF: Distance from the distal edge of the metatarsal tubercle to the maximum incurvation of the

web between fourth and fifth toe; FFTF: Distance from the maximum incurvation of the web between fourth and fifth toe to the tip of fourth toe; WTF: Webbing between third and fourth toe (from the base of the first subarticular tubercle); WFF: Webbing between fourth and fifth toe (from the base of the first subarticular tubercle); WI: Webbing between third and fourth toe when folded along fourth toe (from the base of the first subarticular tubercle); WII: Webbing between fourth and fifth toe when folded along fourth toe (from the base of the first subarticular tubercle).

Other abbreviations – p. t.: per thousand.

SYSTEMATICS

A total of 34 species were recorded during the four months spent in the field. These species are listed in Table 2. Three of the species are new to science, and 17 other species, previously known from outside Cambodia, represent new national records. Taxonomic discussion of rare species and description of new species are listed in systematic order.

Leptolalax Dubois, 1980

Remarks. – A single specimen of this genus was collected from a mountain stream on Phnom Aural, 780 m a.m.s.l. It is a larva at metamorphosis (stage 45) with its tail partially regressed. It is rather large for its stage (SVL 26.1 mm), has a granulose skin, distinctly smoother arms and elbows, and its feet bear rudimentary webbing with fringes along the toes. Ventral coloration in alcohol is uniformly light grey without distinct spots. It is distinguished from the other species of this genus (Ohler et al., 2000) by its relatively long shanks (TL/SVL 598 p.m.). For specific determination however, study of adult specimens is necessary. This is the first record of this genus from Cambodia.

Megophrys (Xenophrys) auralensis, new species
(Fig. 1)

Material examined. – Holotype - MNHN 2001.0209, adult male (Fig. 1). Phnom [Mount] Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province, Southwest Cambodia (UTM 1326600N 0309200E).

Diagnosis. – A large sized species of the subgenus *Xenophrys* with vomerine ridge, but without vomerine teeth, head rather broad, tympanum well developed, no white band on upper lip, tibia relatively long.

Description of holotype. – *(A) Size and general aspect* - (1) Frog of large size (SVL 76.7 mm), body rather robust.

(B) Head – (2) Head rather large, wider than long (HW 31.0 mm; HL 28.0 mm, MN 23.4 mm; MFE 22.0 mm; MBE 13.5 mm), flat above. (3) Snout bluntly pointed, largely protruding, its length (SL 7.6 mm) shorter than horizontal diameter of eye (EL 9.21 mm). (4) Canthus rostralis rather sharp, loreal region concave, acute. (5) Interorbital space slightly convex, larger (IUE 8.55 mm) than upper eyelid (UEW 6.84 mm) and internarial distance (IN 8.16 mm); distance between front of eyes (IFE 11.3 mm) about two times the distance between back of eyes (IBE 20.7 mm). (6) Nostrils oval with low flap of skin laterally, closer to eye (EN 2.76 mm) than to tip of snout (NS 4.47 mm). (7) Pupil indistinct. (8) Tympanum (TYD 6.05 mm) distinct, oval, oblique, 60% of eye diameter; tympanum-eye distance (TYE 6.71 mm) 110% of tympanum diameter. (9) Pineal ocellus absent. (10) Vomerine ridge present, short, rounded, without teeth, parallel to body axis, closer to choanae than from each other, shorter than distance between them. (11) Tongue large, oval, entire, bearing no median lingual process. Tooth-like projections on lower jaw absent. (12) Supratympanic fold distinct, from back of eye to above shoulder. (13) Parotoid glands absent. (14) Cephalic ridges absent. (15) Co-ossified skin on head absent.

(C) Forelimbs – (16) Arm moderately long and thin; forearm (FLL 19.1 mm) shorter than hand (HAL 20.0 mm), not enlarged. (17) Fingers long and rather thin (TFL 10.9 mm). (18) Relative length of fingers: II < I < IV < III. (19) Tips of all fingers rounded, slightly enlarged, without grooves. (20) Dermal fringe and webbing on fingers absent. (21) Subarticular tubercles indistinct, continuous ridge of thickened skin on underside of fingers. (22) Prepollex flat, oval; palmar tubercles indistinct; supernumerary tubercles absent.

(D) Hind limbs – (23) Hind limbs long, heels overlapping when limbs are folded at right angles to body. Tibia four times longer (TL 38.8 mm) than wide (TW 10.6 mm), shorter than thigh (FL 39.2 mm), and longer than distance from base of internal metatarsal tubercle to tip of toe IV (FOL 35.5 mm). (24) Toes long and thin, toe IV (FTL 17.9 mm) three times the distance from base of tarsus to tip of toe IV (TFOL 52.7 mm). (25) Relative length of toes: I < II < V < III < IV. (26) Tips of all toes rounded, enlarged, without grooves. (27) Webbing present, rudimentary, continued by a dermal fringe on toes: I — 2 — $2^1/_2$ II — 2 — $3^1/_2$ — III — 3 — 4 1/4 IV 4 1/4 — 3 V (WTF n. m., WFF n. m., WI n. m., WII n. m.; MTTF 11.3 mm, MTFF 12.6 mm, TFTF 20.0 mm, FFTF 19.4 mm). (28) Dermal ridge along toe V absent. (29) Subarticular tubercles indistinct, continuous ridge of thickened skin on underside of toes. (30) Inner metatarsal tubercle distinct and long, its length (IMT 5.83 mm) 1.2 times the length of toe I (ITL 7.06 mm). (31) Tarsal fold absent. (32) Outer metatarsal tubercle absent, supernumerary tubercles absent; tarsal tubercle absent.

(E) Skin – (33) Snout, between eyes, side of head, anterior part of back smooth; posterior part of back and flanks granular; palpebral horn indistinct. (34) Folds on back, including dorsolateral and middorsal folds outlining hourglass pattern, narrow, fine. (35) Dorsal part of forelimb, thigh, tibia and tarsus granular. (36) Throat, chest, belly and ventral part of thighs smooth. (37) Macroglands: small white femoral and pectoral glands; posterior part of supratympanic fold scarcely enlarged.

(F) Coloration – (In alcohol). - (38) Dorsal parts brown-grey with dark brown triangle between eyes and outlines of dark brown hourglass pattern on back; flanks lighter greyish brown with dark brown spots and whitish dots on larger glandular warts; canthus and tympanic fold dark brown; canthal and tympanic regions greyish brown; tympanum dark brown; upper lip with dark vertical brown bands on greyish brown ground colour; dorsal folds with brown outlines. (39) Forelimb, dorsal parts of thigh, tibia and foot greyish brown with darker brown bands, posterior part of thigh uniformly dark brown. (40) Throat and chest dark brown; margin of throat with dark brown spots on white and brown speckled ground colour; belly dark brown spots on whitish and brown speckled ground colour; ventral part of thighs with dense dark brown spots; webbing brown.

(In life) Dorsum dark tan with hourglass pattern and triangle on head dark mahogany brown; flanks indistinctly marbled dark brown; canthal and tympanic area darker brown, upper lip banded dark brown on vinous grey-brown ground colour. Dorsal surface of limbs and digits same colours as head and back: dark tan banded with darker brown; flushed orange at axes of legs. Throat vinous grey-brown; belly and ventral surface of limbs white with vinous grey-brown blotches; distinct pectoral glands white; posterior surface of thighs dark vinous brown with specks of white; webbing dark vinous brown. Iris copper-coloured.

(G) Male secondary characters – (41) Nuptial pads on fingers I and II formed by small, brown spines arranged in two oval pads. (42) Vocal sacs present, indistinct on throat; a pair of distinct, rounded openings at base of jaw. (43) Other secondary sexual characters absent.

Variation. – The nine males and the young female collected are all very similar. There is some variation in the presence of the dorsal hourglass pattern, which may be obscured by the general coloration of the back. The holotype is lighter than other specimens that are almost all of a dark brown dorsal colour. The ventral coloration is very similar in pattern and intensity in all specimens. A few show indistinct bands on the throat and chest, but never the clear-cut longitudinal shoulder stripes that can be observed in *M. major*.

Ecological notes. – The holotype was collected on Phnom Aural at an altitude of 800 m a.m.s.l., calling from the top of a boulder 0.2 m from a cascade section of a mountain stream in hill evergreen forest. The collection data for the holotype are typical of this species on Phnom Aural: males were found to be common along mountain streams in hill evergreen forest from 500 to 1,140 m a.m.s.l. They were seen and heard frequently calling from cascade sections of these streams. Typically found sitting upright on boulders within the splash zone of falling water, males were always observed within 1 m of the stream, and usually no further than 0.3 m from fast-flowing water. Towards the end of the survey period, when the first "mango" rains had began to fall, male *M. auralensis* were heard to call during and after rain throughout the day, and particularly at dusk. Such calling behaviour, i.e. from cascade sections of mountain

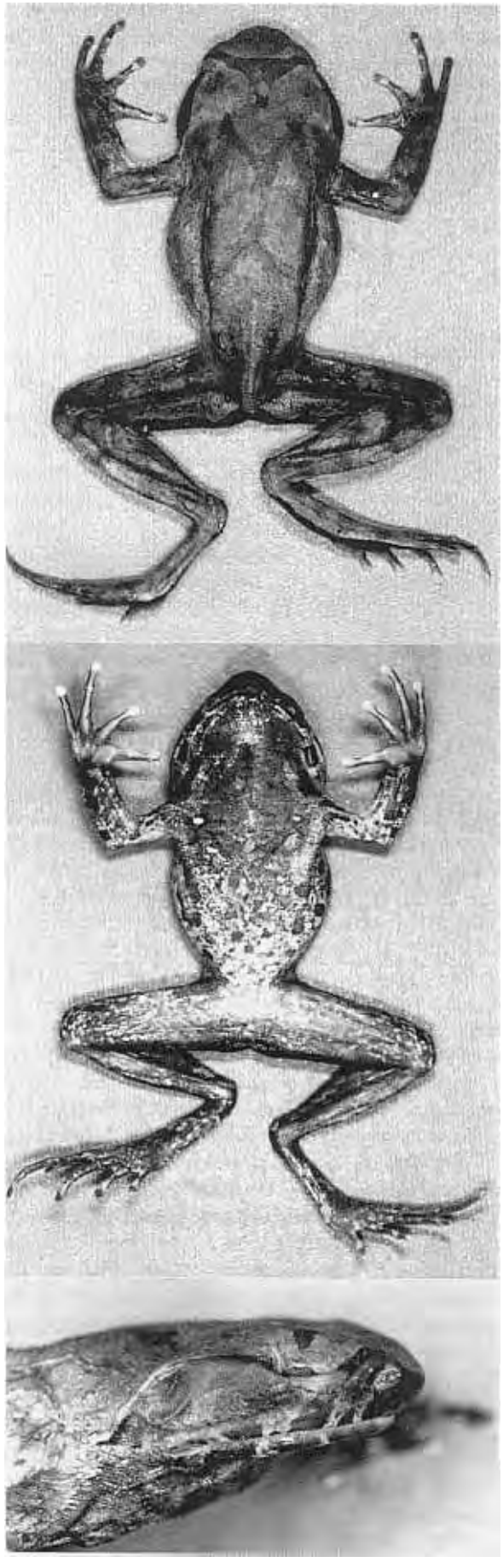

Fig. 1. *Megophrys (Xenophrys) auralensis,* new species. Holotype, MNHN 2001.0209, adult male, SVL 76.7 mm, dorsal view, ventral view, lateral view of head.

