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GEKKOTAN LIZARD TAXONOMY

ARNOLD G. KLUGE

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Front cover: File-eared tree frog (*Polypedates otilophus*). Adult female that was found at the base of Gunung Buri, Sarawak, East Malaysia (Borneo), next to a shallow rainwater pool. This is a large species, females attaining a snout-vent length of 97 mm, while males reach 80 mm. It occurs on Borneo and Sumatra, the saw-edged bony ridge over the tympanum being diagnostic of the species. © Indraneil Das. (Fujichrome Velvia 50 ASA).

Back cover: Spiny hill turtle (*Heosemys spinosa*). A widespread terrestrial turtle from southern Myanmar, Thailand, the Malay Peninsula, Sumatra, Borneo, the Natunas to the Sulu Archipelago and Mindanao. This partially-burnt individual was found in a patch of kerangas forest, Kilometre 13, Labi Road, Belait District, Brunei Darussalam (Borneo). A length of 225 mm is reached by the species, which has strikingly serrated shell margins as juveniles. © Joseph K. Charles. (Fujichrome Velvia 50 ASA).

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KALOPHRYNUS (ANURA: MICROHYLIDAE), A NEW GENUS FOR INDIA, WITH THE DESCRIPTION OF A NEW SPECIES, *KALOPHRYNUS ORANGENSIS*, FROM ASSAM STATE

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(with five text-figures)

ABSTRACT.– **The microhylid genus, *Kalophrynus*, is reported for the first time from India, and a new species, *Kalophrynus orangensis* is described from the Orang National Park, Assam in north-eastern India. *K. orangensis* is diagnosable from all other congeners in showing the following combination of characters: snout acute, projecting beyond mandible; parotid gland absent; head wider than long; an inverted 'v'-shaped mark present on dorsum from tip of snout to the inguinal region; an ocellus present on inguinal region; fingers lacking webbing; toes with rudimentary webbing; a single subarticular tubercle on finger IV; inner outer metatarsal tubercles present; and SVL of adults constituting the type series, 35.0-38.0 mm.**

KEYWORDS.– ***Kalophrynus*, new species, *Kalophrynus orangensis*, systematics, Assam, India.**

INTRODUCTION

Orang National Park (26º 30'N; 92º 15'E, altitudinal range 40-70 m above msl), situated on the east bank of the Dhansiri River, in Darrang and Sonitpur Districts of Assam, lies in the floodplains of the Brahmaputra River (which constitutes the southern boundary), and covers ca. 78.81 sq km. About half the area comprises grassland, dominated by *Phragmites kakra*, *Saccharum* spp., *Imperata cylindrica* and *Erianthus ravannae*. A mere 15% of the area is under natural (2%) or planted forests of *Dalbergia sisoo*, *Bombax ceiba*, *Lannea grandis*, *Terminalia myriocarpa*, *Gmelina arborea*, *Albizzia procera*, *Trewia nudiflora*, *Dillenia indica*, and *Oroxylon indica*. The general vegetation type comprises an admixture of dry and wet grassland and the forest type is dry deciduous. The protected area was gazetted for the conservation of various species of wetland-associated wildlife, including the greater Indian one-horned rhino (*Rhinoceros unicornis*).

During field work conducted in September 1998, a microhylid taken from the National Park, was found to represent a hitherto undescribed species of *Kalophrynus*, a genus with a known distribution ranging from eastern China south to the Sundas and the Philippines (Inger, 1999), and thus previously unreported from within the political boundaries of India (Chanda, 1994; Dutta, 1997). A total of 12 species have been described (Frost, 1985; Kiew, 1984; Duellman, 1993; Iskandar, 1998). In this paper, we describe the species from Assam as new to science.

MATERIALS AND METHODS

The type series was collected on the night of 15 September, 1998, at 2130 h, the holotype photographed in life, and fixed in 4% formalin, ca. 8 h after collection. Measurements were taken with a dial vernier calliper (to the nearest 0.1 mm) from specimens in 70 per cent ethanol. The following measurements were taken: snout-vent length, SVL (from tip of snout to vent); tibia length, TBL (distance between surface of knee to surface of heel, with both tibia and tarsus flexed); trunk length, TL (distance between posterior edge of forelimb at its insertion to body to anterior edge of hind limb at its insertion to body); head length, HL (distance between angle of jaw and snout-tip); head width, HW (measured at angle of jaws); head depth, HD (greatest transverse depth of head, taken at the posterior of the orbital region); eye diameter, ED (diameter of eye); interorbital width, IO (least distance between upper eyelids); internarial distance, IN (distance between nostrils); eye to snout-tip distance, E-S (distance between anterior-most point of eyes to tip of snout); eye to nostril distance, E-N (distance between anterior-most point of eyes and nostrils); and diameter of disk on finger III, FIIID (width of disk at tip of finger III). Measurements of fingers and toes were taken from base of each phalange to tip, on right fore and hind limbs, respectively. Sex was determined through examination of gonad. Alizarin red and Alcian blue preparations were done for osteological study. Comparative materials examined are in Appendix I. Sources of additional data on character states and distribution of congeners include Alcala and Brown (1998), Berry (1975), Boulenger (1882, 1912), Bourret (1942), Dring (1979, 1983), Fei (1999), Inger (1954, 1966), Inger and Stuebing (1989; 1997), Iskandar (1998), Kiew (1984), Matsui et al. (1996), Nieden (1923), Parker (1934), Smith (1922), Taylor (1962), Van Kampen (1923) and Yang and Su (1980). Museum abbreviations include:

SSM- Sabah State Museum, Kota Kinabalu, East Malaysia.

UBD- Deparment of Biology, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam.

ZRC- Zoological Reference Collection (USDZ in Leviton et al., 1985), National University of Singapore, Singapore.

ZSI- Zoological Survey of India, Kolkata (formerly Calcutta), India.

SYSTEMATICS

KALOPHRYNUS ORANGENSIS SP. NOV.

FIGS. 1–5

Holotype.- ZSI A9087 (adult female), from Orang National Park (26º 30’N; 92º 15’E), Darrang District, Assam, north-eastern India. Collected by M. F. Ahmed, 15 September 1998.

Paratypes.- ZSI A9088-91 (two adult males, two adult females), same locality data as holotype, collected by S. K. Dutta, 15 September 1998.

Diagnosis.- *Kalophrynus orangensis* sp. nov. is diagnosable from known congeners in showing the following combination of characters: snout acute, projecting beyond mandible; parotid gland absent; head wider than long; an inverted ‘V’-shaped mark present on dorsum from tip of snout to the inguinal region; an ocellus present on inguinal region; fingers lacking webbing; toes webbed to base; a single subarticular tubercle on finger IV; inner and outer metatarsal tubercles present; and SVL of adults constituting the type series, 35.0-38.0 mm.

Description (based on the type series).- A medium-sized species of *Kalophrynus* (SVL to 38.0 mm); body elongated (Fig. 1), with a narrow waist. Head broader than long (HL/SVL ratio 0.2); snout pointed when viewed dorsally and laterally (Fig. 3), projecting beyond mandible; nostrils dorso-lateral, nearer tip of snout than to anterior corner of eyes (E-N/E-S ratio 0.8); internarial distance greater than distance from anterior margin of eye to nostril (IN/E-N ratio 1.8); eyes small (ED/HL ratio 0.4), its diameter less than eye to nostril distance (ED/E-N ratio 0.7); interorbital width greater than upper eyelid width (IO/UE ratio 1.7); canthus rostralis distinct; loreal region vertical; upper jaw edentate; a ‘W’-shaped notch (the symphysial knob) on anterior edge of mandible; mouth extends to posterior corner of eye; tongue elongate, smooth, with rounded tip; pupil circular; tympanum distinct, with a supratympanic fold.

Fingers without vestiges of webbing; their relative lengths 4 > 1 > 2 > 3; finger tips rounded;

FIGURE 1: Holotype of *Kalophrynus orangensis* sp. nov. (ZSI A9087) in life.

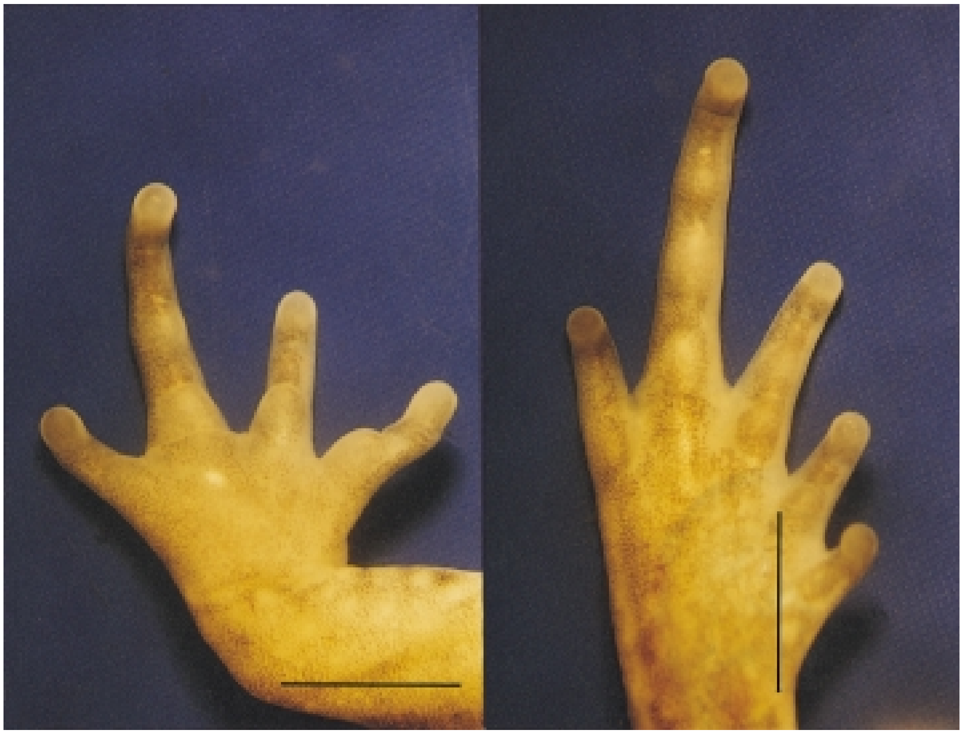

FIGURE 2: Palm (left) and sole (right) of holotype of *Kalophrynus orangensis* sp. nov. (ZSI A9087).

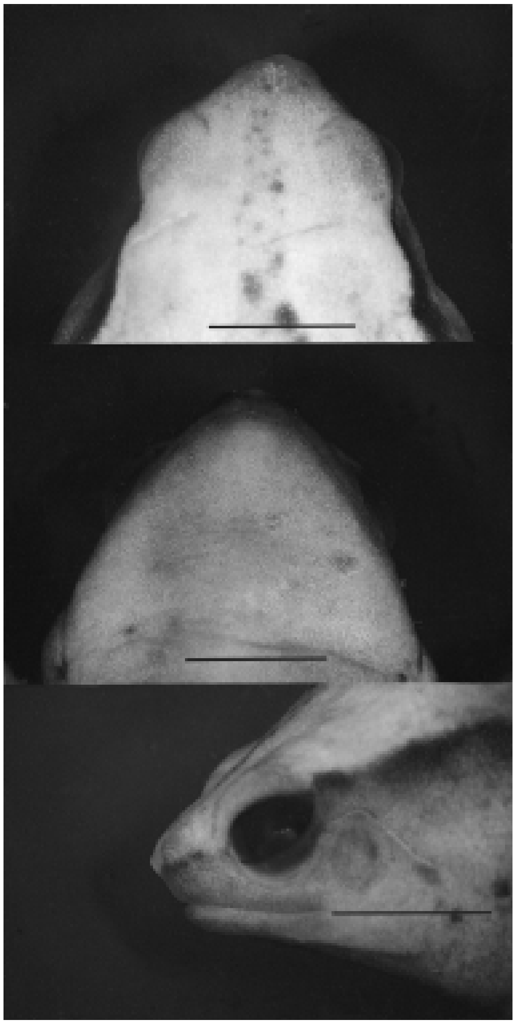

FIGURE 3: Dorsal (top), ventral (middle) and lateral (bottom) views of head of holotype of *Kalophrynus orangensis* sp. nov. (ZSI A9087).

subarticular tubercles prominent, rounded, one on first, second and fourth finger and two on third; fleshy palmar tubercles (Fig. 2).

Toes webbed at base; relative length 4 > 3 > 5 > 2 > 1. Toe tips rounded; subarticular tubercles prominent, rounded, one on first and second toe; two on third and fifth toe and three on fourth toe; rounded inner and outer metatarsal tubercles (Fig. 2).

Osteological preparations (Fig. 4) reveal large cartilaginous sternum, small omosternum, expanded sacral diapophysis, which characterise the genus *Kalophrynus*. Terminal phalanges T-shaped, with irregular bony outgrowths prominent on first and second fingers, and on third and fourth toes (Fig. 5).

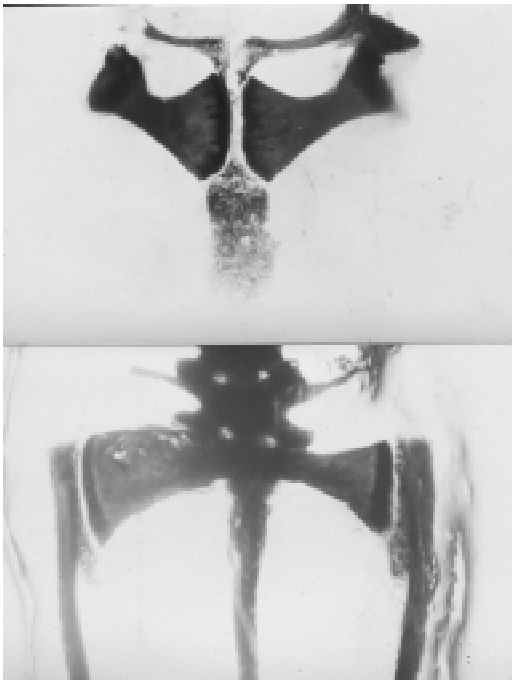

FIGURE 4: Alcian blue and Alizarin red preparations of pectoral (top) and pelvic (bottom) girdles of *Kalophrynus orangensis* sp. nov.

Dorsum granular, with glandular skin; a supratympanic fold extends from posterior angle of eye to base of forelimbs; abdomen and inner side of thighs coarsely granular, with a few white tubercles on the pectoral region of the males.

Colouration (in life).- Deep reddish-brown, or sometimes, cream. A deep brown, inverted ‘V’-shaped mark begins from above tip of snout, and terminates above the vent; a black ocellus on inguinal region; limbs with dark bars and blotches; venter yellowish-cream; mature males with a black speckled throat and abdomen; sides of head and body darker than dorsum.

Etymology.- The new species is named after the type locality, Orang National Park, in Darrang District, Assam State, north-eastern India.

Ecological Notes. - All collections were made in grassland adjacent to the forest, or close to emergent trees bordering grassland. The female holotype was collected from the side of the ap-

TABLE 1: Measurements (in mm) of the type series of *Kalophrynus orangensis* sp. nov.

	Holotype ZSI A9087 female	Paratype ZSI A9088 male	Paratype ZSI A9089 female	Paratype ZSI A9090 female	Paratype ZSI A9091 male
SVL	38.0	36.0	35.0	37.5	38.0
HL	7.5	7.3	7.0	8.5	7.5
HW	10.0	9.8	9.0	10.0	10.0
HD	9.0	8.3	8.0	8.5	9.0
TD	3.0	2.8	2.7	3.0	2.8
ED	3.2	3.2	3.1	3.6	3.2
UE	3.1	3.1	3.0	3.3	3.1
IO	5.2	5.6	5.3	5.8	5.1
IN	3.0	3.0	3.0	3.2	3.0
E-S	6.0	5.9	5.8	6.0	6.0
E-N	4.8	4.6	4.4	4.3	4.7
A-G	21.0	18.5	18.0	19.0	16.0

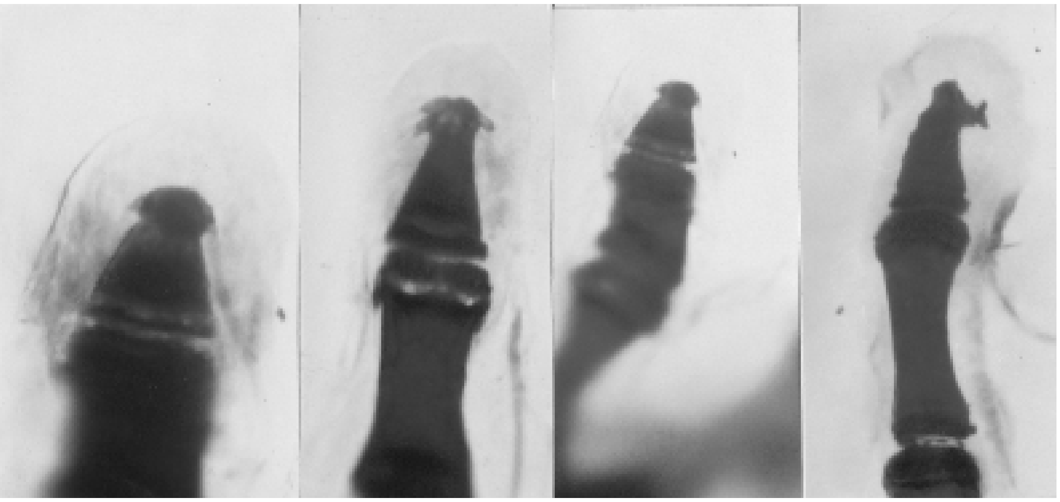

FIGURE 5: Alcian blue and Alizarin red preparations of tips of fingers I and II and toes III and IV of *Kalophrynus orangensis* sp. nov., showing irregular outgrowths on tips.

proach road to the Satsimalu Beat, inside Orang National Park. It was found over dry grasses on the side of the road that were cut to clear the road, ca. 25 cm above the substrate, at about 2130 h. The male and female paratypes were also collected from the same locality, within a stretch of ca. 50 m, in similar habitat. They attempted to escape by crawling and by taking short leaps. When handled, they exuded a cream-coloured sticky secretion that was difficult to remove. Pairs in amplexus were collected in early June (Southwest Monsoons). The males participated in choruses after a heavy shower, and calls were also heard during the morning, up to 1100 h, under overcast and humid conditions. Males call from the bank of small puddles, while hiding under roots and overhanging blades of grasses (*Saccharum* sp.) and from thickets of ferns. One female was collected at about 1600 h while crossing a forest path following a shower. The larval stages are unknown.

COMPARISONS

In the following section, the new species is compared with all known congeners, listing only opposing suite of characters.

Kalophrynus baluensis Kiew, 1984 (distribution: Mount Kinabalu, Sabah, East Malaysia [Borneo]), supratympanic fold absent; weak subarticular tubercles on toes; toe V with a single subarticular tubercle; toes unwebbed; raised fold between eyes; inguinal ocelli yellow bordered with black; and dorsum light brown with a dark brown mark, comprising closely-located blotches, running from snout to inguinal region; *K. bunguranus* (Günther, 1895) (distribution: Great Natuna Island, Indonesia; the Limbang, Sarawak [Borneo] record in Parker, 1934: 100, requires confirmation), male SVL 24.0 mm; female SVL 27.0 mm; snout as long as eye diameter; parotoid glands present; toes one-third webbed; subarticular tubercles indistinct; black inguinal spots in a light area; and dorsum dark brown with a light band around head that extends backwards to the inguinal region; *K. heterochirus* Boulenger, 1900 (distribution: Borneo), male SVL to 27.0 mm; female SVL to 30.0 mm; dorsum unpatterned dark brown; with (e.g., SSM 2174) or without (e.g., SSM 2175 and 2211) bluish-white inguinal spots; dorsum smooth, lacking dermal folds; finger IV with three subarticular tubercles; no outer metatarsal tubercle; webbing on toe IV to median subarticular tubercle; and dorsum orangish-brown, with a light line running from snout to inguinal region; *K. interlineatus* (Blyth, 1855) (distribution: south-eastern China [including Hainan], Myanmar, northern Thailand, Cambodia and Vietnam; although traditionally considered as a subspecies of *K. pleurostigma*, Matsui et al., 1996, showed that this taxon should be given specific status), male SVL to 47.7 mm; free portion of fifth toe longer than snout to nostril length; outer metatarsal tubercle absent; and dorsal pattern comprises a narrow line commencing from tip of snout; *K. intermedius* Inger, 1966 (distribution: northern Borneo, including Sarawak [East Malaysia] and Brunei Darussalam), male SVL to 27.0 mm; two subarticular tubercles under finger IV; snout obtuse; and inguinal ocellus absent; and dorsum brown or purplish-brown, unpatterned or with obscure dark markings; *K. menglienicus* Yang and Su, 1980 (distribution: south-eastern China), male SVL to 23.4 mm; toes free; a dark stripe from nostril to anterior corner of eye and from posterior corner of eye, along flanks, to inguinal region; and dorsum with scattered dark blotches; *K. minusculus* Iskandar, 1998 (distribution: Cieunteur, Ujung Kulon, Java, Indonesia), male SVL to 25.0 mm; paired axillary glands; gular region with lines; dorsum with a dark patch, diverging in the scapular region, to extend up to each inguinal region; and limbs with prominent dark bands; *K. nubicola* Dring, 1984 (distribution: Sarawak, East Malaysia [Borneo]), SVL to 24.4 mm; vocal sac with a slit-like opening; subarticular tubercles on digits indistinct or absent; third and fifth toes subequal; weak fleshy palmar web; inguinal ocellus absent; and ventrum with pale orange and blue markings; *K. palmatissimus* Kiew, 1984 (distribution: Negri Sembilan, Mekala, Peninsular Malaysia), tympanum indistinct; webbing on toe IV to beyond median subarticular tubercle; inguinal ocellus absent; outer metatarsal tubercle absent; and sole of feet with supernumerary spicules; *K. pleurostigma* (Tschudi, 1838) (distribution: southern China, Thailand, the Malay Peninsula, Natuna, Sumatra, Borneo and the Philippines islands of Leyte, Mindanao, Maripipi, Bohol and Camiguin; the Javanese populations require further study; fide Matsui et al., 1998), SVL to 52.0 mm; black ocellus in inguinal region; dorsum with scattered black spots; ventrum pale with scattered dark pigmentation, especially on throat; finger IV with two subarticular tubercles; outer metatarsal tubercle absent; webbing on toe IV to median subarticular tubercle as a broad web on both sides; supratympanic fold absent; and pale spinules on dorsum present; *K. punctatus* Peters, 1871 (distribution: Sarawak [East Malaysia] and Mount Semedum [Kalimantan, Indonesia] in Borneo and Sipora in the Mentawei Islands, Indonesia; the Siberut record requiring confirmation, Dring et al., ‘‘1989’’ 1990), male SVL to 27.0 mm; snout as long as eye diameter; tympanum partially obscured; fifth toe projecting beyond third; fingers II and IV subequal; toes one-third webbed; outer metarsal tubercle indistinct; and dorsum brown, with oblique pale lines on sides of head and flanks; *K. robinsoni* Smith, 1922 (distribution: Peninsular Malaysia), SVL to 18.0 mm; toes one-third webbed; a series of tubercles along dorso-lateral region, from eye to inguinal region; snout as long as eye diameter; subarticular tubercles indistinct; and dorsum light brown with dark brown markings, including a large linear one that diverges anteriorly to enter each upper eye lid, and posteriorly, to the two sides of the inguinal region; and *K. subterrestris* Inger, 1966 (distribution: Sarawak in northern Borneo), male SVL to 23.0 mm, female SVL to 27.0 mm; dorsum granular but lacking dermal folds; supratympanic fold absent; a single subarticular tubercle between palmar tubercle and tip of finger IV; dark brown dorsally, with scattered pale spots; pale inguinal spot; ventrum including throat dark, with scattered pale spots; subarticular tubercles on finger IV; and webbing on toe IV to median subarticular tubercle as a narrow sheath to inner and basal to outer aspect.

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APPENDIX I

List of comparative material examined

Kalophrynus heterochirus Boulenger, 1900. SSM 2174-75. Gunung Lumaku, Sipitang, 4,670 m, Sabah, East Malaysia (Borneo); SSM 2211. SFI Mendolong, 860 m, Sabah, East Malaysia (Borneo).

Kalophrynus interlineatus (Blyth, 1854). ZSI 9853 (holotype of *Engystoma* ? *interlineatum* Blyth, 1854), from “Pegu, Burma” (= Bago, southern Myanmar).

Kalophrynus intermedius Inger, 1966. UBD 448 and 473. Batu Apoi, Brunei Darussalam (Borneo).

Kalophrynus pleurostigma (Tschudi, 1838). ZRC 1.1763-64; ZRC 1.1705, 1.2935. Bukit Timah, Singapore; ZRC 1.1753. Endau Rompin Base Camp, Sungei Kinchin, Pahang, West Malaysia; ZRC 1.2733. Danum Valley Field Centre, Lahad Dato, Sabah, East Malaysia (Borneo); ZRC 1.1201. Sungei Madek, Johore, West Malaysia; ZRC 1.3170-71. Bako National Park, Sarawak, East Malaysia (Borneo); ZRC 1.3288. Seletar Forest, Singapore; SSM 1602, 1643, 1653, 1688. Hutan Simpan, Ulu Tongod, Telupid, Sabah, East Malaysia (Borneo); SSM 2267. Purulon, Tenom, Crocker Range, Sabah, East Malaysia (Borneo); SSM 591. Batu Putih, Kinabatangan, Sandakan, Sabah, East Malaysia (Borneo); SSM 714 and 718. Kampung Lawa, Mandou, Telipok, Sabah, East Malaysia (Borneo); SSM 2546. Hutan Simpan, Bukit Silam, Lahad Datu, 550 m, Sabah, East Malaysia (Borneo); SSM 1305. Gunung Lumaku, Sipitang, Sabah, East Malaysia (Borneo); SSM 1323 and 1373. Gunung Tawai, Telupid, 365 m, Sabah, East Malaysia (Borneo); SSM 2575. Hutan Simpan, Baturong/Kunak, 60 m, Sabah, East Malaysia (Borneo); UBD 41, 48, 197, 232, 361 and ZRC 1.3157. Batu Apoi, Brunei Darussalam (Borneo).

Kalophrynus subterrestris Inger, 1966. ZRC 1.3172. Telok Assam trail, Bako National Park, Sarawak, East Malaysia (Borneo); SSM 2403. Muruk Miau, Sabah, East Malaysia (Borneo).

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MOLECULAR AND KARYOLOGICAL DATA ON THE SOUTH ASIAN RANID GENERA *INDIRANA*, *NYCTIBATRACHUS* AND *NANNOPHRYS* (ANURA: RANIDAE)

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(with four text-figures)

ABSTRACT.– **Phylogenetic relationships of the endemic south Asian frogs of the genera *Indirana*, *Nyctibatrachus* and *Nannophrys* were studied using DNA sequences (a total of 880 bp) of the mitochondrial 16S and 12S rRNA genes. The topology of the obtained cladograms was largely unresolved, indicating a star-like radiation of the main ranid lineages. No molecular affinities were found between the south Asian taxa and Malagasy ranids. *Nannophrys* was positioned as sister group of *Euphlyctis* in all analyses. This grouping, which was supported by moderate to high bootstrap values, indicates that *Nannophrys* is an offshoot of Asian ranids, and not related to the South African cacosternines. Karyotypes were obtained for *Nannophrys ceylonensis* (2n = 26), *N. marmorata* (2n = 26), *Indirana* sp. (2n = 30) and *I.* cf. *leptodactyla* (2n = 24). The 2n = 30 karyotype of *Indirana* sp. was so far unknown in ranids; it may represent a transitory stage in a process of karyotype reduction by means of centric fissions which produce telocentric chromosomes, and their subsequent fusion.**

KEY WORDS.– **Amphibia: Ranidae: *Indirana*, *Nannophrys*, *Nyctibatrachus*; mitochondrial DNA; karyotypes; phylogeny; chromosomal evoloution.**

INTRODUCTION

The anuran family Ranidae is a speciose group (750 nominal species) of largely unsolved phylogenetic relationships. There is little agreement in the subfamilial partition of ranids, and different schemes have been proposed (e.g., Duellman and Trueb, 1986; Laurent, 1986; Dubois, 1992; Blommers-Schlösser, 1993). Relationships of three genera of ranids endemic to south Asia (India and Sri Lanka), *Indirana*, *Nyctibatrachus* and *Nannophrys*, are especially enigmatic (Blommers-Schlösser, 1993).

While *Nannophrys* has been revised by Clarke (1983) and Dutta and Manamendra-Arachchi (1996), no recent comprehensive works have focused on *Indirana* and *Nyctibatrachus*. Their phylogeny has so far only been adressed by Blommers-Schlösser (1993), and no karyological data are available on any of the three genera (King, 1990; Prakash, 1998). In the present paper, we present preliminary molecular data on their relationships, and describe the karyotypes of two species of *Indirana* and two species of *Nannophrys*.

MATERIALS AND METHODS

We sequenced fragments of the mitochondrial 16S and 12S rRNA genes homologous to bp 4012-4561 and bp 2544-2909 of the *Xenopus laevis* mt genome (Roe et al. 1985). Taxa studied

TABLE 1: List of specimens used for analysis, and of GenBank accession numbers of the sequenced fragments of the 16S and 12S rRNA genes. The 12S sequence of *Bufo asper* (marked with an asterisk) was obtained from GenBank. Museum acronyms used are MNHN (Muséum National d'Histoire Naturelle, Paris) and ZFMK (Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn). Subfamilial attribution of genera follows a modified consensus scheme of Dubois (1992) and Blommers-Schlösser (1993).

Family	Species	Origin	Collection number	Genbank 16S	Genbank 12S
Bufonidae	*Bufo asper*	Tanak Masa island, West Sumatra (16S)	-	AF124109	U52733*
Astylosternidae	*Scotobleps gabonicus*	Nlonako, Cameroon	ZFMK 69155	AF215341	AF215141
Ranidae	*Aglyptodactylus madagascariensis*	Andasibe, Madagascar	ZFMK 64137	AF215330	AF215179
Ranidae (Mantellinae)	*Mantidactylus grandisonae*	Ambato, Madagascar	ZFMK 66669	AF215315	AF215149
Ranidae (Cacosterninae)	*Cacosternum boettgeri*	Bredell, South Africa (12S); Hardap, Namibia (16S)	ZFMK 66727	AF215414	AF124096
Ranidae (Raninae)	*Conraua goliath*	Cameroon	ZFMK 64829	AF215388	AF215190
Ranidae (Raninae)	*Euphlyctis hexadactylus*	Unawatuna, Sri Lanka	-	AF215389	AF215191
Ranidae (Raninae)	*Limnonectes corrugatus*	Kandy, Sri Lanka	MNHN 2000.616	AF215393	AF215195
Ranidae (Raninae)	*Limnonectes limnocharis*	Laos	MNHN 1997.3932	AF215416	AF215210
Ranidae (Raninae)	*Limnonectes kuhli*	Laos	MNHN 1997.3904	AF215415	AF215209
Ranidae (Raninae)	*Nannophrys ceylonensis*	Kitulgala, Sri Lanka	MNHN 2000.627	AF215394	AF215197
Ranidae (Raninae)	*Nannophrys marmorata*	Laggalla, Sri Lanka	MNHN 2000.621	AF215395	AF215196
Ranidae (Raninae)	*Rana (Sylvirana) temporalis*	near Kodaikanal, India	ZFMK uncatalogued	AF215390	AF215192
Ranidae (Petropedetinae)	*Natalobatrachus bonebergi*	The Haven, South Africa	ZFMK 66443	AF215396	AF215198
Ranidae (Petropedetinae)	*Phrynobatrachus mababiensis*	Rundu, Namibia	ZFMK 68821	AF215399	AF215200
Ranidae (Petropedetinae)	*Phrynodon* sp.	Kodmin, Cameroon	ZFMK 67324	AF215400	AF215201
Ranidae (Ranixalinae)	*Indirana* cf. *leptodactyla*	near Ooty, India	ZFMK uncatalogued	AF215392	AF215194
Ranidae (Ranixalinae)	*Indirana* sp. (aff. *leptodactyla*)	Kodaikanal, India	ZFMK uncatalogued	AF215391	AF215193
Ranidae (Nyctibatrachinae)	*Nyctibatrachus major*	near Ooty, India	ZFMK uncatalogued	AF215397	AF215199
Ranidae (Rhacophorinae)	*Philautus* sp.	Kandy, Sri Lanka	MNHN 2000.623	AF215350	AF215182

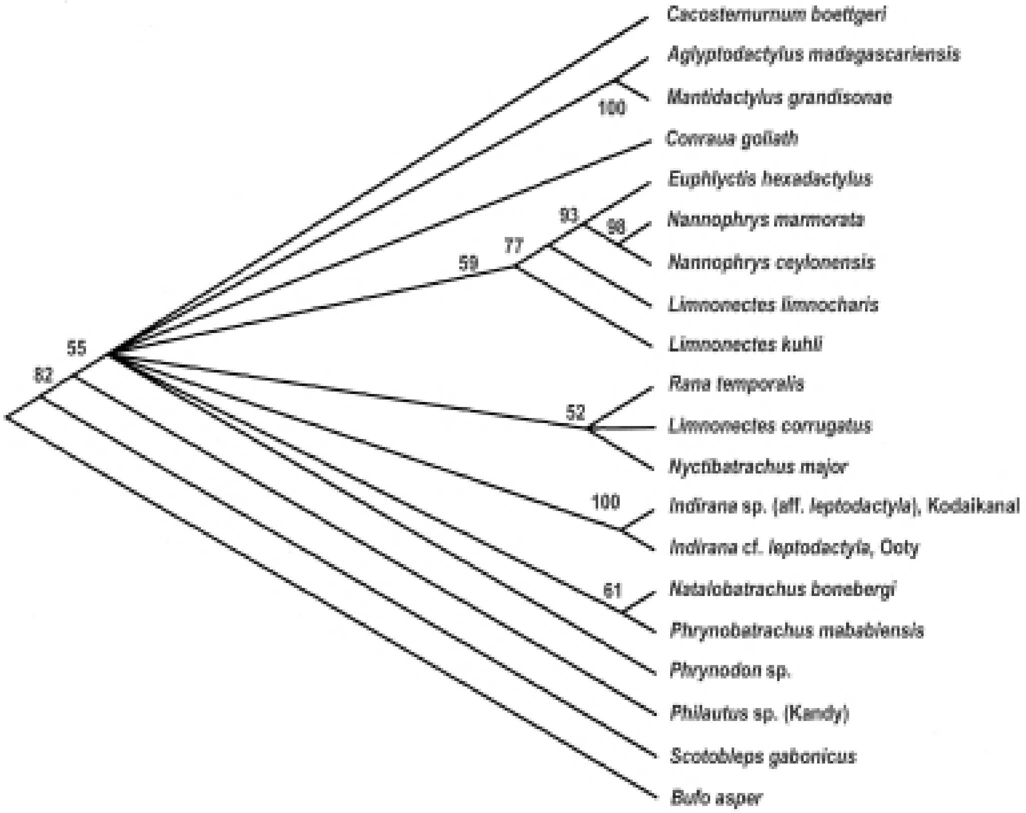

FIGURE 1: Neighbor-joining bootstrap consensus tree (HKY85-distances; shape factor 0.5) of south Asian taxa in comparison to African, Malagasy and Asian ranids, based on 509 bp of 16S rRNA and 371 bp of 12S rRNA gene sequences. Numbers are bootstrap values in percent (2000 replicates). *Bufo asper* was used as an outgroup.

are listed in Table 1. Details of primers, cycling protocols and methodology of analyses are given in Vences et al. (2000).

A female of each *Nannophrys ceylonenis* and *N. marmorata*, a female of *Indirana* cf. *leptodactyla*, and a male and a female of *Indirana* sp. (aff. *leptodactyla*, from Kodaikanal) were available for karyological analysis. Each specimen was injected with a dose (0.01 ml/g of body weight) of a 0.5 mg/ml colchicine solution and sacrificed two hours later, after anaesthesia with tricaine metasulfonate. Chromosomes were taken from intestine, spleen, lungs and (in males) testes, employing the air drying and scraping method described by Odierna et al. (1999). Standard chromosome staining was conducted by means of a solution of Giemsa 5% at pH 7. Of each specimen at least 25 metaphase plates were counted and 6 of them were karyotyped. Relative length (R.L.; percentage ratio between the length of each chromosome and the total lenght of all the chromosomes) and centromeric index (C.I.; ratio between the short arm and total length of a chromosome) were determined in all specimens. Chromosome nomenclature follows the specifications of Green and Session (1991).