Table 3. Minimum, maximum, mean and standard deviation of measurements and their comparison by Mann-Whitney U test of the type series of *Megophrys auralensis*, new species, and specimens of various origins of *Megophrys major*, including a syntype. (Initial SVL measurements are given in mm, all subsequent measurements are presented as per thousands of SVL). n = number; U = Mann-Whitney U; p = probability; n.s. = not significant; * = significant; ** = very significant; *** = highly significant.

Measurement	*M. auralensis* n = 9	*M. major* n = 16	Mann-Whitney U test
SVL	74.1 ± 2.10 (71.0 - 76.9)	72.9 ± 5.88 (63.7 - 87.0)	U = 60.0 p = 0.522 n.s.
RHW	400 ± 9.3 (383 - 416)	371 ± 14.8 (346 - 396)	U = 5.0 p = 0.000 ***
RHL	364 ± 6.9 (352 - 374)	369 ± 14.5 (339 - 392)	U = 55.0 p = 0.357 n.s.
RFLL	254 ± 9.0 (242 - 271)	248 ± 11.9 (220 - 262)	U = 52.0 p = 0.276 n.s.
RHAL	269 ± 8.9 (258 - 287)	249 ± 12.2 (228 - 276)	U= 14.0 p = 0.000 ***
RTL	522 ± 18.7 (491 - 550)	536 ± 24.4 (488 - 564)	U = 47.0 p = 0.169 n.s.
RFOL	473 ± 16.6 (442 - 490)	508 ± 20.5 (466 - 531)	U = 14.0 p = 0.000 ***
REL	127 ± 4.1 (120 - 133)	116 ± 5.53 (106 - 129)	U = 8.0 p = 0.000 ***
RTYD	81.1 ± 5.3 (71 - 91)	61 ± 10.6 (43 - 81)	U = 6.0 p = 0.000 ***
RTYE	90.6 ± 6.3 (78 - 96)	80 ± 4.7 (73 - 90)	U = 15.0 P = 0.001 ***
RMTTF	155 ± 13.7 (137 - 176)	177 ± 23.8 (149 - 215)	U = 34.0 p = 0.032 *
RMTFF	178 ± 11.9 (161 - 198)	204 ± 22.7 (168 - 247)	U = 21.0 p = 0.003 **
RTFTF	272 ± 11.8 (253 - 285)	275 ± 22.5 (233 - 304)	U = 63.0 p = 0.637 n.s.
RFFTF	262 ± 12.3 (241 - 276)	275 ± 17.1 (237 - 302)	U = 38.0 p = 0.057 n.s.

streams, prompted by rain, is typical of other species of *Xenophrys* (pers. obsv.).

Etymology. – The name *auralensis*, indicates that the species was found on Mount Aural, Cambodia's highest mountain.

Remarks. – The specimens from Cambodia belong to a large sized form of *Xenophrys* (see Dubois & Ohler, 1988, for a list of the species referred to this subgenus) showing rudimentary webbing on the hind feet. Between those sharing these characters, *M. gigantica* Liu, Hu & Yang, 1960, *M. glandulosa* Fei, Ye & Huang, 1991, *M. major* (Boulenger, 1908), *M. mangshanensis* Fei & Ye, 1991, and *M. shapingensis* Liu, 1950, are distinct from the new species by showing a well-defined white stripe on upper lip. In *M. medogensis* Fei, Ye & Huang, 1983, *M. omeimontis* Liu, 1950, and *M. major*, vomerine teeth are present, whereas such teeth are absent in specimens examined from the Cardamom Mountains, which only show vomerine ridges devoid of teeth. *Megophrys robusta* (Boulenger, 1908) shows a larger head (412 p. t. SVL for the syntype measured, 428 for a second specimen). It also can be distinguished by the presence of an indistinct unmarked area on the side of the head, and an absence of oblique dark bars, as are present in *M. auralensis*. Biogeographically, the new species is closest to *M. major*, but these two species can be distinguished by several morphometrical characters (Table 3). Externally it can be recognized by the presence of dark bands on the side of head, whereas in *M. major* there is a distinct longitudinal whitish band on upper lip. Two Chinese species of this group, which show no band on upper lip, should be compared to the new species. *Megophrys omeimontis* is of a smaller size (SVL 54.2-63.0 mm in the five type-specimens described by Liu [1950]; U = 0.000, p = 0.001) and has a longer tibia (521-605 p.t. SVL; U = 5.0, p = 0.019). This species also has a smaller head (HW 339-375; U = 0.000, p = 0.001 / HL 322 - 358; U = 2.0, p = 0.004) than the new species from Cambodia, thus has to be considered specifically distinct. *Megophrys medogensis* Fei, Ye and Huang, 1983 is morphologically very similar to *M. omeimontis*, but has no webbing, whereas *M. shapingensis* lacks tympanum and has relatively more developed webbing continuing as a wide fringe on the toes.

Inger (1999: 457) mentions "one single species of *Megophrys*" from the mountains in southeastern Thailand

Table 4. Measurements (mm), means and standard deviations for specimens of *Limnonectes gyldenstolpei* from Thailand (including syntypes) and Laos, compared to specimens collected from the Cardamom Mountains in Cambodia.

Measurement	Thailand and Laos including syntypes		Cardamom Mountains, Cambodia	
	Males N = 8	females N = 3	Males N = 3	Female
Snout-vent length	57.79 ± 6.80 (49.7 - 70.5)	51.43 ± 2.57 (49.9 - 54.4)	63.0 ± 9.06 (52.6 - 69.2)	54.4
Head width	26.53 ± 3.48 (23.5 - 33.0)	20.20 ± 1.20 (19.0 - 21.4)	29.0 ± 4.29 (24.1 - 31.9)	21.2
Head length	26.98 ± 3.93 (23.3 - 34.7)	20.77 ± 0.93 (20.0 - 21.8)	29.9 ± 4.08 (25.2 - 32.5)	22.9
Tibia length	28.76 ± 3.18 (23.0- 33.7)	26.13 ± 0.25 (25.9 - 26.4)	31.5 ± 4.10 (26.8 - 34.3)	28.5

and adjoining western Cambodia. In the summary table for the region defined as Southeast Asian Lowlands, which includes central valleys of Myanmar and Thailand, Cambodia, southern and coastal Vietnam, and the Red River Valley of Vietnam, he then lists *Megophrys longipes* and *M. parva*. Concerning the presence *M. longipes,* we give some remarks below. Whereas it is possible that *M. parva* might be found in the Cardamom Mountains in the present study area, it was not recorded during the present survey.

Only one species of *Xenophrys* has been previously reported from Cambodia – *Megophrys (Xenophrys) longipes* (Boulenger, 1886). Tirant (1885) collected this species from the Elephant Mountains, c. 100 km South of where the Cardamom specimens were collected, but called it *Megalophrys montana*. Bourret (1942) cited these specimens in the synonymy of *Megophrys longipes* in which he also included a specimen from Vietnam, which has important morphological differences to the topotypes. Type specimens of *M. longipes* from Perak (Malaysia) described by Boulenger (1886; 1908), have very long tibia (respectively 574 and 585 p. t. SVL) and relatively small heads (HW 362 and 354 p. t. SVL) compared to the specimens from Cambodia that we could study. We also compared specimens figured by Bourret (1942) as *Megophrys longipes* (Table 3) and concluded that they could not be conspecific with *M. longipes* from Malaysia. As the specimens of Tirant are lost, we cannot confirm the determination made by Bourret, and *M. longipes* should be removed from the list of amphibian species of Cambodia and Vietnam until we have voucher specimens that confirm its presence in these countries.

Limnonectes (Elachyglossa) gyldenstolpei (Andersson, 1916)

Remarks. – This species was, until recently, known as *Rana pileata* Boulenger, 1916, a name that has been shown to be a subjective junior synonym of *Elachyglossa gyldenstolpei* Andersson, 1916 (Ohler & Dubois, 1999). Our collection from the Cardamom Mountains includes three adult males, an adult female, and three juvenile specimens. Form and size of the dermal flap on the top of the head corresponds to adult males from Thailand and Laos, as do major measurements (Table 4).