RESULTS

Phylogenetic analysis of DNA sequences.- After exclusion of 54 bp of one hypervariable region of the 16S rRNA gene fragment, 509 bp of this fragment and 371 bp of the 12S fragment were available for analysis. The maximum parsimony (MP; not shown) and neighbor-joining (NJ) trees obtained show inconsistent topologies, and few lineages are corroborated by bootstrap values > 50% (Fig. 1). Position of some taxa appears to be

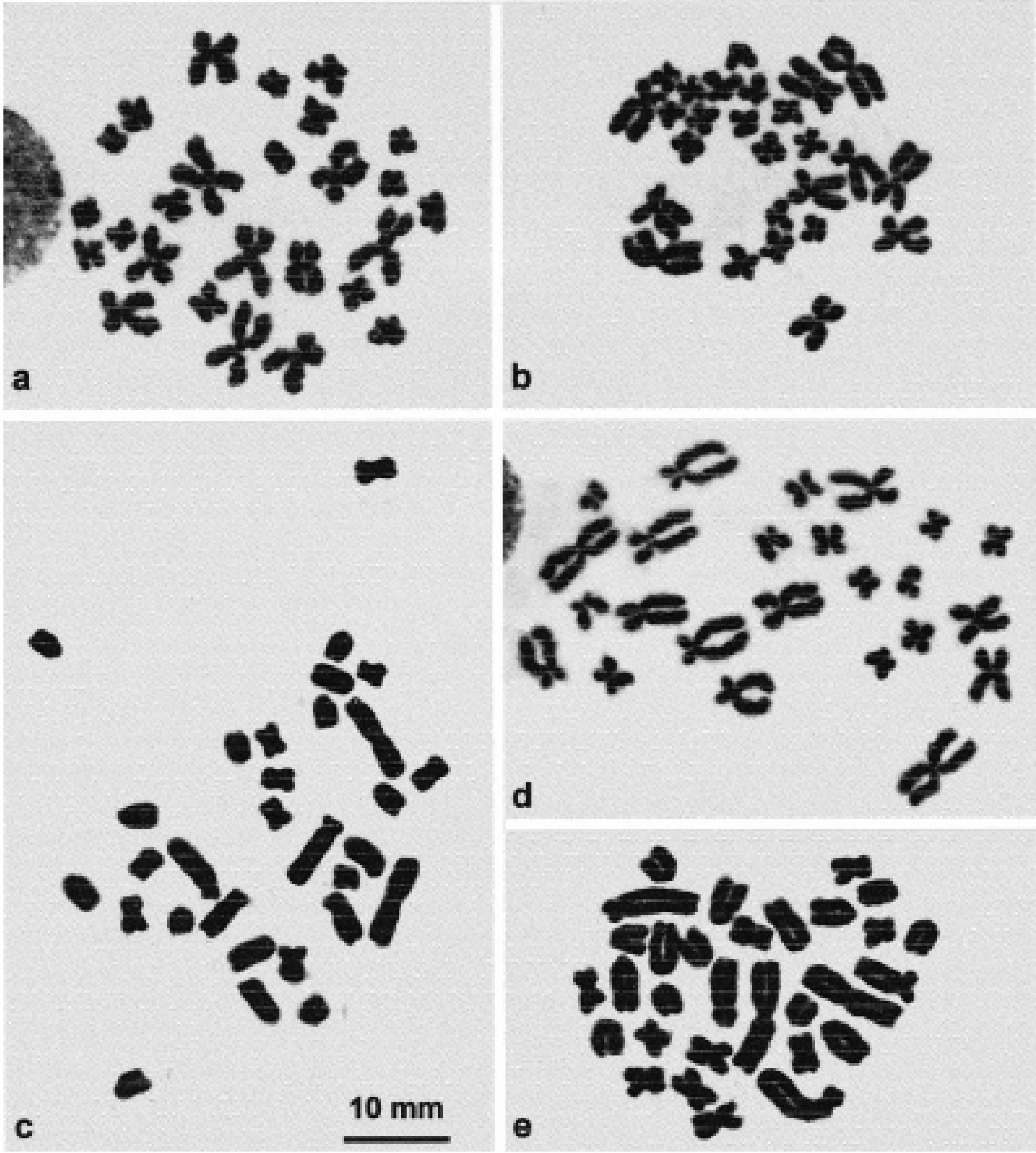

FIGURE 2: Giemsa stained metaphase plates of *Nannophrys ceylonensis* (**a**), *N. marmorata* (**b**), *Indirana* sp. (female) (**c**), *I.* cf. *leptodactyla* (**d**) and *I.* sp. (male) (**e**). The scale bar in **c** refers to all the images.

almost random in a comparison of the results based on different algorithms and different gene fragments. The three endemic south Asian genera are not arranged as monophylum in any cladogram. All trees agree in placing the two Malagasy ranids as monophyletic. The two species of *Nannophrys* are solidly positioned as monophylum in all analyses, as are the two species of *Indirana*. The single aspect of the topology informative regarding the position of the south Asian genera is the consistent clustering of *Nannophrys* with *Euphlyctis hexadactylus*. This monophyletic group is supported by the 16S data (bootstrap support: NJ 84%, MP 72%), the 12S data (NJ 58%, MP 50%), and the combined analysis (NJ 91%, MP 63%). No affinities between *Nannophrys* and the African Cacosternum were detected.

TABLE 2: Relative chromosome lengths (R.L.) and centromeric indices (C. I.) of specimens studied karyologically.

Chrom.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Indirana sp., male															
R.L.	14.2 ± 0.8	12.6 ± 0.6	9.5 ± 0.6	7.9 ± 0.7	7.0 ± 0.4	6.0 ± 0.8	5.6 ± 0.4	5.6 ± 0.9	5.1 ± 0.7	5.1 ± 0.6	5.0 ± 0.6	4.9 ± 0.7	4.7 ± 0.7	4.0 ± 0.6	3.8 ± 0.8
C.I.	48.5 ± 3.3	14.0 ± 4.4	23.2 ± 3.0	0	0	0	41.7 ± 4.4	46.5 ± 3.1	0	47.6 ± 3.6	0	41.9 ± 3.7	0	0	40.0 ± 4.4
Indirana sp., female															
R.L.	14.6 ± 0.5	12.9 ± 0.7	8.5 ± 0.8	8.3 ± 0.5	6.9 ± 0.4	6.4 ± 0.6	6.4 ± 0.8	6.3 ± 0.6	6.1 ± 0.4	5.4 ± 0.5	4.8 ± 0.4	4.8 ± 0.4	4.8 ± 0.5	4.8 ± 0.4	4.0 ± 0.4
C.I.	47.3 ± 3.5	13.0 ± 4.1	24.2 ± 3.2	0	0	0	45.0 ± 4.2	42.3 ± 3.5	0	47.4 ± 3.3	0	44.3 ± 3.2	0	0	38.5 ± 4.9
Indirana cf. *leptodactyla*, female															
R.L.	15.1 ± 0.8	12.9 ± 0.6	11.9 ± 0.6	12.2 ± 0.7	10.6 ± 0.4	9.4 ± 0.8	5.8 ± 0.4	5.0 ± 0.9	4.8 ± 0.7	4.8 ± 0.6	4.6 ± 0.6	3.9 ± 0.7	-	-	-
C.I.	43.2 ± 4.3	19.6 ± 4.0	36.6 ± 3.6	28.7 ± 3.5	20.2 ± 3.8	41.2 ± 4.6	39.8 ± 4.3	46.3 ± 3.7	31.8 ± 3.0	45.2 ± 3.2	49.1 ± 3.9	36.5 ± 4.0	-	-	-
Nannophrys ceylonensis, female															
R.L.	14.1 ± 0.7	13.9 ± 0.8	11.5 ± 0.5	11.2 ± 0.7	10.1 ± 0.9	6.2 ± 0.7	5.9 ± 0.6	5.2 ± 0.8	5.2 ± 0.5	4.4 ± 0.5	4.4 ± 0.8	4.1 ± 0.6	3.8 ± 0.8	-	-
C.I.	43.9 ± 3.8	39.5 ± 4.6	30.8 ± 4.0	34.9 ± 3.5	40.4 ± 4.0	33.2 ± 4.2	43.7 ± 3.3	47.9 ± 4.7	48.2 ± 4.0	35.5 ± 3.6	37.0 ± 3.8	40.5 ± 4.1	32.0 ± 3.7	-	-
Nannophrys marmorata, female															
R.L.	15.7 ± 0.5	13.4 ± 0.9	11.7 ± 0.7	11.0 ± 0.7	10.5 ± 0.6	5.5 ± 0.8	5.5 ± 0.5	4.9 ± 0.9	4.8 ± 0.6	4.4 ± 0.5	4.3 ± 0.7	4.2 ± 0.6	4.1 ± 0.6	-	-
C.I.	42.3 ± 3.1	39.9 ± 4.0	35.3 ± 3.6	40.3 ± 3.9	42.0 ± 3.8	36.5 ± 4.0	41.0 ± 3.8	42.0 ± 4.0	49.0 ± 4.4	37.0 ± 3.8	45.9 ± 4.1	42.2 ± 3.7	36.5 ± 3.9	-	-

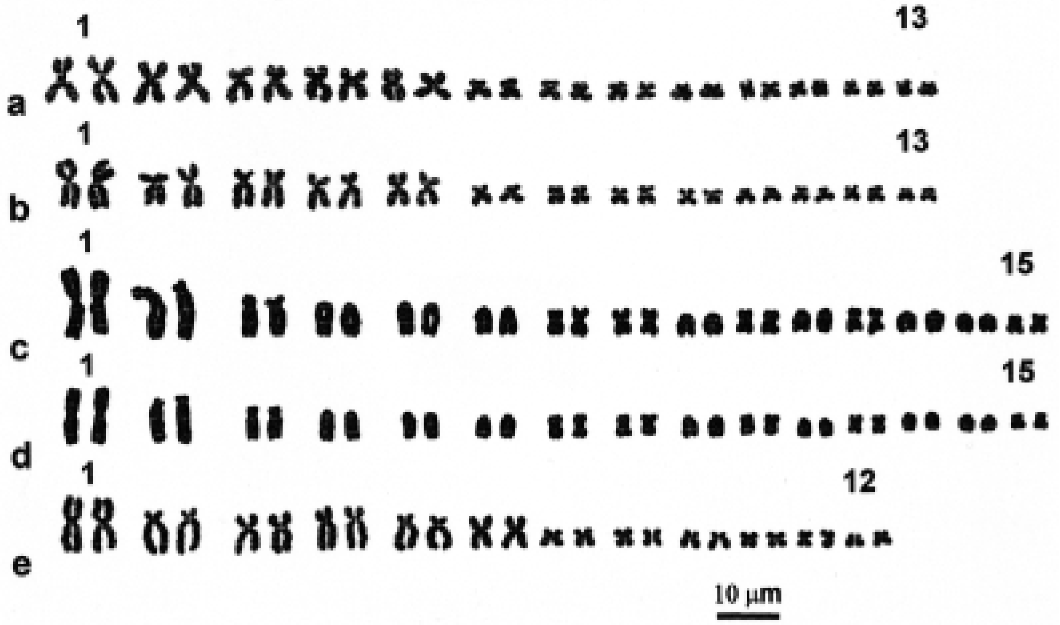

FIGURE 3: Karyotypes of *Nannophrys ceylonensis* (**a**), *N. marmorata* (**b**), *Indirana* sp. (male) (**c**), *I.* sp. (female) (**d**), and *I.* cf. *leptodactyla* (**e**).

Karyotypes.- Metaphase plates and karyotypes of the studied species are shown in Figs. 2-3. Relative chromosome lengths and centromeric indices are given in Table 2. *Nannophrys ceylonensis* and *N. marmorata* possess 2n = 26 biarmed chromosomes, with the first five pairs distinctively larger than the other eight pairs. Chromosome pairs 1, 2, 5, 7, 8, 9 and 12 of *N. ceylonensis* are metacentric, while the other six pairs are submetacentric. In *N. marmorata,* chromosome pairs 1, 2, 4, 5, 7, 8, 9, 11 and 12 are metacentric, while the other four pairs are submetacentric. *Indirana* sp. has 2n = 30 chromosomes, 16 are biarmed and 14 uniarmed. Chromosome pairs 1, 7, 8, 10, 12 and 15 are metacentric, pairs 2 and 3 are subtelocentric and pairs 4, 5, 6, 9, 11, 13 and 14 are telocentric. *Indirana* cf. *leptodactyla* has 2n = 24 biarmed chromosomes. The pairs 1-6 are distinctly larger than the pairs 7-12. Chromosome pairs 1, 7, 8, 10 and 11 are metacentric, pairs 3, 4 and 12 are submetacentric, pairs 2 and 5 are subtelocentric.

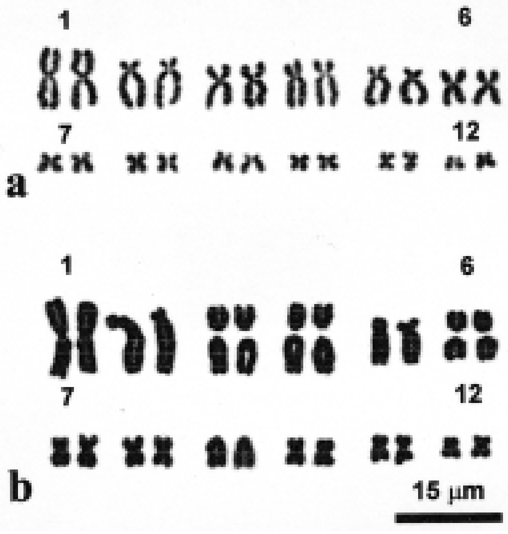

FIGURE 4: Chromosomes of *Indirana* sp. (**b**) arranged to show how three centric fusion events could give place to a karyotype of 2n = 24 chromososomes like that of *Indirana* cf. *leptodactyla* (**a**); in this case by forming the "new" chromosomes 3, 4, and 6.

DISCUSSION

Phylogenetic relationships.- The studied gene fragments do not adequately resolve the relationships between the taxa studied. The respective lineages may have similar ages, and possibly radiated in a relatively short period, rendering the phylogenetic signal in the analysed sequences weak. The lack of conspicuous molecular relationships between south Asian and Malagasy taxa indicates that it is not probable that both groups have a common ancestor which lived in isolation for at least 30 my on the Cretaceous Madagascar-India continent (see Barron et al., 1981; Duellman and Trueb, 1986; Blommers-Schlösser, 1993).

All MP and NJ analyses of the 16S, 12S, and combined data sets agreed in placing *Euphlyctis* as sister group of *Nannophrys*, in agreement with the generalized karyotype of both (2n = 26 according to King 1990; Prakash, 1998; and this study). Although the two genera may not be direct sister groups, they almost certainly are closely related to each other. This is surprising considering their morphological distinctiveness. However, most of the characters which make up the conspicuous general appearance of *Nannophrys* and of *Euphlyctis* are clearly related to their habits. *Euphlyctis* are largely aquatic species, mainly inhabiting lotic water bodies. In contrast, *Nannophrys* are highly derived (see Clarke, 1983), dorso-ventrally compressed anurans specialized for a life in humid crevices along brooks and in waterfalls. The molecular data suggest rejection of Blommers-Schlösser's (1993) inclusion of *Nannophrys* in her otherwise strictly African subfamily Cacosterninae, as well as of Dubois' (1992, 1999) proposal of inclusion of *Nannophrys, Nyctibatrachus* and *Indirana* in an endemic south Asian subfamily Ranixalinae.

Chromosomal evolution.- According to King (1990), the vast majority of ranid frogs have a karyotype of 2n = 26, with all chromosomes biarmed and the first five pairs distinctly larger than the remaining eight pairs. The two studied *Nannophrys* show this typical ranid karyotype. Differences between both species are found in the 4th and 11th chromosome pairs which are metacentric in *N. marmorata* and submetacentric in *N. ceylonensis*. Two pericentric inversions may account for these difference.

In contrast, the karyotype of the two studied *Indirana* species, displaying 24 or 30 chromosomes, deviates from the standard ranid karyological formula. A more reduced diploid number of 2n = 24 chromosomes as observed in *Indirana* cf. *leptodactyla* is known from a number of ranid groups, including petropedetines and some mantellines (King, 1990). Among the Raninae, it is found in all *Ptychadena* karyotyped so far, and in a few *Rana* and *Limnonectes*. On the other hand, the diploid number of 2n = 30, with uniarmed and biarmed chromosomes displayed by *Indirana* sp. is a novelty among the Raninae, and in the Ranidae this diploid number has so far been only found in a Malagasy *Mantidactylus* species, *M.* cf. *femoralis* (Aprea et al., 1998).

The 2n = 24 (or 22 or 20) biarmed chromosome karyotype is considered a derived condition from the 2n = 26 biarmed chromosome state (Morescalchi, 1981; Bogart and Tandy, 1981; Green, 1983). According to these authors this reduction could have occurred by means of a process involving (a) inversions of biarmed chromosomes to form telocentric chromosomes and (b) their subsequent fusion. This evolutionary model has been preferred over an alternative way to reach the reduction to 2n = 24 chromosomes, namely by (a) production of telocentric elements by means of fissions of metacentic elements, and (b) subsequent centric fusions of these new telocentric chromosomes. So far this alternative model suffered from the lack of Raninae species possessing transitional karyotypes with a diploid number higher than 2n = 26 chromosomes and telocentric elements. The karyotype of *Indirana* sp., with 2n = 30 chromosomes and 7 telocentric pairs, could represent a transitional state in the process of chromosome reduction. Three fusions involving six telocentric pairs could lead to a karyotype of 2n = 24 chromosomes as found in *I.* cf. *leptodactyla* (Fig. 4). Additionally, a pericentric inversion of one telocentric pair (tentatively the 9th pair, see also Fig. 4) not involved in centric fusions must also be assumed in this scenario. If it is true that *Indirana* species possess evolving karyotypes by means of centric fissions which produce telocentric chromosomes, and their subsequent fusions, such processes may also favour speciation events within the genus.

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RUSSELL'S VIPER: *DABOIA RUSSELII*, NOT *D. RUSSELLII*, DUE TO CLASSICAL LATIN RULES

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ABSTRACT.– **For over 100 years, Russell's Viper of south and south-east Asia has been known scientifically as *Vipera* (or *Daboia*) *russellii*. The name was first introduced in 1797 as *russelii*, after Patrick Russell, but was corrected in 1849 to correspond to the actual spelling of Russell's name. However, due to the conventions of Classical Latin, Russell is correctly Latinized to the nominative *russelius* and, thus, to the genitive case as *russelii*. As a result, a petition to the International Commission on Zoological Nomenclature to conform the name to Russell's own spelling would probably not be successful.**

KEY WORDS.– **Russell's Viper, *Daboia russelii*, Viperidae.**

INTRODUCTION

Russell's viper, currently known by the scientific name of *Daboia russelii* (although the accepted name for over a century was *Vipera russellii*) is the greatest hazard to humans of any snake in the world, causing thousands of deaths every year in India and elsewhere (Gopalakrishnakone and Chou, 1990). Therefore the proper spelling of its specific name merits more attention than might be the case for a less important species.

The problem of spelling of the specific name arose long ago in recognition that the species was named in honor of Patrick Russell (1726-1805), the first specialist on the snakes of India (Adler, 1989: 16-17). Yet the authors of the first scientific name (Shaw and Nodder, 1797) applied to the species named it *Coluber Russelii*, and Shaw continued to use that spelling in later works.

The first person to correct what appeared to be a misspelling of the specific name was Gray (1849), who also placed the name in its current nominal genus by applying the name *Daboia Russellii*. Strauch (1869) used the same spelling in being the first to place the species in the genus *Vipera*, designating it as *Vipera Russellii*.

In their original description, Shaw and Nodder stated that the species was named for "Dr. Patrick Russel," however, inasmuch as Patrick Russell always spelled his name with a terminal double *l*, correction of the original spelling *russelii* seems superficially to be incontrovertible. Therefore, most works subsequent to 1849 used Gray's "corrected" spelling, and it was defended in Zhao and Adler (1993: 278).

DISCUSSION

In recent years, the first to question Gray's correction of spelling was Dowling (1993), although he mistakenly believed that Russell spelled his name with a single *l*. David and Ineich (1999: 313-314) pointed out that the 1985 International Code of Zoological Nomenclature requires maintenance of the original spelling of a name if there is no internal evidence of error (Art. 32[c][ii]). Such internal evidence is lacking, and therefore according to the Code the spelling *russelii* could be changed only by action of the International Commission on Zoological Nomenclature (ICZN).

An appeal for such action would be based on the supposition that the spelling with a single *l* was simply a lapsus calami or a matter of ignorance of the proper spelling. On the contrary, it appears upon more careful examination that the spelling was correct in conforming with the custom at that time (perpetuated and officially required in subsequent editions of the Code, including Art. 11 of the 1999 edition) of Latinization of scientific names. As was the case for essentially all scientists of his time, Shaw was well trained in the use of classical languages, being originally trained for the clergy at Oxford (Adler, 1989: 17), and could write and read Latin and Greek almost as well as English. He therefore would be expected to create new scientific names with full knowledge of the rules for Latinization.

Shaw and Nodder correctly followed the rules of Classical Latin grammar (as summarized for example in Palmer, 1954: 211-214) in creating the name *russelii.* The single *l* in the spelling of the patronym was a product of the rule that some double consonants, such as *ll,* occur in Classical Latin only as secondary formations (Sihler, 1995: 196-224): either *assimilations* (conversion of a different adjacent consonant to the same consonant, like *st* to *tt*) or *syncopations* (omission of an adjacent syllable, like *koronela* becoming *korolla,* thence the English *corolla).* No such secondary formation was involved in evolution of the name Russell, hence conformance with Classical Latin rules requires the spelling of Russell's patronym with a single *l.* The double *s* in Russell's name, on the other hand, falls into a different category; some Latin words, like *russus* (red), were well established with double consonants as older or simpler secondary formations.

Shaw and Nodder had the option of choosing between the nominative endings *-us* or *-ius* for Russell's name (which would become *-i* or *-ii* respectively in the genitive, possessive case). They chose the longer ending, probably because patronymics were normally formed in Roman times with the *-ius* ending, seldom with the *-us* ending.

It should also be noted that in Shaw and Nodder (1797) and in Shaw's subsequent books, Patrick Russell's name in English was also spelled with a single *l.* While at first it might seem that Shaw misspelled Russell's English name and his use of *russelii* was a consequent inevitable result, this is probably not the case. It was common during the 15th through the 18th centuries to "correct" European names in accordance with their Latin versions, thus resulting in "Russel."

It is therefore clear that Patrick Russell's last name was correctly Latinized in formation of the patronym *Coluber russelii*. Thus, in all probability there is no chance that an appeal to alter Shaw and Nodder's spelling to *russellii* would be approved by the ICZN. This result leaves us with the awkward but irremediable situation in which the common (Russell's Viper) and scientific (*Daboia russelii*) names do not agree.

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A NEW GENUS OF GEOEMYDID TURTLE FROM ASIA

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(with one text-figure)

ABSTRACT.– **Phylogenetic analysis of mitochondrial gene sequence variation in geoemydid turtles suggests that the genus *Geoemyda* as currently recognized is polyphyletic, and that *Geoemyda yuwonoi* is the sister taxon to *Notochelys platynota* (but the two are highly genetically divergent). We herein place *Geoemyda yuwonoi* in a new monotypic genus, *Leucocephalon*, distinguished by its maxillary contact, its lack of a quadratojugal, its large anterior plastral buttresses, its humeropectoral seam posterior to the entoplastron, its long interanal seam, its primarily posteriorly directed neurals (distinctly configured), and its lack of a plastral hinge.**

KEY WORDS.– ***Geoemyda*, *Heosemys*, *Leucocephalon*, *Notochelys*, turtle, genus, Geoemydidae, systematics.**

INTRODUCTION

Although known in the pet trade for at least a decade, the distinctive Sulawesi Forest Turtle was formally described as *Geoemyda yuwonoi* by McCord et al. in 1995 based on specimens purchased from local people by Frank Yuwono in Gorontalo, northern Sulawesi (Indonesia). Subsequent to the original description, Yuwono's supplier on Sulawesi provided additional information which suggested that the type series apparently came from the area of Marisa (00º 14' N; 120º 10' E)(Fritz and Obst, 1999; Yuwono, pers. comm. to McCord, 2 August 2000). In any case, the natural occurrence of the species on northern Sulawesi was subsequently confirmed by Platt (1998), who field-collected specimens in a tributary creek of the Kanggol River (0° 35' N; 121° 02' E), 225 km west of the type locality and 225 km north of the second purchase site (Poso) reported by McCord et al. (1995).

McCord et al. (1995) performed a cladistic analysis of morphological characters for their new species along with those for taxa suspected to be closley related (*Cyclemys*, *Pyxidea*, and all forms placed in either *Geoemyda* or *Heosemys*). That analysis suggested that *yuwonoi* was a member of a clade including *Geoemyda spengleri*, *G. japonica, G. depressa*, *G. silvatica*, and *G. leytensis* (the last three of which have sometimes been included in the genus *Heosemys*; see reviews in Iverson, 1992), and that *Heosemys spinosa* (the type species of the genus) and *H. grandis* belonged to a separate clade. Based on this cladogram McCord et al. (1995) recommended that *yuwonoi* and the other members of its clade (except *Pyxidea*) be included in the genus *Geoemyda* until a more complete phylogenetic analysis of the Geoemydidae (sensu Bour and Dubois, in David 1994; formerly the Bataguridae) could be undertaken. However, Fritz and Obst (1996) described two additional specimens of *Geoemyda yuwonoi*, rejected the cladistic analysis in McCord et al. (1995) because it included characters prone to homoplasy, stressed the similarity between *yuwonoi* and *depressa*, and placed *yuwonoi* (and *depressa*) in the genus *Heosemys* (though without diagnoses).

Clearly there has been no consensus on the taxonomic or phylogenetic status of this complex of turtles. To settle this controversy, we have been accumulating tissues from geoemydid turtles since 1991 with the vision of one day providing a phylogenetic analysis of the entire family based on mitochondrial DNA sequence variation. Sequencing of the cytochrome *b* gene for all genera and 55 of the recognized species in the family has now been completed (Spinks, Shaffer, Iverson, and McCord, unpublished), and our results suggest that the genus *Geoemyda* as defined by McCord et al. (1995) is polyphyletic (Fig. 1). Furthermore, the Sulawesi Forest Turtle is so distinctive morphologically and genetically that we here describe a new genus for this taxon.

METHODS

We obtained blood and tissue samples for 83 specimens of geoemydid turtles (representing all recognized genera, 55 recognized species, and several anomalous, undescribed, and distinctive pet trade specimens) from the collection of William P. McCord (WPM). A tissue sample from the primitive tortoise *Manouria emys* provided by P. Vander Schow served as the outgroup. Whole genomic DNA was extracted from blood or muscle tissue via SDS/protease K digestion followed by phenol/chloroform extraction (Shaffer et al., 1997). Specific regions of the mitochondrial cytochrome *b* gene were amplified using Taq-mediated PCR and sequenced on an ABI 377 automated sequencer (Applied Biosystems) using primers developed from a subset of geoemydid taxa (available from the authors on request). In order to confirm the sequences, we sequenced each species in both directions. For sequences from individual species, overlapping sequences were aligned and edited using SeqEd (Applied Biosystems, Foster City, CA) and then the complete sequences of all individuals were aligned using ClustalW (Thompson et al., 1994). All sequences will be deposited in Genbank. Alignments were unambiguous, with no insertions or deletions detected.

RESULTS AND DISCUSSION

Our final data set consisted of 968 to 1139 nucleotides of the cytochrome *b* gene encompassing 85% to 100% of the gene. 521 nucleotide sites were parsimony-informative, 92 variable sites were parsimony-uninformative and 526 sites were constant across all taxa. Phylogenetic analyses were conducted under parsimony, using PAUP* 4.0b3a (provided by David L. Swofford) and, to assess statistical reliability, we bootstrapped our data set 100 times (Felsenstein, 1985). All characters were equally weighted and a heuristic search produced 126 equally parsimonious trees that were combined into a 50% majority rule consensus tree. The complete results of our phylogenetic analysis will be published separately; we here present only that part of the consenses tree relevant to the systematic position of *yuwonoi* (Fig. 1).Our phylogenetic analysis leaves little doubt that 1) the Sulawesi Forest Turtle is not closely related to other species currently or previously included in *Geoemyda* or *Heosemys* (genetic distance > 12%; Table 1), 2) it is most closely related to *Notochelys platynota* (though still 12% distant), 3) the genus *Geoemyda* should be restricted to *G. spengleri* (the type species) and *G. japonica*, and 4) in order to avoid paraphyly, *Hieremys annandalei* should perhaps be included in the genus *Heosemys* (as suggested earlier by Williams (in Loveridge and Williams, 1957), although that change should probably await a reexamination of the morphology. Unfortunately, we still lack sequence data for "*Geoemyda*" *leytensis* and "*G.*" *silvatica*, and thus their generic placement is uncertain. We therefore recommend that they tentatively be placed in the genus *Heosemys* as recommended by some (but not all) previous authors (review in Iverson, 1992).

SYSTEMATICS

LEUCOCEPHALON NEW GENUS

SULAWESI FOREST TURTLES

Geoemyda Gray 1834 (in part; see McCord et al., 1995).

Heosemys Stejneger 1902 (in part; see Fritz and Obst, 1996).

Type species.- *Geoemyda yuwonoi* McCord, Iverson & Boeadi, 1995.

Diagnosis.- A genus of geoemydid turtle that is distinguished by having the maxillae in con-

TABLE 1: Relevant portion of uncorrected (”p”) distance matrix for 83 geoemydids representing at least 55 species.

	Gj	Gs	Np	Ly	Ha	Hs	Hd
Geoemyda japonica	—						
Geoemyda spengleri	0.106	—					
Notochelys platynota	0.153	0.151	—				
Leucocephalon yuwonoi	0.157	0.152	0.123	—			
Hieremys annandalii	0.138	0.132	0.139	0.128	—		
Heosemys spinosa	0.137	0.140	0.133	0.134	0.097	—	
Heosemys depressa	0.149	0.141	0.133	0.133	0.091	0.090	—
Heosemys grandis	0.138	0.145	0.132	0.135	0.089	0.100	0.078
(3 specimens)	-0.143	-0.154	-0.147	-0.145	-0.095	-0.113	-0.084

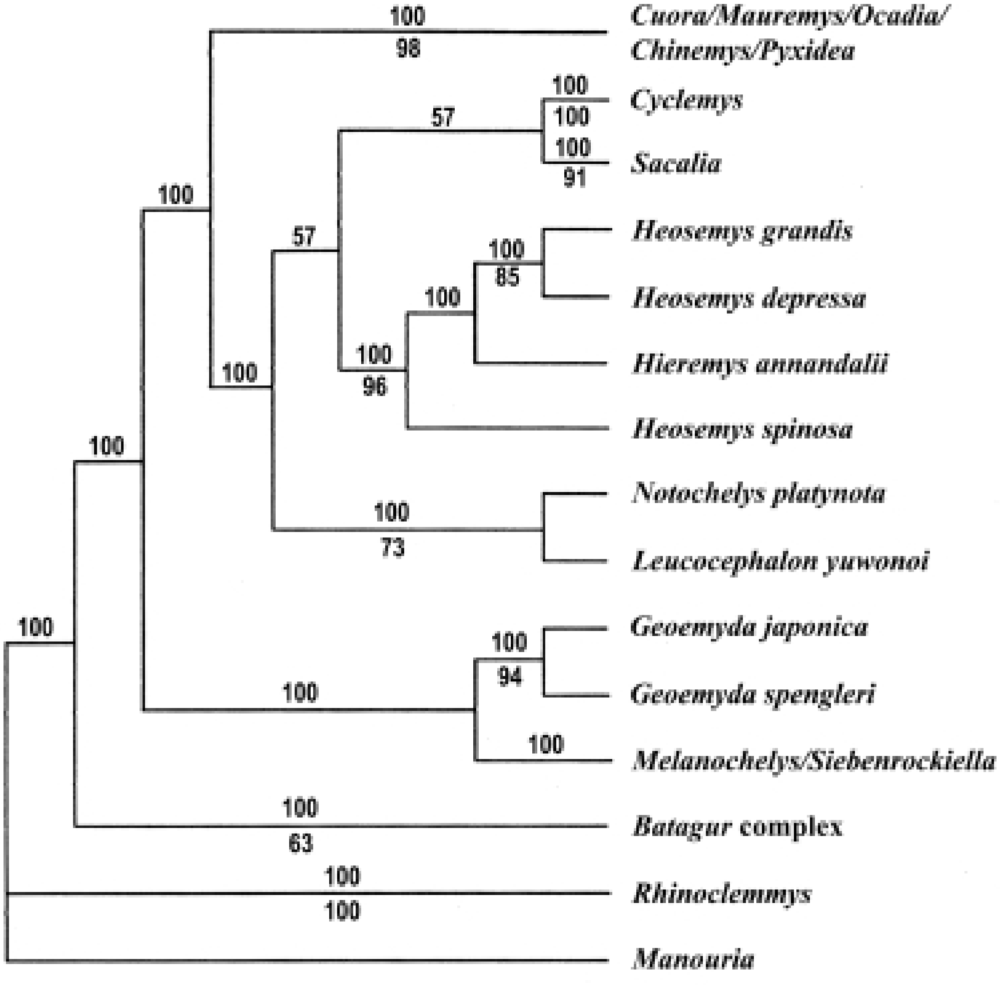

FIGURE 1: Majority rule consensus tree of relationships within the Geoemydidae as determined from parsimony analysis of mitochondrial DNA sequence data. Full cladogram (3457 steps; CI = 0.26) for 83 geoemydid specimens and one tortoise has been collapsed to focus on the genera most closely allied to *Leucocephalon yuwonoi*. Numbers above nodes are percent of shortest trees with this topology; numbers below nodes are percent bootstrap support (> 50%).

tact anteriorly (as in *Geoemyda* as defined here; separated by the premaxilla in *Notochelys* and all *Heosemys* but *H. silvatica*), lacking a quadratojugal (as in *Heosemys*; present in *Geoemyda* and *Notochelys*, though weakly attached in the latter; see McDowell 1964), having no plastral hinge in the adult (as in *Geoemyda* and *Heosemys*; a hinge between the hyo- and hypoplastron in *Notochelys*), having a solid bony bridge (as in *Geoemyda* and *Heosemys*; ligamentous in *Notochelys*), having large anterior plastral buttresses (almost no anterior buttresses in *Notochelys*; although both possess well-developed posterior buttresses, contrary to McDowell, 1964), having the plastral plane well below the plane of the margin of the carapace (as in *Geoemyda* and *Heosemys*; nearly in the same plane in *Notochelys*), having the humeropectoral seam posterior to entoplastron (the seam crossing the entoplastron in *Geoemyda*, *Notochelys*, and all *Heosemys* but *H. silvatica*), having the interanal seam (typically) as the longest plastral midline seam (the interabdominal seam is typically longest in *Notochelys*, *Heosemys*, and *Geoemyda*), having eight neural bones (nine in *Notochelys*) with the first five posteriorly directed and six-sided and the eighth anteriorly directed and six-sided (the first quadrangular, the second through seventh anteriorly directed and six-sided, and the eighth posteriorly directed and six-sided in *Notochelys*).

Description.- McCord et al. (1995) provided a full description of the species, including additional external morphological characters that diagnose the species, and hence, the genus. Table 1 in that publication also reviewed the morphological characters of each of the species currently or previously included in *Geoemyda* or *Heosemys*.

Content.- Includes only *Leucocephalon yuwonoi*.

Distribution and biogeography.- *Leucocephalon yuwonoi* is known only from northern Sulawesi, Indonesia, and is one of only two geoemydid turtles known east of Wallace's Line (Iverson, 1992). Its sister taxon, *Notochelys platynota*, occupies a complementary range on the larger Indonesian islands to the west (as well as on the mainland), suggesting a vicariant event. The close geologic and zoogeographic affinity of northern Sulawesi and Borneo (Audley-Charles et al., 1972; Auffenberg, 1980; Yoshii and Greenslade, 1993) also argues that *L. yuwonoi* evolved in isolation from the common ancestor of *Notochelys* and *Leucocephalon*.

Etymology.- From the Greek *leukos*, meaning white, and *kephale*, meaning head, referring to the sexually dimorphic white markings on the head of this species, which are more extensive and reach to the dorsum of the head in males.

Skeletal material examined.- *Leucocephalon yuwonoi*: PCHP 4984, 4669, 4949, 4657; UF 97335, 109835. *Notochelys platynota*: JBI uncatalogued (one specimen); PCHP 3649-50, 4594, 4698, 4939-40, 4961, uncatalogued (one specimen). Note that whole animals in this study include those recorded in McCord et al. (1995) and Iverson and McCord (1997), as well as 20 *Leucocephalon* and six *Notochelys* alive in the collection of WPM.

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SEA SNAKES OF NEW CALEDONIA AND SURROUNDING WATERS (SERPENTES: ELAPIDAE): FIRST REPORT ON THE OCCURRENCE OF *LAPEMIS CURTUS* AND DESCRIPTION OF A NEW SPECIES FROM THE GENUS *HYDROPHIS*

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(with three text-figures)

ABSTRACT.– **During an examination of all available New Caledonian *Hydrophis ornatus* from the Muséum national d'Histoire naturelle (Paris) collections, we found a specimen of *Lapemis curtus* included in the material. This is the first report of *L. curtus* from New Caledonia. Two additional specimens of the genus *Hydrophis*, acquired recently by MNHN from Chesterfield Reefs waters and an unknown locality, but certainly also from New Caledonian waters, are compared with congeneric species. Since they do not correspond to any described species in the genus *Hydrophis,* we describe them as a new species. The specimen with a known locality was collected by trawl most likely at a deep of 62 meters. The total number of sea snakes from New Caledonian waters is now 14 verified species and one unverified species. We suspect that several additional taxa present in Australian or Asian waters will be recorded from New Caledonia once more material becomes available.**

KEY WORDS.– **Serpentes, Hydrophiinae, Elapidae, *Lapemis curtus, Hydrophis laboutei* new species, Chesterfield Reefs, New Caledonia.**

INTRODUCTION

The most recent reviews of the sea snakes from Chesterfield Reefs, New Caledonia mainland and Loyalty Islands are by Minton and Dunson (1985), Bauer and Vindum (1990) and Ineich and Rasmussen (1997), giving a total of 13 species from that area (12 confirmed, one unconfirmed). We here report an additional species previously unrecorded from New Caledonia waters. We also recently examined two specimens of the genus *Hydrophis*, one collected close to Chesterfield Reefs and one also from New Caledonia waters, both donated to the Muséum national d'Histoire naturelle, Paris, by Pierre Laboute (IRD, formerly ORSTOM, Nouméa), that cannot be allocated to any currently-recognized taxon. They are therefore considered representative of a new species, which we describe below. With the new species the genus *Hydrophis* comprises 35 species (David and Ineich, 1999; Rasmussen et al., in press). In New Caledonia, Loyalty Islands, and Chesterfield Reefs the genus *Hydrophis* is represented by the new species and the following six species: *Hydrophis caerulescens,* the only species not confirmed by Bauer and Vindum (1990) and Ineich and Rasmussen, (1997), *H. coggeri*, *H. macdowelli*, *H. major*, *H. ornatus* and *H. spiralis*. The new species is described using external and internal morphological characters and is compared with congeners.

MATERIALS AND METHODS

All terminology and measurements follow Ineich and Rasmussen (1997), Rasmussen and Smith (1997) and Rasmussen et al. (in press).

The following abbreviations are used: the position of the posterior tip of the heart, the anterior tip of the liver and the distance between heart and liver were all determined in relation to the number of the adjacent ventral scales (VS-heart, VS-liver and VS-heart/liver, respectively). The relative positions of the posterior tip of the heart and the anterior part of the liver are expressed as a percentage of the total number of ventral scales (% VS-heart and % VS-liver, respectively). Vertebral counts were obtained from soft radiographs. Three counts were obtained from each snake: number of body vertebrae (VB-body), number of tail vertebrae (VB-tail), and number of vertebrae from the head to the posterior tip of the heart (VB-heart). The relative position of the posterior tip of the heart is expressed as a percentage of the total number of body vertebrae (% VB-heart). Body and tail were delimited by the first pair of forked ribs in the cloacal region; this pair of ribs is included in the number of tail vertebrae.

Institutional abbreviations follow Leviton et al. (1985). Specimens examined are listed in Appendix I.

RESULTS

First report of *Lapemis curtus* (Shaw, 1802) in New Caledonian waters.- Reexamination of the specimens of *Hydrophis ornatus* from New Caledonia (MNHN collections) in order to assess their systematic status revealed the presence of a specimen of *Lapemis curtus* misidentified as the former species by one of us (I.I.; see Ineich and Rasmussen, 1997). This specimen (MNHN 1994.3114, female) was collected in New Caledonia (without precise collection location) by Philippe Bourret (collection number 43; IRD, Nouméa), and has the following counts: one pre and one postocular on each sides, a total of five scales touching the eye on each sides. Eight supralabials on each sides. Supralabials one and two in contact with nasal, supralabials two and three in contact with prefrontal, supralabial three in contact with preocular, supralabials three and four in contact with the eye. Eleven and 12 infralabials on right and left sides, respectively, first and second in contact with anterior pair of sublinguals, which are well-developed and in contact with each other; second and third in contact with posterior pair of sublinguals. Thirty-five scale rows around neck, 39 scale rows around body, 33 scale rows around body counted 10 ventral scales before vent, 25 scale rows around mid-tail. Ventrals 198, preventrals 12. Subcaudals 39. Snout-vent length 60 cm, tail 8 cm. Bands on body 52, not extending downward on the greenish/yellow flank; seven dark bands on tail. All the characters mentioned above are in agreement with earlier descriptions of *Lapemis curtus* by Smith (1926) and Cogger (1975) (syn.: *L. hardwickii;* see Gritis and Voris, 1990). When preserved the specimen superficially resembles *H. ornatus* from New Caledonia; however, it can easily be distinguished from the latter by its smaller number of ventrals, elongated dorsal scales on the sides, and larger number of bands on the body. The rostral scale in *H. ornatus* is easily visible in dorsal view, whereas in *L. curtus* this plate is only weakly distinguishable in dorsal view.

According to the parietal scales patterns defined by Gritis and Voris (1990), our specimen (parietal pattern “c”) only shares affinities with the Indo-Australian populations and not with the Indian Ocean populations. Concerning anterior, midbody and posterior ventral patterns as defined by Gritis and Voris (1990), our specimen has the following pattern: “a”, “e” and “a”, respectively. However, it is difficult to attribute a single specimen to one geographical area because the differences between areas are based on statistically significant means. However, the pattern is in good agreement with other specimens from the Australian region.

Description of a new species.- Recently acquired additional material comprised two specimens referable to an undescribed species. The new species has a combination of characters that place it in the genus *Hydrophis* as defined by Smith (1926): maxillary bone not extending forward beyond the palatine; poison-fang followed, after a diastema, by 1-18 teeth; palatine straight; nostrils superior; nasal shields in contact with each other; head shields large, regular; and ventrals small, distinct throughout, and usually en-

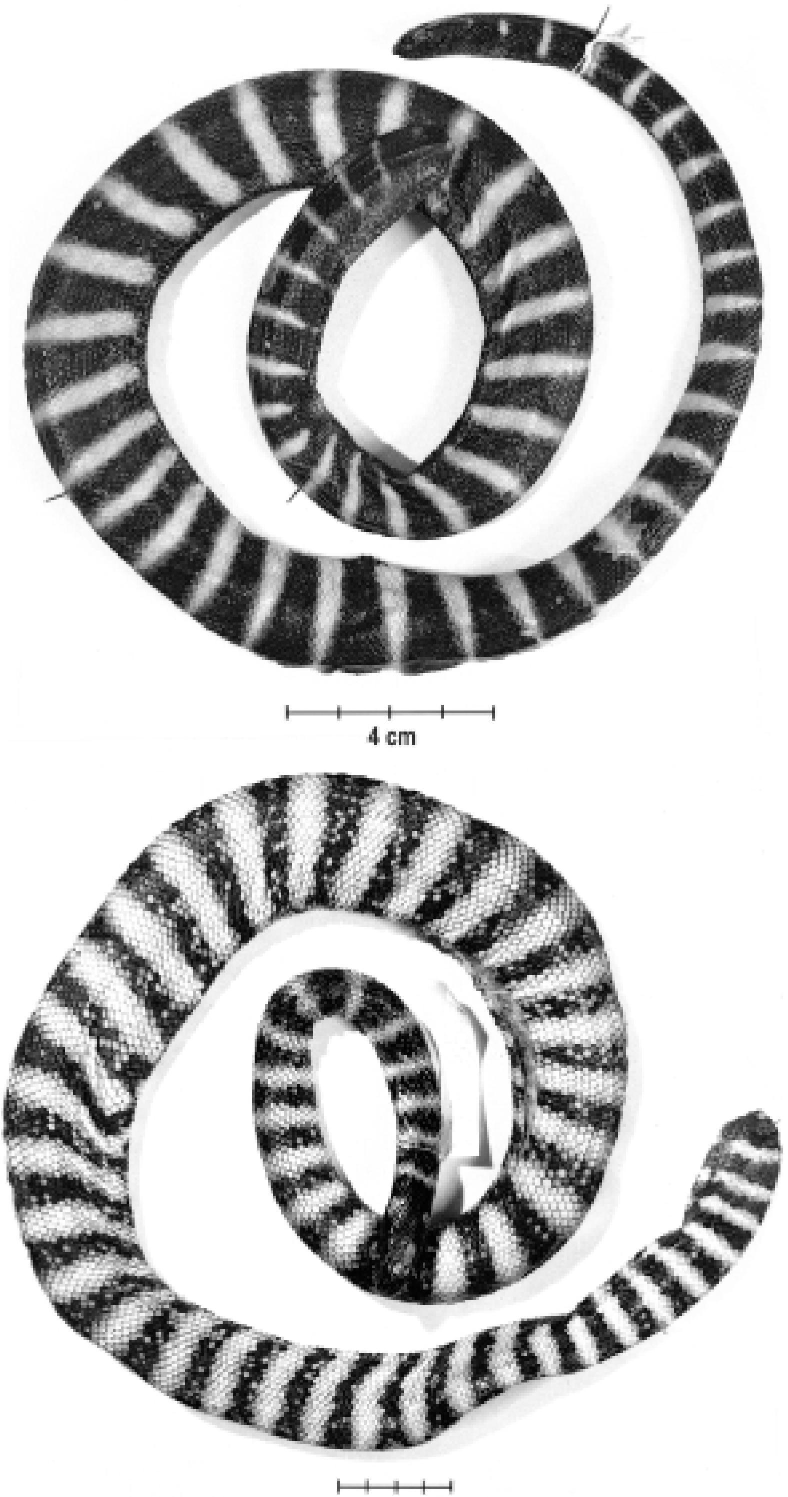

FIGURE 1: General view of *Hydrophis laboutei* (top: holotype, subadult; bottom: paratype, adult female); photo by G. Brovad.

FIGURE 2: Detail view of the holotype of *Hydrophis laboutei.* Left: ventral view of the head area; middle: right lateral head view; right: dorsal head view; photo by G. Brovad.

tire. McDowell (1972) recognized three subgenera in the genus *Hydrophis*; Rasmussen (1994) presented a cladistic analysis of one of them and his results indicated that this subgenus is paraphyletic. Based on McDowell's results, Kharin's (1984) proposal to raise the three subgenera to generic status was rejected (Rasmussen, 1994). For a more throughout review of sea snake systematics, see Rasmussen (1997). We surveyed the morphological variation in all the recognized species of the genus *Hydrophis* and concluded that the two specimens from New Caledonia waters represent an undescribed species. We propose this new species to be known as:

HYDROPHIS LABOUTEI SP. NOV.

FIGS. 1–2

Holotype.- Subadult male from Chesterfield Reefs, New Caledonia (20°21.98'S, 161°04.87'E), 22 July 1988, trawl, oceanographic campaign CORAIL 2, most likely caught at a deep of 62 meters as the diameter of the net entrance is considerably reduced on its way up and down, coll. Pierre Laboute (IRD, Nouméa), MNHN 1999.6574.

Diagnosis.- A species of *Hydrophis* with a gap of 8-16 ventrals between posterior tip of heart and anterior part of liver, 44-46 scale rows around body, 88-103 VS-heart, 186-187 vertebrae, and with first two or three black bands

TABLE 1: *Hydrophis laboutei* can be distinguished from the six other sympatric species of *Hydrophis* using a combination of external and internal characters. Meristic differences (gap) between *H. laboutei* and the listed species are given in parentheses. See Materials and Methods for abbreviations. Data are our own except for scales row on body and bands on body taken from Smith (1926), McDowell (1972), Cogger (1975), and Kharin (1983).

Species	Scale rows body (gap)	VS-heart (gap)	% VS-heart (gap)	VS-heart/liver (gap)	Bands body (gap)	VB-body (gap)
H. laboutei	44-46	88-103	33.2-36.9	8-16	45-46	186-187
H. caerulescens	41-54	112-154 (8)	39.5-45.7 (2.5)	0-6 (1)	36-60	183-194
H. coggeri	31-37(6)	117-143 (13)	47.7-51.0 (10.7)	0-3 (4)	24-35 (9)	192-214 (4)
H. macdowelli	37-44	78-106	33.1-36.5	0-3 (4)	29-36 (8)	185-193
H. major	37-45	87-118	38.6-44.0 (1.6)	0-2 (5)	24-35 (9)	172-178 (7)
H. ornatus	39-54	72-104	29.6-35.2	0-3 (4)	35-56	152-163 (22)
H. spiralis	33-38 (5)	149-182 (45)	45.2-50.1 (8.2)	0-3 (4)	34-54	218-228 (30)

TABLE 2: *Hydrophis laboutei* can be distinguished from five of the seven allopatric species found in the Australian region using only number of ventrals. Meristic differences (gap) between *H. laboutei* and the listed species are given in parentheses.

Species	Ventrals (gap)	References
H. laboutei	265-280	Our data
H. atriceps	323-453 (42)	Smith, 1926; Cogger et al., 1983
H. elegans	345-432 (64)	Cogger, 1975; our data
H. kingii	311-360 (30)	Our data
H. pacificus	320-430 (39)	Cogger, 1992
H. vorisi	331 (50)	McDowell, 1972; Kharin, 1984

TABLE 3: *Hydrophis laboutei* can be distinguished from six small-headed species found in Asia using only number of ventrals. Meristic differences (gap) between *H. laboutei* and the listed species are given in parentheses.

Species	Ventrals (gap)	References
H. laboutei	265-280	Our data
H. brookii	328-453 (47)	Smith, 1926; 1943
H. cantoris	404-468 (123)	Smith, 1926
H. fasciatus	410-514 (129)	Smith, 1926; our data
H. klosssi	360-430 (79)	Taylor, 1965; our data
H. parviceps	343-348 (62)	Taylor, 1963; our data
H. stricticollis	374-452 (93)	Smith, 1926

melting together with head dorsally. Remarks: *Hydrophis laboutei* differs from all other species of *Hydrophis* except *H. belcheri* and *H. bituberculatus* in number of ventrals between posterior tip of heart and anterior part of liver. *Hydrophis belcheri* can be separated from *H. laboutei* in having 34-37 scale rows around body and 108-130 VS-heart. *H. bituberculatus* can be separated from *H. laboutei* in having 163-183 vertebrae and the first bands not melting together dorsally. For more details see the “Discussion” section.

Description of holotype (Figs. 1-2).- Seven maxillary teeth behind poisonfang. One pre and two postoculars on right side, and one and three on left side. Seven supralabials on each side. Supralabials one and two in contact with nasal; supralabials two in contact with prefrontal; supralabials two and three in contact with preocular; supralabials three and four separated from eye on right side, in contact with eye on left side. Three anterior temporals on each side. Nine infralabials on each side, first and second in contact with anterior pair of sublinguals, which are well-developed and in contact with each other; small cuneated scales after second infralabials, dividing third and fourth infralabials, the cuneated scales were counted as infralabials (Fig. 2). Posterior pair of sublinguals are separated posteriorly by a small scale. Twenty-eight scale rows around neck, 46 scale rows around body, 37 scale rows around body counted 10 ventral scales before vent, 29 scale rows around mid-tail. Ventrals 280, distinct throughout, about 2.5 times as broad as adjacent scales. Subcaudals 39. Snout-vent length 54 cm, tail 7 cm. VS-heart 103, % VS-heart 36.8, VS-liver 112, % VS-liver 40, VS-heart/liver 8. VB-body 187, VB-tail 41, VB-heart 81, % VB-heart 43.3.

TABLE 4: *Hydrophis laboutei* can be distinguished from eight allopatric species using a combination of internal characters (our own data). Meristic differences (gap) between *H. laboutei* and the listed species are given in parentheses. *H.* sp. see Rasmussen et al. (in press) See Materials and Methods for abbreviations.

Species	VS-heart (gap)	% VS-heart (gap)	VB-body (gap)
H. laboutei	88-103	33.2-36.9	186-187
H. cyanocinctus	>114 (11)	>40.1 (3.1)	>214 (26)
H. mamillaris	127-146 (23)	40.5-45.9 (3.5)	188-195
H. melanocephalus	137-164 (33)	42.4-48.2 (5.4)	218-232 (30)
H. obscurus	143-174 (39)	47.9-52.9 (11)	209-229 (21)
H. semperi	136-166 (32)	43.1-49.2 (6.1)	205-221 (17)
H. sp.	108-109 (4)	41.2-42.1 (4.2)	164-167 (18)
H. torquatus	118-148 (14)	41.1-47.4 (4.1)	165-194

Colouration of holotype (in preservative).- Head black dorsally, with a weak light line over each eye, lighter ventrally. Body encircled by black bands, interspaces white, broadest on the flank, narrow dorsally and disappearing ventrally. First two black bands melting together with head dorsally, giving only white interspace on the flank. All ventral scales black, the bands merging together on the belly; tail with a black stripe both dorsally and ventrally, bands on flank of tail not corresponding with each other; 45 bands on body and seven bands on left side of tail and eight on right side. No spots or ocelli on body and tail.

Etymology.- The specific name is dedicated to the collector of the holotype, Pierre Laboute, a diver and submarine photographer at the French IRD research organization (Nouméa Station, New Caledonia).

Paratype.- MNHN 1999-6575, an adult female from an unknown locality, but certainly from the New Caledonian area, collected by an unknown collector and given to the MNHN collections by Pierre Laboute. This specimen was deposited in an office of the IRD research organization Nouméa (New Caledonia) several years ago.

Variation in paratype.- Nine palatine teeth, 17 pterygoid teeth, 17 dentary teeth and no maxillary process on palatine (Fig. 3). One pre and two postoculars on each side. Supralabials three and four in contact with eye. Two anterior temporals on right side and three anterior temporals on left side. Nine infralabials on each side, first, second and third in contact with anterior pair of sublinguals, which are well-developed and in contact with each other; third infralabial touching posterior pair of sublinguals, which are separated by small scales in the posterior part. Third infralabial elongated, parallel with two pairs of sublinguals. Fourth infralabial divided horizontally. Twenty-six scale rows around neck, 44 scale rows around body, 34 scale rows around body counted 10 ventral scales before

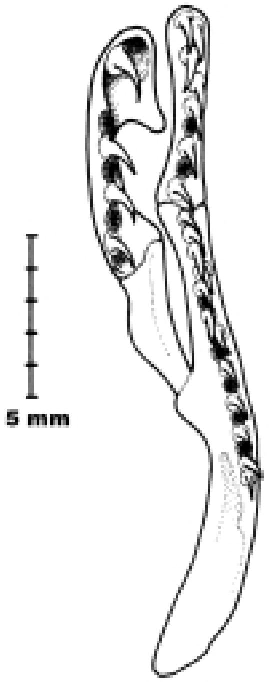

FIGURE 3: Ventral aspect of maxilla, ectopterygoid, palatine, and pterygoid of paratype of *Hydrophis laboutei* (MNHN 1999.6575); drawing by M. Andersen.

vent, 24 scale rows around mid-tail. Ventrals 265, distinct throughout, about twice as broad as adjacent scales. Subcaudals 38. Snout-vent length 98 cm, tail 10.5 cm. VS-heart 88, % VS-heart 33.2, VS-liver 105, % VS-liver 39.6, VS-heart/liver 16 ventrals. VB-body 186, VB-tail 38, VB-heart 82, % VB-heart 44.1.

Colouration of the paratype (in preservative).- Head black dorsally with dark green area on supralabials and lighter dark green area on rostral, mosaic of dark green and light green scales ventrally with a few white scales. Body encircled by black bands, white interspaces. Few white scales scattered in the black bands. Skin between scales black dorsally, lighter ventrally. Interspace between bands broadest on flank, narrowest ventrally. First three or four black bands melting together dorsally. Bands on body 46, bands on tail 8. No spots or ocelli on body and tail. All other aspects of external and internal characters are in agreement with those of the holotype.

Distribution.- One of our two specimens has a precise locality, Chesterfield Reefs. The second specimen is without a locality, but there are strong probabilities that it was collected from New Caledonian waters. Thus the known distribution of *H. laboutei* is at present restricted to Chesterfield Reefs, but the species is presumed to be present in other areas within the waters of New Caledonia.

DISCUSSION

Comparisons with sympatric species.- As mentioned above, six species of the genus are sympatric with *Hydrophis laboutei*: *H. caerulescens* (not confirmed), *H. coggeri, H. macdowelli, H. major, H. ornatus,* and *H. spiralis.* The sympatric species can be distinguished from *H. laboutei* using a combination of scale rows around body, VS-heart, % VS-heart, VS-heart/liver, bands on body and VB-body (table 1). In addition to features shown in table 1, *H. laboutei* can be separated from *H. caerulescens* and *H. ornatus* in having seven maxillary teeth (11-18 maxillary teeth in *H. caerulescens* and 9-13 maxillary teeth in *H. ornatus)*, from *H. coggeri* and *H. spiralis* in having 43.3-44.1% VB-heart (47.8-51.8 % VB-heart in *H. coggeri* and > 47.0% VB-heart in *H. spiralis*), from *H. macdowelli* and *H. major* in having no spots or ocelli on the body (*H. macdowelli* and *H. major* have either spots or ocelli on the flank).

Comparisons with species from the Australian region.- The following eight species are found in the Australian region but they are not sympatric with the new species *H. laboutei*: *H. atriceps*, *H. czeblukovi*, *H. elegans*, *H. gracilis*, *H. kingii, H. melanosoma*, *H. pacificus*, and *H. vorisi*. The new species is clearly distinct from the following five of the eight species mentioned above using only the number of ventrals (Table 2): *H. atriceps*, *H. elegans*, *H. kingii, H. pacificus*, and *H. vorisi*. The new species is easy to separate from *H. czeblukovi* in having 26-28 scale rows around the neck and 44-46 scale rows around the body (*H. czeblukovi* has 31-35 scale rows on the neck and 51-59 scale rows on the body (Kharin, 1983; Rasmussen and Smith, 1997)) and from *H. gracilis* which has the ventrals divided by a longitudinal furrow posteriorly (absent in *H. laboutei*), and from *H. melanosoma* in having 88-103 VS-heart and 186-187 VB-body (*H. melanosoma* has 126-150 VS-heart and 192-210 VB body.).

Comparison with species outside the Australian region.- The remaining 20 species in the genus *Hydrophis* are not found in the Australian region and are separated from *H. laboutei* using a combination of external and internal characters.

H. nigrocinctus and *H. walli* have only 0-3 maxillary teeth, *H. laboutei* has seven maxillary teeth. The following six small-headed species are easily separated from *H. laboutei* in having a much higher number of ventrals (Table 3): *H. brookii*, *H. cantoris*, *H. fasciatus*, *H. klossi*, *H. parviceps* and *H. stricticollis.*

The following seven species are separated from *H. laboutei* using a combination of VS-heart, % VS-heart and VB-body (Table 4): *H. cyanocinctus*, *H. mamillaris*, *H. melanocephalus*, *H. obscurus*, *H. semperi*, *H.* sp. (see Rasmussen et al., in press), and *H. torquatus* (all three subspecies are included).

H. lamberti and *H. inornatus* are separated from *H. laboutei* in having more than eight maxillary teeth (seven maxillary teeth in *H.*

laboutei), more than 34 scale rows around the neck (26-28 scale rows on the neck in *H. laboutei*), and less than 174 VB-body (186-188 VB-body in *H. laboutei*). Of the remaining three species, *H. lapemoides* is separated from *H. laboutei* in having 288-395 ventrals (265-280 ventrals in *H. laboutei*), 106-155 VS-heart (88-103 VS-heart in *H. laboutei*) and 8-13 maxillary teeth (7 maxillary teeth in *H. laboutei*).

The last two species, *H. belcheri* and *H. bituberculatus*, are in external and internal characters surprisingly close to *H. laboutei,* especially *H. bituberculatus,* despite that the latter is only known from Sri Lanka (holotype) and the Andaman Sea (Rasmussen, 1992), which is more than 10,000 km north-west of the Chesterfield Reefs. *Hydrophis belcheri* is found in New Guinea (holotype) and in the South China Sea (McCarthy and Warrell, 1991 ; our data). However, *H. laboutei* is distinct from *H. belcheri* in having 44-46 scale rows around the body (34-37 in *H. belcheri*), 88-103 VS-heart (106-126 in *H. belcheri*), cuneated scales at the oral margin between the infralabials (no cuneated scales in *H. belcheri*) and a black and white color pattern (light and dark yellow colour pattern in *H. belcheri*). *H. laboutei* is distinct from *H. bituberculatus* in having 186-187 VB-body (163-183 VB-body in *H. bituberculatus*), 38-39 subcaudals (41-52 subcaudals in *H. bituberculatus*), and a different colour pattern; the first two or three black bands melting together dorsally (Fig. 1 ; left and right interspace between the first two bands sometimes disconnected, both always present dorsally in *H. bituberculatus*; Rasmussen, 1992; Fig. 2).

Relationships.- Rasmussen (1994) analysed the subgenus *Chitulia,* including 13 species of the genus *Hydrophis*. In the analysis, *H. belcheri* and *H. bituberculatus* came out as sister groups and showed a vicariance pattern. One of the two apomorphic characters keeping the two species together is whether the vomer ring is complete or not (Rasmussen, 1994), however, it is not possible to identify this character without dissecting the skull fully, which is also the case for most of the other characters used in this analysis (Rasmussen, 1994). The other character indicating this small group as monophyletic is the number of dentary teeth which are less than 21 (Rasmussen, 1994). *Hydrophis laboutei* has also less than 21 teeth on the dentary bone, sharing this apomorphic character with *H. belcheri* and *H. bituberculatus.* All other external and internal character states which have been possible to identify without dissecting the skull completely are also shared between *H. laboutei*, *H. belcheri* and *H. bituberculatus,* indicating a monophyletic group. None of the three species are sympatric, but *H. laboutei* fits into the vicariance pattern shown by the two other species.

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APPENDIX I

Examined specimens.- For other specimens examined see Rasmussen, 1989, 1992, 1993, 1994 ; Ineich and Rasmussen, 1997, Rasmussen and Smith, 1997; Rasmussen et al., in press. *Hydrophis cyanocinctus*-complex BMNH 1946.1.9.23 (type), ZMUC 6625, 66211, 66299, 66300, 66365-66, 66363, 66671-79, 66683-85. *H. elegans*-complex BMNH 1946.1.3.89 (type), 70.11.30, 74.8.11.14, AMS 13127, 25834, 26365, 33362, 41866, 44618, 54978, 54983, 121206-07, CAS 103022, USNM 213475-77. *H. macdowelli* MCZ 137487,137512. *H. pacificus* MCZ 142394-98. *H. spiralis* BMNH 1946.1.6.94 (type), 79.8.15.37, 61.10.11.45, USNM 129751, 159786, ZMUC R 66549-586, 66819-849. *H. stricticollis* BMNH 1908.6.23.80-84, 68.4.3.41. *H. vorisi* MCZ 141279.

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CATALOGUE OF AMPHIBIAN TYPES IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA

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ABSTRACT.– The amphibian types in the collection of the National Zoological Collection, maintained by the Zoological Survey of India (ZSI), Kolkata (Calcutta), as well as those held by the regional stations at Dehra Dun and Chennai, are listed, up to 1 September 2000. The list includes many historical specimens collected and/or described by pioneering European naturalists, including Edward Blyth, Thomas Jerdon, William Blanford, William Theobald, Ferdinand Stoliczka, Nelson Annandale, and John Anderson, as well as those more recently described from expeditions to the Nicobar Islands, Arunachal Pradesh and Kerala, by the staff of the ZSI during the present century. The annotated list includes original citations, registration numbers, nature of types, and present status of every taxon. Additional remarks are provided where necessary. A total of 346 type specimens of amphibians are represented, including those representing 105 anuran species, one caudate species and nine apodan species, from Pakistan, India, Sri Lanka, Myanmar, China, Malaysia, and Indonesia. Syntypes from the original type series of two name-bearing taxa have lost their type status through the designation of lectotypes. In addition, the types of 39 name-bearing taxa described by the staff and members of the Asiatic Society of Bengal cannot be located in the ZSI collection.

KEYWORDS.– Zoological Survey of India, systematic collection, amphibians, type specimens, type catalogue, south Asia, herpetology.

INTRODUCTION

The history of the herpetological collections of the Zoological Survey of India (ZSI) has been recently traced by Das et al. (1998), who compiled a list of the reptile types in the collection. The amphibian types in the same collection, which have great historical value too, had remained neglected for over a century. The first effort to prepare a catalogue of the herpetological holdings, including a listing of the then extant types, was that of William Theobald (1868), staff member of the Geological Survey of India, then based in Burma (now Myanmar). Prepared during a visit to Calcutta (at present, Kolkata) by Theobald, this work was criticized for the omission of several important types of amphibians described by Edward Blyth, a former Curator, by the then Superintendent, Anderson (1871b). Although a rebuttal followed (see Theobald, 1873), this presumably was the cause of bitterness between the two in the years to follow (see Iverson and McCord, 1997).

The last catalogue of the amphibians was the one by Sclater (1892b). The present catalogue of the amphibian types of the ZSI includes not only the holdings of the National Zoological Collection, Kolkata, but also those in the regional stations at Dehra Dun and and Chennai, up to 1 September 2000. Also appended is a list of amphibian names established by members and staff of the Asiatic Society of Bengal or the inheritor of its zoological collections, the Indian Museum), whose types are at present not traced in the ZSI collection.

Pioneering European naturalists who were associated with the amphibian collection and/or descriptions based on material that are at present in the ZSI include Edward Blyth (1810-1873), Thomas Claverhill Jerdon (1811-1872), Edward Frederick Kelaart (1819-1860), John Anderson (1833-1900), William Thomas Blanford (1832-1905), William Theobald (1829-1908), Ferdinand Stoliczka (1838-1874), and Thomas Nelson Annandale (1876-1924), who collected from all over southern Asia, and often, well beyond. A few types of southern Chinese and south-east Asian amphibians were received in exchange with European museums (Dresden and London) at the turn of the century. More recently, collections have been made during expeditions to the Nicobar Islands, Arunachal Pradesh, and Kerala, by the staff of the ZSI, as well as systematicists attached to other institutions.

For each name-bearing type of amphibian, we provide the original name (retaining the original orthography), authority (with reference), registration (and when available, field) number, nature of type, type locality (within quotes, when taken from the original description; without quotes if this information is based on the museum register or other data sources), current systematic status, and where appropriate, additional systematic and/or nomenclatural remarks. In all, 346 primary and secondary types are represented (96 anurans, one caudate and nine apodans), including 65 holotypes, 115 syntypes, and 166 paratypes, representing 105 name-bearing taxa (including 96 anurans, one caudate and nine apodans). The geographical coverage of the type collection includes Pakistan, India, Sri Lanka, Myanmar, China, Malaysia, and Indonesia. The types of 39 name-bearing taxa cannot be located in the ZSI collection at present.

ABBREVIATIONS USED

Institutional abbreviations used in the present catalogue are listed below. Those listed in Leviton et al. (1985) are marked with an asterisk.

BMNH*- The Natural History Museum, London, London, U.K.

BNHM*- Bombay Natural History Society, Mumbai, India.

IMRR*- Indian Museum Reptile Registry, at present ZSI (see below).

FMNH*- Field Museum of Natural History, Chicago, USA.

KIZ*- Kunming Institute of Zoology, Kunming, People's Republic of China.

KU*- University of Kansas, Natural History Museum, Lawrence, Kansas, U.S.A.

MCZ*- Museum of Comparative Zoology, Harvard University, Cambridge, MA, U.S.A.

MNHN*- Museum National d'Histoire Naturelle, Paris, France.

MSNG*- Museo Civico di Storia Naturale di Genova, Genova, Italy.

MTKD*- Staatliches Museum für Tierkunde, Dresden, Germany.

NMW*- Naturistorisches Museum Wien, Vienna, Austria.

USNM*- National Museum of Natural History, Washington, D.C., U.S.A.

WII- Museum of the Wildlife Institute of India, Dehra Dun, India.

ZMB*- Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin, Germany.

ZSI*- Zoological Survey of India, Kolkata, India. Regional stations of the ZSI with holdings of amphibian types include Chennai (Southern Regional Station; SRS) and Dehra Dun (Northern Regional Station; NRS). The amphibian types of the ZSI Shillong (Eastern Regional Station; ERS) have already been amalgamated with the ZSI National Zoological Collection.

ZSP*- Zoological Survey Department, Karachi, Pakistan.

In addition, 'The Code' refers to the Fourth Edition of the International Code of Zoological Nomenclature (International Commission of Zoological Nomenclature, 1999).

CATALOGUE OF AMPHIBIAN TYPES

MEGOPHRYIDAE

Bombinator sikimmensis Blyth, 1854. *J. Asiatic Soc. Bengal* 23(3): 300.

Types: ZSI 9854-55 (two syntypes from the original series; see below); type locality not given in the original description, although the species name makes it evident that the provenance of the syntypes was Sikkim. Theobald (1868) formally restricted the type locality to "Sikkim" (in Sikkim State, eastern India).

Current status: *Scutiger sikimmensis* (Blyth, 1854).

Remarks: Dubois ("1986" 1987: 20) designated the neotype, BMNH 1887.11.2.25, from "Byutan, foot of Yakla Pass, Sikkim" (in eastern India). Article 75.8 of the Code sets aside the designation.

Megalophrys gigas Blyth, 1854. *J. Asiatic Soc. Bengal* 23(3): 299.

Types: ZSI 9577-79 (three syntypes), from "Sikim" (= Sikkim State, eastern India).

Current status: Subjective synonym of *Paa liebigii* (Günther, 1860).

Remarks: See Theobald (1873) for remarks on the types. Synonymy follows Dubois (1976).

Megalophrys kempii Annandale, 1912. *Rec. Indian Mus.* 8(1): 20.

Type: ZSI 17013 (holotype), from "Upper Rotung (2,000 ft)" (in the Abor Hills, Arunachal Pradesh, north-eastern India).

Current status: *Megophrys kempii* (Annandale, 1912).

Remarks: Treated as synonymous with *Megophrys boettgeri* (Boulenger, 1899) by Gorham (1974: 42), although listed as valid by Zhao and Adler (1993: 118), Dutta (1997b: 36-37) and Fei (1999: 116-117). The first two works discussed the taxonomic problems surrounding this species.

Scutiger mokokchungensis Das & Chanda, 2000:

Type: ZSI A 8889 (holotype), from "Mokokchung (26° 20'N; 94° 30'E), alt. ca. 1200 m above msl., Nagaland State, north-eastern India".