Limnonectes (Elachyglossa) kohchangae (Smith, 1922)

Remarks. – *Limnonectes kohchangae* is considered to have a restricted range being first described from Koh Chang Island in the Gulf of Thailand, and was only known from this island and the islands of Koh Kut, Koh Mehsi, and from Ok Yam on mainland Thailand (Smith, 1922a; Taylor, 1962). However, whilst studying the material collected from the Cardamom Mountains, two specimens (MNHN 1924.0065-0066) of this species were discovered in the collection of the Museum National d'Histoire Naturelle, Paris, donated by Smith in 1924, who collected them from Bokor in the Elephant Mountains of Southwest Cambodia, c. 150 km Southeast of the Cardamom range. Bourret (1942: 265) mentions *Rana kohchangae poilani* from Dong Tam Ve, Vietnam. His description was presented as a conditional one, 'il pourrait être considéré comme appartenant à une race différente', but the name is nevertheless available (Article 11.5.1 of Anonymous, 1999). The holotype from Vietnam, figured by Bourret (1942: fig. 66) an adult male, is in the collections of the Paris Museum (MNHN 1948.0127 ex LZNH B-298) and is definitely a distinct, large sized (SVL 90.2 mm) species of *Limnonectes* (*Elachyglossa*) that should bear the name *Limnonectes* (*Elachyglossa*) *poilani* (Bourret, 1942). *Limnonectes kohchangae* has not been reported from Vietnam thus far. A Laotian record of *Limnonectes kohchangae* mentioned by Stuart (1999), citing a draft of a report to the Laotian authorities of Ohler (1997), is wrong. Study of the Laotian voucher specimens indicate them being of the *Taylorana hascheana* group (mentioned as *Limnonectes limborgi* by Stuart 1999: 45). Comparison between the specimens collected during the present surveys from the Cardamom Mountains, and the syntypes of *Limnonectes kohchangae* from Natural History Museum (London), confirms that the specimens from Cambodia are conspecific with those from Thailand (Table 5).

Limnonectes kohchangae was found to be widespread throughout the evergreen forests of the Cardamom Mountains, from below 600 m a.m.s.l. to the top of the range, the highest record for this species being 1,200 m a.m.s.l. Often associated with forest streams but occasional, dispersed individuals were also recorded on the forest floor hundreds of meters from any body of water. In March of both years, breeding choruses of *L. kohchangae* were observed beside slow-flowing streams in upper hill evergreen forest.

Table 5. Measurements (mm), means and standard deviations for specimens of *Limnonectes kohchangae* from Thailand (syntypes) compared to specimens collected from the Cardamom Mountains in Cambodia.

Measurements	Thailand, syntypes		Cardamom Mountains, Cambodia	
	Male	Female	Males N = 8	Females N = 5
Snout-vent length	40.6	40.5	42.0 ± 14.9 (40.0 - 44.0)	37.6 ± 3.84 (32.3 - 40.8)
Head width	17.7	14.4	19.6 ± 1.37 (18.0 - 21.0)	15.4 ± 1.95 (12.9 - 17.1)
Head length	17.8	15.2	19.4 ± 1.21 (17.9 - 20.9)	15.3 ± 1.85 (12.8 - 16.7)
Tibia length	19.9	20.3	20.8 ± 0.69 (19.4 - 21.7)	19.1 ± 1.98 (15.7 - 20.7)

Table 6. Measurements (mm) of type specimens of *Paa fasciculispina*, as published in Inger (1970) of topotypic collection, and material collected from the Cardamom Mountains in Cambodia.

Measurement	Thailand			
	Holotype	Paratype	Topotypes males N=3	Topotype female
Snout-vent length	106	104	108.37 ± 5.51	101.1
Head width	43	41	43.27 ± 1.95	39.1
Head length	42	40	41.03 ± 1.40	39.3
Tibia length	53	49	53.93 ± 4.40	49.3
	Topotype young	Cardamom Mountains, Cambodia Adult male	Adult female	Young N=5
Snout-vent length	94.3	100.9	108.3	47.74 ± 8.38
Head width	37.7	40.3	45.2	19.06 ± 3.27
Head length	35.7	39.3	41.1	18.6 ± 3.05
Tibia length	46.7	47.6	49.5	23.3 ± 4.07

As a consequence of an apparent restricted range *L. kohchangae* is listed as "Threatened" by the IUCN (2001), but under the Data Deficient category. The conservation status of this species should be reviewed in the light of the present discovery of *L. kohchangae* in the Cardamom Mountains.

Paa (Eripaa) fasciculispina (Inger, 1970)

Remarks. – The specimens of *Paa fasciculispina* collected in the Cardamom Mountains represent the first record of the ranid genus *Paa* from Cambodia and the second record of this species since its description by Inger in 1970. Considering the type locality (in Chanthaburi Province, Southeast Thailand) of this species, *P. fasciculispina* would be expected to inhabit the forest streams of the Cardamom Mountains.

Morphological comparison (Table 6) to type specimens (Inger, 1970) and to topotypes from the Paris collection reveals a close similarity between the Cambodian and Thai specimens, and secondary sexual characters of Cambodian males are consistent with the description of the holotype. The populations of this species from the Cardamom Mountains are without doubt conspecific with those in Thailand.

Paa fasciculispina was recorded in streams flowing through hill evergreen forest, at altitudes of c. 700-1,000 m a.m.s.l. During March, male *P. fasciculispina* were heard calling from concealed positions, under boulders, in cascade sections of mountain streams on Mount Aural and Mount Samkos.

Philautus cardamonus, new species
(Fig. 2)

Material examined. – Holotype, BMNH 2000.0149, adult male (Fig. 2). Phnom Samkos in the Phnom Samkos Wildlife Sanctuary, Pursat Province, Southwest Cambodia (UTM 1343841 N, 0287890 E).

Diagnosis. – Small sized *Philautus* without vomerine teeth; nuptial pad present; m. cutaneus pectoris absent; m. geniohyoideus medialis free; ova half pigmented; feet half webbed; ventral body with distinct dark and light marbling.

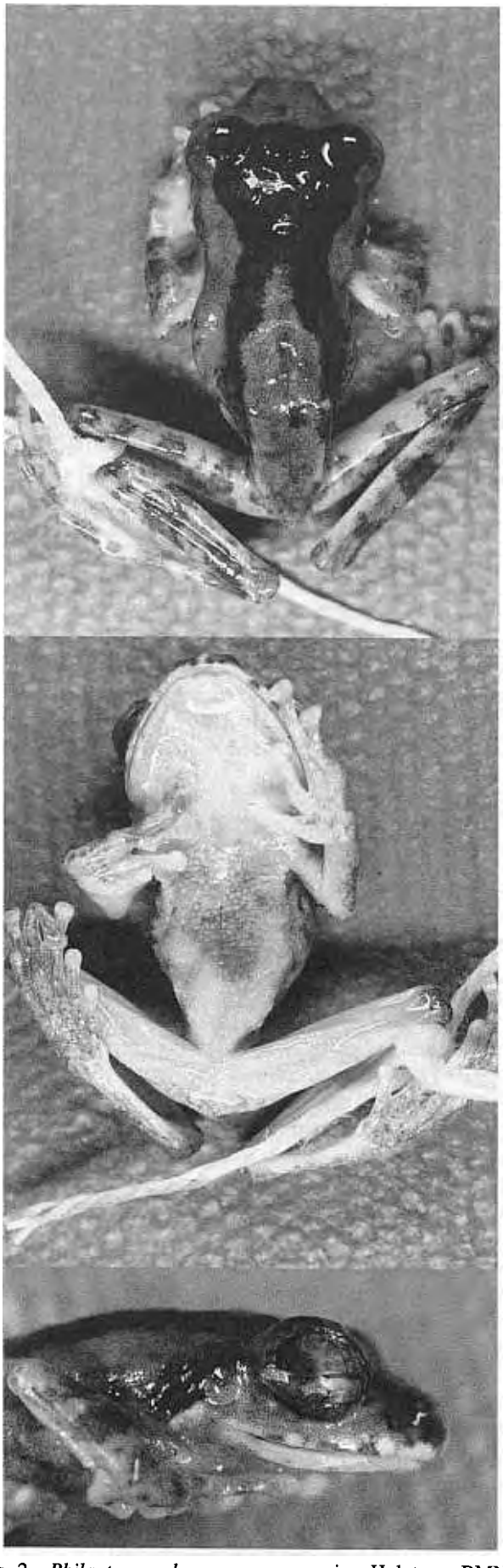

Fig. 2. *Philautus cardamonus,* new species. Holotype, BMNH 2000.0149, adult male, SVL 19.3 mm, dorsal view, ventral view, lateral view of head.

Description of holotype. – *(A) Size and general aspect* - (1) Frog of small size (SVL – 19.3 mm), body rather stout.

(B) Head – (2) Head moderate size, longer than wide (HW 7.3 mm; HL 8.2 mm, MN 7.37 mm; MFE 6.18 mm; MBE 2.89 mm), convex above. (3) Snout rounded, slightly protruding, its length (SL 3.44 mm) equal to horizontal diameter of eye (EL 3.44 mm). (4) Canthus rostralis rounded, loreal region concave, flared. (5) Interorbital space convex, larger (IUE 3.05 mm) than upper eyelid (UEW 2.14 mm) and than internarial distance (IN 2.27 mm); distance between front of eyes (IFE 4.86 mm) about two times in distance between back of eyes (IBE 8.43 mm). (6) Nostrils rounded without flap of skin laterally, slightly closer to tip of snout (NS 1.62 mm) than to eye (EN 1.81 mm). (7) Pupil oval, horizontal. (8) Tympanum (TYD 1.43 mm) distinct, rounded, 42% of eye diameter; tympanum-eye distance (TYE 0.39 mm) 27% of tympanum diameter. (9) Pineal ocellus absent. (10) Vomerine ridge absent. (11) Tongue moderately, cordate, emarginate, bearing no median lingual process. Tooth-like projections on lower jaw absent. (12) Supratympanic fold distinct, from back of eye to above shoulder. (13) Parotoid glands absent. (14) Cephalic ridges absent. (15) Co-ossified skin on head absent.

(C) Forelimbs – (16) Arm short and thin; forearm (FLL 5.25 mm) shorter than hand (HAL 7.26 mm), not enlarged. (17) Fingers I and II short and thin; fingers III (TFL 4.21 mm) and IV long and thin. (18) Relative length of fingers: I < II < IV < III. (19) Tips of all fingers with well-developed disks, with distinct circummarginal grooves, rather wide compared to finger width (fd1 0.65, fw1 0.43 mm; fd2 0.90 mm, fw2 0.43 mm; fd3 1.13 mm, fw3 0.85 mm; fd4 1.10 mm, fw4 0.43 mm). (20) Dermal fringe on inside of fingers I to III; webbing on fingers absent. (21) Subarticular tubercles distinct, rounded, single, all present. (22) Prepollex distinct, oval; two palmar tubercles; supernumerary tubercles present on all fingers.

(D) Hind limbs – (23) Hind limbs long, heels overlapping when limbs are folded at right angles to body. Tibia five times longer (TL 11.1 mm) than wide (TW 1.9 mm), longer than thigh (FL 10.2 mm) and distance from base of internal metatarsal tubercle to tip of toe IV (FOL 10.66 mm). (24) Toes moderately long and thin, toe IV (FTL 5.70 mm) 2.5 times the distance from base of tarsus to tip of toe IV (TFOL 14.5 mm). (25) Relative length of toes: I < II < III < V < IV. (26) Tips of all toes with moderate disks, with distinct circummarginal grooves, moderately wide compared to toe width (td1 0.59 mm, tw1 0.50 mm; td2 0.70 mm, tw2 0.47 mm; td3 0.74 mm, tw3 0.50 mm; td4 0.90 mm, tw4 0.54 mm; td5 0.95 mm, tw5 0.65 mm). (27) Webbing present, moderate: I — 2 — $2^1/_2$ II — 1 — $2^1/_2$ — III — $1^1/_2$ — $2^1/_2$ IV $2^1/_2$ — $1^1/_2$ V (WTF 1.34 mm, WFF 1.80 mm, WI 1.03 mm, WII 1.24 mm; MTTF 4.99 mm, MTFF 5.64 mm, TFTF 4.99 mm, FFTF 4.41 mm). (28) Dermal ridge along toe V present, from tip of toe to proximal subarticular tubercle. (29) Subarticular tubercles prominent, rounded, simple, all present. (30) Inner metatarsal tubercle distinct and short, its length (IMT 0.90 mm) 2.9 times the length of

toe I (ITL 2.58 mm). (31) Tarsal fold absent. (32) Outer metatarsal tubercle absent, supernumerary tubercles present on all toes; tarsal tubercle absent.

(E) Skin – (33) Snout, between eyes, side of head, anterior and posterior part of back and flanks shagreened. (34) Dorsolateral folds absent. (35) Dorsal part of forelimb, thigh, tibia and tarsus shagreened. (36) Throat, chest, belly and ventral part of thighs granular ("tree frog belly skin"). (37) Macroglands: small white rictal gland posterior to corner of mouth.

(F) Coloration – (In alcohol). - (38) Dorsal parts bluish grey with dark grey brown pattern, notably a large triangular spot between eyes separating into two bands continuing laterally to groin; lower flanks cloudy dark brown; canthus and tympanic fold dark brown; canthal and tympanic area greyish; tympanum light grey; upper lip with snow-white spots on greyish ground. (39) Forelimb, dorsal parts of thigh, tibia and foot fawn with some darker brown bands, posterior part of thigh yellow-orange. (40) Throat, margin of throat and chest yellow white with very indistinct brown marbling; belly yellow white with round white spots; ventral part of thighs yellow white; webbing greyish.

(In life) Dorsum dark tan with a pattern of dark mahogany brown; flanks indistinctly marbled dark brown; canthal and tympanic area same dark brown. Dorsal surface of limbs same colours as head and back: dark tan banded with darker brown. Throat and chest white marbled with dark brown blotches; belly and ventral surface of limbs greenish yellow. Iris copper-coloured.

(G) Male secondary characters – (41) Nuptial pads present, single oval patch from base of finger I to level of subarticular tubercle, indistinct ivory white spines. (42) Vocal sacs present, indistinct on throat; a pair of distinct, slit openings at base of jaw. (43) Other secondary sexual character: not observed.

Variation. – The two female paratypes show the same dorsal pattern as the male, but ventrally and laterally they show a very distinct white and dark brown vermiculation, less distinct on throat and lower belly. In the male this pattern is indistinct, visible only from the presence of the white rounded spots on the belly. In life the paratypes are of a lighter colour than the holotype: the dorsal surfaces of both body and limbs being a very pale gold colour with patterns of copper rather than dark brown. The venter is white with a more distinct dark grey-brown marbling that extends on to the flanks and upper lip; the ventral surfaces of the limbs are yellow. Iris colour of the paratypes in life is an iridescent mix of gold and copper.

Ecological notes. – The holotype was collected on Phnom Samkos, in upper montane evergreen forest at an altitude of 1,650 m a.m.s.l. This specimen was found on the leaf of a bush, hundreds of meters from any source of water. The paratypes were collected in a similar forest type at the lower altitude of 1,250 m a.m.s.l. on Phnom Tumpor in the same wildlife sanctuary. These frogs were also found on leaves of plants approximately 2.5 m from a mountain stream.

Etymology. – *Cardamonus*, adjective, derived from the Latin "*cardamonus*", the name of the plant esteemed for its seeds that are used as a spice in cooking and in traditional medicine. The specific name refers to the type locality in the Cardamom Mountains.

Remarks. – Character combination in *Philautus cardamonus* does not fit with any of species groups as defined by Dring (1987). It shares with species from the *vermiculatus* group, the absence of m. cutaneus pectoris and the presence of a free geniohoideus medialis and the pigmented ova. However the males of the *vermiculatus* group are devoid of nuptial pads, whereas the holotype bears distinct pads on first finger and prepollex. The dorsal pattern is very similar to *P. carinensis* (Boulenger, 1893) and *P. jinxiuensis* Hu, 1978. However both these species do not have a distinct ventral pattern, even if some individuals of *P. carinensis* show a greyish shade on the vent. The size of adult males in both species is superior to the size of the holotype (23.2 - 33.9 mm in six adult males of *P. carinensis* from Sa Pa, Vietnam; 23.5 mm in *P. jinxiuensis* according to Fei et al. [1999]). The presence of a distinct tympanum distinguishes this species from species such as *P. banaensis* Bourret, 1939, *P. gryllus* Smith, 1924, *P. parvulus* (Boulenger, 1893), *P. kempiae* (Boulenger, 1919) and *P. annandalii* (Boulenger, 1906). The webbing of *P. cardamonus* is somewhat intermediate and less developed than in *P. carinensis*, *P. maosonensis* and *P. banaensis*, but more developed than *P. parvulus*, *P. gryllus* and *P. annandalii*, which have only basic webbing on the feet. The presence of distinct white spots on the flank easily distinguishes this species of other *Philautus*.

The first record of this genus is from Smith (1930) who mentioned Northern Siam (Khum Tan) and Southern Cambodia as the northern limits of the range of *Philautus petersi*. This information was also repeated by Bourret (1942). Smith (1930) does not cite voucher specimens, so specific allocation cannot be confirmed. Dring (1987) consigned *Philautus petersi* to the *Philautus aurifasciatus* group. This might indicate that the specimens mentioned by Smith (1930) are not conspecific with our sample. *Philautus petersi* has not been mentioned from Thailand and Cambodia in more recent works (Taylor, 1962; Frost, 2000) nor could we find mention of Smith's specimens in Taylor (1962).

Rana (Sylvirana) Dubois, 1992

Remarks. – Two groups of ranid frog belonging to the subgenus *Sylvirana* were collected from the Cardamom Mountains. These two frogs are from the *Rana nigrovittata* complex. One species should be given the name *Rana mortenseni* Boulenger, 1903. We compared the Cambodian specimens to a syntype and a topotype of *Rana mortenseni* from Koh Chang Island, but also to a series of specimens from northeastern Thailand, that all share the short-snouted,

large head and relatively large body size of *Rana mortenseni* (see Table 7 for measurements). The validity of this species has been confirmed by comparison with the lectotype and paralectotypes of *Rana nigrovittata* (Blyth, 1855). Matsui et al. (2001) found at least two genetically distinct subgroups (Nei distance > 0.2) in their sample of the *Rana nigrovittata* group from Thailand. This genetic differentiation is strengthened by morphological differentiation (Ohler, unpublished data) but as many as five different taxa might be recognized in Thailand and the Indochinese subregion for this species group (Ohler, unpublished data).

The second species found on the Cardamom Mountains is distinct from all known species of *Sylvirana*. It is a large sized form, reminding *Rana guentheri* Boulenger, 1882, but males of the Cardamom specimens have no externally visible vocal sacs and are distinctly smaller. This taxon was separated earlier by Smith (1922b) from *Rana nigrovittata* sensu stricto and also from *Rana mortenseni*, but considering it a variation, he did not name it. We will formally name the second species from Cardamom Mountains in memory of the work of Malcolm Smith on Southeast Asian amphibians, particularly on some difficult groups such as *Limnonectes* (*Elachyglossa*) and *Rana (Sylvirana)*.

Rana (Sylvirana) faber, new species
(Fig. 3)

Material examined. – Holotype, MNHN 2001.0261, adult male (Fig. 3). Phnom Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province Southwest Cambodia (UTM 1328200N 0307700E).

Diagnosis. – Large sized *Sylvirana* with relatively narrow head, vocal sacs externally not visible, humeral gland indistinct. Dorsal skin finely granular forming horny spinules on posterior back, narrow prominent dorsolateral folds. Dorsal colour light tan, limbs paler with indistinct bands, throat same colour than chest and belly.

Description of holotype. – *(A) Size and general aspect* - (1) Frog of rather large size (SVL 59.4 mm), body elongate.