Current status: *Scutiger mokokchungensis* Das & Chanda, 2000.

Xenophrys gigas Jerdon, 1870. *Proc. Asiatic Soc. Bengal* 1870(3): 85.

Types: ZSI 9670, 9681, 10777, 10779 (four syntypes), from "Darjeeling" (in West Bengal State, eastern India).

Current status: *Megophrys major* (Boulenger, 1908).

Remarks: *Megophrys major* (Boulenger, 1908) is a replacement name for *Xenophrys gigas* Jerdon, 1870, which is preoccupied by *Megalophrys gigas* Blyth, 1854. Taylor (1962: 302) included *Xenophrys gigas* Jerdon, 1870 in the synonymy of *Megophrys major* (Boulenger, 1908), although Gorham (1974: 43) treated it as a synonym of *Megophrys lateralis* (Anderson, 1871a).

BUFONIDAE

Ansonia kamblei Ravichandran & Pillai, 1990. *Rec. Zool. Surv. India* 86(3-4): 506.

Type: ZSI/SRS Chennai V198 (holotype), from "Jeur, 29 Km north of Tembhurni, Karnala" (in Sholapur, Maharashtra State, western India).

Current status: Subjective synonym of *Bufo melanostictus* Schneider, 1799.

Remarks: Synonymy follows Dubois and Ohler (1999).

Ansonia meghalayana Yazdani & Chanda, 1971. *J. Assam Sci. Soc.* 14(1): 76.

Types: ZSI A6969 (holotype), ZSI A6970 (paratype), from "Mawblang, about 5 kms…from Cherrapunji" (in the Khasi Hills, Meghalaya, in north-eastern India).

Current status: *Bufoides meghalayana* (Yazdani & Chanda, 1971).

Remarks: Removed to the newly-established genus *Bufoides* by Pillai and Yazdani (1973).

Ansonia Penangensis Stoliczka, 1870a. *Proc. Asiatic Soc. Bengal* 1870(4): 104.

Types: ZSI 2717-18, ZSI 3585-86 (four syntypes), from "Penang hill" (= Pinang Hill, Pulau Pinang, West Malaysia). According to the original description, two of the syntypes were from "..above Alexandra bath", two from "..about half way up the Penang hill".

Current status: *Ansonia penangensis* Stoliczka, 1870.

Remarks: Sclater (1892b: 27) lists IMRR (= ZSI) 3585-6 as the types. Although Stoliczka (1870b) is generally considered to be the original citation for the name, Das (2000) showed that the name was validly published in Stoliczka (1870a).

Ansonia rubigina Pillai & Pattabiraman, 1981. *Proc. Indian Acad. Sci. (Anim. Sci.)* 90B(2): 203; 1 pl.

Types: ZSI/SRS Chennai VA/775 (holotype), from "Kummatan Thodu, a tributary of River Kunthi, Silent Valley, S. India, Altitude 1005 metres"; ZSI Chennai VA/776 (paratype), from "Kummatan Thodu….Altitude 1000 metres".

Current status: *Ansonia rubigina* Pillai & Pattabiraman, 1981.

Remarks: Erroneously spelt *Ansonia rubrigina* in Frost (1985).

Bufo camortensis Mansukhani & Sarkar, 1980. *Bull. Zool. Surv. India* 3(1 & 2): 97; Pl. III.

Types: ZSI A6955 (holotype), from "Camorta Guest House, Camorta, Andaman and Nicobar Islands, India"; ZSI A6956-62 (14 paratypes), from "Camorta" (in the central Nicobars, Bay of Bengal, India); ZSI A6963-65 (three paratypes), from "Nancowry" (in the central Nicobars, Bay of Bengal, India). The original description mentions of four further paratypes from "Camorta" (in the central Nicobars, Bay of Bengal, India), but these cannot be located at present.

Current status: Subjective synonym of *Bufo melanostictus* Schneider, 1799.

Remarks: Crombie (1986) drew attention to the availability of the name *Bufo spinipes* Fitzinger in: Steindachner, 1867, for populations from the central Nicobars, should it prove specifically different. However, Dubois and Ohler (1999) showed that the author of the name *camortensis* is Steindachner (1867).

Bufo koynayensis Soman, 1963. *J. Biol. Sci., Bombay* 6(2): 73.

Type: ZSI A1784 (holotype), from "Humbali Village" in "Shivaji Sagar lake at Koyna, in Satara District, Maharashtra" (in western India).

Current status: *Bufo koynayensis* Soman, 1963.

Remarks: Paratypes include BMNH 1963.938-39, FMNH 197992 (formerly BMNH 1963.940) and USNM 166954-55.

Bufo olivaceus Blanford, 1874. *Ann. & Mag. nat. Hist. Ser. 4* 14: 35.

Types: ZSI 3523 (syntype), from Dasht River, Balochistan, north-western Pakistan; ZSI 3524 (syntype), from Ghistigan, Balochistan, north-western Pakistan; ZSI 3525 (syntype), from Bahu Kelat, Balochistan, north-western Pakistan. The type locality in the original description is given as "in Gedrosia".

Current status: *Bufo olivaceus* Blanford, 1874.

Remarks: An additional syntype is BMNH 1947.2.20.93 (formerly BMNH 74.11.23.122; fide Frost, 1985: 55). Minton (1966) and Eiselt and Schmidler (1973) suggested that *Bufo olivaceus* may eventually prove to be a geographic race of the more widespread *B. stomaticus* Lütken, 1863. A study of the geographic variation in these taxa by Auffenberg and Rehman (1997) concluded that both nominal taxa are valid.

Bufo parvus Boulenger, 1887. *Ann. & Mag. nat. Hist. Ser. 5* 19: 346; Pl. X.

Types: ZSI 15196-97 (two syntypes; see 'Remarks'), from "..within a radius of fifty miles from the town of Malacca" (= Melaka, West Malaysia).

Current status: *Bufo parvus* Boulenger, 1887.

Remarks: Additional syntypes are BMNH 1947.2.21.72-82 (formerly BMNH 86.12.28.42-51); MCZ 2208, MNHN 1887.0123 (four syntypes; fide Dubois and Ohler, 1999: 170; Frost, 1985: 56 and Iskandar, 1998: 46). Capocaccia (1957) invalidly (see Dubois and Ohler, 1999: 170) designated MSNG 29413 as the lectotype.

Bufo silentvalleyensis Pillai, 1981. *Bull. Zool. Surv. India* 3(3): 156; Pl. IV.

Type: ZSI/SRS Chenai VA/777 (holotype), from "Valiaparai Thodu" in "Silent Valley Forests, S. India, Alt. 800 metres" (in Kerala State).

Current status: *Bufo silentvalleyensis* Pillai, 1981.

Bufo stomaticus peninsularis Rao, 1920. *J. Bombay nat. Hist. Soc.* 27(1): 126.

Type: ZSI 19176 (holotype), from "Mavkote, Watekolle, Coorg" (in Karnataka State, south-western India).

Current status: Subjective synonym of *Bufo stomaticus* Lütken, 1862.

Remarks: Relegated to the synonymy of *Bufo stomaticus* Lütken, 1862, by Daniel (1963), which was followed by Dubois (1974) and Dutta (1997b: 51).

Bufo stuarti Smith, 1929. *Rec. Indian Mus.* 31(1): 78.

Type: ZSI 19958 (holotype), from "Putao Plain, N.E. Burma, near Tibet Frontier" (= northern Myanmar).

Current status: *Bufo stuarti* Smith, 1929.

Nectophryne kempi Boulenger, 1919. *Rec. Indian Mus.* 16(2): 207.

Type: ZSI 18481 (syntype), from "..above Tura" (in Garo Hills District, Meghalaya State, north-eastern India).

Current status: *Pedostibes kempi* (Boulenger, 1919)

MICROHYLIDAE

Callula variegata Stoliczka, 1872a. *Proc. Asiatic Soc. Bengal* 1872(6): 111.

Type: ZSI 2761 (syntype; see also below), from "Ellore" (= Eluru, Andhra Pradesh, south-eastern India).

Current status: *Ramanella variegata* (Stoliczka, 1872a).

Remarks: *Callula variegata* Stoliczka, 1872a, was based on two syntypes, according to the original description; the second was in the possession of F. Stoliczka at the time of description. Two additional specimens are indicated as syntypes: NMW 4019 (Häupl et al., 1994) and BMNH 74.11.12.2 (listed as a probable "cotype": Dutta, 1997b: 66, and questionably as a syntype by Dutta and Manamendra-Arachchi, 1996: 51). It is therefore clear that one of these do not have type status. The Indian Museum specimen (now ZSI 2761) was indicated as a type by Sclater (1892b: 24).

Engystoma ? *interlineatum* Blyth, 1854. *J. Asiatic Soc. Bengal* 23(3): 732.

Type: ZSI 9853 (holotype), from "Pegu, Burma" (= Bago, southern Myanmar).

Current status: *Kalophrynus interlineatus* (Blyth, 1854).

Remarks: Sclater (1892b: 22) questionably recognised the referred specimen as a type, although earlier, Anderson (1871a) could not locate it in the IMRR. Subsequently, Bourret (1942: 500) mentioned that the holotype is in the BMNH, although two specimens in this collection, BMNH 1868.4.3.128-129, are catalogues as '?Types'. We consider ZSI 9853 to be the holotype, as it matches the original description of Blyth, 1854.

Although treated as a subspecies of *Kalophrynus pleurostigma* by Parker (1934: 99), Matsui et al. (1996) showed that a specific status is more appropriate.

Kalophrynus orangensis Dutta, Ahmed & Das, 2000. *Hamadryad* 25(1): 67.

Types: ZSI A9087 (holotype), ZSI A9088-91 (four paratypes) from "Orang National Park (26º 30'N; 92º 15'E), Darrang District, Assam, north-eastern India".

Current status: *Kalophrynus orangensis* Dutta, Ahmed & Das, 2000.

Melanobatrachus indicus Beddome, 1878. *Proc. Zool. Soc. London* 1878(3): 722.

Type: ZSI 10969 (syntype), from "The Anamallays and the Ghat range to the south of those mountains…400 feet elevation" (= Anaimalai Hills, Nilgiri District, Tamil Nadu State, south-western India).

Current status: *Melanobatrachus indicus* Beddome, 1878.

Remarks: An additional syntype is BMNH 78.9.3.1. Although ZSI 10969 is not identified as a type by Sclater (1892b: 22), it is here considered part of the type series because of the date of accession (16.11.1878), locality ("Annamallays" [= Anaimalai Mountains") and collector (R. H. Beddome), as given in the register.

Microhyla chakrapanii Pillai, 1977. *Proc. Indian Acad. Sci.* 86B(2): 135.

Type: ZSI/SRS Chennai VA/770 (holotype), from "Mayabunder (east of Burma temple), North Andamans" (in the Bay of Bengal, India).

Current status: *Microhyla chakrapanii* Pillai, 1977.

Microhyla sholigari Ray & Dutta, 2000. *Hamadryad* 25(1): 38.

Types: ZSI A 9061 (holotype), from "Bhargavi stream bed near Doddasampige (12° 27' N; 76° 11'E), Biligirirangan Hills, Chamrajanagar District, Yelandur Taluk, Karnataka State, south-western India"; ZSI A9062-65 (four paratypes), from "Vivekananda Girijana Kalyana Kendra Campus (VGKK), ca. 10 km s Biligirirangan Hills".

Current status: *Microhyla sholigari* Ray & Dutta, 2000.

RANIDAE

Amolops chakrataensis Ray, 1992b. *Indian J. Forestry* 15(4): 346.

Type: ZSI/NRS Dehra Dun A-197 (holotype), from "INDIA. Dehra Dun District, Chakrata, Uttar Pradesh...14 km northwest of Chakrata on Tuni road, 2100 m" (in northern India).

Current status: *Amolops chakrataensis* Ray, 1992b.

Amolops jaunsari Ray, 1992b. *Indian J. Forestry* 15(4): 348.

Type: ZSI//NRS Dehra Dun A-196 (holotype), from "INDIA, Dehra Dun District, Chakrata, Uttar Pradesh...Amlawa River, nearly 2km upstream from Sahiya, 1800 m" (in northern India).

Current status: *Amolops jaunsari* Ray, 1992b.

Hylorana granulosa Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 23.

Types: ZSI 2789-90 (two syntypes), from "Seebsaugor, Assam" (= Sibsagar, Assam State, north-eastern India); ZSI 4009 (syntype), from "Pegu" (= Bago, southern Myanmar).

Current status: Subjective synonym of *Rana leptoglossa* (Cope, 1868).

Remarks: Sclater (1892b: 9) lists only ZSI 2789 (from Sibsagar, collected by S. E. Peal) and ZSI 2780 (from Pegu, collected by W. Theobald) as "co-types". ZSI 10830 was also collected by Peal, but not indicated as a type by Sclater (1892b: 9).

Hylorana monticola Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 25.

Type: ZSI 10036 (holotype), from "Darjeeling, 3,500 feet" (in West Bengal State, eastern India).

Current status: *Amolops monticola* (Anderson, 1871a).

Hylorana Nicobariensis Stoliczka, 1870a. *Proc. Asiatic Soc. Bengal* 1870(2): 104.

Types: ZSI 2783, ZSI 2785-86, ZSI 3562-63, ZSI 3565-70 (10 syntypes), from "Nicobar" (in the Bay of Bengal, India).

Current status: *Rana nicobariensis* (Stoliczka, 1870a).

Remarks: Sclater (1892b: 9) listed 14 syntypes; three syntypes thus cannot be traced in the ZSI collection at present. The registration numbers of the types, according to the aforementioned catalogue are: IMRR (= ZSI) 2782-6 and IMRR (= ZSI) 3562-70. Although Stoliczka (1870b) is generally considered to be the original citation for the name, Das (2000) showed that the name was validly published in Stoliczka (1870a).

Hylorana pipiens Jerdon, 1870. *Proc. Asiatic Soc.Bengal* 1870(3): 83.

Types: ZSI 10039, ZSI 10043-45 (four syntypes), from "Shillong" (in Khasi Hills District, Meghalaya State, north-eastern India).

Current status: Objective synonym of *Rana alticola* Boulenger, 1882.

Remarks: Considered synonymous with *Rana nigrovittata* (Blyth, "1855" 1856) by Sclater (1892b: 9). Gorham (1974: 140 and 148) considered it synonymous with *Rana alticola* Boulenger, 1882, and also, questionably with *R.* (at present *Amolops*) *monticola* (Anderson, 1871a).

H. (= *Hylorana*) *tytleri* Theobald, 1868. *J. Asiatic Soc. Bengal* (extra number 88) 37: 84.

Type: ZSI 10035 (holotype), from "Dacca" (= Dhaka, Bangladesh).

Current status: Subjective synonym of *Rana erythraea* (Schlegel, 1837).

Remarks: Synonymy by Sclater (1892b: 10).

Ixalus argus Annandale, 1912. *Rec. Indian Mus.* 8(1): 16.

Type: ZSI 16950 (holotype), from "Upper Renging, alt. 2,150 feet" (in the Abor Hills, Arunachal Pradesh, north-eastern India).

Current status: Subjective synonym of *Amolops marmoratus* (Blyth, 1855).

Remarks: Boulenger (1920) relegated *Ixalus argus* Annandale, 1912 to the synonymy of *Amolops afghanus* (Günther, 1859), which Dubois (1992) showed to be a subjective synonym of *Amolops marmoratus* (Blyth, 1855).

Limnonectes orissaensis Dutta, 1997a. *Hamadryad* 22(1): 2.

Types: ZSI A8879-82 (four paratypes), from "Rasulgarh area, Bhubaneswar, Khurda District, Orissa, India".

Current status: *Fejervarya orissaensis* (Dutta, 1997a).

Remarks: The holotype is KU 197186; additional paratypes are KU 197187-89, KU 197190-95; 197196-97, and an unregistered BMNH specimen that cannot be located at present (B. T. Clarke, pers. comm, 1999).

Limnonectes shompenorum Das, 1996. *J. South Asian nat. Hist.* 2(1): 128.

Types: ZSI A8741 (holotype), ZSI A8742-44 (three paratypes), from "ca. 2 km east of Kopen Heat, ca. 14 km on the East-West Road, Great Nicobar, India".

Current status: *Limnonectes shompenorum* Das, 1996

Lymnodytes macularius Blyth, 1854. *J. Asiatic Soc. Bengal* 23(3): 299.

Type: ZSI 10037 (holotype), from "Ceylon" (= Sri Lanka).

Current status: Subjective synonym of *Rana gracilis* Gravenhorst, 1829.

Lymnodytes nigrovittatus Blyth, "1855" 1856. *Proc. Asiatic Soc. Bengal* 1866(7): 718.

Material: ZSI 2685 and ZSI 2773 (two syntypes from the original series; see 'Remarks'); type locality not specified in the original description, although the same paper (p. 711) mentioned that the collections worked on were made from "Mergui" (= Myek or Beik, southern Myanmar) and "Tenasserim Valley" (in southern Myanmar). The ZSI type register lists the types as being collected from Mergui, as does Sclater's (1892b: 9) type catalogue.

Current status: *Rana nigrovittata* (Blyth, "1855" 1856).

Remarks: A third syntype from the original series, ZSI 2774 (see Sclater, 1892b: 9) was exchanged with the BMNH. Dubois (1992) designated BMNH 1947.2.2.93 (formerly BMNH 1893.2.14.4, possibly ex ZSI 2774) as the lectotype of this nominal species.

Micrixalus borealis Annandale, 1912. *Rec. Indian Mus.* 8(1): 10.

Type: ZSI 16932 (holotype), from "..about 3 miles S. of Yembung" (in the Abor Hills, Arunachal Pradesh, north-eastern India).

Current status: *Phrynoglossus borealis* (Annandale, 1912).

Remarks: Annandale (1912) examined 11 examples of this species (ZSI 16914-20 and ZSI 16923 and ZSI 16932), but did not formally make the rest part of the type series. The collection localities for the series were "Rotung (alt. 1,300 ft), and "about 3 miles S. of Yembung" (in the Abor Hills, Arunachal Pradesh, north-eastern India), and according to the type register, the holotype was collected from second locality. Removed to the genus *Phrynoglossus* Peters, 1867, by Dubois (1992), but retained in *Micrixalus* by Zhao and Adler (1993: 136), pending a revision of the group.

Micrixalus gadgili Pillai & Pattabiraman, 1990. *Rec. Zool. Surv. India* 86(2): 386; Pl. 1.

Types: ZSI/SRS Chennai VA/780 (holotype), from "Dynamite House, Pamba, Sabarigiri, S. India, Alt. 990 metres"; ZSI Chenai unreg. (paratype), from "3 km to Moozhiar from I.B., Sabarigiri, S. India, Alt. 440 metres"; ZSI Chennai VA/781 (three paratypes), from "Vettayar, Sabarigiri, Alt. 520 metres" (in Kerala State, south-western India); ZSI Chennai VA/781 (paratype), from "..western side of (Eighteen five), Pamba, Sabarigiri, S. India, Alt. 110 metres".

Current status: *Micrixalus gadgili* Pillai & Pattabiraman, 1990.

Micrixalus nudis Pillai, 1978a. *Proc. Indian Acad. Sci.* 87B(6): 173.

Types: ZSI/SRS Chennai VA/771 (holotype), VA/772 (four paratypes), from "Chedleth, Kurichiat Reserve Forest, Wynad, S. India, Altitude 825 metres" (in Kerala State).

Current status: *Micrixalus nudis* Pillai, 1978a.

Micrixalus thampii Pillai, 1981. *Bull. Zool. Surv. India* 3(3): 153; Pl. IV.

Types: ZSI/SRS Chennai VA/778 (holotype), "..stream which drains into Madiri Mavam Thodu"; VA/779 (paratype), from "Madiri Mavam Thodu, .. a tributary of the Kunthi River" in "Silent Valley, S. India, Alt. 900 metres" (in Kerala State).

Current status: *Micrixalus thampii* Pillai, 1981.

Nyctibatrachus humayuni Bhaduri & Kripalani, 1955. *J. Bombay nat. Hist. Soc.* 52(4): 853.

Type: ZSI 20628 (holotype; formerly BNHM 576), from "Mahableshwar, Satara District, Bombay" (at present in Maharashtra State, western India).

Current status: *Nyctibatrachus humayuni* Bhaduri & Kripalani, 1955.

Remarks: Paratypes includes BNHM 577, from from "Mahableshwar, Satara District, Bombay" (at present in Maharashtra State, western India); BNHM 775, 427-30, from "Khandala, ca. 1,500 ft., Bombay" (in Maharashtra State, western India); see Das and Chaturvedi (1998).

Nyctibatrachus sanctipalustris Rao, 1920. *J. Bombay nat. Hist. Soc.* 27(1): 125.

Types: ZSI 19182-84 (three syntypes), from "The sacred swamps of the Cauvery, Brahmagiri Hills, 4000 ft., Coorg" (in Karnataka State, south-western India).

Current status: *Nyctibatrachus sanctipalustris* Rao, 1920.

Remarks: A fourth syntype is BMNH 1947.2.4.44 (formerly BMNH 1919.9.15.1).

Nyctibatrachus sanctipalustris modestus Rao, 1920. *J. Bombay nat. Hist. Soc.* 27(1): 125.

Type: ZSI 19179 (holotype), from "Jog, Shimoga, Mysore" (in Karnataka State, south-western India).

Current status: Subjective synonym of *Nyctibatrachus sanctipalustris* Rao, 1920.

Remarks: Chanda and Das (1997) relegated *Nyctibatrachus sanctipalustris modestus* Rao, 1920 to the synonymy of *Nyctibatrachus sanctipalustris* Rao, 1920. The paratype is ZSP Am-T.2 (Siddiqi, 1973).

Nyctibatrachus vasanthi Ravichandran, 1997. *Hamadryad* 22(1): 9.

Types: ZSI/SRS Chennai VA 1074 (holotype), ZSI Chennai VA 1075 (paratype), from "Solaipalam Aru (Kakachi), Kalakad Tiger Reserve, Tirunelveli District, Tamil Nadu, south India, altitude ca. 1,120 m above msl"; ZSI Chennai VA 1076 (paratype), from "Kuvapati Odai, near Sengaltheri, Kalakad Tiger Reserve, Tirunelveli District, Tamil Nadu, south India, altitude ca. 800 m above msl".

Current status: *Nyctibatrachus vasanthi* Ravichandran, 1997.

Polypedates Hascheanus Stoliczka, 1870a. *Proc. Asiatic Soc. Bengal* 1870(4): 104.

Types: ZSI 2696-97 (two syntypes), from "..about 1000 feet above sea level) in the island of Penang" (in Great Hill, Pulau Pinang, West Malaysia).

Current status: *Taylorana hascheana* (Stoliczka, 1870a).

Remarks: A third syntype (ZSI 2695; see Sclater, 1892b: 4) is mentioned as "Destroyed" in the register. Although Stoliczka (1870b) is generally considered to be the original citation for the name, Das (2000) showed that the name was validly published in Stoliczka (1870a).

Pterorana khare Kiyasetuo & Khare, 1986. *Asian J. Exp. Sci.* 1: 12.

Types: ZSI A9095 (formerly ZSI/ERS Shillong V/ERS 8214; holotype), from "Sanuoru river, Kohima, Nagaland (alt. 1,440 m a. s. l.)" (in north-eastern India); ZSI A9097 (formerly ZSI/ERS Shillong V/ERS 8215 (paratype), from "Rukhroma river, Kohima, Nagaland (alt. 1,400 m a. s. l.)" (in north-eastern India).

Current status: *Pterorana khare* Kiyasetuo & Khare, 1986.

Remarks: Dubois (1992) assigned the species to the genus *Rana* (subgenus *Pterorana*) without examining the types. We return the species to the original genus, on the basis of the highly distinctive patagium.

Rana annandalii Boulenger, 1920. *Rec. Indian Mus*. 20: 77.

Material: ZSI 18571 and 18573 (syntypes from the original series; see 'Remarks'), from "Sureil, Darjeeling district, 5500 ft" (in West Bengal State, eastern India), ZSI 18929 and 18931 (syntypes from the original series; see 'Remarks'), from "Suchal Waterworks, near Ghoom" (sic for Senchal, Darjeeling District, West Bengal State, eastern India).

Current status: *Paa annandalii* (Boulenger, 1920)/*P. blanfordii* (Boulenger, 1882).

Remarks: Dubois (1992) removed *Rana annandalii* Boulenger, 1920, to the genus *Paa* Dubois, 1975. The species was based on a male, a "young" (presumably a newly metamorphosed individual) and tadpoles from "Sureil, Darjeeling district, 5500 ft", a male and two females from "Suchal Waterworks, near Ghoom" (in Darjeeling District, West Bengal State, eastern India) and a female, young (presumably a newly metamorphosed individual) and tadpoles from "Pashok, alt. 4500 ft." (in Darjeeling District, West Bengal State, eastern India). Dubois (1975) showed that the type series of *Rana annandalii* Boulenger, 1920 comprised material of both *Paa annandalii* (Boulenger, 1920) and *P. blanfordii* (Boulenger, 1882), and designated BMNH 1947.2.1.93 (formerly BMNH 1920.3.22.2), from "Suchal Waterworks, near Ghoom" (sic for Senchal, Darjeeling District, West Bengal State, eastern India) as the lectotype.

Rana bilineata Pillai & Chanda, 1981. *Rec. Zool. Surv. India* 79: 163.

Type: ZSI A9096 (formerly ZSI/ERS Shillong V/ERS 914; holotype), from "Dianadubi forest, Garo Hills (alt. About 400 metres)" (in Meghalaya State, north-eastern India).

Current status: Subjective synonym of *Rana taipehensis* Van Denburgh (1909).

Remarks: Dubois ("1986" 1987) showed that *Rana bilineata* is preoccupied, and provided the replacement name, *Rana albolineata*. Subsequently, Dubois (1992) synonymized the taxon with *Rana taipehensis* Van Denburgh (1909).

Rana burkilli Annandale, 1910a. *Rec. Indian Mus.* 5(1): 79.

Types: ZSI 16569-70 (two syntypes), from "Tavoy" (= Dawei, southern Myanmar); ZSI 4175, ZSI 9008, ZSI 9020-23; ZSI 9447, ZSI 9517 (eight syntypes), from "Mandalay. Upper Burma" (in central Myanmar).

Current status: Subjective synonym of *Hoplobatrachus rugulosus* (Wiegmann, 1834).

Remarks: Synonymy follows Bourret (1942: 242), who treated the taxon as synonymous with *Rana tigerina rugulosa* Wiegmann, 1834. According to the original description, the species also occurs in "Mandalay. Upper Burma…Bassein, Pegu" (in central and southern

Myanmar), although only the Tavoy specimen was indicated as a "type". However, additional specimens were available to Annandale when he prepared the description (see Annandale, 1917a: 127), but these are at present not extant in the ZSI, and the Bassein and Pegu records are suspected to be on the basis of secondary information.

Rana charlesdarwini Das, 1998. *Hamadryad* 23(1): 42.

Types: ZSI A8890 (holotype), ZSI A8891-92 (two paratypes- adults); ZSI A8893 (five paratypes- tadpoles), from "ca. 0.3 km N of summit of Mount Harriet (10 45'N and 92 46 E), Mount Harriet National Park, South Andaman Island, Bay of Bengal, India; altitude 365 m above msl".

Current status: *Rana charlesdarwini* Das, 1998.

Rana danieli Pillai & Chanda, 1977. *J. Bombay nat. Hist. Soc*. 74(1): 136.

Types: ZSI/ERS A 6966 (holotype; formerly ZSI Shillong V/ERS 804), ZSI 6967-68 (two paratypes; formerly ZSI Shillong V/ERS 805 and 818), from "Mawphlang forest (Alt. 1535 m), Khasi Hills" (in Meghalaya State, north-eastern India).

Current status: *Rana danieli* Pillai & Chanda, 1977.

Rana flavescens Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 531.

Types: ZSI 2776-78 (three syntypes), ZSI 4298-4301 (four syntypes); ZSI 10248 (syntype), from "S. India" (on p. 522).

Current status: Subjective synonym of *Rana temporalis* (Günther, 1864).

Remarks: Erroneously considered a nomen nudum by Gorham (1974: 152).

Rana fusca Blyth, "1855" 1856. *Proc. Asiatic Soc. Bengal* 1855(7): 719.

Type: ZSI 9077 (syntype), from "Tenasserim valley" (in southern Myanmar).

Current status: *Limnonectes blythii* (Boulenger, 1920).

Remarks: Sclater (1892b: 4) mentioned that the type series comprised two adults (IMRR = ZSI 9076-77) and eight tadpoles (IMRR = ZSI 9078-85). The fate of the rest of the types is unknown. Questionably considered synonymous with *Rana blythii* Boulenger, 1920 (Bornean population once referred to this species is now referred to as *Limnonectes leporina* Andersson, 1924; see Inger and Tan, 1996) by Gorham (1974: 141). Bourret (1942: 255) placed *Rana fusca* in the synonymy of *Rana macrodon* Duméril & Bibron, 1841. We treat *R. blythii macrodon* var. *blythii* Boulenger, 1920 as a replacement name for *Rana fusca* Blyth, 1856, which is preoccupied by several senior primary homonyms and is thus a junior primary homonym (Article 57.2 of the Code).

Rana Gammii Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 21.

Type: ZSI 9664-67 (four syntypes), from "Darjeeling, Alt. 4000 ft. to 6000 ft." (in West Bengal State, eastern India).

Current status: Subjective synonym of *Chaparana sikimensis* (Jerdon, 1870).

Remarks: For a nomenclatural history of *Rana Gammii* Anderson, 1871a, see Dubois (1975; 1976).

Rana garoensis Boulenger, 1920. *Rec. Indian Mus*. 20: 170.

Types: ZSI 18557 and ZSI 18857 (two syntypes), from "Garo Hills, Assam, above Tura, at altitude of 3,500 to 3,900 feet" (at present in Meghalaya State, north-eastern India).

Current status: *Rana garoensis* Boulenger, 1920.

Remarks: Frost (1985: 492) mentioned that the syntypes are in the BMNH, which is in error, as the original description matches the two ZSI specimens, and the BMNH has no records of the types ever being deposited there.

Rana gerbillus Annandale, 1912. *Rec. Indian Mus*. 8(1): 10.

Type: ZSI 16925 (holotype), from "Yembung, Abor foot-hills, at an altitude of

1,100 ft." (in Arunachal Pradesh, north-eastern India).

Current status: *Amolops gerbillus* (Annandale, 1912).

Remarks: Generic allocation follows Dubois (1992: 321) and Fei et al. (1999: 232).

Rana ghoshi Chanda, 1990b. *Hamadryad* 15(1): 16.

Type: ZSI A8472 (holotype), from "Khuigairk Reserve Forest, Manipur, India".

Current status: *Euphlyctis ghoshi* (Chanda, 1990b).

Remarks: Generic allocation follows Dubois (1992).

Rana gracilis (variety) *Andamanensis* Stoliczka, 1870b. *J. Asiatic Soc. Bengal* 39(2): 143.

Type: ZSI 8539 (syntype from the original series designated lectotype; see Remarks), from "Andamans" (in the Bay of Bengal, India).

Current status: *Fejervarya andamanensis* (Stoliczka, 1870b).

Remarks: *Rana gracilis* var. *andamanensis* Stoliczka, 1870b, was based on four syntypes, which included examples of *Fejervarya andamanensis* (Stoliczka, 1870b), *Taylorana hascheana* (Stoliczka, 1870a) and *Limnonectes doriae* (Boulenger, 1887). Annandale (1917) designated ZSI 8539 as the lectotype of *Rana gracilis* (variety) *Andamanensis* Stoliczka, 1870b, and Dubois (1984b) allocated the species to *Fejervarya*. Sclater (1892b: 6) mentioned that the syntypes from Stoliczka's (1870) original series included IMRR (= ZSI) 2732 (*L. doriae*), ZSI 3538-39 (the latter two registration numbers in error). Two of these types cannot be located at present.

Rana limnocharis syhadrensis Annandale, 1919. *Rec. Indian Mus*. 16(1): 123.

Type: ZSI 18764 (holotype), from "Bombay Presidency...Satara district at altitudes between 2,000 and 4,000 feet; also from Khandala (2-3,000 feet) in the Poona district and from Igatpuri (2,000 feet) in the Nasik district" (in Maharashtra State, western India). According to the register, the holotype is from Khandala, Poona district, Bombay Presidency, alt. 2500 ft. (in Maharashtra State, western India).

Current status: *Fejervarya syhadrensis* (Annandale, 1919).

Remarks: Annandale (1919) examined several specimens of his new taxon, although only one was formally designated type. In his 1984 paper, Dubois (1984b) allocated the species to the genus *Rana* (*Fejervarya*), and subsequently (1992), he transferred the taxon to *Limnonectes*.

Rana mawlyndipi Chanda, 1990a. *J. Bengal nat. Hist. Soc.* n.s. 9(1): 44.

Type: ZSI A8473 (formerly ZSI/KZ [= ERS], Shillong 983; holotype), from "Mawlyndip, Khasi hills, Meghalaya, North-east India".

Current status: *Rana mawlyndipi* Chanda, 1990a.

Rana mawphlangensis Pillai & Chanda, 1977. *J. Bombay nat. Hist. Soc*. 74(1): 139.

Type: ZSI A6979 (formerly ZSI/ERS Shillong V/ERS 803; holotype), from "Mawphlang, (Alt. 1535 m), Khasi Hills" (in Meghalaya State, noth-eastern India).

Current status: *Limnonectes mawphlangensis* (Pillai & Chanda, 1977).

Remarks: Allocated to the genus *Limnonectes* by Dubois (1992), while Ohler and Dubois (1999) referred this species to the subgenus *Elachyglossa* Andersson, 1916.

Rana murthii Pillai, 1979. *Bull. Zool. Surv. India* 2(1): 39; Pl. IV.

Types: ZSI/SRS Chennai VA/773 (holotype), VA/774 (four paratypes), from "Naduvattom, 18 km. From Gudallur, S. India, Alt. 1829 metres".

Current status: *Fejervarya murthii* (Pillai, 1979).

Remarks: Allocated to the genus *Limnonectes* (*Fejervarya*) by Dubois (1986; 1992).

Rana plicatella Stoliczka, 1873. *J. Asiatic Soc. Bengal* 42(2): 116; Pl. XI.

Type: ZSI 9542 (holotype), from "Penang" (= Pulau Penang, West Malaysia; see p. 112).

Current status: *Limnonectes plicatellus* (Stoliczka, 1873).

Remarks: Ohler and Dubois (1999) referred this species to the subgenus *Elachyglossa* Andersson, 1916.

Rana robusta Blyth, 1854. *J. Asiatic Soc. Bengal* 23(3): 298.

Types: ZSI 9123-24 (two syntypes), from "Ceylon" (= Sri Lanka).

Current status: Subjective synonym of *Euphlyctis hexadactylus* (Lesson, 1834).

Remarks: Synonymy follows Gorham (1974: 145).

Rana senchalensis Chanda, 1986. *J. Bengal nat. Hist. Soc.*5(2): 146.

Type: ZSI A8474 (holotype), from "Senchal Lake, Darjeeling District, West Bengal" (in eastern India).

Current status: Subjective synonym of *Amolops marmoratus* (Blyth, 1855).

Remarks: Synonymy follows Dubois (2000).

Rana sikimensis Jerdon, 1870. *Proc. Asiatic Soc. Bengal* 1870(3): 83.

Type: ZSI 9580 (syntype), from "Darjeeling, E. Himalayas" (in West Bengal State, eastern India).

Current status: *Chaparana sikimensis* (Jerdon, 1870).

Remarks: Treated as synonymous with *Paa liebigii* (Günther, 1860) by Gorham (1974: 146), but considered valid by Dubois (1975; 1976; 1992).

Rana tenasserimensis Sclater, 1892a. *Proc. Zool. Soc. London* 1892(3): 345.

Types: ZSI 10429-30 and ZSI 10497 (three syntypes), from "Tenasserim" (in southern Myanmar).

Current status: *Ingerana tenasserimensis* (Sclater, 1892a).