(B) Head – (2) Head moderate size, longer than wide (HW 19.8 mm; HL 22.8 mm, MN 19.7 mm; MFE 13.7 mm; MBE 7.2 mm), flat above. (3) Snout rather pointed, slightly protruding, its length (SL 10.00 mm) longer than horizontal diameter of eye (EL 7.89 mm). (4) Canthus rostralis rounded, loreal region concave, vertical. (5) Interorbital space flat, narrower (IUE 5.13 mm) than upper eyelid (UEW 6.18 mm) and than internarial distance (IN 6.05 mm); distance between front of eyes (IFE 11.1 mm) two thirds of distance between back of eyes (IBE 15.7 mm). (6) Nostrils oval with flap of skin laterally, closer to tip of snout (NS 4.34 mm) than to eye (EN 5.26 mm). (7) Pupil oval, horizontal. (8) Tympanum (TYD 5.39 mm) distinct, rounded, 70% of eye diameter; tympanum-eye distance (TYE 1.97 mm) 37% of tympanum diameter. (9) Pineal ocellus present, between anterior border of eye. (10) Vomerine ridge present, bearing numerous (N=8) small teeth; with an angle of 45° to body axis, as close to choanae as to each other, longer than distance between them. (11) Tongue moderate, spatulate, emarginate, bearing no median lingual process. Tooth-like projections on lower jaw absent. (12) Supratympanic fold absent. (13) Parotoid glands absent. (14) Cephalic ridges absent. (15) Co-ossified skin on head absent.

(C) Forelimbs – (16) Arm moderate; forearm (FLL 13.8 mm) shorter than hand (HAL 15.9 mm), slightly enlarged. (17) Finger II short and thin; fingers I, III (TFL 9.3 mm) and IV long and thin. (18) Relative length of fingers: II < I < IV < III. (19) Tips of all fingers pointed with disks, with latero-ventral grooves, moderately wide compared to finger width (fd1 1.37 mm, fw1 0.87 mm; fd2 1.24 mm, fw2 1.09 mm; fd3 1.34 mm, fw3 0.87 mm; fd4 1.40 mm, fw4 1.00 mm). (20) Dermal fringe on inside of fingers absent; webbing on fingers absent. (21) Subarticular tubercles very prominent, oval, single, all present. (22) Prepollex distinct, oval; two oval, distinct palmar tubercles; a distinct supernumerary tubercle on base of each finger.

(D) Hind limbs – (23) Hind limbs long, heels overlapping when limbs are folded at right angles to body. Tibia more than four times longer (TL 37.9 mm) than wide (TW 8.1 mm), longer than thigh (FL 33.6 mm) and distance from base of internal metatarsal tubercle to tip of toe IV (FOL 35.2 mm). (24) Toes long and thin, toe IV (FTL 20.8 mm) 2.5 times the distance from base of tarsus to tip of toe IV (TFOL 50.6 mm). (25) Relative length of toes: I < II < III < V < IV. (26) Tips of all toes pointed with small disks possessing latero-ventral grooves, rather wide compared to toe width (td1 1.62 mm, tw1 0.87 mm; td2 1.71 mm, tw2 1.09 mm; td3 1.71 mm, tw3 0.90 mm; td4 1.49 mm, tw4 0.93 mm; td5 1.56 mm, tw5 0.87 mm). (27) Webbing present, rather large: I — 0 — $1^1/_2$ II — 0 — 2 — III — 0 — 2 IV 2 — 0 V (WTF 9.61 mm, WFF 9.34 mm, WI 8.82 mm, WII 7.63 mm; MTTF 19.4 mm, MTFF 20.9 mm, TFTF 12.9 mm, FFTF 13.0 mm). (28) Dermal ridge along toe V present, from tip of toe to external metatarsal tubercle. (29) Subarticular tubercles prominent, oval, simple, all present. (30) Inner metatarsal tubercle distinct and rather short, its length (IMT 3.16 mm) 2.8 times the length of toe I (ITL 8.95 mm). (31) Tarsal fold absent. (32) Outer metatarsal tubercle rounded, prominent; supernumerary tubercles absent; tarsal tubercle absent.

(E) Skin – (33) Snout, between eyes, side of head and anterior part of back finely granular; posterior part of back and upper part of flanks with small glandular warts bearing horny spinules; lower part of flanks rather smooth. (34) Dorso-lateral folds prominent, rather narrow. (35) Dorsal part of forelimb with small glandular warts; thigh, tibia and tarsus with small glandular warts in longitudinal lines bearing horny spinules. (36) Throat, chest, belly and ventral part of thighs smooth; posterior part of thigh around vent with dense glandular warts. (37) Macroglands: distinct rictal gland posterior to corner of mouth; flat indistinct humeral glands.

(F) Coloration – (In alcohol). - (38) Dorsal parts light grey-brown; dark grey stripe below the dorsolateral folds, lower

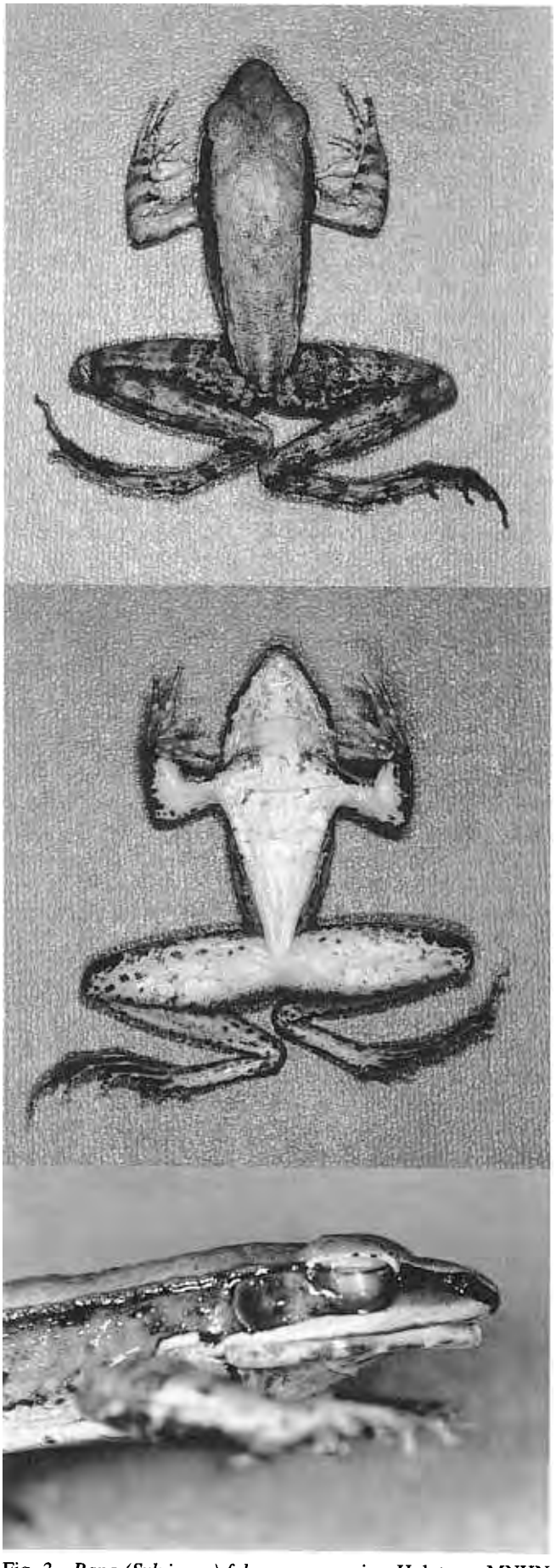

Fig. 3. *Rana (Sylvirana) faber,* new species. Holotype, MNHN 2001.0261, adult male, SVL 76.7 mm, dorsal view, ventral view, lateral view of head.

flanks light grey with blackish speckles; canthus dark grey; canthal and tympanic area light grey; tympanum brownish grey, transparent; upper lip with pearl-white stripe continued by pearl-white rictal gland; dorsolateral fold medially greyish brown, externally black underlining. (39) Forelimb, dorsal parts of thigh, tibia and foot greyish brown with dark grey bands, posterior part of thigh blackish with numerous light grey spots. (40) Throat and margin of throat grey-white with greyish flecks; chest light grey with two symmetrical grey marks in the middle; belly cream-white with indistinct greyish spots; ventral part of thighs yellow-white with greyish spots; webbing dark grey, transparent.

(In life) Dorsal ground colour uniform light tan; flanks dark brown; canthal and tympanic area dark brown; tympanum dark brown; upper lip pearly white continuous with pearly white rictal gland. Dorsal surfaces of limbs paler than back with indistinct darker brown bands; posterior part of thigh blotched dark brown on light tan ground colour. Venter pearly white; limbs flushed pink.

(G) Male secondary characters – (41) A single continuous, oval shaped nuptial pad on finger I formed by indistinct, small, cream coloured spines. (42) Vocal sacs present, indistinct on throat; a pair of distinct, rounded openings at base of jaw. (43) Other secondary sexual characters: forearm slightly enlarged; humeral gland present but little prominent.

Variation. – Morphometric variation is presented in table 7. Dorsal colour in most specimens is greyish brown, but many show light grey or blackish flecking reminding lichens. The throat never shows distinct darker coloration than chest and belly. Vocal sacs are indistinct externally; sometimes a darker zone can be observed where the vocal sacs are located. The humeral gland, that shows thickened glandular tissue when dissected, is indistinct by superficial observation in all males.

Ecological notes. – The holotype was collected from Phnom Aural in hill evergreen forest at an altitude of 710 m a.m.s.l. The specimen was found sitting on a rock, 0.4 m from a stream. *Rana faber* was found to be common and widespread throughout the Cardamom Mountains occurring in a range of vegetation types: dry dipterocarp, lowland dry evergreen and hill evergreen forest types, moorland areas on the top of the central range, and flooded forest in the Veal Veng wetland. *Rana faber* was recorded in heavily disturbed areas as well as in near-pristine forests. Typically this species was found close to permanent watercourses, often slower moving sections of mountain streams.

Etymology. – This species is dedicated to Malcolm A. Smith in recognition of his work on Southeast Asian amphibians. *Faber* in Latin means "smith" or "craftsman working hard material".