Remarks: Type species of the genus *Ingerana* Dubois (1987). See Inger (1996) and Das (1998) for comments on the generic allocation. Two additional syntypes (ZSI 10495-96; see Sclater, 1892b: 8) cannot be located at present, although one of these is apparently BMNH 1947.2.2.95 (formerly BMNH 1892.11.25.1) that was mentioned by Bourret (1942: 379).

Rana tuberculata Tilak & Roy, 1985. *Zool. Anz.* 215(3/4): 231.

Types: ZSI/NRS Dehra Dun NRS/A-1 (holotype), ZSI Dehra Dun NRS/A-2 (paratypes- four adults and 10 tadpoles), from "..the origin of Kheel Gad, Roadside west of Purari, 5 km west of Chakrata, District DehraDun, Uttar Pradesh, altitude-2000 m" (in northern India).

Current status: Subjective synonym of *Paa minica* (Dubois, 1975).

Remarks: Dubois (1992) relegated *Rana tuberculata* Tilak & Roy, 1985, to the synonymy of *Paa minica* (Dubois, 1975).

Rana vicina Stoliczka, 1872b. *Proc. Asiatic Soc. Bengal* 1872(7): 130.

Type: ZSI 9147 (holotype), from "Marri, Western Himalayas, about 6,000 feet" (= Murree, Punjab Province, Pakistan).

Current status: *Paa vicina* (Stoliczka, 1872b).

Remarks: Allocated to the genus *Paa* by Dubois (1976; 1980).

Rana wasl Annandale, 1917a. *Mem. Asiatic Soc. Bengal* 6: 131; Pl. V.

Type: ZSI 17282 (holotype), from "Kuching, Sarawak" (in east Malaysia [Borneo]).

Current status: Subjective synonym of *Fejervarya limnocharis* (Gravenhorst, 1829).

Remarks: Synonymy follows Van Kampen (1923: 167) and Bourret (1942: 250). Annandale (1917a) makes it clear from both the formal description and list of material examined that more than a single specimen was involved in the description of the species, although none were specifically designated as part of the type series.

RHACOPHORIDAE

Chirixalus dudhwaensis Ray, 1992a. *Indian J. Forestry* 15(3): 260.

Types: ZSI/NRS Dehra Dun A-16 (holotype), from "..near Dudhwa Forest Rest House, Dudhwa National Park, (28°21'-2842' N, 80°56'E) District Lakhimpur Kheri, Uttar

Pradesh" (in northern India); ZSI/NRS A-17 (12 paratypes), from "..near Belraien Forest Rest House campus, Dudhwa National Park, District Lakhimpur Kheri, Uttar Pradesh" (in northern India).

Current status: *Chirixalus dudhwaensis* Ray, 1992a.

Chirixalus simus Annandale, 1915. *Rec. Indian Mus.* 11(4): 345; Pl. XXXIII.

Type: ZSI 17971 (holotype), from "Mangaldai, Assam, north of the Brahmaputra" (in north-eastern India).

Current status: *Chirixalus simus* Annandale, 1915.

Ixalus bombayensis Annandale, 1919. *Rec. Indian Mus.* 16(1): 124; Pl. I.

Type: ZSI 18287 (holotype), from "Castle Rock" (in Uttar Kanara District, Karnataka State, western India).

Current status: *Philautus bombayensis* (Annandale, 1919).

Remarks: Annandale (1919) also examined several specimens of his new species from "..Bombay Presidency from N. Canara (Castle Rock) to the Satara (Khas) and Poona (Khandalla) districts at altitudes between 2,500 and 4,000 feet" (in Karnataka and Maharashtra States, western India), although these were not made part of the type series. The original description provides an erroneous registration number for the holotype (ZSI 18782).

Ixalus cinerascens Stoliczka, 1870c. *Proc. Asiatic Soc. Bengal* 1870(9): 275.

Types: ZSI 2716 (four syntypes), from "Ataran river, east of Moulmein, Tenasserim Province" (in Myanmar), restricted to "..probably the Dawna Hills inland from Moulmein" by Annandale (1913).

Current status: *Philautus cinerascens* (Stoliczka, 1870c).

Remarks: Bourret (1942: 451) synonymised the taxon under *Megophrys major* (Boulenger, 1908), while Gorham (1974: 43) questionably treated it as synonymous with *Megophrys lateralis* (Anderson, 1871). Bossuyt and Dubois (in press) resurrected the name as valid under the combination *Philautus cinerascens* (Stoliczka, 1870c).

Ixalus garo Boulenger, 1919. *Rec. Indian Mus.* 16(2): 207.

Type: ZSI 19187 (holotype), from "..above Tura" (in the Garo Hills District, Meghalaya State, north-eastern India).

Current status: *Philautus garo* (Boulenger, 1919).

Ixalus semiruber Annandale, 1913. *Rec. Indian Mus.* 9(4): 305; Pl. XV.

Type: ZSI 17401 (holotype), from "Pattipola near Nuwara Eliya, Central Province, Ceylon; alt. Ca. 6000 ft." (= Sri Lanka).

Current status: Subjective synonym of *Philautus leucorhinus* (Lichtenstein & Martens, 1856).

Nyctixalus robinsoni Annandale, 1917b. *J. Fed. Malay State Mus.* 7(3): 110.

Type: ZSI 18337 (holotype), from "Tjibodas, Java: alt. 4,700-6,500 feet" (at present within Cibodas Botanical Gardens, adjacent to Mt. Gede-Pangrango National Park, Java, Indonesia).

Current status: Subjective synonym of *Philautus aurifasciatus* (Schlegel, 1837).

Remarks: Synonymy follows Gorham (1974: 166) and Iskandar (1998: 86).

Philautus cherrapunjiae Roonwal & Kripalani, 1966. *Rec. Indian Mus*. 59(1-2): 325.

Types: ZSI 20806 (holotype) and ZSI 20807-12 (six paratypes), from near Circuit House, 3 km from Cherrapunji town, Khasi-Jaintia Hills District, Assam...altitude 1330 metres" (in Meghalaya State, north-eastern India).

Current status: *Philautus cherrapunjiae* Roonwal & Kripalani, 1966.

Remarks: Bossuyt and Dubois (in press) showed that the date of publication of the present species name was 1966, not 1961.

Philautus namdaphaensis Sarkar & Sanyal, 1985. *Rec. Zool. Surv. India* 82(1-4): 287.

Types: ZSI A7177 (holotype), ZSI A7178-79 (two paratypes), from "Farmbase Camp (alt. 350 m), Tirap district, Arunachal Pradesh" (in north-eastern India).

Current status: *Philautus namdaphaensis* Sarkar & Sanyal, 1985.

Philautus sanctisilvaticus Das & Chanda, 1997. *Hamadryad* 22(1): 22.

Types: ZSI A1778 (holotype), ZSI A1777 and A1779 (two paratypes), from "Kapildhara Falls, Amarkantak (23º 10'N; 81º 70'E), ca. 190 km SE Jabalpur City, Shahdol District, Madhya Pradesh, central India.

Current status: *Philautus sanctisilvaticus* Das & Chanda, 1997.

Philautus shillongensis Pillai & Chanda, 1973. *Proc. Indian Acad. Sci.* 78B(1): 30.

Types: ZSI A6971 (formerly ZSI/ERS Shillong V/ERS 472; holotype) and ZSI A6972-73 (formerly ZSI/ERS Shillong V/ERS 473-474 [two paratypes] and V/ERS 6608 [five paratypes], from "Malki Forest, Shillong, Altitude 5,000 ft. (1,524 metres)" (in Meghalaya State, north-eastern India).

Current status: *Philautus shillongensis* Pillai & Chanda, 1973.

Philautus shyamrupus Chanda & Ghosh, 1989. *J. Bombay nat. Hist. Soc.* 86(2): 215.

Types: ZSI A8475 (formerly ZSI/KZ [= ERS] Shillong 313; holotype), ZSI/KZ [= ERS] 314-317; four paratypes), from "Hornbill, Namdapha Tiger Reserve and proposed Biosphere Reserve, Arunachal Pradesh" (in north-eastern India).

Current status: *Philautus shyamrupus* Chanda & Ghosh, 1989.

Remarks: Additional characters are in Chanda and Sarkar (1997).

Philautus terebrans Das & Chanda, 1998. *J. South Asian nat. Hist.* 3(1): 105.

Types: ZSI 2868-74 (seven paratypes), from "Golconda Hills (17º 22'N; 78º 26'E), Visakhapatnam District, Andhra Pradesh, south-eastern India".

Current status: *Philautus terebrans* Das & Chanda, 1998.

Remarks: The holotype is USNM 239428.

Phrynoderma moloch Annandale, 1912. *Rec. Indian Mus.* 8(1): 18; 25.

Types: ZSI 16951-52 (two syntypes), from "Upper Renging (alt. 2,150 ft)" (in the Abor Hills, Arunachal Pradesh, north-eastern India).

Current status: *Theloderma moloch* (Annandale, 1912).

Polypedates cruciger Blyth, 1852. *J. Asiatic Soc. Bengal* 21(4): 355.

Types: ZSI 10176-79 (four syntypes); type locality not specified in the original description. The register gives the type locality as Ceylon (= Sri Lanka).

Current status: *Polypedates cruciger* Blyth, 1852.

Polypedates insularis Das, 1995. *Hamadryad* 20: 15.

Types: ZSI A8731 (holotype), ZSI A8732-34 (three paratopotypes), from "circa 2 km E mouth of Galathea River, Galathea National Park, Great Nicobar, India"' ZSI A8575, from "Campbell Bay, Great Nicobar, India" ZSI A8735-36 (two paratypes), from "Shompen Hut, Great Nicobar, India"; ZSI A8737-40 (four paratypes), from "circa 2 km E Kopen Heat (41 km point on the East-West Road), Great Nicobar, India".

Current status: *Polypedates insularis* Das, 1995.

Polypedates tuberculatus Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 26.

Types: ZSI 10154 and ZSI 10156 (two syntypes), from "Seebsaugor, Assam" (= Sibsagar, Assam State, north-eastern India).

Current status: *Rhacophorus tuberculatus* (Anderson, 1871a).

Remarks: According to Sclater (1892b: 16), the syntypes included ZSI 10152-53, which is recorded in the register as given in exchange to W. Meise of MTKD on 26.11.1935.

Rhacophorus maculatus Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 27.

Types: ZSI 10291; ZSI 2753-56 (five syntypes), from "Khasi Hills" (in Meghalaya State, north-eastern India).

Current status: *Rhacophorus bipunctatus* Ahl, 1927.

Remarks: Boulenger (1882: 90) provided the replacement name *Rhacophorus bimaculatus* Boulenger, 1882, for *Rhacophorus maculatus* Anderson, 1871a, which was preoccupied by *Rhacophorus maculatus* Gray, 1830 (figured as *Hyla maculata*; for details on authorship and date, see Dubois, 1984a). Subsequently, Ahl (1924) provided the replacement name *Rhacophorus bipunctatus,* as he treated Boulenger's (1882) name as a secondary homonym of *Leptomantis bimaculata* Peters, 1867. Sclater's (1892b: 16) mention that IMRR (= ZSI) 10291 is a 'type', is not a valid lectotype designation, according to the Code .

Rhacophorus maculatus himalayensis Annandale, 1912. *Rec. Indian Mus.* 8(1): 14.

Types: ZSI 16944 and ZSI 16969 (two syntypes), from "Kobo, alt. 4000 ft.....Abor Hills" (in Arunachal Pradesh, north-eastern India).

Current status: *Polypedates maculatus himalayensis* (Annandale, 1912).

Remarks: Gorham (1974: 170) treated the taxon as synonymous with *Polypedates leucomystax* (Gravenhorst, 1829). Dubois ("1986" 1987: 85) considered *himalayensis* valid, but his designation of MNHN 1983.1170, from "Rakshe, 2000-2070 m, Est-Nepal" as the neotype is set aside with the discovery of the syntypes (Article 75.8 of the Code).

Rhacophorus microdiscus Annandale, 1912. *Rec. Indian Mus*. 8(1): 13.

Type: ZSI 16924 (holotype), from "Kobo, at the base of Abor foot-hills (alt. 400 ft.)" (in Arunachal Pradesh, north-eastern India).

Current status: *Philautus microdiscus* (Annandale, 1912).

Remarks: Synonymised under *Rhacophorus jerdonii* Günther, 1876, by Gorham (1974: 169), but considered a valid species of *Philautus* by Dubois (1987).

Rhacophorus namdaphaensis Sarkar & Sanyal, 1985. *Rec. Zool. Surv. India* 82(1-4): 290.

Types: ZSI A7180 (holotype), ZSI A781-84 (four paratypes), from "Namdapha Camp (alt. 350 m), Tirap district, Arunachal Pradesh" (in north-eastern India).

Current status: *Rhacophorus namdaphaensis* Sarkar & Sanyal, 1985.

Rhacophorus naso Annandale, 1912. *Rec. Indian Mus.* 8(1): 12.

Type: ZSI 16929 (holotype), from "Egar stream between Renging and Rotung" (in the Abor Hills, Arunachal Pradesh, north-eastern India).

Current status: *Rhacophorus naso* Annandale, 1912.

Remarks: Gorham (1974: 168) treated the taxon as a synonym of *Rhacophorus appendiculatus* (Günther, 1858), although several subsequent workers, including Fei (1999: 272) have treated the taxon as distinct.

Rhacophorus pleurostictus batangensis Vogt, 1924. *Zool. Anz.* 60(11-12): 341.

Type: ZSI 20389 (paratype), from "Batang" ([County] in Sichuan Province, south-central China).

Current status: Subjective synonym of *Polypedates dugritei* David, "1871" 1872.

Remarks: Received on exchange from MTKD, according to the register, although the holotype (ZMB 27878) and other paratypes are at the ZMB (ZMB 27879, ZMB 54916-28), along with the rest of T. Vogt's herpetological types.

Rhacophorus pseudomalabaricus Vasudevan & Dutta, 2000. *Hamadryad* 25(1): 21.

Types: ZSI/SRS VA 1078-79 (two paratypes), from "Andiparai Shola, 1190 m in Indira Gandhi Wildlife Sanctuary, Tamil Nadu, India".

Current status: *Rhacophorus pseudomalabaricus* Vasudevan & Dutta, 2000.

Remarks: The holotype is BNHM 3095; an additional paratype is WII 514.

Rhacophorus taeniatus Boulenger, 1906. *J. Asiatic Soc. Bengal* n.s. 2(9): 385.

Type: ZSI 15715 (syntype from the original series, and at present paralectotype; see 'Remarks'), from "Purneah, Bengal" (at present in Bihar State, eastern India).

Current status: *Rhacophorus taeniatus* Boulenger, 1906.

Remarks: A second syntype from the original description, BMNH 1947.2.26.57 (formerly BMNH 1906.8.10.39) was designated lectotype by Dubois ("1986" 1987: 79).

HYLIDAE

Polypedates annectans Jerdon, 1870. *Proc. Asiatic Soc. Bengal* 1870(3): 84.

Types: ZSI 10170-72 (three syntypes), from "Khasi Hills" (in Meghalaya State, north-eastern India).

Current status: *Hyla annectans* (Jerdon, 1870).

SALAMANDRIDAE

Tylototriton verrucosus Anderson, 1871c. *Proc. Zool. Soc. London* 1871(2): 423.

Types: ZSI 10366, 10368, 10370-72, 10374-75, 10377-78, 10380-81 (11 syntypes), from "Nantin, Momien, and Hotha valleys, Western Yunan, China" (at present Tengchong Co. and Husa, Longchuan Co., China).

Current status: *Tylototriton verrucosus* Anderson, 1871c.

Remarks: Sclater (1892b: 36) indicated that there were 16 syntypes: IMRR (= ZSI) 10366-79 (from Momien, Yunnan) and IMRR (= ZSI) 10380-1 (from Ponsee, Kakhyen hills). An additional syntype is BMNH 1874.6.1.3. Four syntypes have not been located. The discovery of these syntypes sets aside Nussbaum et al.'s (1995) designation of a neotype (KIZ 74 II 0061 VI.16) for the species.

CAECILIIDAE

Herpele fulleri Alcock, 1904. *Ann. & Mag. nat. Hist.* 14: 267.

Type: ZSI 14759 (holotype), from "Rampur Tea Garden, Kuttal, Cachar" (at present Kathal, encompassed within the city of Silchar, Assam State, north-eastern India).

Current status: *Gegeneophis fulleri* (Alcock, 1904).

Remarks: Taylor (1968: 735) allocated the species to the genus *Gegeneophis*, whose other members are distributed in the Western Ghats of south-western India.

Gegeneophis krishni Pillai & Ravichandran, 1999. *Occ. Pap. Zool. Surv. India.* (172): 87.

Types: ZSI SRS VAG 32 (holotype) and ZSI SRS VAG 33 (paratype), from "Krishna Farms, Gurpur, Karnataka" (in south-western India).

Current status: *Gegeneophis krishni* Pillai & Ravichandran, 1999.

ICHTHYOPHIIDAE

Ichthyophis garoensis Pillai & Ravichandran, 1999. *Occ. Pap. Zool. Surv. India.* (172): 28.

Types: ZSI SRS 18458 (holotype), from "Anogiri Lake, Garo Hills, Meghalaya" (in north-eastern India); BNHM 16 (paratype), from "Tura, Garo Hills, Meghalaya" (in north-eastern India).

Current status: *Ichthyophis garoensis* Pillai & Ravichandran, 1999.

Ichthyophis glutinosus tricolor Annandale, 1909. *Rec. Indian Mus.* 3(3): 286.

Type: ZSI 16173 (holotype), from "Maddathoray, Travancore" (in Kerala State, south-western India).

Current status: *Ichthyophis tricolor* Annandale, 1909.

Ichthyophis husaini Pillai & Ravichandran, 1999. *Occ. Pap. Zool. Surv. India.* (172): 36.

Type: ZSI SRS 18426 (holotype), from "Thebronggiri Coffee Garden, Rongram, Garo Hills, Meghalaya" (in north-eastern India).

Current status: *Ichthyophis husaini* Pillai & Ravichandran, 1999.

Ichthyophis longicephalus Pillai, 1986. *Rec. Zool. Surv. India* 84(1-4): 231.

Types: ZSI/SRS Chennai VA/1056 (holotype), from "Silent Valley, Kerala, S. India, alt. 1050 metres". An additional 39 specimens (all paratypes, ZRI/SRS Chennai unreg.) are part of the type series, and were taken from "smaller tributaries and streamlets joining Kunthi River" (in Silent Valley, Kerala State, south-western India).

Current status: *Ichthyophis longicephalus* Pillai, 1986.

Ichthyophis orthoplicatus Taylor, 1965. *Univ. Kansas Sci. Bull.* 46(6): 253.

Type: ZSI 17010 (holotype), from "Ceylon" (= Sri Lanka), restricted to "Pattipola, Central Province, Ceylon" by Taylor (1968: 115).

Current status: *Ichthyophis orthoplicatus* Taylor, 1965.

URAEOTYPHLIDAE

Uraeotyphlus interruptus Pillai & Ravichandran, 1999. *Occ. Pap. Zool. Surv. India.* (172): 60.

Types: ZSI SRS VAG 14 (holotype) and ZSI SRS VAG 15 (paratype), from "Chengalam Village, Kerala" (in south-western India".

Current status: *Uraeotyphlus interruptus* Pillai & Ravichandran, 1999.

Uraeotyphlus menoni Annandale, 1913. *Rec. Indian Mus.* 9(4): 301.

Types: ZSI 16707 (syntype), from "Trichur in Cochin" (in Kerala State, south-western India); ZSI 16695 (syntype), from "Kondatti in the S. Malabar district" (in Kerala State, south-western India).

Current status: *Uraeotyphlus menoni* Annandale, 1913.

AMPHIBIAN TYPES NOT LOCATED

The types of the following amphibian taxa described by Anderson, Annandale, Blyth, Jerdon, Sclater, Stoliczka, and Theobald were not located in the collection of the ZSI. The flooding of the Varuna River at Varanasi during World War II is thought to have destroyed a part of the zoological material stored in a building on the banks of the river (Chopra, 1946). However, it is possible that some of the types were never deposited in the Museum of the Asiatic Society of Bengal or the Indian Museum.

MEGOPHRYIDAE

Ixalus lateralis Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 29.

Type: Type locality not given in the original description (see Zhao and Adler, 1993: 119).

Current status: *Megophrys lateralis* (Anderson, 1871a).

Remarks: Synonymy follows Bourret (1942: 199). Sclater (1892b: 33) listed IMRR (= ZSI) 10967 as the holotype of the species, which cannot be traced at present.

MICROHYLIDAE

Engystoma ? *Berdmorei* Blyth, "1855" 1856. *Proc. Asiatic Soc. Bengal* 1855(7): 720.

Types: "Pegu" (= Bago, southern Myanmar).

Current status: *Microhyla berdmorei* (Blyth, "1855" 1856).

Remarks: Sclater (1892b: 23) erroneously listed the syntypes as from Arakan (= Rakhine Yoma, western Myanmar). It is probable that Sclater was unaware of Theobald's (1873) remarks on Anderson's (1871b) opinion that the four discoloured specimens in the collection (three of which are extant, ZSI 9718-20, from Arakan, presented by Colonel Arthur Purves Phayre) was incorrect. According to the records, the syntypes were collected by Major Berdmore from Schwe Gyen (= Shwegyin; see also Theobald, 1860; 1873).

Engystoma malabaricum Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 534.

Type: "Malabar" (in Kerala State, south-western India).

Current status: Subjective synonym of *Microhyla ornata* (Duméril & Bibron, 1841).

Remarks: Both Bourret (1942: 524) and Gorham (1974: 125) questionably allocated the species to *Microhyla ornata* (Duméril & Bibron, 1841).

Engystoma rubrum Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 534.

Type: "Carnatic" (the region between the Eastern Ghats and the Coromandel Coast, south of 16º N, in south-eastern India).

Current status: *Microhyla rubra* (Jerdon, 1854).

Remarks: The type was reported lost by Dutta and Manamendra-Arachchi (1996: 38).

Hylaedactylus carnaticum Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 533.

Type: "Carnatic" (the region between the Eastern Ghats and the Coromandel Coast, south of 16º N, in south-eastern India).

Current status: Subjective synonym of *Microhyla ornata* (Duméril & Bibron, 1841).

Remarks: Parker (1934: 93) questionably allocated the species to *Ramanella variegata* (Stoliczka, 1872), while Bourret (1942: 524) allocated it to *Microhyla ornata* (Duméril & Bibron, 1841). Gorham (1974: 123 and 126) treated the name as synonymous with both *Microhyla ornata* (Duméril & Bibron, 1841) and questionably to *Ramanella variegata* (Stoliczka, 1872).

Hylaedactylus montanus Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 533.

Type: "Wynaad" (in Kerala State, south-western India).

Current status: *Ramanella montana* (Jerdon, 1854b).

Megalophrys guttulata Blyth, "1855" 1856. *Proc. Asiatic Soc. Bengal* 1855(7): 717.

Type: "Pegu" (= Bago, southern Myanmar).

Current status: *Calluella guttulata* (Blyth, "1855" 1856).

Remarks: The types were not found in the collection of the Indian Museum even at the time of Theobald's (1868: 82) catalogue, although Bourret (1942: 483) mentioned types being in the BMNH; none are extant at present (B. T. Clarke, pers. comm., 1999).

RANIDAE

Ixalus kakhienensis Anderson, "1878" 1879. *Anat. Zool. Res. Western Yunnan* 1: 845.

Type: "Nampoung valley, 1,000 feet" (in the Kakhien Hills, northern Myanmar).

Current status: Subjective synonym of *Amolops marmoratus* (Blyth, 1855)

Remarks: Synonymy by Boulenger (1890: 462), who considered *Ixalus kakhienensis* Anderson, "1878" 1879 to be a subjective synonym of *Staurois latopalmatus* (Boulenger, 1882), which, in his and in Bourret's (1942: 390) concept of the species, included *Amolops afghanus* (Günther, 1858), which is predated by *Amolops marmoratus* (Blyth, 1855). Gorham (1974: 127) listed the taxon as a synonym of *Amolops afghanus* (Günther, 1858).

Limnodytes ? phyllophila Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 532.

Type: "western forests" (of southern India = the Western Ghats).

Current status: *Micrixalus phyllophilus* (Jerdon, 1853b).

Remarks: Boulenger (1882: 95; 1890: 465) and Gorham (1974: 134) treated the taxon as synonymous with *Micrixalus ophisthorhodus* (Günther, 1868), although Dubois ("1986" 1987) considered it valid and designated the holotype (BMNH 1947.2.29.87) of *Ixalus opisthorhodus* Günther, 1868, as the neotype of this nominal species.

L. (= *Lymnodytes*) *lividus* Blyth, "1855" 1856. *Proc. Asiatic Soc. Bengal* 1855(7): 297.

Type: "Ceylon" (in Sri Lanka).

Current status: Probably a subjective synonym of *Rana temporalis* Günther, 1858.

Remarks: Questionably considered synonymous with *Rana temporalis* Günther, 1858, by Kirtisinghe (1957: 2).

Polypedates lividus Blyth, "1855" 1856. *J. Asiatic Soc. Bengal* 24(7): 718.

Type: "Tenasserim valley" (in southern Myanmar). According to Theobald (1860), the species was found in Mergui (= Myeik or Beik, southern Myanmar).

Current status: *Rana livida* (Blyth, "1855" 1856).

Remarks: The type(s) were not present in the collection of the IMRR even at the time of Theobald's (1868: 83) catalogue, and were not found by Sclater (1892b: 10) either. Fei (1999: 188) allocated the species to the genus *Odorrana* Fei, Ye & Huang (1990).

Polypedates marmoratus Blyth, 1855a. *J. Asiatic Soc. Bengal* 24: 188.

Type: "Pegu" (= Bago, southern Myanmar). Although missing at present, the holotype of *Polypedates marmoratus* Blyth, 1855 was examined by Anderson (1871).

Current status: *Amolops marmoratus* (Blyth, 1855).

Remarks: Dubois (1992) showed that *Polypedates marmoratus* Blyth, 1855 has priority over *Amolops afghanus* (Günther, 1858). Gorham (1974: 127) spelt the species name incorrectly as *marmaratus.*

Polypedates ? *saxicola* Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 533.

Type: "Malabar" and "Wynaad" (in Kerala State, south-western India).

Current status: *Micrixalus saxicola* (Jerdon, "1853" 1854b).

P. (= *Polypedates*) *smaragdinus* Blyth, 1852 *J. Asiatic Soc. Bengal* 21(4): 355.

Type: "Naga hills, Asám" (at present Nagaland State, north-eastern India).

Current status: Subjective synonym of *Rana livida* (Blyth, "1855" 1856).

Remarks: The now lost syntypes were redescribed by Anderson (1871b).

Polypedates yunnanensis Anderson, "1878" 1879. *Anat. Zool. Res. Western Yunnan* 1: 843.

Type: "Hotha" (= Husa, Yunnan Province, southern China).

Current status: *Rana andersonii* (Boulenger, 1882).

Remarks: Boulenger (1882: 55) provided the replacement name *Rana andersonii,* as *Rana yunnanensis* was coincidentally preoccupied by Anderson "1878" 1879. Fei (1999: 194) allocated the species to the genus *Odorrana* Fei, Ye & Huang (1990).

Pyxicephalus fodiens Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 534.

Type: "Carnatic" (the region between the Eastern Ghats and the Coromandel Coast, south of 16º N, in south-eastern India).

Current status: *Sphaerotheca pluvialis* (Jerdon, "1853" 1854).

Remarks: Considered a member of the *Tomopterna* (*Sphaerotheca*) *breviceps* (Schneider, 1799) complex by Günther (1864), while treated as synonymous with *Tomopterna breviceps* (Schneider, 1799) by Theobald (1868: 81) and Gorham (1974: 141). Dubois (1999) indicated that the name is synonymous with *Sphaerotheca pluvialis* (Jerdon, "1853" 1854). Dubois (1999), Marmayou et al. (2000) and Vences et al. (2000) showed that the name *Sphaerotheca* is valid for Asian species of ranids that were formerly placed in the genus *Tomopterna*, which is now restricted to African species.

Pyxicephalus frithi Theobald, 1868. *J. Asiatic Soc. Bengal* (extra number) 37: 81.

Type: "Jessore" (= Joshore, Khulna District, southern Bangladesh).

Current status: Incertae sedis, according to Dubois (1984b).

Remarks: Probably a member of the *Tomopterna breviceps* (Schneider, 1799) complex, according to Dubois (1984b). Theobald (1868: 81) had earlier treated it as synonymous with *P.* (= *Pyxicephalus*) *rufescens* Jerdon, "1853" 1854). Dubois (1999), Marmayou et al. (2000) and Vences et al. (2000) showed that the name *Sphaerotheca* is valid for Asian species of ranids that were formerly placed in the genus *Tomopterna*, which is now restricted to African species.

Pyxicephalus Khasianus Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(2): 23.

Type: "Khasi Hills" (at present in Meghalaya State, north-eastern India).

Current status: *Limnonectes khasianus* (Anderson, 1871a).

Remarks: Based on an indeterminate number of types that are at present not traced, *Pyxicephalus Khasianus* Anderson, 1871a was questionably included in the synonymy of *Limnonectes kuhlii* (Duméril & Bibron, 1841) by Bourret (1942: 278) and Gorham (1974: 146), and tentatively listed as valid by Frost (1985: 498) and Chanda (1994: 75-76; 1995: 471).

Pyxicephalus pluvialis Jerdon, "1853" 1854. *J. Asiatic Soc. Bengal* 22(5): 534.

Type: "Carnatic" (the region between the Eastern Ghats and the Coromandel Coast, south of 16º N, in south-eastern India).

Current status: *Sphaerotheca pluvialis* (Jerdon, "1853" 1854).

Remarks: Probably a member of the *Tomopterna* (= *Sphaerotheca*) *breviceps* (Schneider, 1799) complex, according to Günther (1864), to which species it was synonymised subsequently by Theobald (1868: 81). Dubois (1999), Marmayou et al. (2000) and Vences et al. (2000) showed that the name *Sphaerotheca* is valid for Asian species of ranids that were formerly placed in the genus *Tomopterna*, which is now restricted to African species.

Pyxicephalus rufescens Jerdon, "1853" 1854. *J. Asiatic Soc. Bengal* 22(5): 534.

Type: "Malabar coast" (in Kerala State, south-western India; but see below).

Current status: *Fejervarya rufescens* (Jerdon, 1853).

Remarks: Dubois (1984b) designated the neotype, MNHN 1984.2348, from "Gundia, forêt de Kemphole, à l'ouest de Sakleshpur, Karnataka, Inde", allocating the species to the genus *Rana* (*Fejervarya*).

Rana agricola Jerdon, "1853" 1854. *J. Asiatic Soc. Bengal* 22(5): 532.

Type: "S. India" (on p. 522).

Current status: Incertae sedis, according to Dubois (1984b).

Remarks: Treated as a synonym of *Rana vittigera* Wiegmann, 1834 by Theobald (1868: 80), and of *Fejervarya limnocharis* (Gravenhorst, 1829) by Boulenger (1890) and Bourret (1942: 250). Dubois ("1986" 1987) considered it a member of the genus *Hoplobatrachus* Peters, 1863.

Rana altilabris Blyth, 1855. *Proc. Asiatic Soc. Bengal* 1855(7): 720.

Type: "Pegu" (= Bago, southern Myanmar).

Current status: Treated as a synonym of *Rana vittigera* Wiegmann, 1834 by Theobald (1868: 80). Incertae sedis, according to Dubois (1984b).

Rana assamensis Sclater, 1892a. *Proc. Zool. Soc. London* 1892(3): 343; Pl. XXIV.

Type: "Khasi Hills" (in Meghalaya State, north-eastern India).

Current status: Subjective synonym of *Chaparana sikimensis* (Jerdon, 1870).

Remarks: Considered synonymous with *Chaparana sikkimensis* (Jerdon, 1870) by Dubois (1974), but listed as valid by Dutta (1997b: 155-156) and Chanda (1994: 58-60; 1995: 468), without justification.

Remarks: Sclater (1892b: 4) gave the registration number of the holotype as IMRR (= ZSI) 9574, and the register mentions that the specimen was "thrown away by the Superintendent".

R. (= *Rana*) *assimilis* Blyth, 1852. *J. Asiatic Soc. Bengal* 21(4): 355.

Types: "Calcutta" (= Kolkata, West Bengal State, eastern India) and "Arakan" (= Rakhine, Myanmar).

Current status: Questionably allocated to *Rana* (at present, *Fejervarya*) *limnocharis* (Gravenhorst, 1829) by Bourret (1942: 250) and Gorham (1974: 146), and earlier, to *Rana vittigera* Wiegmann, 1834 by Theobald (1868: 80). Incertae sedis, according to Dubois (1984b).

Rana crassa Jerdon, "1853" 1854. *J. Asiatic Soc. Bengal* 22(5): 531.

Type: "Carnatic" (the region between the Eastern Ghats and the Coromandel Coast, south of 16º N, in south-eastern India).

Current status: *Hoplobatrachus crassus* (Jerdon, "1853" 1854).

Remarks: Reallocated to the genus *Hoplobatrachus* by Dubois (1992). In the catalogue of Theobald (1868), one or more examples of this species are recognised as being donated by "Dr. Jerdon", without being identified as types.

Rana curtipes Jerdon, "1853" 1854. *J. Asiatic Soc. Bengal* 22(5): 532.

Type: "S. India" (on p. 522).

Current status: *Rana curtipes* Jerdon, 1853.

Remarks: Frost (1985: 482) wrote that the types were originally in the ZSI and are now lost.

Rana gracilis var. *nicobariensis* Stoliczka, 1870. *J. Asiatic Soc. Bengal* 39(2): 144.

Type: "Nicobars in the neighbourhood of Nancouri harbour" (in the Bay of Bengal, India).

Current status: Subjective synonym of *Fejervarya limnocharis* (Gravenhorst, 1829).

Remarks: Synonymy by Sclater (1892b: 6) and Dutta (1997b: 133). Incertae sedis, according to Dubois (1984b). Sclater (1892b: 6) gave the registration number as IMRR (= ZSI) 2679. The holotype cannot be located at present.

Rana gracilis var. *pulla* Stoliczka, 1870b. *J. Asiatic Soc. Bengal* 39(2): 144.

Types: "..about 2,000 feet on the Penang hill" (= Great Hill, Pulau Pinang, West Malaysia).

Current status: Incertae sedis.

Remarks: Synonymy by Boulenger (1890: 450) and Dutta (1997b: 133). Incertae sedis, according to Dubois (1984b), subsequently being assigned to the genus *Hoplobatrachus* Peters, 1863, by Dubois ("1986" 1987). The subspecies was based on two untraced syntypes, according to the original description. Sclater (1892b: 5), who synonymised the taxon under *Rana tigerina*, listed only one- IMRR (= ZSI) 3529, a juvenile, that is mentioned in the register as being destroyed by the order of the Superintendent.

Rana limborgii Sclater, 1892a. *Proc. Zool. Soc. London* 1892(3): 344.

Type: "Tenasserim" (in southern Myanmar).

Current status: *Taylorana limborgii* (Sclater, 1892a).

Remarks: Included in the synonymy of *Taylorana hascheana* (Stoliczka, 1870) by Taylor (1962: 412) and Gorham (1974: 145), but considered valid by Dubois (1992). Sclater (1892b: 4) gave the registration number of the holotype as IMRR (= ZSI) 5400.

Rana nilagirica Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 532.

Types: "Wynaad and Neelgherries" (=Wynad, in Kerala State, and the Nilgiris in Tamil Nadu State, south-western India).

Current status: *Fejervarya nilagirica* (Jerdon, "1853" 1854b).

Remarks: Dubois (1984b) designated a neotype, MNHN 1984.2340, from "Governor Shola, à 4 km d'Udhagamangalam en direction de Porthimund, Nilgiris, Tamil Nadu, India", allocating the species to the genus *Rana* (*Fejervarya*).

Rana travancorica Annandale, 1910b. *Rec. Indian Mus*. 5(3): 191.

Types: "Eathancaud" and "Anachardie in the Ariankavu Range near Shencottah on the Madras frontier" (in Kerala State, south-western India).

Current status: *Rana travancorica* Annandale, 1910.

Remarks: Pillai (1978b) treated *Rana travancorica* Annandale, 1910 as a junior synonym of *Nyctibatrachus major* Boulenger, 1882, while Dutta (1997: 165) tentatively considered the species valid. Frost (1985: 518) wrote that the types are in the ZSI.

Rana yunnanensis Anderson, "1878" 1879. *Anat. Zool. Res. Western Yunnan* 1: 839.

Type: "Hotha" (= Husa, Yunnan Province, southern China), restricted to "Tongchuan Fu, Yunnan Prov." (= Dongchuan Shi), by neotype designation of Dubois ("1986" 1987).

Current status: *Paa yunnanensis* (Anderson, "1878" 1879).

Remarks: Treated as a valid species by Bourret (1942: 299), Yang (1991), Dubois ("1986" 1987: 45-46) and Fei (1999: 218-220).

Dubois ("1986" 1987: 45) designated BMNH 1947.2.3.76 as the neotype of *Rana yunnanensis* Anderson, "1878" 1879.

RHACOPHORIDAE

Ixalis ? *glandulosa* Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 532.

Type: "S. India" (on p. 522).

Current status: *Philautus glandulosus* (Jerdon, "1853" 1854b).

Remarks: Generic name misspelt in the original description.

Ixalus punctatus Anderson, 1871a. *J. Asiatic Soc. Bengal* 40(1): 27.

Type: "Nilgiris" (= Nilgiri Mountains, Tamil Nadu State, south-western India).

Current status: Subjective synonym of *Philautus glandulosus* (Jerdon, 1853).

Remarks: Sclater (1892b: 21), who synonymised it under *Philautus glandulosus* (Jerdon, 1853), mentioned that the holotype was IMRR (= ZSI) 2709. The holotype of *Ixalus punctatus* Anderson, 1871a, was part of the type series of *Phyllomedusa* ? *tinniens* Jerdon, "1853" 1854.

Ixalus tuberculatus Anderson, "1878" 1879. *Anat. Zool. Res. Western Yunnan* 1: 845.

Type: "Nampoung" (in the Kakhyen Hills, northern Myanmar).

Current status: *Philautus tuberculatus* (Anderson, "1878" 1879).

Remarks: Ahl (1927) provided the replacement name *Rhacophorus andersoni* Ahl, 1927, for *Ixalus tuberculatus* Anderson, "1878" 1879, which was preoccupied by *Ixalus tuberculatus* Boulenger, 1882. The 1999 Code does not support the replacement name, and Fei (1999: 260) validly used the name *Philautus tuberculatus* for the taxon.

Phyllomedusa ? *tinniens* Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 533.

Type: "Neelgherries" (= Nilgiri Mountains, Tamil Nadu State, south-western India).

Current status: Subjective synonym of *Philautus glandulosus* (Jerdon, "1853" 1854b).

Remarks: The holotype of *Ixalus punctatus* Anderson, 1871a (= *Philautus glandulosus* [Jerdon, 1853]), was part of the type series of *Phyllomedusa* ? *tinniens* Jerdon, "1853" 1854b. Synonymy follows Gorham (1974: 166).

Phyllomedusa ? *wynaadensis* Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 533.

Type: Type locality not specifically mentioned, although the specific name makes it clear that its providence was Wynaad (in Kerala State, south-western India).

Current status: Subjective synonym of *Philautus variabilis* (Günther, 1858).

Remarks: Gorham (1974: 167) questionably synonymised the taxon under *Philautus variabilis* (Günther, 1858).

Polypedates variabilis Jerdon, "1853" 1854b. *J. Asiatic Soc. Bengal* 22(5): 532.

Type: "Neelgherries" (= Nilgiri Mountains, Tamil Nadu State, south-western India).

Current status: Incertae sedis.

Remarks: Theobald (1868: 85) listed the species as valid, but did not indicate the presence of the holotype in the Indian Museum collection.

Rhacophorus gigas Jerdon, 1870. *Proc. Asiatic Soc. Bengal* 1870(3): 84.

Type: "Sikim and Khasi Hills" (= Sikkim State, eastern India and Khasi Hills, Meghalaya State, north-eastern India).

Current status: Subjective synonym of *Rhacophorus maximus* Günther, 1864.

Remarks: Boulenger (1882: 88) considered the name as synonymous with *Rhacophorus maximus* Günther, 1864 (whom we follow here), as opposed to Gorham (1974: 170), who synonymised the taxon under *Rhacophorus nigropalmatus* Boulenger, 1895.

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APPENDIX 1

We append below an appeal made by Theobald (1868: 80), which is still relevant today:

"There are no reptiles in India in such a confused state as the *Ranidae*, and I can add but little towards disentangling the shadowy species, real enough perhaps, but not as yet characterised. The series in the Museum is a very poor one, and the *Ranidae* from all parts of India must be assiduously collected, before sound results can be obtained. Let us hope that an urgent appeal for frogs from all quarters of India will be liberally responded to by local naturalists and collectors, without which aid the subject must long remain in its present unsatisfactory state. Each contributor should not send merely the most conspicuous frogs from his neighbourhood, but all the species and varieties he can procure".

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CRITICAL REVIEW OF SOME RECENT DESCRIPTIONS OF PAKISTANI *TYPHLOPS* BY M. S. KHAN, 1999 (SERPENTES: TYPHLOPIDAE)

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ABSTRACT.– **Due to inadequate diagnoses and descriptions, conflicting data, and variable or vague taxonomic characters, the systematic status of Khan's *T. m. madgemintonae, T. m. shermani,* and *T. Ahsanuli* is uncertain and they are all placed *incertae sedis* within the Typhlopidae until the type material can be examined. Unfortunately, none of the holotypes are presently deposited in an institution. The names of the above three taxa, as proposed, are incorrect original spellings and are corrected. *Typhlops ductuliformes* Khan is shown to be a synonym of *Typhlops porrectus* Stoliczka.**

KEY WORDS.– ***Typhlops ductuliformes, T. m. madgemintonae, T. m. shermani, T. ahsanuli, T. porrectus.***

INTRODUCTION

In a pair of recent papers, Khan (1999a-b) described four new taxa of 18 scale rowed blind snakes from Pakistan, three species and one subspecies. Both papers suffer from numerous errors involving citations, nomenclature, data analysis, characters, diagnoses, descriptions, and comparisons that escaped both the editorial and review processes. This critique will discuss the papers in chronological order of publication, beginning with Khan (1999a) and ending with Khan (1999b). Editorial errors will be discussed first, followed by a review of the data and characters, and then a discussion of the status of the newly described taxa.

REVIEW OF KHAN (1999A)

Typographical errors.– Constable (1949) is twice referred to as "Constable, 1947" (pp. 386, 389), Tiedemann et al., (1994) is cited as "Tiedeman et al., 1994" (p. 389), and Khan (1980) is cited as "Khan, 1982" (p. 389). The second author in Tiedemann et al. (1994) is Häupl, misspelled as "Hupl" in both Khan, 1999a-b. Three references are cited in the text but not listed in the bibliography: Minton (1966), Mertens (1969), and Khan (1982). Also, the paper by Khan (1980) listed in the bibliography is not cited in the text.

Among other typographical errors, the species *T. filiformis* is misspelled as *"filiformes"* four times (p. 388-389), *T. meszoelyi* is misspelled as *"messoelyi"* (p. 388), *T. madgemintoni* is misspelled as *T. "medgemintoni"* (Table II), and *T. ahsanai* is misspelled as *"ahsani"* (p. 389). Figure 2C is referred to in the text as "Fig. 3" (p. 389). The holotype of *T. ductuliformes* (MSK 0650.97) is referred to in the description as "MSK 0650" and is also referred to in several places as FMNH 235536. In the visceral comparison section of Khan (1999a), reference is made to "Fig. 3" of Khan, in press (=1999b); the figure of the viscera is actually Fig. 1 in Khan (1999b).

In the Acknowledgements of Khan (1999a-b), I am referred to as "Mr. Wallach" in the "Department of Herpetology," although I have a Ph.D. and have not been a member of that department since 1993. Addison Wynn, who is at the USNM, is listed on the staff of the "American Museum of Natural History, Washington, DC" when in fact the AMNH is in New York. Khan (1999a) misspelled Wynn as "Wyn" and Khan (1999b) elevated Addison to the status of "Dr. Wynn."

Nomenclatural errors.– In Khan (1999a), nine paratypes are listed (p. 386) although raw data are provided for only eight of them (Table I, p. 388). Three paratypes are listed as being in the author's personal collection in Pakistan and one paratype in the collection of S. A. Minton, Jr. (now deceased). The holotype, which is cited as FMNH 235536, is not currently present in the Field Museum; evidently a number was issued before the specimen was received and it has not yet reached the museum. In Khan (1999b), all type specimens (three holotypes and three paratypes) are listed in the author's personal collection in Pakistan and no mention is made of where, or if, they will eventually be deposited. The specimens are reportedly being sent to the U.S.A. (M. S. Khan*,* in litt.).

Khan (1999a-b) states that the holotype of *T. porrectus* Stoliczka is "apparently lost, however four of the syntypes are reported to be in Naturhistorisches Museum Wien." Since Stoliczka's (1871) description was based upon "eight specimens measured," the original type series consisted of at least eight syntypes, four of which (NMW 15357a-b, 15358a-b) are known to exist in (Hahn, 1980; Tiedemann et al., 1994).

Although not intended to be the formal description, Khan (1999a) mentioned *T. madgemintonae* (misspelled as *T. "medgemintoni"* and *"madgemintoni,"* both of which are incorrect original spellings) and *T. ahsanuli* (misspelled as *T. "ahsanai"* and *T. "ahsani,"* again as incorrect original spellings) in both the text (pp. 388-389) and in Table II with defining characters, so the availability of those two names dates to the 1999a paper under Art. 13(a)(i) (I.C.Z.N., 1985). According to Art. 31(ii) of the Code (I.C.Z.N., 1985), a species-group name formed directly from a modern personal name is formed by adding to that name *-i* if the name is that of a man, and *-ae* if of a woman. Thus, *T. madgemintoni, T. medgemintoni, T. ahsanai,* and *T. ahsani* are all incorrect original spellings and according to Art. 32(c)(i) must be corrected to *T. madgemintonae* and *T. ahsanuli.* Article 33(b)(i) of the Code is invoked to establish the orthography of the patronym *ahsanuli* based upon the statement in Khan's (1999b) Etymology section that the species was being named in honor of his late mentor, Dr. Ahsanul-Islam, later clarified that the Professor's name is actually a compound Arabic name Ahsanu-l-Islam (M. S. Khan, in litt.). The nearly simultaneous publication of the two papers is taken to be equivalent to an author's corrigendum, bearing in mind that it was not the intention of Khan to describe those species in his 1999a paper. Otherwise, because the name becomes available in Khan (1999a), the species would have to be known as either *T. ahsani* or *T. ahsanai. Typhlops m. shermani* (misspelled as *T. m. "shermanai")* is listed on p. 389 without a description or definition, so it is a *nomen nudum.*

Technical errors.– Khan (1999a) refers "all SMF numbers in Mertens (1969: 52)" to his new species as paratypes but does not provide any data on them: he does not list the museum numbers, the number of specimens, or present data for them in his Table II. For the record, these include five paratypes catalogued as SMF 62749-53. If these specimens were examined, no acknowledgement is given by the author. Their allocation as paratypes seems to be based solely upon geography since Mertens (1969) did not provide morphological data on the specimens either.

Khan (1999a) erroneously reports that "*Ramphotyphlops braminus* has long been known to have 18-21 scale rows around the body," citing Minton (1966), Mertens (1969), and Khan (1982). The material that Minton (1966) reported on was either composite or the scale rows were counted incorrectly as *R. braminus* consistently has 20 scale rows (McDowell, 1974; Roux-Estève, 1974; Nussbaum, 1980; Gasperetti, 1988; Ota et al., 1991; pers. obs.). The same holds true for Mertens' (1969) report of *R. braminus* with 18 scale rows. Khan (1982) stated that scale rows for *R. braminus* are "20 (rarely 18-19)."

In describing the supraoculars of *T. ductuliformes,* Khan (1999a: 388) mentioned only that they are "oblique, about twice deeper than their breadth" (partially substantiated by Fig. 2A showing only a single supraocular on the left side). However, Fig. 2B depicts the head dorsum of the holotype of *T. ductuliformes* with a pair of supraoculars on each side, a condition unique, not only in *Typhlops,* but also within the Typhlopidae. Presumably the illustration is in error.

In Table II of Khan (1999a), tail length for *T. filiformis* should be 2.0 (not 2.5) mm, body length, body diameter, and mid-dorsal scales in *T. meszoelyi* should be 161.5-178.5 (not 161.5) mm, 2.5-3.0 (not 3) mm, and 414-421 (not 421), respectively, the tail end in *T. ductuliformes* (based upon UMMZ 123429) should be a spine (not a cone), and the mid-dorsal scales and eye indication in *T. porrectus* should be 388-468 (not 406-440) and faint (not distinct).

Internal anatomy.– Khan (1999a) describes the posterior internal anatomy of *T. ductuliformes* and provides a list of comparative visceral features. He illustrates the presence of two oviducts in "Fig. 3" (= Fig. 2C) and ambiguously reports "Oviduct[s] (2) originate from the posteriorly elongated ovaries" (p. 388). Fig. 2C represents a ventral view of the body as the ovary and kidney on the "right side" are slightly longer and anterior to those on the "left side," which is the typical ophidian condition, and Khan states that the right ovary "lies at a higher level than the left." The presence of a left oviduct is noteworthy as it is unknown within both the Typhlopidae and Leptotyphlopidae (Fox and Dessauer, 1962; Fox, 1965; Robb, 1960; Robb and Smith, 1966). However, there are a few rare exceptions of presence of a left oviduct reported in the Typhlopidae: one *Rhinotyphlops acutus* (CAS-SU 12515) out of three (Wallach, 1998), one *R. caecus* (CM 90395) out of seven (Wallach, 1998), and one *Ramphotyphlops exocoeti* (Greer, 1997: p. 4, footnote) although the right oviduct is not present in CAS 16867 or MCZ 28643. Examination of a female paratype of *T. ductuliformes* (UMMZ 123429) reveals no trace of a left oviduct; this still does not discount the presence of paired oviducts in the holotype of *T. ductuliformes* but it casts some doubt upon the reliability of the report. It is essential that the holotype be examined to confirm or reject this finding.

Another feature listed for *T. ductuliformes* by Khan (1999a: 388) is that each ovary is "composed of two ellipsoidal moieties, joined to each other at ends." This sounds as if a pair of vitellogenic ova were present as bipartite ovaries have not yet been reported in the Typhlopidae. UMMZ 123429 has two ova in the right ovary (and one in the left) but they do not appear as two moieties connected at their ends; rather, they are embedded in the tissue of the ovary.

The *Typhlops madgemintonae* group is separated from *T. ductuliformes* by several internal characters. However, three of them are universal among typhlopids: "compact flat kidneys, ureters given [off] from inner side of the kidneys, and fat bodies lobed." All of these characters are typical of the Typhlopidae. In some species of typhlopids the kidneys show traces of transverse creasing but the organs are not lobed or multipartite. The ureters arise from the medial surface of the kidneys in all scolecophidians that I have examined, and fat bodies are always lobed.

One significant difference reported between *T. ductuliformes* and the *T. madgemintonae* group is that in the former the ureter empties into the cloaca near its base whereas in the latter the ureter joins the vas deferens to form a urogenital duct (called the "ejaculatory duct" in Khan, 1999b) that enters the cloaca. However, the *T. ductuliformes* condition (Khan, 1999a) was based upon a female and the *T. madgemintonae* condition (Khan, 1999b) was based upon a male. The urogenital condition has been described in *Typhlops vermicularis* (Heyder, 1968) and *Ramphotyphlops* spp. (Robb, 1960). In both genera the female condition is as reported by Khan (1999a) for *T. ductuliformes* but the male condition differs from that reported for the *T. madgemintonae* group in that the ureter and vas deferens remain separate until their entrance into the cloaca. If confirmed, the presence of a common urogenital duct in the male would represent a synapomorphy for the group.

Systematic status.– *Typhlops ductuliformes* is diagnosed from the other 18 row *Typhlops* by the

TABLE 1: Comparison of *Typhlops ductuliformes*, *T. m. madgemintonae, T. m. shermani*, and *T. ahsanuli* with 18 scale row Asian species (unless otherwise defined, + = present, 0 = absent). LSR= longitudinal scale rows, TMD = total middorsals, SC = number of subcaudals, LOA = total length (mm), MBD = midbody diameter (mm), L/W = total length/midbody diameter, T/LOA = tail length/total length, TL/W = tail length/midtail diameter, SIP = supralabial imbrication pattern, SNS = superior nasal suture, INS = inferior nasal suture contact (SL2 = Second supralabial, PO = Preocular), PO = number of postoculars, SO = number of suboculars, G = glands beneath head shields in addition to scale margins, E = eye (+ = present with discernible pupil, d = distinct eyespot, i = indistinct eyespot, 0 = absent), N = nasals in contact middorsally, AS = apical spine, TP = lateral tongue papillae, PN = postnasal concavity

Species	n	LSR	TMD	SC	LOA	MBD	L/W	T/LOA	TL/W	SIP	SNS	INS	PO	SO	G	E	N	AS	TP	P
Ductuliformes[3,5]	10	18	412-461	10-13	90-202	1.1-2.0	56-112	1.2-2.3	1.8-2.5	T-V	0.5	SL2	1	0	0	i	0	+	?	+
m. Madgemintonae[4]	2	18	337-342	9-10	170-200	2.6-2.7	62-76	1.9-2.3	1.6-1.9	T-V	1.0	SL2	1	0	0	d	0	+	?	0
m. Shermani[4]	3	18	336-364	8-9	120-192	1.2-2.2	87-130	1.3-1.7	1.7-2.9	T-V	0.5	SL2	1	0	0	d	0	?	?	0
Ahsanuli[4]	1	18	341	7	170	2.5	68	1.5	1.4	T-V ?	0.75	SL2	1	0	0	d	0	?	?	+
Porrectus[2,5]	10	18	388-468	7-12	65-285	1.5-4.3	50-91	1.4-2.3	1.0-2.0	T-V	0.7-1.0	SL2	1-2	0	0	d	0	+	+	0
Meszoelyi[5]	2	18	414-421	9-10	162-179	2.5-3.0	54-71	2.0-2.2	1.6-1.8	T-III	0.5-0.7	SL2	1	0	0	i	0	+	+	+
Loveridgei[5]	1	18	430	11	208	3.0	83	1.9	1.4	T-III	0.9	SL2	1	0	0	0	0	+	?	0
Exiguus[5]	1	18	348	12	135-196	2.5	60-78	1.5	1.6	T-III	0.5	SL2	1	0	0	d	0	0	?	0
Floweri[2,5]	3	18	478-520	20-23	174-230	2.5-3.0	62-89	3.4-4.0	1.0-3.0	T-V	1.0	SL2	2-3	1	+	+	0	0	?	0
Andamanensis[1,2]	1	18	390-407	17	160-165	3.5	47	4.0	2.1	T-II	1.0	SL2	2	2	?	d	0	+	?	0
Beddomii[2,5]	5	18	190-225	10-13	90-140	2.5-3.5	20-40	2.3-3.7	1.3-1.8	T-II	1.0	SL2	1	0	+	+	+	0	?	0
Mirus[2,5]	4	18	298-360	12-16	99-140	2.5-3.0	35-60	3.3-3.8	1.5-2.0	T-II	1.0	SL2	1-2	0	+	0	0	0	?	0
Tindalli[2]	3	18	300	9	140-175	3.5	42-53	1.9	1.0	T-II	0	PO	1	0	?	0	+	0	?	?

[1] data from Stoliczka, 1871
[2] data from Smith, 1943
[3] data from Khan, 1999a
[4] data from Khan, 1999b
[5] pers. obs.

allel rostral, 3) narrow body diameter, 4) longer total length, and 5) greater number of middorsal scales. None of these characters separate *T. ductuliformes* from *T. meszoelyi:* 1) the depression of the snout is a subjective character and often is an artefact of preservation or dessication, and according to Fig.2A, the snout does not appear depressed; 2) the rostral in *T. ductuliformes, T. filiformis, T. loveridgei, T. meszoelyi,* and most *T. porrectus* is oval in shape dorsally (slightly wider medially than anteriorly and posteriorly); 3) the width of a blind snake is not a reliable taxonomic character as it varies ontogenetically with age and temporarily is dependent upon other variables such as general health, preservation state, whether or not food is in the gut, and reproductive condition. Dixon and Kofron (1984) found body diameter to be useless in defining taxonomic boundaries in *Liotyphlops:* in 55% of *L. albirostris* the greatest diameter was at midbody, in 36% it was posteriorly, and in 9% it was equal at midbody and posteriorly. Allometry was present in body width to length ratios: all juveniles had lower length/width ratios than adults. The length/width ratio in local populations of *Leptotyphlops* varies by a factor of 10-17% (Broadley and Watson, 1976) and varies ontogenetically in *Liotyphlops* (Dixon and Kofron, 1984). However, body width can be useful as an indicator of size with large samples; 4) the maximum length of a blind snake is a good character for indication of size. However, unless a large series is present or sexual maturity is confirmed by internal examination, one cannot determine if the specimen is a juvenile or adult. Comparisons of length or width between juveniles or sub-adults and adults are meaningless. A more reliable character (although not a great one) is a ratio of the width to length and all seven species in Khan's (1999a) Table II, when calculated, are included with a range from 60-70; 5) the number of total middorsals is a good taxonomic character but the range in *T. ductuliformes* (412-461) includes that of *T. meszoelyi* (414-421) and is included within that of *T. porrectus* (388-468). As such, the range of *T. ductuliformes* is not diagnostic. However, with a large series of specimens, the sample means can sometimes reveal a statistically significant difference between populations having overlapping ranges.

Khan (1999a) does not summarize data for some of the more meaningful taxonomic characters of typhlopids: total length/midbody width ratio, tail length/total length ratio, and tail length/midtail width ratio. These data are provided here in Table 1 (including data for UMMZ 123429, which is listed as a paratype but not included in Khan's Table I). The length/width ratio for *T. ductuliformes* is 56-112, an unusually large range for a single species. However, there is no correlation with middorsals to suggest two taxa are involved: the four thinnest specimens (L/W = 100-112, mean = 105.0) have 416-461 (mean = 431.8) middorsals while the three stoutest specimens (L/W = 56-68, mean = 63.0) have 425-430 (mean = 427.3) middorsals, while the three intermediate specimens (L/W = 76-95, mean = 84.3) have 412-431 (mean = 420.7) middorsals.

Khan (1999a) reports a terminal cone rather than a spine in *T. ductuliformes.* Examination of a paratype (UMMZ 123429) shows that the apical spine was present but is now missing. When the spine is broken or torn off, the soft tissue underneath remains in a spinelike configuration. A terminal cone presents an entirely different aspect.

Khan (1999a) has not adequately differentiated *T. ductuliformes* from *T. meszoelyi* or *T. porrectus* (see Table 1). Probably the single most important character in typhlopids is the supralabial imbrication pattern (SIP) as it shows insignificant intraspecific variation and characterizes most species groups (Wallach, 1993a, 1998). Among a sample of 255 *Acutotyphlops kunuaensis,* which is characterized by a T-III pattern, only two individuals (0.8%) had a T-V pattern (MCZ 72067 and 77295). Although Khan (1999a) mentions that *T. ductuliformes* has a T-V SIP, he does not use the character in his diagnosis or comparisons with other species. A T-V SIP distinguishes *T. ductuliformes* from *T. meszoelyi* (SIP = T-III), leaving the former as a possible synonym of *T. porrectus.*

TABLE 2: Comparison of visceral characters of *Typhlops ductuliformes* shared most closely with *T. porrectus.* All characters presented as mean (range) in % SVL (n = sample size, M = male, F = female): H = heart length, HMP = heart midpoint, JLSA = junction of left systemic arch, SHI = snout-heart interval, HGBG = heart-gall bladder gap, RL = right liver lobe length, RLMP = right liver lobe midpoint, LL = left liver lobe length, LLMP = left liver lobe midpoint, TL = total liver length, TLMP = total liver midpoint, LL+RL = left liver lobe length plus right liver lobe length, LL/RL = left liver lobe/right liver lobe, ALA = anterior liver tail/total liver length, GBMP = gall bladder midpoint, GBKG = gall bladder-kidney gap, GBKI = gall bladder-kidney interval, ROMP = right ovary midpoint, TOMP = total ovary midpoint, RAMP = right adrenal midpoint, LAMP = left adrenal midpoint, TAMP = total adrenal midpoint, RKMP = right kidney midpoint, LKMP = left kidney midpoint, TKMP = total kidney midpoint, RCVI = rectal caecum-vent interval, T = trachea length, TMP = trachea midpoint, NTR = number of tracheal rings/10% SVL, TLg = tracheal lung length, RLgMP = right lung midpoint, TotLg = total lung length, Tra = trabecular lung.

	T. meszoelyi	T. porrectus	T. ductuliformes	T. exiguus
n sex	2 M	3 M, 2 F	1 F	1 F
H	3.2 (3.1-3.2)	4.3 (3.3-5.4)	4.1	3.4
HMP	29.4 (29.3-29.4)	30.5 (29.1-32.4)	30.8	28.9
JLSA	0.67 (0.60-0.73)	0.88 (0.79-1.00)	0.82	0.77
SHI	31.0 (30.9-31.0)	32.7 (31.2-35.1)	32.8	30.6
HGBG	32.3 (31.6-32.9)	34.2 (30.9-36.9)	35.4	36.3
RL	20.3 (19.6-20.9)	26.5 (23.4-30.0)	24.6	21.2
RLMP	42.1 (41.8-42.4)	48.2 (45.6-51.1)	46.3	43.3
LL	17.4 (17.1-17.7)	23.6 (21.6-28.3)	21.6	16.6
LLMP	39.0 (38.9-39.1)	43.9 (41.3-46.1)	42.2	37.6
TL	21.9 (21.2-22.6)	29.3 (26.6-33.6)	27.2	24.6
TLMP	41.3 (41.0-41.6)	46.8 (44.0-49.5)	44.3	41.6
LL+RL	37.7 (36.7-38.6)	50.1 (45.0-58.3)	46.2	37.8
LL/RL	0.86 (0.85-0.87)	0.89 (0.82-0.94)	0.88	0.78
ALA	0.08 (0.07-0.08)	0.10 (0.07-0.12)	0.10	0.14
GBMP	63.9 (63.5-64.4)	67.7 (63.8-71.7)	68.8	67.4
GBKG	22.6 (22.2-22.9)	19.5 (15.3-24.8)	19.8	22.5
GBKI	29.6 (29.4-29.7)	27.0 (23.4-31.2)	25.7	28.0
ROMP	—	81.5 (80.9-82.0)	81.5	79.5
TOMP	—	82.3 (81.9-82.6)	82.8	80.8
RKMP	89.1 (88.3-89.9)	90.0 (87.7-91.1)	90.5	91.6
LKMP	91.0 (90.2-91.7)	92.0 (89.9-92.8)	92.7	93.5
TKMP	90.0 (89.3-90.8)	91.0 (88.8-92.0)	91.6	92.6
RCVI	8.2 (7.4-8.9)	7.0 (5.9-9.2)	6.7	4.9
T	29.7 (29.7-29.8)	31.8 (30.2-34.5)	32.5	30.1
TMP	16.1 (16.0-16.1)	16.8 (16.1-17.9)	16.6	15.5
NTR	91.4 (89.5-93.3)	84.9 (68.5-99.2)	87.1	109.3
TLg	17.5 (16.6-18.4)	19.0 (17.1-22.8)	22.0	16.8
RLgMP	36.4 (36.0-36.7)	40.9 (39.2-43.7)	39.9	37.8
TotLg	31.5 (30.0-32.9)	39.7 (36.7-46.1)	40.3	34.7
Tra	3.9 (3.2-4.6)	8.8 (6.6-10.8)	7.5	8.3

Khan (1999a-b) does not consider another member of the *T. porrectus* group *(T. exiguus)* in his comparisons. Table 1 presents external data on all 18 scale rowed *Typhlops* from south Asia, while Tables 2-5 present visceral data on the *T. porrectus* group species for which internal data are available. It is clear that *T. ductuliformes* most closely resembles *T. porrectus* in its visceral arrangement with 30 shared characters (Table 2), whereas

TABLE 3: Comparison of visceral characters of *Typhlops ductuliformes* shared most closely with *T. meszoelyi.* All characters presented as mean (range) in % SVL (n = sample size, M = male, F = female): S = posterior tip of sternohyoideus, SHG = sternohyoideus/snout-anterior heart tip interval, PLA = posterior liver tail/total liver length, RLS = right liver segments, LLS = left liver segments, TLS = total liver segments, LKI = liver-kidney interval, GBGG = gall bladder-gonad gap, GKG = gonad-kidney gap, C = chambers/cells in tracheal lung, RLg/TLg = right lung/tracheal lung.

	T. meszoelyi	T. porrectus	T. ductuliformes	T. exiguus
n sex	2 M	3 M, 2 F	1 F	1 F
S	8.0 (7.9-8.0)	9.1 (6.1-10.8)	8.2	10.9
SHG	0.72 (0.71-0.72)	0.68 (0.62-0.80)	0.71	0.60
PLA	0.21 (0.19-0.22)	0.19 (0.15-0.24)	0.21	0.33
RLS	18.5 (18-19)	10.8 (7-13)	18	8
LLS	19.5 (18-21)	10.4 (8-14)	22	11
TLS	38.0 (36-40)	21.2 (15-27)	40	19
LKI	62.4 (61.7-63.1)	61.7 (59.8-63.5)	62.7	65.5
GBGG	11.4 (11.1-11.7)	9.2 (6.8-11.4)	10.8	9.3
GKG	4.2 (3.2 -5.1)	5.6 (3.8-8.7)	4.1	6.5
C	30.5 (29-32)	25.8 (22-26)	34	26
RLg/TLg	0.62 (0.62-0.62)	0.87 (0.83-0.88)	0.65	0.86

TABLE 4: Comparison of visceral characters of *Typhlops ductuliformes* shared most closely with *T. exiguus.* All characters presented as mean (range) in % SVL (n = sample size, M = male, F = female): HLG = heart-liver gap, LGBI = liver-gall bladder interval, RC = rectal caecum length, B = bronchus length, B/RLg = bronchus length/right lung length, RLg = right lung length, TotLgMP = total lung midpoint.

	T. meszoelyi	T. porrectus	T. ductuliformes	T. exiguus
n sex	2 M	3 M, 2 F	1 F	1F
HLG	-0.6 (-0.6 to -0.6)	-0.6 (-1.4 to 0.7)	-1.5	-1.3
LGBI	32.7 (32.3-33.1)	33.6 (30.7-35.3)	35.4	35.2
RC	1.1 (0.9-1.3)	0.9 (0.7-1.0)	1.5	1.3
B	7.1 (6.9-7.3)	11.5 (10.6-13.4)	8.2	7.8
B/RLg	0.66 (0.64-0.67)	0.70 (0.66-0.76)	0.58	0.54
RLg	10.8 (10.3-11.4)	16.5 (14.2-20.0)	14.2	14.5
TotLgMP	20.9 (20.6-21.2)	29.3 (28.0-31.0)	26.9	27.7

only 11 characters are shared with *T. meszoelyi* (Table 3) and 7 characters with *T. exiguus* (Table 4). For the remaining 13 characters, *T. ductuliformes* does not show any particular affinity (Table 5). Based upon the visceral anatomy, in conjunction with the external data (Table 1), distinction of *T. ductuliformes* from *T. porrectus* does not seem justified. It is quite possible that *T. ductuliformes* is composite, but until the holotype can be examined to determine its identity, it is best considered a synonym of *T. porrectus.* A redescription of *T. porrectus* is being undertaken by A. H. Wynn and C. Gans.

REVIEW OF KHAN (1999B)

Typographical errors.– Smith (1943) is cited in the text as “Smith, 1941” four times and Constable (1949) is cited in the text as “Constable 1947.” Tiedemann et al. (1994) is misspelled as “Tiedeman” in the text and in the bibliographic citation, Häupl is misspelled as “Hupl.” The male vas deferens is misspelled as “vas deference” in the key to Fig. 1 (p. 233).

In discussing the male reproductive system, the hemipenial retractor muscle and awn are referred to as “pineal” (pp. 232-233), the pineal body or epiphysis being a part of the

TABLE 5: Comparison of visceral characters of *Typhlops ductuliformes* not closely shared with any species.All characters presented as mean (range) in % SVL (n = sample size, M = male, F = female): HLI = heart-liver interval, LGBG = liver-gall bladder gap, LKG = liver-kidney gap, LOMP = left ovary midpoint, RAMP = right adrenal midpoint, LAMP = left adrenal midpoint, TAMP = total adrenal midpoint, TB = trachea-bronchus length, TBMP = trachea-bronchus midpoint, BPT = bronchus posterior tip, AT = anterior tip of tracheal lung, TLgMP = tracheal lung midpoint, PT = posterior tip of right lung.

n sex	T. meszoelyi 2 M	T. porrectus 3 M, 2 F	T. ductuliformes 1 F	T. exiguus 1F
HLI	24.4 (23.7-25.1)	33.0 (30.3-37.0)	29.9	26.7
LGBG	11.0 (10.9-11.1)	5.5 (2.9-8.7)	9.7	13.0
LKG	35.0 (34.8-35.1)	26.7 (24.1-32.1)	30.6	36.5
LOMP	—	83.1 (82.9-83.2)	84.0	82.1
RAMP	86.3 (86.1-86.7)	82.3 (80.1-84.1)	88.8	—
LAMP	88.0 (88.0-88.0)	83.8 (81.8-85.6)	90.9	—
TAMP	87.2 (87.0-87.3)	83.1 (80.9-84.8)	89.9	—
TB	36.8 (36.6-37.0)	43.3 (40.8-46.1)	40.7	37.8
TBMP	19.6 (19.4-19.8)	22.5 (21.3-24.0)	20.7	19.4
BPT	38.0 (37.7-38.3)	44.2 (41.7-47.1)	41.0	38.3
AT	10.3 (9.5-11.1)	9.5 (7.5-12.7)	6.7	10.4
TLgMP	20.7 (20.3-21.0)	21.1 (19.9-23.9)	17.7	20.5
PT	41.8 (41.1-42.4)	49.2 (47.3-53.7))	47.0	45.1

diencephalon of the brain. Khan (1999b: Fig. 1) correctly refers to the peneal awn and sheath.

The personal collection number of the holotype of *T. madgemintonae* is erroneously reported as “MSK 0949.93” (p. 232) when it is actually 0904.93 according to Fig. 2a, Table 1, and remaining text.

In Table 1, the scale counts at midbody, vent level, and midtail plus the scale count parameters of dorsocaudals, subcaudals, and middorsals are all followed by “mm” as if their values represented measurements.

In discussing the orientation of the parietal shields, Khan (1999b: 235) uses the term “vertical” rather than transverse even though the parietals are on the dorsum of the head. Also, the four supralabials are mistakenly referrred to as “four supraoculars.”

Khan (1999b) places Boulenger (1893) before Boulenger (1890) in the bibliography. The following works are cited in the text but not listed in the bibliography: Duméril and Bibron (1844), Jan (1860), Jan (1863), and Boulenger (1888). The bibliographic citation of Wall (1923), listed as “Wall (923),” is not cited in the text.

The author of *T. floweri* is Boulenger *in* Flower (1899), not “Boulenger (1888).” *Typhlops beddomii* Boulenger (1890) is twice misspelled as *“T. beddomei.”*

The correct date of *Typhlops mackinnoni* Wall is 1910, as it was published in February of that year, not 1909 as erroneously cited by Wallach (1999: 185). However, Khan (1999b) cited the work in the bibliography as “Wall (1911),” and provided a reference that was not the original description of *T. mackinnoni.* Incidentally, Khan (1999b), in discussing *T. mackinnoni* and *T. venningi* as valid species, does not credit Addison Wynn as the source of information on the status of those names. They are currently considered synonyms of *T. porrectus* (McDiarmid et al., 1999). Although Khan (1999b) listed both *T. mackinnoni* and *T. venningi* as 18 scale row species from South Asia, he did not mention *T. exiguus* Jan, 1864 *in* Jan and Sordelli, 1860-1866.