Remarks. – *Rana (Sylvirana) faber* is compared here to two similar species, *R. nigrovittata* and *R. mortenseni.* Although *R. mortenseni* was recently regarded as a junior subjective synonym of *Rana nigrovittata* by Matsui et al. (2001), we have unpublished information indicating that the two species

Table 7. Minimum, maximum, mean and standard deviation of measurements of specimens of *Rana (Sylvirana) mortenseni* from Thailand and the Cardamom Mountains, Cambodia, and the type series of *Rana (Sylvirana) faber,* new species, from the Cardamom Mountains, Cambodia. (Initial SVL measurements are given in mm, all subsequent measurements are presented as per thousands of SVL).

	Rana mortenseni				*Rana faber,* new species		
	Thailand		Cardamom Mountains, Cambodia		Cardamom Mountains, Cambodia		
	adult male N = 11	adult female N = 6	adult male N = 8	adult female N = 2	adult male N = 9	juvenile male N = 2	adult female N = 3
Snout-vent length	64.5 ± 6.37 (54.3 - 72.3)	67.8 ± 2.38 (64.6 - 70.7)	65.4 ± 6.57 (51.2 - 73.4)	63.8 - 79.8	60.0 ± 3.72 (53.1 - 66.9)	38.5 - 41.1	57.4 ± 0.35 (57.1 - 57.8)
Head width ratio	362 ± 19.4 (319 - 387)	343 ± 14.1 (322 - 356)	380 ± 7.72 (367 - 392)	314 – 327	321 ± 10.7 (306 - 339)	316 – 343	344 ± 10.5 (336 - 356)
Head length ratio	395 ± 10.8 (374 - 415)	382 ± 6.29 (375 - 388)	414 ± 8.24 (405 - 431)	370 – 389	381 ± 10.5 (365 - 397)	364 – 384	387 ± 17.8 (367 - 401)
Tibia length ratio	527 ± 26.6 (488 - 567)	540 ± 13.7 (515 - 552)	535 ± 21.3 (500 - 557)	618 – 630	618 ± 16.5 (594 - 638)	569 – 600	558 ± 19.2 (536 - 571)

are indeed distinct. Therefore, for the time being and for purposes of comparison, *R. nigrovittata* and *R. mortenseni* are regarded here as separate species.

Rana (Sylvirana) faber is distinctly larger than *Rana nigrovittata*, it also has longer tibia than this species. In *R. nigrovittata,* vocal sacs are distinct on a throat that generally shows a dark brown coloration in males. *Rana mortenseni* is a little larger size but can easily be recognized by its enlarged short-snouted head, and the shanks of *R. mortenseni* are significantly shorter than those of *R. faber.* Morphometric measurements of specimens of *R. mortenseni* form the Cardamom Mountains, plus a series from Thailand, and those of the type series of *R. faber* are presented for comparison in Table 7. The dorsal pattern of *R. mortenseni* is also a distinctive reddish brown, and the chest and throat are dark brown (in some specimens even the belly is dark brown). *Rana mortenseni* also shows a rounded, well-developed humeral gland. This species pair can also be clearly separated in the field by their distinct calls, in addition to their morphological differences and habitat preferences. The Cardamom members of the subgenus *Sylvirana* exhibit some degree of altitudinal zonation: *R. mortenseni* is abundant in the lowland dry evergreen and gallery forests of the basin areas and lower slopes but was rarely found above c. 700 m a.m.s.l.; *R. faber*, although found at lower altitudes, was more common on streams above the extent of *R. mortenseni*'s ecological range.

Rhacophorus bisacculus Taylor, 1962

Remarks. – The oldest available name for small-sized rhacophorids from the oriental region with an hourglass pattern on the back and tubercles on the margins of the tarsi and feet is *Rhacophorus appendiculatus* (Günther, 1859), which was described from a variety of type localities including the Philippines, Java, Singapore and the East Indies. Subsequently, *Rhacophorus verrucosus* Boulenger, 1893 was described from Burma; *Rhacophorus phyllopygus* Werner, 1900 from Sumatra; *Rhacophorus naso* Annandale, 1912 from Arunachal Pradesh, India; and *Rhacophorus chaseni* Smith, 1924 from the Malay Peninsula. All but *verrucosus* are considered synonyms of *Rh. appendiculatus* (Frost, 2000).

More recently, Taylor (1962) described *Rhacophorus bisacculus* without comparison to the other species of this group. Fei & Ye (Ye et al., 1993) coined the name *Philautus odontotarsus* for the Chinese specimens considered until then as *Rhacophorus appendiculatus,* and Inger et al. (1999) named the southern Vietnamese population *Rhacophorus baliogaster.*

Here, we follow Inger et al. (1999) in considering *Rh. appendiculatus* a species distinct from *Rh. verrucosus*, and *Rh. bisacculus* different again from both of these, based on size and differences in body proportions. The specimens from the Cardamom Mountains possess body and tympanum sizes corresponding to those measured for *Rhacophorus bisacculus*. Van Dijk (unpublished data) mentions *Rh. verrucosus* from Cambodia, but as no voucher specimens are available, these specimens should be considered *Rh. bisacculus.*

DISCUSSION

In terms of species composition of the Cardamom Mountain amphibian fauna, the results of these surveys have produced few surprises. The lowland communities of the open dry dipterocarp forests, at the base of the mountains, are comprised of common species widely distributed throughout Southeast Asia, that often characterise disturbed or agricultural habitats. Of the species of the evergreen forests of the mountains themselves, although many never recorded in Cambodia before, most have been reported from other parts of the Indochinese region, particularly from eastern Thailand. The data presented here merely fills in the gaps (or confirms predictions) in the distribution of many Indochinese amphibians.

Despite the relative geographical isolation of the Cardamom Mountains, their restricted altitude combined with a limited

temporal isolation has not been sufficient to produce particularly high levels of endemism. Three species of amphibian new to science from the Cardamom Mountains collection could be considered potentially endemic to these mountains: *Megophrys auralensis, Philautus cardamonus,* and *Rana faber. Philautus* is the most speciose of frog genera in the Orient, characterised by direct development (Bossuyt & Dubois, 2001) and concomitant restricted specific distribution and high levels of endemism. It is not uncommon for surveys of previously unstudied forests in Indochina to yield at least one new species of *Philautus*, e.g. Inger et al. (1999), Ohler et al. (2000) and Swan (unpublished data). Therefore, it was not unexpected to find at least one new species from the higher elevations of the Cardamom Mountains. Further searching at the higher elevations is bound to yield more species, rare and potentially endemic, which are inevitably the last to be discovered.

Endemicity at the species level in the Cardamom Mountains appears to be somewhat restricted in other vertebrate groups. For example, only a single species of terrapin (*Cyclemys atripons* Iverson & McCord, 1997), lizard (*Cyrtodactylus intermedius* Smith, 1917), snake (*Lycodon* sp.) and bird (*Arborophila cambodiana* Delacour & Jabouille, 1928) seem to be endemic to the mountains of Southwest Cambodia and adjacent eastern Thailand to date (Daltry & Chheang Dany, 2000; Daltry & Wüster in press; Steinheimer et al., 2000), although further research may find more. In the case of all of these examples, and that of the two new species of frog described here, the Cardamom endemic species are very similar in external morphology to closely related congeners from other parts of Southeast Asia. This suggests that the fauna of the Cardamom Mountains has undergone only limited divergent evolution in isolation.

Little has been recorded of Cambodia's amphibian fauna prior to this study and a synthesis of this information has never been produced, thus limiting comparisons of overall species richness between the results presented here with those from other parts of the country. However, the number of species recorded in the Cardamom Mountains (34 in total) is higher than known levels of species richness documented for other Indochinese mountainous areas of comparable elevation. For example, Robichaud & Stuart (1999) documented 25 species of amphibian during a one-month survey in the Annamite Mountains in Laos. Similarly, at a site on the Vietnamese side of the same mountain chain, 30 species of amphibian were recorded during a four-month survey (Swan unpublished data). Yet the Cardamom Mountain amphibian fauna appears not to be as species rich as the mountain isolates of the region that attain altitudes in excess of 2,500 m a.m.s.l., such as the Central Highlands of Vietnam (54 species – Inger et al., 1999; Le Trong Trai et al., 1999, 2000; Tordoff et al., 2000), or the Hoang Lien Mountains, again in Vietnam (42 species - Ohler et al., 2000).

None of these examples, or the surveys reported herein, can be considered complete. There are undoubtedly more species of amphibian to be discovered throughout the mountainous regions of Indochina, including the Cardamom Mountains. The incompleteness of data sets, and the variable levels of survey effort for sites already studied, hinders valid comparisons of species richness between sites. Despite these restrictions, it is apparent that the many and varied habitats that comprise the Cardamom Mountain area support a relatively rich amphibian fauna, including a few taxa which have evolved in isolation to produce species endemic to the mountain range.

Forests in Cambodia were once, ironically, protected to some degree by an ongoing civil war. In the last few years, since attaining relative political stability, the forests of the Cardamom Mountains have become vulnerable to both human encroachment and commercial logging. At the time of the survey, development aid agencies were actively resettling refugees within the two protected areas in the Cardamom Mountains, while between the protected areas, the forest had been placed under concession to a number of commercial logging companies.

This preliminary inventory of the amphibian species of the Cardamom Mountains was part of a larger effort to document and conserve the fauna and flora of this vast forested wilderness. Until the 2000 dry season surveys of amphibians and other taxa, both wildlife sanctuaries lacked active management on the ground. Results of the biological surveys have provided the justification to establish the first ranger forces in these mountains and begin developing management plans for the protected areas, while logging concessions in the Central Cardamoms are being revoked now that the biological value of these forests is becoming apparent. It is hoped that these initial steps towards enforced protection of the Cardamom Mountains will constitute the foundations of an UNESCO World Heritage Site nomination, a prestigious profile that is necessary to safeguard the future of one of the largest and most intact areas of forest cover in mainland Southeast Asia.

The survey of the Cardamom Mountains reported herein, was the first survey for amphibians to be conducted in Cambodia. Following immediately after the 2000 surveys of in the Cardamom Mountains, the first author conducted a rapid survey of the plains of Northeast Mondulkiri on opposite side of the country, close to the border with Dak Lak Province in Vietnam. This low-lying (<200 m) plain at the foot of the Chhlong Plateau is part of the lower Mekong basin and is clad in dry dipterocarp forest (Long et al., 2000) much the same as that found in the basin areas at the foot of the Cardamom Mountains. Only 14 species of amphibian were recorded during this survey, all but one, *Rana (Pelophylax) lateralis* Boulenger, 1887 (BMNH 2000.0130-0132), of which were recorded in the Cardamom Mountains. The inventories produced by these two preliminary studies, coupled with a few other incidental reports comprise the known amphibian fauna of Cambodia. A checklist of the fauna is presented in Table 8, which lists a total of 40 species of amphibian recorded from Cambodia.

Surveys for amphibians in other areas of Cambodia (notably the Elephant Mountains and southern Mondulkiri Province)

Table 8. Checklist of amphibian species known to occur in Cambodia.

SPECIES	REFERENCE
MEGOPHRYIDAE Bonaparte, 1850	
Leptolalax sp.	Present study
Megophrys (Xenophrys) auralensis, new species	Present study
BUFONIDAE Gray, 1825	
Bufo galeatus Günther,1864	Günther, 1864; van Dijk unpublished data
Bufo macrotis Boulenger, 1887	Long et al., 2000; this paper
Bufo melanostictus Schneider, 1799	Flower, 1896; Mocquard, 1904; Long et al., 2000; van Dijk unpublished data; present study
Bufo parvus Boulenger, 1887	Present study
RANIDAE Rafinesque-Schmaltz, 1814	
Chirixalus doriae Boulenger, 1893	Present study
Chirixalus vittatus (Boulenger, 1887)	Present study
Fejervarya cancrivora (Gravenhorst, 1829)	Bourret, 1942
Fejervarya limnocharis (Gravenhorst, 1829)	Long et al., 2000; van Dijk unpublished data; present study
Hoplobatrachus chinensis (Osbeck, 1765)	Long et al., 2000; present study
Limnonectes (Elachyglossa) gyldenstolpei (Anderson, 1916)	Present study
Limnonectes (Elachyglossa) kohchangae (Smith, 1922)	Present study
Limnonectes toumanoffi (Bourret, 1941)	Bourret, 1941; Ohler & Dubois, 1999; van Dijk unpublished data
Occidozyga lima (Gravenhorst, 1829)	Boulenger, 1882; Flower, 1896; Bourret, 1942; Long et al., 2000; van Dijk unpublished data; present study
Paa (Eripaa) fasciculispina (Inger, 1970)	Present study
Philautus cardamonus, new species	Present study
Philautus parvulus (Boulenger, 1893)	Present study
Phrynoglossus martensii Peters, 1867	Flower, 1896; Long et al., 2000; van Dijk unpublished data; Present study
Polypedates cf. *leucomystax* (Gravenhorst, 1829)	Long et al., 2000; van Dijk unpublished data; present study
Rana (Hylarana) erythraea (Schlegel, 1837)	Tirant, 1885; van Dijk unpublished data; present study
Rana (Hylarana) macrodactyla (Günther, 1858)	Boulenger, 1920; Bourret, 1942; Long et al., 2000; van Dijk unpublished data; present study
Rana (Hylarana) taipehensis van Denburgh, 1909	Present study
Rana (Pelophylax) lateralis Boulenger, 1887	Bourret, 1942; Long et al., 2000 ; present study
Rana (Sylvirana) faber, new species	Present study
Rana (Sylvirana) mortenseni Boulenger, 1903	Present study
Rhacophorus bipunctatus Ahl, 1927	Present study
Rhacophorus bisacculus Taylor, 1962	van Dijk unpublished data; present study
Theloderma asperum (Boulenger, 1893)	Present study
MICROHYLIDAE Günther, 1858	
Glyphoglossus molossus Günther, 1869	Bourret, 1942; van Dijk unpublished data
Kalophrynus interlineatus Blyth, 1855	Bourret, 1942; van Dijk unpublished data; present study
Kaloula pulchra Gray, 1831	Flower, 1896; Long et al., 2000; van Dijk unpublished data; Present study
Micryletta inornata (Boulenger, 1890)	van Dijk unpublished data; present study
Microhyla annamensis Smith, 1923	Present study
Microhyla berdmorei (Blyth, 1856)	Flower, 1896; Long et al., 2000; van Dijk; unpublished data; Present study
Microhyla butleri Boulenger, 1900	Present study
Microhyla heymonsi Vogt, 1911	Bourret, 1942; Long et al., 2000; van Dijk unpublished data; Present study
Microhyla ornata (Duméril & Bibron, 1841)	Boulenger, 1882 Flower, 1899; Long et al., 2000; van Dijk unpublished data; present study
Microhyla pulchra (Hallowell, 1861)	Boulenger, 1882; Flower, 1899; Long et al., 2000; present study

were conducted by other researchers during the time of the Cardamom and Northeast Mondulkiri surveys reported here (WCS unpublished data). Unfortunately the species collected during these surveys have yet to be identified and therefore these data cannot be included in the national checklist presented here. Undoubtedly the known amphibian fauna of Cambodia will expand rapidly over the next decade or so as more areas of the country are explored for the first time by biological survey teams. It is hoped that the results of the initial amphibian surveys of Cambodia reported here will provide a reliable foundation for future research to build upon.

ACKNOWLEDGEMENTS

The surveys for amphibians in both the Cardamom Mountains and Northeast Mondulkiri Province were conducted as part of Fauna & Flora International's Indochina Programme in collaboration with the Department of Forestry and Wildlife (Ministry of Agriculture, Forestry and Fisheries), and the Department of Nature Conservation and Protection (Ministry of the Environment). We are indebted to the Government of Cambodia for providing the opportunity to work in Cambodia. We are grateful to all our guides who were essential to our fieldwork, and especially to Kry Masphal for his assistance in the field in 2000, and Jeremy Holden who collected many of the specimens from the Cardamom Mountains, including those of the new *Philautus* species. Peter Paul van Dijk provided constructive advice and kindly granted access to unpublished data. Alain Dubois and Miguel Vences gave useful comments to the manuscript. This is publication N°65 of the "Programme Pluriformation Asie du Sud-Est. Publication N°64 see Deuve, 2002).

LITERATURE CITED

Anonymous, 1999. *International code of zoological nomenclature. Fourth edition.* London, International Trust for Zoological Nomenclature. xxix + 306 pp.

Ashwell, D., 1997. *A National Biodiversity Prospectus: A Contribution towards the Implementation of the Convention on Biological Diversity with Particular Emphasis upon Cambodia's Terrestrial Ecosystems.* IUCN–Cambodia, Phnom Penh.

Bossuyt, F. & A. Dubois, 2001. A review of the frog genus *Philautus* Gistel, 1848 (Amphibia, Anura, Ranidae, Rhacophorinae). *Zeylanica*, **1** (2): 1-108.

Boulenger, G. A., 1882. *Catalogue of the Batrachia Gradentia s. Caudata in the collection of the British Museum.* London, Taylor & Francis. xvi + 503pp., 30 pl.

Boulenger, G. A., 1886. First report on additions to the batrachian collection in the Natural-History Museum. *Proceedings of the Zoological Society of London*, **1886** (3): 411-416, pl. 39.

Boulenger, G. A., 1908. A revision of the Oriental pelobatid batrachians (Genus *Megalophrys*). *Proceedings of the Zoological Society of London*, **1908**: 407-430.

Boulenger, G. A., 1920. A monograph of the South Asian, Papuan, Melanesian, and Australian frogs of the genus *Rana*. *Records of the Indian Museum*, **20**: 1-126.

Bourret, R., 1941. Notes herpétologiques sur l'Indochine française. XXII. Reptiles et Batraciens reçus au Laboratoire des Sciences Naturelles de l'Université au cours de l'année 1941. Description d'une espèce et d'une variété nouvelles. *Annexe du Bulletin de l'Instruction publique, Hanoi*, **1941**: 5-29.

Bourret, R, 1942. *Les Batraciens de l'Indochine.* Institute Océanographique de l'Indochine, Hanoi. x + 547 pp., 4 pl.

Daltry, J. C. & Chheang Dany, 2000. Reptiles. In: Daltry, J. C. & F. Momberg (eds.), 2000. *Cardamom Mountains Biodiversity Survey 2000.* Fauna & Flora International, Cambridge, UK. 254 pp.

Daltry, J. C. & F. Momberg (eds.), 2000. *Cardamom Mountains Biodiversity Survey 2000.* Fauna & Flora International, Cambridge, UK. 254 pp.

Deuve, Th., 2002. Nouveaux *Carabus* L. et *Cychrus* F. de Chine occidentale (Coleoptera, *Carabidae*). *Coléoptères*, **8**: 239-246.

Dring, J. C. M., 1987. Bornean tree frogs of the genus *Philautus* (Rhacophoridae). *Amphibia-Reptilia*, **8**: 19-47.

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

Dubois, A. & A. Ohler, 1999. Asian and Oriental toads of the *Bufo melanostictus*, *Bufo scaber* and *Bufo stejnegeri* groups (Amphibia, Anura): a list of available and valid names and redescription of some name-bearing types. *Journal of South Asian Natural History*, **4** (2): 133-180.

Dubois, A. & A. Ohler, 2000. Systematics of *Fejervarya limnocharis* (Gravenhorst, 1829) (Amphibia, Anura, Ranidae) and related species. 1. Nomenclatural status and type-specimens of the nominal species *Rana limnocharis* Gravenhorst, 1829. *Alytes*, **18** (1-2): 15-50.

Fei, L., C. Ye & Y. Huang, 1991. *Key to Chinese Amphibia.* Chongqing, Editions of Sciences and Techniques. [iv] + 2 + 364 pp. [In Chinese.]

Flower, S. S., 1896. Notes on a collection of reptiles and batrachians made in the Malay Peninsula in 1895-96; with a list of the species recorded from that region. *Proceedings of the Zoological Society of London*, **1896**: 856-914.