It should be noted that the catalogue number of the holotype of *T. diardii platyventris* Khan is CAS 170527, not CAS 170526 as listed by Khan (1998: 214, Fig. 1, Table I).

Nomenclatural errors.– The formulation of all species-group names in Khan (1999b) is incorrect: *T. madgemintonai* is an incorrect subsequent spelling, *T. m. shermanai* is an incorrect original spelling, and *T. ahsanai* is an incorrect subsequent spelling. Khan (1999b) clearly stated in the Etymology section that the three taxa were named in honor of Mrs. Madge Minton, Dr. Sherman A. Minton, Jr., and Prof. Dr. Ahsanul-Islam, respectively. He appeared to have been trying to combine both a masculine and feminine termination to each name with the addition of *-ai,* an incorrect and unjustified ending according to the rules of Latin grammar and the Code (I.C.Z.N., 1985). These names are misspelled no fewer than 31 times throughout the paper. Although their descriptions appear in Khan (1999b), the names *Typhlops madgemintonae* and *T. ahsanuli* both derive from Khan (1999a), as discussed above. The name *T. m. shermani* dates from Khan (1999b) but it is an incorrect original spelling as *"shermanai."*

Technical errors.– One character used to define and diagnose the *T. madgemintonae* group from the *T. porrectus* group is the division of the nasal shield (completeness of the superior nasal suture). The *T. porrectus* group is defined as having an "incompletely divided nasal scale" whereas the *T. madgemintonae* group is defined as having "variations in the extent of the narial suture: 100, 75, 50, or 25% complete." In the diagnosis of *T. madgemintonae* (p. 233), the species is reported to have a "completely divided nasal scale" but in the description of *T. madgemintonae* the holotype is reported to have the "nasal scale divided on right, nearly so on the left side." In the holotype and both paratypes of the subspecies *T. m. shermani,* the "supranasal suture is 50% complete" whereas Fig. 3 depicts a superior nasal suture of 75%. The holotype of *T. ahsanuli* "differs in having 75% complete supranasal suture" whereas Fig. 4 depicts a nearly complete superior nasal suture (> 90%). The range of variation of the length of the nasal suture is 25-100%: the holotype of *T. m. madgemintonae* has 100% and perhaps 90%, *T. m. shermani* has from 50-75%, and *T. ahsanuli* has 75-90% (depending upon whether you accept the description or the figures). No specimen is mentioned with a suture only 25% in length, yet it is mentioned in the diagnosis.

In the past the completeness of the superior nasal suture was a key diagnostic feature of typhlopids. However, careful examination of specimens with good optics and the comparison of large samples of individual species has revealed that the superior nasal suture can be quite variable. It is informative within a limited range, such as a short (< 33%), moderate (approximately 50%, but from 40-60%), or long (> 67%) suture. Some species lack a superior nasal suture (0%) or have it completely divided (100%), but in such cases the taxon usually does not exhibit any variation. An extreme example can be seen in a sample of 114 *Typhlops boettgeri* from Madagascar with the following data on the superior nasal suture (% division with number of specimens parenthetically): 0% (1), 33% (3), 50-60% (39), 67-75% (41), 90% (22), 100% (8) (Wallach, Nussbaum and Raxworthy, unpubl. data).

Another purported characteristic of the *T. madgemintonae* group is the length/width ratio, which is presented as 62-76 in the Introduction (p. 231). However, that range applies only to *T. m. madgemintonae* because the range in *T. m. shermani* is 87-130.

The diagnosis of the *T. porrectus* species group appears to be based solely upon Stoliczka's (1871) initial description of *T. porrectus.* Since that time, many additional specimens have been reported upon in collections. Khan (1999b) listed a midbody diameter range of 1.8-1.9 mm for the *T. porrectus* group; however, some specimens have a midbody diameter of 3-4 mm (FMNH 60645, MCZ 165023). As mentioned above, these data are meaningless without comparison with the length as in the length/width ratio. Likewise, other ranges for *T. porrectus* in Khan (1999b) are, I believe, underestimations. Based upon material that I have examined, his length/width ratios of "87-91" should be 50-91, his total middorsal counts of "412-461" should be 388-468, and his total length values "130-210" mm actually range from 65-285 mm (Table 1).

In contrasting the genera *Typhlops* and *Ramphotyphlops,* Khan (1999b) lists five features characterizing the former genus but only four for the latter genus. The three diagnostic characters of the male reproductive system of both *Ramphotyphlops* and *Acutotyphlops* are a medial insertion of retractor muscle on the hemipenis (Robb, 1960, 1966b), coiling of the retracted hemipenis within the tail (Robb, 1960, 1966b; McDowell, 1974; Wallach, 1998), and presence of retrocloacal sacs in the posterior abdominal cavity (Guibé, 1949; Robb, 1960, 1966a).

The fourth character (superior nasal suture) is listed only for *Typhlops,* and while the suture may be incomplete or complete, Khan (1999b) noted that it extends horizontally from the nostril so that little, if any, of the inferior nasal shield is visible in dorsal view. I suspect that Khan (1999b) meant to include the contrasting condition for *Ramphotyphlops* as found in *R. braminus* and the *R. erycinus* species group, where the superior nasal suture extends dorsally onto the snout for a considerable distance, thus exposing part of the inferior nasal shield (McDowell, 1974). This condition, however, does not hold true for the majority of *Ramphotyphlops.*

The fifth character is the ileocolic or rectal caecum (McDowell, 1974). Khan (1999b) states that a long caecum is always present in *Ramphotyphlops* and most species do have a caecum longer than 3% snout-vent length. However, some *Ramphotyphlops* have a short caecum *(R. acuticaudus,* 1.3-2.0%; *R. angusticeps,* 1.3-2.7%; *R. nema,* 1.6%; *R. flaviventer,* 1.2-2.1%) and a caecum is absent from specimens in at least four species: *R. albiceps, R. becki, R, hamatus,* and *R. willeyi.* Granted, both *R. becki* and *R. willeyi* approach *Acutotyphlops,* which has lost the rectal caecum (except for *A. infralabialis),* and *R. hamatus* is a derived form that also is reported to lack retrocloacal sacs (Alpin and Donnellan, 1993; but present in WAM R66323 *fide* Wallach, 1993b). Khan (1999b) emphasized that in *Typhlops* the caecum "when present it is small." However, many species of *Typhlops* possess caeca as long or longer than do species of *Ramphotyphlops:* African *T. blanfordii,* 3.9%; *T. congestus,* 4.8-5.6%; *T. lineolatus,* 3.4-4.7%; *T. punctatus,* 4.2-5.0%; *T. schmidti,* 4.4-4.7%; *T. steinhausi,* 3.0-4.3%; *T. tanganicanus,* 4.7%; Malagasy-Comoro *T. mucronatus,* 3.2-5.0%; *T. comorensis,* 4.3%; *T. ocularis,* 3.0-4.5%; Asian *T. diardii,* 3.0-4.0%; *T. khoratensis,* 4.7-5.5%; *T. lankaensis,* 3.6%; *T. malcolmi,* 5.0%; *T. pammeces,* 3.8-3.9%; *T. violaceus,* 3.2%; *T. marxi,* 3.6%; *T. koekkoeki,* 8.0%; American *T. minuisquamis,* 3.3%; *T. richardii,* 3.1-4.0%. The rectal caecum is therefore not a diagnostic character at the generic level, although it is useful at the species and sometimes species group level.

In contrasting *T. madgemintonae* and *T. porrectus,* Khan (1999b) reports a "completely divided" vs. "undivided" nasal scale, shown above to be variable and unreliable. The middorsal scale count is reported to be fewer (336-364) in *T. madgemintonae* than in *T. porrectus* (414-465). However, Table 1 lists the middorsal ranges for *T. m. madgemintonae* and *T. m. shermani* to be 337-342 and 336-364, respectively. Thus, Khan (1999b) included the subspecies *T. m. shermani.*

Two other diagnostic characters are the color of the dorsum and venter, both being darker in *T. madgemintonae* than in *T. porrectus* (dark brown vs. yellowish-brown and light brown vs. yellowish, respectively) (Khan, 1999b). Colour, especially in scolecophidians, is a dubious taxonomic character (a color pattern, like the stripes in *Rhinotyphlops unitaeniatus* or *Typhlops elegans,* makes a better character). With the exception of pigmentless *Rhinotyphlops,* most typhlopids are some shade of brown, intraspecific variation in the density of pigmentation is common, and fading occurs in preservative. Khan (199b: 237) even reported that the paratypes of *T. m. shermani* are "light brown" whereas the holotype is "dark brown," indicating that perhaps the change in colouration is ontogenetic in nature. It is known that at least one species of scolecophidian

(Leptotyphlops scutifrions) can change color from black to silver within minutes (Visser, 1966).

The supralabial imbrication pattern of *T. ahsanuli* is described as being T-V, with the second supralabial overlapping the preocular. However, Fig. 4b clearly shows the superior nasal shield and not the preocular as overlapping the second supralabial. Also, couplet no. 5 of the identification key states that the "preocular in contact with third supralabial only," which is equal to a T-III SIP. If the figure and key are correct, then the SIP is T-III. Perhaps the SIP is asymmetrical with T-V on one side of the head and T-III on the other. Such a condition is rare but has been observed previously (i.e., *Rhinotyphlops simoni* (n=20) with FMNH 69220 having T-0 on left, T-II on right; *R. sudanensis* paratype, MCZ 13599 having T-III on left, T-0 on right; *Typhlops trangensis* holotype, FMNH 178236 having T-V on left, T-II on right; *Acutotyphlops kunuaensis* (n=255) with MCZ 77003 and 77298 having T-III on left, T-V on right). Occasionally the fusion of two labials or the division of a single labial on one side of the head will produce an artificially asymmetrical SIP pattern.

The only information provided on the sex of the new taxa is that the holotype of *T. m. madgemintonae* is a male. None of the other specimens were sexed, even though this is a simple procedure and such information is valuable.

Descriptions of *T. m. shermani* and *T. ahsanuli* are lacking as only brief diagnoses are given for each taxon.

In the Discussion, Khan (1999b) does not mention the most distinctive synapomorphy of the *T. ater* species group *(T. beddomii, T. ceylonicus, T. floweri, T. mirus,* and probably *T. andamanensis* and *T. tindalli):* the presence of glands scattered throughout the central portions of the head shields, not just in the sutures between the shields (McDowell, 1974). Also, *T. floweri* has a subocular shield.

In the identification key for 18 scale rowed *Typhlops* from the Himalayas (p. 239), the first two couplets employ ambiguous characters. Couplet no. 1 uses midbody diameter as a criterion and couplet no. 2 uses the condition of the superior nasal suture. Both of these characters are variable and unreliable in the way they are used as discussed above. Couplet no. 3 uses 400 middorsal scales as a criterion. Reference to Table 1 shows that the ranges of *T. m. madgemintonae, T. m. shermani*, and *T. ahsanuli* all fall within the range of *T. porrectus* (388-468). Couplet no. 5 uses a T-III SIP to separate *T. ahsanuli* from *T. m. shermani,* with a T-V SIP. However, the description of *T. ahsanuli* gives the SIP as T-V (although contradicted by Fig. 4b, which depicts a T-III pattern).

External anatomy.– A common ratio used in scolecophidian systematics is tail length/midtail diameter (Dixon and Hendricks, 1979; Wallach, 1995). In the Materials and Methods section, Khan (1999b) reported that one of the ratios calculated from the data was "tail length/tail breadth." He does not state how the width of the tail was measured but in Table 1 the values given for "tail length/tail width" are derived from tail length/diameter at vent level, which can be troublesome when compared with data from the literature.

A diagnostic character of *T. madgemintonae* is "micro-ornamentation of body scales micropits" vs. "microstriations" in *T. porrectus* (p. 233). It is unclear exactly what the author is referrring to here. Khan (1999b: 235) states that "the flared part of body scales are heavily pitted with micropits" but they are not illustrated. The flared part of the costals presumably refers to the free margin (Jackson and Reno, 1975).

The cutaneous touch corpuscles of the head shields are incorrectly referred to as "microspinules" by Khan (199b). A spinule is a small spine, so microspinules must be microscopic spinules. The author does not describe his microspinules but based upon their reported position on the lateral head shields (rostral and nasals in Fig. 2b of *T. madgemintonae* and Fig. 3b of *T. m. shermani* and rostral, nasals, preocular, ocular, and supralabials in Fig. 4b of *T. m. shermani)* and absence on the head dorsum and rest of body, it appears that he is referring to the integumentary sense organs or cutaneous touch corpuscles, which appear as minute elevated domes (Jackson, 1977; Orejas-Miranda et al., 1977).

A characteristic of the holotype of *T. m. shermani* (Fig. 3b) and *T. ahsanuli* (Fig. 4b) is the presence, along the preocular-ocular suture, of squamous glands that are "thickened" (Khan, 1999b: 237). A description of how these glands differ from the others on the head or body is not presented, but they are depicted as large dark squares in the figures as opposed to the typical scolecophidian glands, which are represented with short dashed bars. Even if these glands are in some way distinctive, what is baffling is their presence in *T. ahsanuli* and the holotype of the subspecies *T. m. shermani,* being absent in *T. m. madgemintonae* and the paratypes of *T. m. shermani.* On phylogenetic grounds, they would be expected to occur in both subspecies and all individuals of *T. madgemintonae.* Likewise, a subnarial pit (=striated inferior nasal gland of McDowell, 1974) is only reported in the holotype of one subspecies *T. m. shermani* (Khan, 1999b: 237, Fig. 3b); the two paratypes lack the "subnarial pit."

The two paratypes of *T. m. shermani* when collected "were intertwined with each other," suggesting that they were a male and female in copulation. An attempt to "dislodge them from each other" was abandoned and they were then "put alive in the preservative" (Khan, 1999b: 237), an inhumane preservation technique by present-day standards (Heyer et al., 1994). In the process of dying, the specimens evidently separated themselves as Fig. 3a reveals the two paratypes to be no longer entwined.

Internal anatomy.– The right testis of the holotype of *T. madgemintonae* is mentioned as being smaller than the left, a condition rarely seen in scolecophidians (Wallach, 1998). While a rare occurrence, it is possible, but without actual measurements and confirmation, the condition is suspect in light of the number of typographical errors in the text and other controversial reports (i.e., paired oviducts in *T. ductuliformes).* Also, Khan (1999b) reports the left testis to be "divided in three lobes," a multipartite condition that is not depicted in Fig. 1. This would represent the first record of segmented testes in an Asian typhlopid as most multipartite taxa inhabit Africa, with representatives also occurring in the Caribbean, Central America, South America, Madagascar, Indonesia, and Australia. Multipartite testes are a diagnostic character of the Leptotyphlopidae with 2-21 lobes (Fox, 1965; Werner and Drook, 1967; Wallach, 1998), but segmented testes are less commonly observed in the Typhlopidae, where as many as 15 segments occur in a few species of most genera: *Acutotyphlops kunuaensis* (1-3), *A. subocularis* (1-3), *Ramphotyphlops multilineatus* (7-15), *R. nigroterminatus* (9-18), *R. waitii* (3), *Rhinotyphlops caecus* (8), *R. debilis* (7-8), *R. graueri* (4-7), *R. gracilis* (6-7), *R. mucruso* (2), *R. pallidus* (7), *R. rufescens* (6-9), *R. simoni* (2-4), *R. sudanensis* (5-6), *Typhlops catapontus* (8-13), *T. cuneirostris* (3-5), *T. decorosus* (8-9), *T. gierrai* (2-3), *T. mucronatus* (4-8), *T. reticulatus* (2-5), *T. richardii* (2-3), *T. steinhausi* (5-7), *T. tenuis* (4-5), and *T. vermicularis* (3-8) (Fox, 1965; Werner and Drook, 1967; Heyder, 1968; Wallach, 1998).

The description and illustration of the hemipenis (Khan, 1999b: 232 and Fig. 1) are different from all previous reports and observations of scolecophidian hemipenes. It is difficult to visualize how such an organ would work (if accurately described). Only the examination of the type specimen will resolve this perplexity.

CONCLUSIONS

Numerous typographical and stylistic errors have been pointed out in the two papers by Khan (1999a-b), suggesting that the manuscripts were never properly proofread or edited. Nomenclaturally, the correct orthography and authorship of the four taxa are *Typhlops ductuliformes* Khan (1999a), *T. madgemintonae* Khan (1999a), *T. ahsanuli* Khan (1999a), and *T. madgemintonae shermani* Khan (1999b), as the latter name is a *nomen nudum* in Khan (1999a).

The status of all of Khan's species is dubious. Because the material was not adequately diagnosed, descriptions were poor or nonexistent, taxonomic characters were variable or unreliable, character descriptions were vague or nonexistent, and conflicting data were presented, nothing can be determined at this point without reference to the type material. Even discounting the poor descriptions and lack of diagnostic characters, there is concern as none of the holotypes are presently deposited in an institution. In comparing his new species with *T. porrectus*, Khan did not present his concept of *T. porrectus* nor list his material examined so that others could determine what he considered *T. porrectus* to be.

If the rest of the type material ever becomes available for examination, the status of Khan's names will either be confirmed or disproven. The following characters need to be examined: 1) presence or absence of left oviduct in *T. ductuliformes,* 2) presence or absence of four supraoculars in *T. ductuliformes,* 3) presence or absence of bipartite ovaries in *T. ductuliformes,* 4) microstructure of free margins of costals in all taxa (microstriations in *T. ductuliformes,* micropits in *T. madgemintonae* group), 5) extent of superior nasal suture in *T. madgemintonae,* 6) presence of multipartite testes in *T. madgemintonae,* 7) presence of microspinules on lateral head shields of *T. madgemintonae* group, 8) presence or absence of striated inferior nasal gland in all taxa, 9) distinctiveness of "thickened" glands under ocular-preocular suture in all taxa, 10) presence or absence of pupil in eye in *T. madgemintonae* group, 11) supralabial imbrication pattern in *T. ahsanuli,* 12) structure of the hemipenis in *T. madgemintonae,* and 13) sex of all specimens.

I suggest that *T. ductuliformes* Khan (1999) is identical to *T. porrectus* Stoliczka (1871) based upon the examined paratype (UMMZ 123429; Tables 2-5). The former cannot be distinguished from the latter by any external character and the viscera overwhelmingly agree with that of *T. porrectus.* Pending examination of additional type material, I place *T. ductuliformes* in the synonymy of *T. porrectus.*

The status of *T. m. madgemintonae, T. m. shermani,* and *T. ahsanuli* remains questionable. I propose placing them in Typhlopidae *incertae sedis* until the type material becomes available for examination.

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AN INVENTORY OF CHELONIANS FROM MIZORAM, NORTH-EAST INDIA: NEW RECORDS AND SOME OBSERVATIONS ON THREATS

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ABSTRACT.– **We present observations on six species of chelonians documented during herpetological surveys in Ngengpui Wildlife Sanctuary and surrounding areas in south Mizoram, north-east India. All are first reports from the area. These records help fill in distribution gaps for four species, and extend the known distribution range of two (*Kachuga sylhetensis* and *Amyda cartilaginea*). Of the latter, *A. cartilaginea* is reported from the Indian subcontinent for the first time. These records emphasize the need for surveys to refine the distribution mapping of testudines in north-eastern India, particularly in the hill states. Vernacular names of all species recorded in the present survey are provided, along with notes on their status in the area. We also discuss threats to each species, with special emphasis on the effects of shifting cultivation and consumptive use.**

KEY WORDS.– **Chelonians, distribution, north-eastern India, Mizoram, threats, consumptive use, shifting cultivation.**

INTRODUCTION

The Indian subcontinent, with its unique situation at the junction of the Oriental, Palearctic and Ethiopian biogeographical realms, supports a unique and diverse biota. Two major biodiversity hotspots have been identified here, Western Ghats–Sri Lanka and North-east India–Myanmar (Collins et al., 1991; Myers et al., 2000). Of these, north-eastern (NE) India is an important region harboring unique tropical and subtropical rainforests (Gadgil and Mehr-Homji, 1986; Collins et al., 1991). Though a part of the Indian Union, the zoogeographical affinities of NE India and of those of the hill-states in particular, lie more with the Indo-Malayan and Indo-Chinese sub-regions than the Indian sub-region of the Oriental Realm (Mani, 1974).

Hitherto, 26 species of non-marine chelonians have been reported from India (three families and 18 genera), a majority of which are found in NE India. In the last decade or so, a number of new records have been added to the distributional information of testudines in NE India (Das, 1990; Frazier and Das, 1994; Bhupathy et al., 1994; Choudhury, 1996; Datta, 1998; Choudhury et al, 1999), and the list for NE India now stands at 19 species (Das, 1996). However, most of these records are from the Brahmaputra plain and adjoining areas in lower Eastern Himalayas, and the hill states, especially those south of the Brahmaputra basin, viz., Nagaland, Manipur, Tripura, Meghalaya and Mizoram, remain poorly surveyed. From Mizoram, three species of chelonians have been reported in literature (e.g., Hanfee, 1999), but none of these have been confirmed.

In June 1998, SSP conducted a herpetological survey in Ngengpui Wildlife Sanctuary (WLS) and surrounding areas in south Mizoram (Fig.1), followed by a six-month study from November 1998 to April 1999 in the same area (henceforth, we refer to Ngengpui WLS and surrounding area

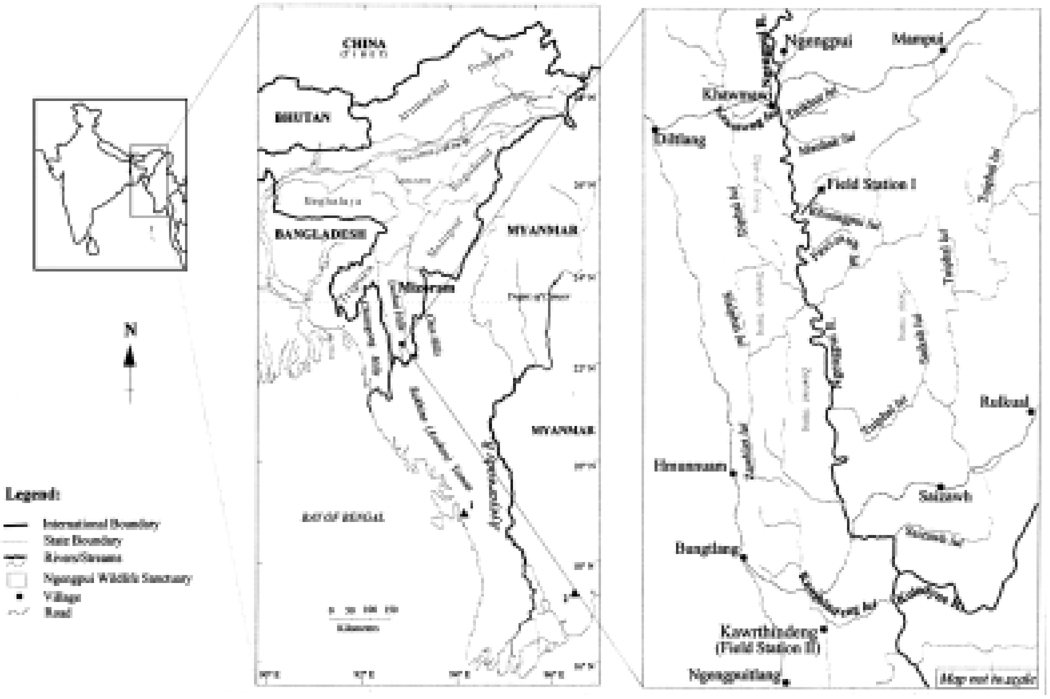

FIGURE 1: Present record (■) of *Amyda cartilaginea* from south Mizoram, India (Ngengpui WLS, 92.753–92.839^{o}E/22.357–22.502^{o}N), along with nearest previous records (▲), from Myanmar (1 = Thandoe River, Kwinchuang, Chaungpya,18.900^{o} N/93.917^{o} E; 2 = Bago (formerly Pegu), 17.333 ^{o} N/96.483 ^{o}E).

collectively as "Ngengpui area"). These surveys resulted in the documentation of 68 species of herpetofauna, including at least three new taxa and a number of new distribution records (Pawar, 1999). Among these are six species of chelonians, including a softshell turtle (Testudines: Trionychidae) previously not known from this region.

Ngengpui WLS (92^{o}45’12”E-92^{o}50’20” E/22^{o}21’24”N-22^{o}30’06”N; final notification in 1997), with an area of ca. 110 sq km, encloses the valley of Ngengpui River and adjoining hills (Fig. 1). The actual extent of the area surveyed was more (ca. 150 sq. km), as areas adjoining the sanctuary were also covered. Ngengpui river flows through the heart of the sanctuary from north to south, and joins the Kolodyne River in the south (Fig.1). The terrain is hilly, and there are three main ridges (vern. = tlang) in the sanctuary, viz., Zawhlet-tlang, Sialphai-tlang and Diphal-tlang on the western side of the river, and Saisi-tlang on the eastern side. Altitude ranges from *ca.*180 msl along the riverbank to ca.540 msl on Saisi-tlang. Under the direct influence of the southwest monsoon, rainfall is high (average precipitation 2752 mm), and conditions are humid, even in the rainless periods. The mature vegetation of the study area is tropical (moist) evergreen, corresponding to Northern Tropical Evergreen Forest (1b/c2) and Chittagong Tropical Evergreen Forest (1b/c4) (Champion and Seth, 1968; Wikramanayake, 1998). Most of the area within the sanctuary is mature/primary dipterocarp-dominated forest, while the surrounding areas are a mosaic of bamboo-dominated patches, remnant mature forest, teak plantations and jhum (shifting cultivation or slash-and-burn agriculture) fallows of varying ages. Numerous rocky as well as silted streams (vern.: lui) dissect the whole area, delineating the boundary of the WLS in places (Fig.1).

A few villages are situated around the WLS, most of them along a metalled road that surrounds it (see Fig.1). Most of the people are of the Pawi, Bawm, Pang or Bru tribes, with a few Mizo, Mara and Châkma. Only Ngengpui and

Khawmawi villages are situated near the sanctuary boundary. Most of the areas outside the boundary of Ngengpui WLS are notified as village council reserves with each village exercising rights over a fixed area of forest in its vicinity.

Most of the survey-work was done from two makeshift field stations: an abandoned jhum hut near Khuangpui lui in the northern part of the sanctuary, and the village Kawrthindeng in the southern part of the study area (Fig.1; Field Station I and II respectively). Information was collected from direct sightings, indirect evidence (shells and scutes) and by questioning local people. Natural history observations were recorded by direct observations and as far as possible, from indirect information. This also provided useful insights into the effects of habitat alteration (mainly due to jhumming) on the chelonians of the area. Whenever possible, direct observations of turtle hunting/collection by local people were made. Local markets were regularly monitored and inquiries made about the availability of turtles and turtle meat. Specimens were identified by general (Smith, 1931; Das, 1991; Ernst and Barbour, 1989) and taxon-specific (*Amyda*: fide van Dijk, 1992; *Cyclemys*: fide Fritz et al., 1997) descriptions and diagnostic keys. We also referred to the museums of the Zoological Survey of India, Calcutta and the Bombay Natural History Society (ZSI and BNHM, respectively; Leviton et al., 1985).

In the text, we provide separate species accounts including the following information collected during the study– names (in two local languages: Mizo and Rhiang), description (morphological details included only where atypical characteristics were noted), distribution notes, natural history observations taken during the study and threats due to consumptive use and jhumming. All distances pertaining to turtle distributions and range extensions have been calculated from maps, and are straight distances in kilometeres. Abbreviations used for morphometric measurements (in cm) are (after Frazier and Das, 1994), CCL= curved carapace length; SCL= straight carapace length (at midline); CCW= curved carapace width; SCW= straight carapace width (maximum); PL= plastron length. Nomenclature and terminology is after Ernst and Barbour (1989), Das (1991), and van Dijk (1992).

RESULTS

Asiatic softshell turtle *Amyda cartilaginea* (Boddaert, 1770)

Vernacular names.- Mizo- sumsi; Rhiang – Tuimui

Description: In all, seven individuals were examined, comprising six adults and one subadult (identified based on presence of rows of tubercles on the back). Carapace and plastron of an adult was collected (BNHM 1446).

Measurements.- BNHM 1446, CCL (bony carapace) = 19.2, SCL (bony carapace) = 18.4; CCL (live specimens; bony carapace + flaps) = 23.5 (subadult), 45.3, 42, 41.5, 56.4 (adults).

Morphology and colour-pattern (Fig.2).- Carapace of adult smooth; that of subadult with rows of blisters. Carapace of subadult greenish brown with indistinct streaks and traces of yellow spots; distinct yellow spots on head; adults with olive grey to greenish brown carapace, with traces of markings or of almost uniform colour; head with indistinct markings; some traces of lines. Plastron of all specimens whitish in colour, with five indistinct plastral callosities.

To validate our identification of the species, in addition to literature, we used colour photographs of specimens from Mizoram (Fig.2) and referred to specimens at ZSI (ZSI 2632 and 13207).

Our identification of the species as *Amyda cartilaginea* is based on the following combination of characters from Smith (1935), Ernst and Barbour (1989), and van Dijk (1992)– A single neural plate between the first pair of costals; snout longer than the diameter of the eye; the epiplastra in contact or nearly so; both adults and subadults with a distict row (as opposed to a patch) of nuchal tubercles at the anterior carapacial rim above the neck; head, neck and limbs olive with yellow spots in young, and with dark lines on the head in the adults.

From the closely related Burmese peacock softshell turtle *Nilossonia formosa* (cf. van Dijk, 1992), the Mizoram softshell differs in the following characters (Smith, 1935; Ernst and Barbour, 1989; van Dijk, 1992).- Epilastra narrowly separated from one another, anterior part long (vs. epiplastra widely separated and comparatively shorter in *N. formosa*); Five plastral callosities (vs. four callosities); width of nuchal bone three times anteroposterior length (vs. twice the length); both, subadult and adults with irregularly distributed markings (vs. large paired ocelli). Of these characters, only the last one could be examined and confirmed in all the individuals seen, while the others are from the carapace and plastron of the single collected specimen, BNHM 1446.

The taxon *Amyda cartilaginea* has actually been considered a species complex, which, however, confounds any further taxonomic resolution at present, because of the erratic occurrence of variants and variations (van Dijk, 1992). van Dijk (1992) differentiates three forms based on colouration and the development of nuchal dermal tubercles: (1) A dark form with abundant yellow spots, ocelli, and coarse tubercles, inhabiting lowland water bodies in central Thailand, Vietnam, Java and perhaps Makulu (formerly, the Moluccas); (2) A more pale brown form characterized by three converging black lines on the crown of the head and limited development of the nuchal tubercles and yellow spots on the carapace, occuring in streams and rivers in western Thailand and Cambodia; (3) A form similar to the latter, but with an obvious black mark in the shape of a saddle on its carapace, which occurs on Borneo and Sumatra. Of these, the Mizoram form superficially resembles (2), a form that is generally restricted to hill-streams, according to van Dijk (1992). However, the Mizoram *Amyda* apparently has much lesser yellow marking on the carapace than has been reported for typical *cartilaginea.* van Dijk (1992) also states that the status of the species in Myanmar, especially the Arracan (Rakhine) hills, is not clear (presumably does not match any of the forms above). Apparently, the Myanmar *Amyda* is the closest (geographically and morphologically) to the Mizoram one (see below).

Distribution.- The previous known range of this species was from southern Myanmar (Fig. 1) to central Vietnam, Laos, Cambodia, and Thailand, southward through Malaysia to Indonesia (Java, Sumatra, Borneo) (Ernst and Barbour, 1989). This is the first report of this species from the Indian Subcontinent, the previous western-most localities being in southern Myanmar (Thandoe River, Kwinchuang, Chaungpya, and Pegu; Iverson, 1986). This record (Ngengpui WLS, 92.753°–92.839° E and 22.357° –22.502° N) extends the known range of this species ca. 350 km towards the north from Thandoe River, Kwinchuang, Chaungpya in Myanmar (18.900°N; 93.917°E; see Fig. 1).

Natural history.- All the specimens examined during this survey had been caught by locals, mainly from Pawizawh and Kawrthindeng lui. Pawizawh lui delineates the eastern and south-eastern boundary of Ngengpui WLS, while Kawrthindeng lies about 15 km south of the sanctuary boundary. Both are hill streams with sand/silt as well as rocky bottom, the former flowing into Ngengpui River and the latter into the Kolodyne. This turtle is reportedly also found in both these rivers, from where it probably enters hill streams in the monsoons. In the dry seasons when the hill streams flow sluggishly, they burrow in silt/sand of the streambed in the daytime. It is during these times that they are hunted by the locals, who probe and impale them with sharpened iron rods. The meat is sold locally for Rs. 40-50 /kg (ca. US$1). Of the seven individuals, three were alive. All of them were quite pugnacious, biting with determination and vigor whenever the opportunity arose. One of the females (collected in the third week of February) had 18 small (diameter 1–2 cm) eggs in her oviducts.

Indian black turtle *Melanochelys trijuga* (Schweigger, 1812)

Vernacular.- Mizo – Tui-satel; Rhiang – Tetu

Description.- Nine specimens of this turtle were examined, comprising one juvenile and eight adults. The shell of an adult female was collected (BNHM 1447).

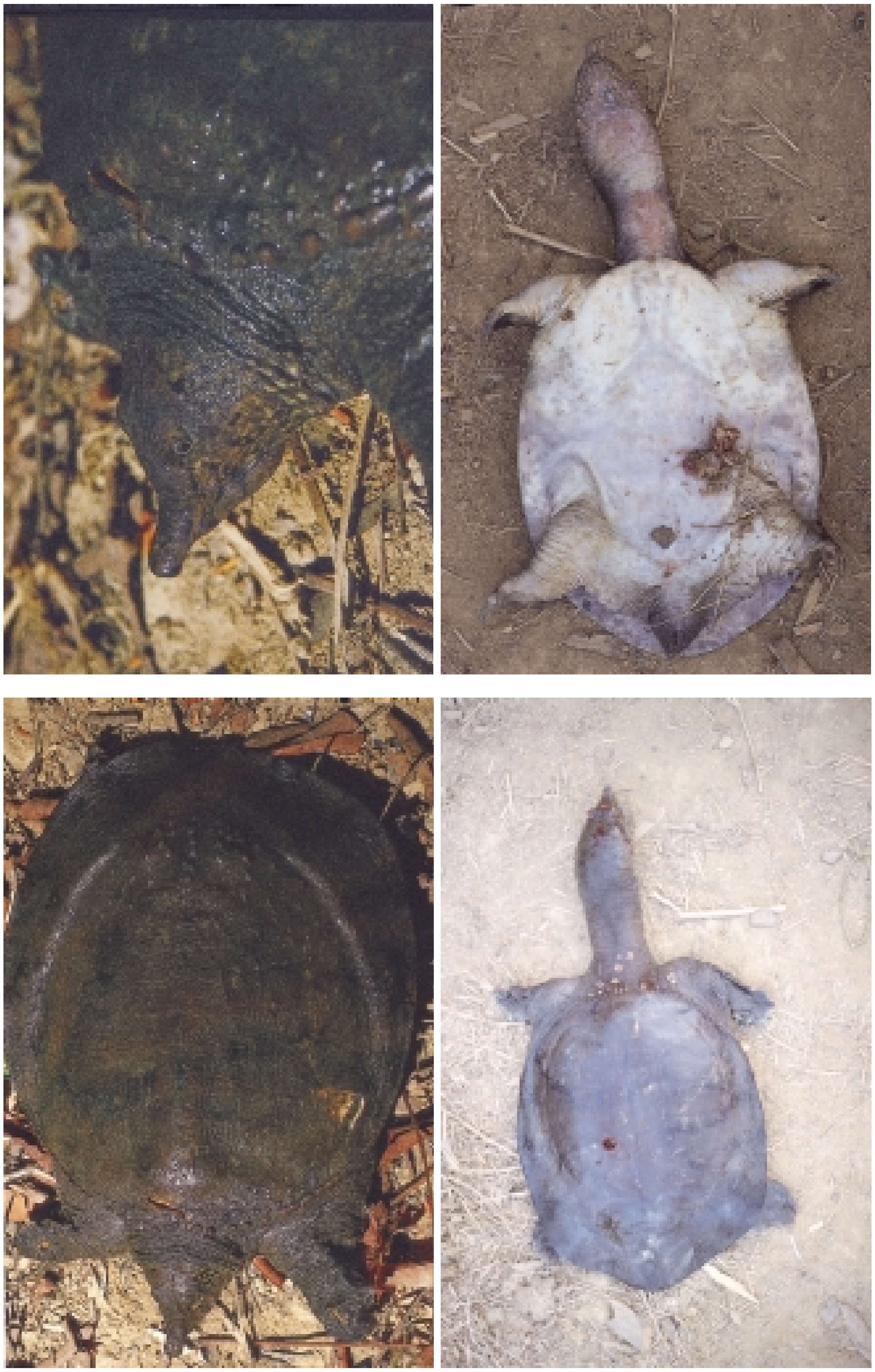

FIGURE 2: Subadult (CCL of bony carapace + flaps = 23.5 cm) *Amyda cartilaginea* from Mizoram, north-eastern India. Top left. In dorsal view. Note the wounds on the side and the nuchal area; it is a common practice to tie the nuchal and epiplastral flaps together to prevent the turtles from snapping. Top right. Close-up of head. Adult *Amyda cartilaginea* (BNHM 1446) from Mizoram, north-eastern India. Bottom left. In dorsal view. Note the hole on the carapace; both this turtle, and that shown on top were also caught by impaling with an iron rod. Bottom right. In ventral view (BNHM 1447).