Flower, S. S., 1899. Notes on a second collection of batrachians made in the Malay Peninsula and Siam, from November 1896 to September 1898; with a list of the species recorded from those countries. *Proceedings of the Zoological Society of London*, **1899**: 600-696.

Fontanel, J., 1972. Carton des Bioclimats. In *Notice de la Carte du Cambodge.* (Carte Internationale du Tapis Vegetal et de conditions Ecologiques au Cambodge, 1:1,000,000). *Travaux. Section Scientifique et Technique. Institut Francais de Pondichery*, Hors ser. **11**:1-238.

Frost, D. R., 2000. *Amphibian species of the world: an online reference.* Version 2.20. http://research.amnh.org/herpetology/amphibia/

Günther, A., 1864. *The Reptiles of British India.* Ray Society, London. xxvii + 452 pp., 26 pl.

Inger, R. F., 1970. A new species of frog of the genus *Rana* from Thailand. *Fieldiana: Zoology Memoires*, **51**: 169-174.

Inger, R. F., 1999. Distribution of amphibians of southern Asia and adjacent islands. In: Duellman, W. E. (ed.), *Patterns of distribution of amphibians: A global perspective.* John Hopkins University Press, Baltimore: 456-482.

Inger, R. F., N. Orlov & I. Darevsky, 1999. Frogs of Vietnam: a report on new collections. *Fieldiana: Zoology Memoires,* New series, No. **92**: 1-46.

IUCN (2001) *2000 IUCN Red Data List of Threatened Species.* www.redlist.org

Le, T. T., V. C. Le, Q. N. Tran, H. M. Tran, V. S. Nguyen, A. L. Monastyrskii, B. D. Hayes & J. C. Eames, 2000. *An Investment Plan for Kon Ka Kinh Nature Reserve, Gia Lai Province Vietnam: a Contribution to the Management Plan.* BirdLife International Vietnam Programme, Hanoi.

Le, T. T., W. J. Richardson, V. C. Le, H. M. Tran, Q. N. Tran, V. S. Nguyen, A. L. Monastyrskii & J. C. Eames, 1999. *A Feasability Study for the Establishment of Phong Dien (Thua Thien Hue Province) and Dakrong (Quang Tri Province) Nature Reserves, Vietnam.* BirdLife International Vietnam Programme, Hanoi.

Liu, C. -C., 1950. - Amphibians of Western China. *Fieldiana: Zoology Memoires*, **2**: 1-400, pl. 1-10.

Long, B., S. R. Swan & Kry Masphal, 2000. *Wildlife Survey of Northeast Mondulkiri.* FFI Indochina Programme, Hanoi.

Matsui, M., K. Nishikawa, W. Khonsue, S. Panha & J. Nabhitabhata, 2001. Allozymic variation in *Rana nigrovittata* (Amphibia: Anura) within Thailand with special reference to the taxonomic status of *R. mortenseni. The Natural History Journal of Chulalongkorn University,* **1**(1): 15-22.

Mocquard, R., 1904. Batraciens recuillis par M. A. Pavie en Indochine. In Pavie, A., *Mission Pavie Indo-Chine. 1879-1895.* Etudes diverses. III. Recherches sur l'histoire naturelle de l'Indo-Chine orientale. Paris, Ernest Leroux: 473-474

Momberg, F. & J. C. Daltry, 2000. General Introduction. In: Daltry, J. C. & F. Momberg (eds.), *Cardamom Mountains Biodiversity Survey 2000.* Fauna & Flora International, Cambridge, UK.

Ohler, A., 1997. *Amphibiens.* Unpublished draft, Paris, MNHN. 2 pp.

Ohler, A. & A. Dubois, 1999. The identity of *Elachyglossa gyldenstolpei* Anderson, 1916 (Amphibia, Ranidae), with comments on some aspects of statistical support to taxonomy. *Zoologica Scripta,* **28**, (3-4): 269-279.

Ohler, A., O. Marquis, S. Swan & S. Grosjean, 2000. Amphibian diversity of the Hoang Lien Nature Reserve (Lao Cai Province, northern Vietnam), with a description of two new species. *Herpetozoa,* **13** (1/2): 71-87.

Robichaud, W. & B. L. Stuart, 1999. *Summary of Saola, Herpetological and Wildlife Trade Studies in Nakai-Nam Theun NBCA and the Proposed Nam Theun Extension.* Wildlife Conservation Society Laos Program, Vientiane.

Smith, M. A., 1922a. The frogs allied to *Rana doriae. Journal of the Natural History Society of Siam,* **4**: 215-225.

Smith, M. A., 1922b. On a collection of reptiles and batrachians from Siam and Indo-China (No. 1). *Journal of the Natural History Society of Siam,* **4**: 203-214, pl. 8.

Smith, M. A., 1930. The Reptilia and amphibia of the Malay Peninsula. *Bulletin of the Raffles Museum,* **3**: i-xviii + 1-149.

Steinheimer, F. D., J. C. Eames, M. Chandamony & R. Bansok, 2000. Birds. In: Daltry, J. C. & F. Momberg (eds.), *Cardamoms Biodiversity Survey 2000,* pp. 87-98. Fauna & Flora International, Cambridge. 254 pp.

Stuart, B. L., 1999. Amphibians and Reptiles. In: Duckworth, J. W., R. E. Salter & K. Khounboline (compilers), *Wildlife in Lao PDR: 1999 Status Report.* Pp. 43-67. IUCN, WCS, CPAWM, Vientiane.

Taylor, E. H., 1962. The amphibian fauna of Thailand. *University of Kansas Science Bulletin,* **43**(8), 265–599.

Tirant, G., 1885. Notes sur les reptiles et batraciens du Cochinchine. *Excursions et Reconnaissances,* **21**: 236-246.

Tordoff, A. W., H. M. Tran & Q. N. Tran, 2000. *A feasibility study for the establishment of Ngoc Linh Nature Reserve, Quang Nam Province, Vietnam.* BirdLife International Vietnam Programme, Hanoi.

Veith, M., J. Kosuch, A. Ohler & A. Dubois, 2001. Systematics of *Fejervarya limnocharis* (Gravenhorst, 1829) (Amphibia, Anura, Ranidae) and related species. 2. Morphological and molecular variation in frogs from the Greater Sunda Islands (Sumatra, Java, Borneo) with the definition of two species. *Alytes,* **19** (1): 5-28.

Weiler, H., 1998. *The distribution of tiger, leopard, elephant and wild cattle (gaur, banteng, buffalo, khting vor and kouprey) in Cambodia.* Cat Action Treasury/Wildlife Protection Office, Phnom Penh.

Ye, C., L. Fei & S. Hu, 1993. *Rare and economic amphibians of China. Chengdu,* Sichuan Publishing House of Science and Technology. [iii] + 2 + 2 + 7 + 412 pp. [In Chinese].

APPENDIX

Material studied. – *Megophrys (Xenophrys) major*: BMNH 1868.7.3.98, 1 adult male, Pegu, Myanmar; BMNH 1947.2.24.92-96, syntypes of *Xenophrys gigas* Jerson, 1870, 4 adult males, 1 adult female, Darjeeling, India; BMNH 1872.4.17.431, 1 juvenile female, Darjeeling, India; MSNG 29066, 1 adult male, Sikkim, India; BMNH 1908.4.8.4-6, 2 adult males, 1 juvenile female, Cherrapunji, Meghalaya, India; MNHN 1893.0514-0516, 1 adult male, 1 sub-adult male, 1 juvenile female, Karin Bia-Po, Myanmar; BMNH 1940.6.2.4-10, 1974.810, 2 adult males, 6 adult females, Pangnamdim, Triangle, Myanmar; MNHN 1987.2183, 1 juvenile female, Doi Pui, Thailand; MNHN 1986.2184-2185, 1 adult male, 1 adult female, Siriphum, Doi Inthanon, Thailand; MNHN 1986.2186, 1 sub-adult male, Huai Pha Mon, Doi Inthanon, Thailand; MNHN 0000.8182, lectotype of *Megophrys longipes maosonensis* Bourret, 1937, 1 juvenile female, Maoson, Vietnam; MNHN 1938.0096-0097, 0000.8181, paralectotypes of *Megophrys longipes maosonensis* Bourret, 1937, 3 adult males, Maoson, Vietnam; MNHN 1938.0098-0099, paralectotypes of *Megophrys longipes maosonensis* Bourret, 1937, 1 adult male, 1 sub-adult male, Sa Pa, Vietnam; MNHN 0000.9179-8180, paralectotypes of *Megophrys longipes maosonensis* Bourret, 1937, 1 adult female, 1 juvenile female, Sa Pa, Vietnam; RMNH 4770, 1 adult male, Annam, Vietnam; MSNG 29453, 1 adult female, 1 juvenile male, 1 juvenile female, Mount Karin, Myanmar, coll. L. Fea, 1888.
Megophrys (Xenophrys) robusta: BMNH 1947.2.25.19, syntype, Darjeeling, India; BMNH 1872.4.17.430, Darjeeling, India.
Limnonectes gyldenstolpei: BMNH 1947.2.1.97-99, 1947.2.2.1, 1947.2.2.3-5, syntypes, Khao Sebab, Chantabun, Thailand; BMNH 1947.2.2.10, syntype, Meh Song, forest near Prae, Thailand; BMNH 1947.2.2.11, syntype, Hup Bon, Sriracha, Thailand; MNHN 1997.4149-4150, Bokeo, Laos.
Paa fasciculispina: MNHN 1989.0706-0710, topotypes, Kao Soi Dao, Changwat Chantaburi, Thailand.
Rana mortenseni: BMNH 1974.1957-1974.1968, 9 adult males, 3 adult females, Ban Pipeng, Thailand; BMNH 1947.2.2.51, syntype, adult male, Koh Chang, Thailand; BMNH 1915.8.14.14, 1919.3.28.1-2, 1921.2.12.1, 1 adult male, 3 adult females, topotypes, Koh Chang, Thailand.
Rana nigrovittata: BMNH 1947.2.2.93, lectotype, ZSI 2685, paralectotype, 2 adult males, ZSI 2773, paralectotype, adult female, Mergui, Myanmar.