FIGURE 3: *Melanochelys trijuga* from Ngengpui area in Mizoram. Photo: Samraat Pawar.

FIGURE 4: Subadult *Cyclemys oldhami* (SCL = 12.7 cm) from Ngengpui area in Mizoram. Photo: Shomen Mukherjee.

Measurements.- BNHM 1447**??**, CCL= 24.1; SCL= 21.8, CCW= 20.1, SCW=16.8, PL=19.9; Juvenile, SCL= 9.5.

Morphology and colour-pattern (Fig. 3).- Carapace of juvenile with three distinct keels; that of adult with weak, but discernable keels. Carapace and plastron of adults uniform brown to brown-black; shell of juvenile darker and plastron with an indistinct yellow margin; head brown in adults (darker in juvenile) with pale yellow marks, the one behind eye very distinct; limbs brown.

Seven subspecies of this turtle have been described (Das, 1991; cf. Ernst and Barbour, 1989). Of these, *M. t. indopeninsularis* occurs in NE India, while *M. t. edeniana* occurs in Myanmar (Rakhine Yoma, Karenni hills, and Moulmein). Both the subspecies are very similar (fide Ernst and Barbour, 1989). Based on carapace dimensions and colour-pattern of the shell and head, the Mizoram *trijuga* are very similar to both *M. t. indopeninsularis* and *M. t. edeniana*. However, subspecies of *M. trijuga* are inadequately described and in the present circumstances, we refrain from commenting upon the infraspecific identity of the *M. trijuga* from Mizoram.

Distribution.- *M. trijuga* is widely distributed in the Indian subcontinent. Eastwards, it extends up to central Myanmar and northern Thailand. From NE India, it had hitherto been reported only from Meghalaya and Assam. The nearest record to the present one is from Chittagong (22.333°N; 91.800°E) in Bangladesh (Khan, 1982), and this record helps fill the gap in its known distribution of this species from Bangladesh-NE India to Myanmar.

Natural history.- Of the nine turtles seen during the present survey, seven were on one occasion with a party of hunters in Pawizawh lui. The eighth adult was encountered in Zawhlet lui, where it was seen basking near the streamside on a winter (January) morning. The juvenile was caught near a small stream in the northern part of the sanctuary (Khuangpui lui). Though no *M. trijuga* were seen in the Ngengpui and Kolodyne rivers, they are reportedly found there too. In the streams, these turtles seem to prefer stretches with rocky crevices on the sides, which they use as a retreat. The locals search for them in such places, probing and coaxing them out with the help of long sticks and rods. Apparently, the black turtle is often collected for food and traded locally in and around the Ngengpui area. The meat fetches a price of 40-60 Rs/kg.

Assam roofed turtle *Kachuga sylhetensis* (Jerdon, 1870)

Vernacular.- Mizo – tui-satel? (a generic name used for all batagurid turtles); Rhiang – Tetu-singmanakong

Description.- Only a single adult female (sexing based on shell size and concavity of plastron) was encountered. One museum specimen (ZSI 110, from Cachar District, Assam) was also examined.

Measurements.- CCL= 18.4; SCL= 15.3; SCW= 14.1

Morphology and colour-pattern.- Carapace serrated posteriorly, with a strong backward-pointing projection on third vertebral scute. Carapace dark brown, with a hint of darker marking at the centre of each scute; plastron lighter; head and neck brown, with faint yellow markings.

Distribution.- Originally described from Sylhet in Bangladesh (Smith, 1931), *K. sylhetensis* has subsequently been reported from Assam, North Bengal, Meghalaya, Arunachal Pradesh, and Nagaland (Das, 1991, cf. Hanfee, 1999). The present report extends its known range slightly southwards, by ca.200 km.

Natural history.- As has been reported elsewhere, this seems to be a rare turtle in Ngengpui area. The single individual was found in the southwestern part of the Ngengpui WLS, in a small stream flowing into Zawhlet lui.

Asian leaf turtle *Cyclemys oldhami* (Gray, 1831)

Mizo.- Tui-satel té (=little water turtle); Rhiang –Atangkrai

Description.- Three individuals were examined, all juveniles.

Measurements.- SCL = 10.2, 9.5, 12.7; SCW = 9.1, 8.3, 10.6.

Morphology and colour-pattern (Fig. 4).- Shell with serrated margins posteriorly, a single, distinct medial keel. Carapace mud-brown, each scute with faint radiating lines evident only in one specimen; plastron lighter, with distinct radiations; head, neck and limbs brown in colour, without any distinct markings. A recent revision of the genus *Cyclemys* by Fritz et al. (1997) revealed that the *Cyclemys* in NE India (and Bangladesh) are *C. oldhami* and not *C. dentata*, as was previously believed. *C. oldhami* is characterised by mainly dark coloured soft parts, without distinct head and neck stripes (vs. reddish, intensely striped head and neck pattern in *C. dentata*) and a generally dark plastron (vs. yellow in *C. dentata*). *C. dentata* sensu stricto is distributed from Thailand over the Malay peninsula to Sumatra, Java, Borneo and some islands of the Philippines (Fritz et al., 1997), not reaching the area north of the Isthmus of Kraa (Uwe Fritz, personal communication).

Distribution.- From the Indian Subcontinent, over Burma, Thailand, and the Malay peninsula to Borneo, Sumatra, and Java. (Fritz et al., 1997). In India, it has been reported from W. Bengal, Assam, Meghalaya, Nagaland and Arunachal Pradesh (Das, 1991; Hanfee, 1999). There also reports from localities in Bangladesh, some adjoining Tripura and Mizoram (Rashid and Khan, 2000). Our report from Mizoram adds another NE Indian hill state to its known distribution, and suggests that this turtle is probably present throughout NE India-Bangladesh.

Natural history.- Of the three individuals, two were obtained from Bungtlang (Fig. 1), where some village children were found playing with them. Enquiries revealed that both the turtles had been collected from small streams bordering the WLS. Apparently, small specimens are often kept as pets locally. The third individual was collected from a small stream flowing in to Pawizawh lui (Fig. 1). The first two specimens were kept at the field station for about a month. During this time, they showed no signs of discomfort, and took a variety of vegetable matter and fruits. They also fed willingly on chopped red meat whenever it was offered. The locals collect this turtle whenever encountered, but do not hunt it as actively as some of the other species, maybe on account of its small size and relative scarcity.

Yellow tortoise *Indotestudo elongata* (Blyth, 1853)

Vernacular names.- Mizo – Telang; Rhiang – Kerangkormo (Kerang = tortoise, Kormo = Turmeric)

Description.- Three individuals, one complete shell, two carapaces and three plastra were examined, all adults.

Measurements.- Not taken; SCL of all specimens above 25 cm.

Morphology and colour-pattern.- Carapace and plastron uniform dirty yellow to brown, dark patches at the centre of each carapacial scute evident in most cases.

Distribution.- Distributed in much of south-east Asia, the Indian Subcontinent is the north-western limit of this tortoise. From India, it is reported from northern W. Bengal, Assam, Meghalaya and northern Mizoram (Dampa Tiger Reserve), extending eastwards into Orissa, Bihar and Uttar Pradesh along the moist deciduous Sal forest belt (Das, 1991, cf. Hanfee, 1999). The present record extends its known distributional range in India slightly southwards, and helps fill the gap in its known distribution. Moreover, recent records of *I. elongata* from north, north-eastern and southern Bangladesh (Rashid and Khan, 2000; adjoining West Bengal, Assam, Tripura and Mizoram, respectively), suggest that the tortoise is continuously distributed along much more of the hill tracts in the eastern portion of the Indian Subcontinent than was previously thought or at least, hint at such a continuous distribution in the past.

Natural history.- All three live specimens were seen during June survey, in a Rhiang hamlet near the WLS. All the shells were found in various villages around the Ngengpui WLS. The tortoises are particularly vulnerable during the jhum cultivation time. During March, when the jhum fields are burnt, the tortoises often take refuge in moist gullies in the forest. Many are also caught in bamboo forests, where they are easier to detect. The species is mainly herbivorous, and it is possible that some tortoises are attracted to jhum fields during certain times. In fact, from May to November, when most of the actual jhum cultivation takes place, individuals occasionally stray in cultivation plots, where they are easily caught. Inquiries revealed that in May-July, when fresh bamboo shoots appear, yellow tortoises are often found in bamboo forests. Overall, the yellow tortoise is not particularly rare in Ngengpui area, but is much coveted for its meat by the locals, who hunt them with hunting dogs, and if many are caught, 'store' them to be eaten or sold later.

Asian giant tortoise *Manouria emys* (Schlegel and Müller, 1844)

Vernacular.- Mizo – Telpui; Rhiang – Pepui

Description.- In all, one live specimen, three complete shells, one carapace and one plastron were examined, all adults.

Measurements.- Not taken; SCL of all specimens above 35 cm in.

Morphology and colour-pattern.- Carapace typical; gulars small, do not extend beyond the carapace rim; pectorals in contact.

At present, two subspecies are tentatively recognized (Das, 1991; Ernst and Barbour, 1989), primarily separated based on whether the pectoral scutes are separated (*M. e. emys,* southern ssp.) or meet at the midseam (*M. e. phayrei*, northern ssp.). Bhupathy (1994) have raised doubts on the taxonomic status of the subspecies, based on evidence that populations with both characters are found in NE India. However, all the examples collected from the present survey conform to the description of *M. e. phayrei*. However, ours is a small sample, and further observations are needed to determine whether both the forms are present in the area or not.

Distribution.- *Manouria emys* is distributed in many parts of south-east Asia, and the Indian Subcontinent is the north-western limit of its range. From India, it is known only from the NE region, and has been reported from Meghalaya, Assam, Nagaland and Northern Mizoram (Dampa Tiger Reserve). It has been reported from south-eastern Bangladesh (adjoining south Mizoram; Rashid and Khan, 2000), and this record helps fill the gap in its distribution from NE India through Bangladesh to Myanmar (see Fig. 1).

Natural history.- The single live specimen was found in February, resting in deep leaf litter in a moist nullah (gullies in evergreen and bamboo forest) in bamboo forest. According to the locals, such areas are a favourite resting place of this species, and in the winter and summer seasons; individuals are often found in such places. Like *Indotestudo elongata, M. emys* is also hunted by the locals with the help of dogs, and is more vulnerable in certain periods during jhum cultivation. In general, both these tortoises are much in demand locally for meat, but are seldom traded, probably on account of their relative rarity. Intact shells of the brown tortoise are often found in villages in and around the Ngengpui area, where they are used as hassocks.

DISCUSSION

Of the six new locality records for chelonians that we present here, that of *Amyda cartilaginea* is particularly interesting, and we consider it worthwhile to discuss it in some detail. This is apparently the softshell in our study area, is not particularly rare, and is locally exploited; the only reason why this species was not reported from Mizoram previously, is that there have been no herpetofaunal surveys in this area or the state. This is also evident from other records that were documented during the present study, not only for chelonians, but other herpetofauna as well, which add significantly to their distribution information. For instance, the parachute gecko *Ptychozoon lionotum* was reported for the first time from the mainland of the Indian Subcontinent, increasing the known range of the genus, from southern Myanmar towards the northwest by ca. 700 km, (Pawar and Biswas, ms).

van Dijk (1992) speculates that the present dispersion of *A. cartilaginea* may have been by dispersal not just along drainages, but also by hill-stream individuals crossing watershed divides by terrestrial excursions and also relatively more passively, by changes in drainage patterns (such as stream shifting and capture) (van Dijk, 1992). The topography of Myanmar consists of the central lowlands of the Ayaerawaddy River Basin, ringed by steep, rugged highlands (Collins et al. 1991). Of the latter, the Chin Hills are adjacent to the Lushai hills of Mizoram. To the west of the Lushai hills are the Chittagong hills of Bangladesh. All these hill tracts are a series of parallel hills running from north to south, connected to the lowland moist evergreen forests of southwest Myanmar by mid- to low-elevation rainforests along the Rakhine (Arracan/Arakan) Yoma Range (Collins et al., 1991). Mizoram has many rivers, which governed by the geomorphology, flow from either north to south, or vice versa, often following a tortuous course. This creates a complex drainage pattern with several parallel rivers flowing in opposite directions, often traversing the boundary between Mizoram and Myanmar more than once. For instance, the river Kolodyne enters from Myanmar, flows through Mizoram, and exits back into Myanmar from the south (Singh, 1996; Fig.1).

Considering these facts, and the relative location of Mizoram and the nearest locality of the earlier known distribution of *A. cartilaginea* (Thandoe River, Kwinchuang, Chaungpya, South Myanmar; 18.900°N/93.917°E; Fig. 1), the most parsimonious explanation is that the species has dispersed northwards from there along the Rakhine Yomas, by a combination of riverine as well as terrestrial routes (Fig. 1). Another route is also possible, northwards from Bago (formerly, Pegu; 17.333°N/96.483°E) along more riverine routes, and then westwards, again by a combination of terrestrial as well as aquatic routes. This explanation becomes more plausible if it subsequently comes to light that *A. cartilaginea* is also found along the upper reaches of the Ayeyarwady, as well as the NE Indian hill states along the western border of Myanmar.

Of these two possibilities, the first explanation is more parsimonious, because it means a shorter distance of dispersal (Fig. 1). However, it may also be a combination of both situations, and in any case, these conjectures will get firmer footing only if further surveys the presence of *A. cartilaginea* in areas south and east of Mizoram, and/or in other NE Indian Hill states (especially those along the eastern border- Arunachal Pradesh, Nagaland and Manipur; see Fig. 1 for locations of NE Indian states).

Another softshell turtle from Myanmar, that has not yet been reported from NE India, is the Burmese peacock softshell *Nilossonia formosa*. In fact, the localities of this species in Myanmar are much nearer to NE India than those of *A. cartilaginea* (from Kachin, Myitkyina 25.400°N/97.417°E; Bhamo, 24.250° N/97.250° E; Mandalay; 21.950°N/96.067°E, cf. Arunachal Pradesh, Nagaland and Manipur, respectively) (Iverson, 1986; see Fig. 1 for locations of NE Indian states).

Aspideretes Hay 1904, the predominant genus of softshell turtles in the Indian Subcontinent, is closely related to *A. cartilaginea* and *N. formosa*, and superficially, these taxa have many characters in common (van Dijk, 1992). For instance, at least some juveniles of *Aspideretes gangeticus*, *A. leithii* and *A. nigricans*, and all animals of both *A. hurum* and *N. formosa* show ocelli (van Dijk, 1992). There have been a few records of *Aspideretes* species from NE India and Bangladesh, especially in the last decade or so (Iverson, 1986; Das, 1990; Rashid and Swingland, 1997; Datta, 1998). Superficial similarities are often enough to create confusion in the field, and some of the records of *Aspideretes* from NE India may be worth re-examining. *Aspideretes* species are characteristically from aquatic habitats in the plains of the Indian subcontinent (Das, 1991), and the presence of *Aspideretes* from and around the Brahmaputra River and its delta (Iverson, 1986) is probably a result of their dispersal across the Ganges-Brahmaputra delta. On the other hand, if ecological cues are anything to go by, the records of *Aspideretes* from contiguous hill areas may be particularly interesting. Datta's (1998) record of *A. hurum* from Arunachal Pradesh is from a drainage that runs into the Barak River in Assam, and both upstream and downstream of the river catchment area are worth investigating. The stronghold of the genus *Aspideretes* being peninsular India, NE India is at the fringe of its distribution. This region is particularly interesting for chelonian studies as it seems to be the boundary between the *Aspideretes* and *Amyda-Nilossonia* species complex (sensu van Dijk, 1992). Once the limits of the distribution of *Amyda* and *Nilossonia* vis-à-vis *Aspideretes* are determined, the situation will be ideal for interesting speculations and studies on the ecological interactions and taxonomic relationship between these species groups.

Our record of *K. sylhetensis* suggests that this species may also be found in neighbouring hill tracts of Bangladesh and Myanmar. One of the smallest species of *Kachuga*, the dispersal of this species may have been aided by semi-passive transportation during the flooding that occurs in the Brahmaputra basin every year during the monsoons. This may also account for the reports of this species from the Brahmaputra basin, from habitats apparently atypical of its preferred habitat of streams in evergreen and semi evergreen hill forest (Choudhury, 1993; Choudhury et al., 1999; cf. Moll, 1987; Das, 1991).

The distribution records of all other species that we have discussed, essentially help fill the hiatus in their known distributions.

THREATS

Consumptive use.- Though hunting practices in tribal areas are generally traditional and have a long history, their sustainability in the present situation is due to burgeoning population growth (Robinson, 1993; Robinson and Bodmer, 1999). The level of exploitation of non-marine chelonians is a major concern in South and South-east Asia (Jenkins, 1995; van Abbema, 1997; van Dijk, et al., 2000), and much information has appeared on turtle trade in India as well (Moll, 1990; Choudhury and Bhupathy, 1993). Preliminary information suggests that in many hill states of NE India, turtle trade is rather localized and difficult to quantify (Bhupathy et al, in prep). Our observations suggest that in Ngengpui area too, though turtle hunting is a common practice, it is mainly for subsistence, with some localized trade. All our direct records of turtle collection were outside of or at the boundary of Ngengpui WLS. In general, turtle collection is probably much lower in the sanctuary area, where there are greater chances of being detected by Forest Department personnel.

As we have mentioned above, *A. cartilaginea* is not very rare in Ngengpui area, though it is hunted and locally traded for its meat. However, the situation is not as bad as described for the species elsewhere in South-east Asia, where it has almost been rendered locally extinct in many areas (van Dijk, 1992), and these turtles are often sold openly in markets (Indraneil Das, pers. comm.). The situation is similar in neighbouring Myanmar, where recent herpetological surveys have yielded very few specimens, and the turtle has apparently become very difficult to find (Joseph Slowinski, pers. comm). At present, this species, though threatened, may not be critically so, because as is the case with the whole state, population pressure is still relatively low in southern Mizoram (Singh, 1996).

Of the six species that we could document, some seem to be more threatened from hunting than others. Along with *A. cartilaginea, M. trijuga, I. elongata,* and *M. emys* are apparently hunted more than the other two (*K. sylhetensis* and *C. oldhami*). There may be various reasons for this, including their size, behaviour, and relative abundance. For instance, both the tortoises *I. elongata*, and *M. emys*, being terrestrial and more conspicuous (especially if hunting dogs are used), are probably affected in a different manner by both hunting for consumptive use and jhumming (see below) than the aquatic turtles in the area.

Shifting cultivation.- Along with direct exploitation, effects of anthropogenic habitat alteration is also a serious concern for the conservation of tropical chelonians (van Abbema, 1997, and references therein). As is the case with tropical forests worldwide, habitat loss and degradation due to shifting cultivation is a major concern in NE India (Collins et al., 1991; Ramakrishnan, 1992; National Research Council, 1993). The study of which this article is a result, was aimed towards gauging the response of frog and lizard assemblages of primary forest to habitat alteration due to jhumming and plantation forestry (Pawar, 1999). The study design was along the lines of similar work on other faunal groups in the same region (Raman, 1996; Raman et al., 1998) and elsewhere (e.g., Bowman et al., 1990). All these studies have shown drastic degradation of diversity and community patterns of fauna during such alteration regimes, followed by gradual recovery along natural succession to mature forest. The reason why the study was aimed primarily at frogs and lizards was that it would not be feasible to include all herpetofaunal groups in such an undertaking. Therefore our information on chelonians and other groups (such as snakes; Pawar, unpublished data), are an outcome of additional observations made during the course of the main study. To the best of our knowledge, studies objectively dealing with the effect of such alteration patterns on chelonians have not been attempted. However, studies of the effects of wild fires have shown long-lasting effects on (Pianka, 1992), and probably, terrestrial chelonians as well (see Lambert et al., 1998). We hope that our preliminary observations may give some indications and provide baseline information for future studies on chelonians in the same area, and in similar situations elsewhere.

The life history characteristics of a faunal group is an important factor to consider while gauging its response to a habitat alteration regime as drastic and dramatic as jhumming. Also, many chelonians show ontogenic differences in behaviour (during various life stages), a factor worth considering in studies looking at the impact of habitat alteration on chelonians. For instance, adult *C. oldhami* are more or less terrestrial, while the juveniles are aquatic (Das, 1991). The first stage of jhum cultivation, viz., the slashing and burning process results in a drastic alteration of primary habitat. In such situations, relatively mobile animals such as avifauna have a greater chance of survival and a faster rate of recolonisation than relatively sessile ones such as herpetofauna. Even among herpetofauna, certain sub-groups will respond in a different manner than others. In the case of chelonians, the terrestrial species are likely to be affected by jhumming in a different manner than the aquatic ones. While the former may face the brunt of the initial damage due to burning, hill-stream habitats can also be badly affected, not just due to the effects of the fire, but also because their habitat may become more exposed. As we have mentioned above, both the tortoises were more vulnerable to hunting during certain periods of the jhumming activity. Of these two, *Manouria emys* may be more sensitive both directly and indirectly, to conversion of primary/mature forest habitat.

Evidence suggests that habitat alteration may not be a major detrimental factor for *A. cartilaginea*. The species apparently adapts to changing conditions quite well, and in fact, has even benefited from alterations, taking advantage of the availability of edible matter near human habitation (van Dijk, 1992).

CONCLUSIONS

Our report of *Amyda cartilaginea* adds another species to the chelonian fauna of India. At the confluence of biogeographic zones, North-east India is a fascinating region, where biota of contrasting origins intermingle. The status and distribution of chelonians in this region need to be determined and updated, and further surveys are urgently needed, particularly in certain poorly assayed parts.

The combined effect of hunting and jhumming can pose considerable threat to the chelonians of Ngengpui WLS and surrounding areas. It can be said that while viewing the threats to turtles in Ngengpui area, jhumming is atleast as important a factor to consider as hunting. This practice is widely practiced in the area (as indeed, most of Mizoram; Singh, 1996), and it has directly as well as indirectly evident effects on the chelonians of the area. Also, relatively speaking, Mizoram is as yet sparsely populated (but that scenario is likely to be changing fast), and hunting pressure is probably less concentrated than many other areas in South and South-east Asia.

But the full implications, especially of slash-and-burn agriculture need to be studied further, not only in this area, but also in similar situations elsewhere in North-east India. In any case, until the distribution mapping of turtles in North-east India remains incomplete, our understanding of the conservation requirements of chelonians in this region will be inadequate.

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ON *BOA VARIEGATA* THUNBERG, 1807, A NEGLECTED BOID SNAKE NAME

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(with one text-figure)

ABSTRACT. – **The name *Boa variegata* was proposed by Thunberg (1807) for a species of snake from what is today Indonesia. The type description clearly reveals that *Boa variegata* is referrable to the synonymy of *Candoia carinata*, although it has not appeared in any synonymy of that species. Scale features further suggest that the types were derived from the South Moluccas (Maluku), as was the lectotype of *Boa carinata* Schneider, 1801. One of the two original types is extant in Uppsala and is herein designated as the lectotype.**

KEY WORDS.– ***Boa variegata, Candoia carinata*, Boidae, synonymy, South Moluccas, lectotype designation**

INTRODUCTION

The investigation of older herpetological systematic literature occasionally reveals the existence of forgotten names. In some cases the names so revealed represent valid taxa that have remained known only from the types (e.g., *Simotes semicinctus* Peters, 1862; Wallach and Bauer, 1997). More frequently, such names represent junior (or occasionally senior) synonyms of taxa widely known by another name. In the course of the preparation of a review of early Swedish herpetological literature (Wahlgren, 2000), we discovered the description of a snake which appears to have escaped synonymy (or recognition) for almost 200 years. What is surprising is that the species is a boid, one of the most frequently reviewed groups of snakes, and one for which numerous specific synonymies have been compiled.

IDENTITY AND PROVENANCE OF *BOA VARIEGATA*

Thunberg (1807) described two varieties of snakes under the name *Boa variegata*. The type of the first (his figure 1 a.) had scale counts of 172 ventrals and 47 subcaudals, and a total length of 16 inches (406 mm). The type representing the second form (his figure 1 b) was characterized by 173 ventrals and 50 subcaudals, and a total length of 15 inches (381 mm). His descriptions of color patterns of the snakes indicate that the first snake was "marble coloured in undulating stripes, which often make up distinct squares, with several smaller white spots, scattered all about," whereas the second was "less coloured in marble compared with the former, patterned with a more faint yellowish colour, with stripes that occasionally meet and form elongated cubes" (translations those of Wahlgren, 2000). The description is accompanied by a plate, which is reproduced here (Fig. 1). It is clear from the illustrations that the species being described is *Candoia carinata* (Schneider, 1801). This is confirmed by the scale counts. De Rooij (1917), for example gave summary scale counts for *C. carinata* of 160-200 ventrals and 38-56 subcaudals, versus 130-153 + 14-22 in *C. asper* and 232-295 + 50-62 in *C. australis* (currently considered a synonym of *C. bibroni*).

The name *Boa variegata* does not appear in the detailed synonymies provided by Boulenger (1893), Werner (1921), Stimson (1969), McDowell (1979) or McDiarmid et al. (1999). Likewise, no mention is made of the

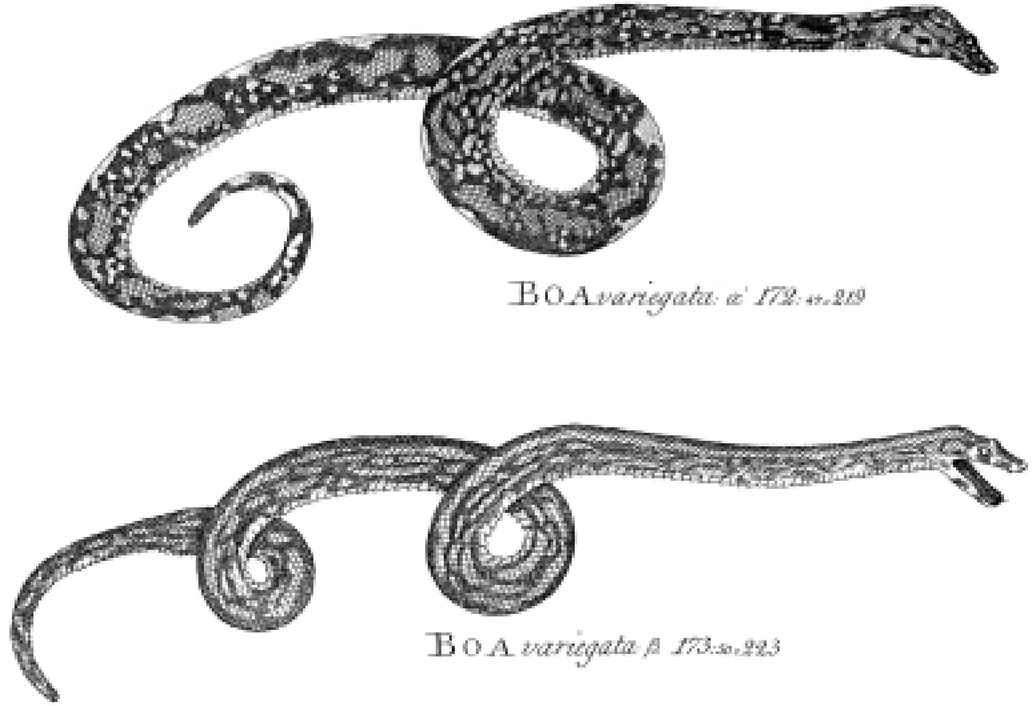

FIGURE 1: Original illustration of the types of *Boa variegata* from Thunberg (1807). The specimen figured below is ZMUU 313 and is designated herein as the lectotype of *B. variegata*. The spacing of the original figures relative to one another has been modified to accommodate page layout.

name in the more nearly contemporary works of Merrem (1820) and Schneider (1821). Its absence from Schneider's monograph on the genus *Boa* is especially surprising, given that Schneider, in his monograph on geckos (1812), made reference to another paper also published in the *Kongl. Vetenskaps Academiens nya Handlingar* (see Bauer, 2000). Although Thunberg was not primarily known as a herpetologist, he was a prominent biologist and his description was published in the leading Swedish scientific periodical of the time. It is thus especially interesting that his description escaped the attention of all subsequent reviewers of the species. Indeed, the only reference we have found to the name in the literature is a listing of the name in the *Index Animalium* (Sherborn, 1932). The most recent review of the species (McDiarmid et al., 1999) indicates that the oldest validly described name in synonymy of *Boa carinata* Schneider 1801 is *Enygrus superciliosus* Günther, 1863, from the "Pelew Islands" [= Palau].

Candoia carinata has the widest distribution of the three recognized species in the genus, extending from Sulawesi and the Moluccas (Maluku) in Indonesia, east to the Solomon Islands. Thunberg (1807) indicated merely that he had brought the two specimens to Sweden from the "East Indies." Carl Peter Thunberg (1743-1828) had been a student of Linnaeus and eventually occupied the same Chair of Botany at Uppsala that had been his mentor's. Like many of the "apostles" of Linnaeus, Thunberg spent time abroad on a scientific mission; unlike many, however, he survived the experience, which was chronicled in his four volume narrative (Thunberg, 1788-1793). Thunberg travelled abroad during the period 1770-1779, spending most of his time in Japan and at the Cape of Good Hope. He also visited Java and Sri Lanka (then

Ceylon). His time in the East Indies consisted of one month (May 18-June 21, 1775) in Java en route to Japan and another six months (4 January-7 July 1777) there on his return voyage. Although he did make various excursions into the Javan countryside, there is no evidence that Thunberg, who was based at the Dutch center of Batavia (now Jakarta), visited other islands in the Indo-Australian Archipelago. *Candoia carinata*, however, does not occur on Java or adjacent islands so it is unlikely that Thunberg collected the snakes himself unless they were obtained in port at a brief stop en route between Batavia and Japan. Even this seems unlikely, however, as Thunberg's itinerary indicates that his route to Japan was through the South China Sea rather than the Philippine Sea and that his return journey was made in such a short time as to have precluded a collecting detour.

Although it is possible that the snakes could have originated anywhere within the Dutch sphere of influence in the region, roughly corresponding to modern Indonesia, it is most likely that they came from the west-central part of the Archipelago, where Dutch trading stations were most well established, and traffic with Java was greatest. McDowell (1979) examined *Candoia carinata* from across its distributional range, and noted significant geographic variation scale counts. This variation enables us to restrict the possible islands of origin of the types of *Boa variegata*. Based on McDowell's data, samples from several geographic regions (Koror, Palau; Timor Laut, Ambon, Ceram, Misool, Sangihe, Irian Jaya and most of northern Papua New Guinea; south-eastern Papua New Guinea and nearby islands; the Trobriand Islands; and Samarai Island) have ventral scale ranges that encompass the counts recorded for the types of *Boa variegata*. The subcaudal counts of the types fall into the range seen in populations from Ambon, Ceram, Misool, Sangihe, northern and western New Guinea, Misima Island, and Woodlark Island. Several other population ranges barely include one but not the other of the types. Thus among McDowell's samples only the populations from Sangihe, the South Moluccas (Ambon, Ceram, and Misool), and parts of mainland New Guinea match the scale counts reported by Thunberg. Böhme et al. (1998) provided additional characteristics of the *C. carinata* from this region and concluded that there were no morphological features that could be used to distinguish specimens from the South Moluccas, Irian Jaya, northern Papua New Guinea, New Britain and New Ireland. Given that New Guinea remained largely unvisited by Europeans in the 1770's, we think it most likely that the types of *Boa variegata* originated from the South Moluccas, possibly Ambon, which was a frequent port of call for ships, and was the origin of another reptile described from the region at an early date (*Lacerta amboinensis* Schlosser 1768 = *Hydrosaurus amboinensis*).

Several authors (McDowell, 1979; Böhme et al.,1998; Austin, 2000) have considered that more than one species may be involved in what is now considered to be *Candoia carinata*. This raises the issue of the possibility that the name *Boa variegata* might be available for some specifically recognizable set of populations in the future. The types of *Boa carinata* were themselves described without specific locality. However, McDowell (1979), based on Schneider's detailed description of a Göttingen Museum specimen, chose this individual as the lectotype and indicated that it had probably originated from the South Moluccas. This was based on McDowell's reading of the description itself, as the types were unlocated at the time. The lectotype designated by McDowell (1979), however, has since been found (Böhme et al., 1998), and is associated with the locality data "Amboina" [= Ambon]. It thus appears unambiguous that both the lectotype of *Boa carinata* and the syntypes of *B. variegata* are derived from the same population or group of populations and that *B. variegata* would be a junior subjective synonym of *B. carinata*, even if the species as currently construed were to be subdivided and other names currently synonymized for the Palauan (*Enygrus superciliosus* Günther, 1863) and Solomon Islands (*Enygrus carinatus paulsoni* Stull, 1956) populations were to be resurrected and recognized as specifically valid.

STATUS OF THE TYPES OF *BOA VARIEGATA*

Although *Boa variegata* is unlikely to ever be considered a valid name, the whereabouts of the two types specimens remains an interesting historical sidelight. Thunberg (1807) did not state explicitly where the types were deposited. Because he was associated with the University of Uppsala as both a student and a faculty member it was likely that the specimens, if extant, would have been deposited in the Zoological Museum of this institution (ZMUU). Lönnberg (1896) published a catalogue of the Linnaean types in the Uppsala collection which, although mentioning some non-Linnaean types as well, did not refer to *Boa variegata*. Wallin (1996), however, included Thunberg's reptilian types in his "General Zoology" catalogue of the ZMUU collection. In this he noted the presence of ZMUU Type # 313, identified by him as the holotype of *Boa variegata* Thunberg 1807, with the type locality "East India" and C. P. Thunberg as collector. Wallin's (1996) reference to a holotype, however, although implying that only one specimen was present in the collection, did not clarify if the surviving specimen was Thunberg's form "a" or "b." Dr. Mats Eriksson, the current curator of the collection, has indicated that only one specimen remains in the collection and that this is the specimen illustrated and described by Thunberg as his variety "b." The scale counts confirm this identity as there are 173 ventral scales (including the anal plate) and 51 subcaudals (the difference of one subcaudal probably reflects an error in Thunberg's original count or a slightly different method of counting). The specimen is accompanied by three labels indicating, respectively, its reidentification as *Enygrus carinatus* by A. Wirén, its registration as specimen number 313 in the type collection, and the existence of Thunberg's original labels in the collection.

As noted above, the scale counts provided by Thunberg (1807) strongly suggest that the type is derived from the South Moluccas (or less likely from New Guinea). This is confirmed by the presence of keeled scales in the second row of dorsal scales, another diagnostic feature of this population (fide H. M. Smith, in litt.). Although Wallin's (1996) reference to a holotype (given the original existence of two syntypes) may be taken as an implicit lectotype designation, Wallin's catalogue, as a work printed on demand, does not satisfy the definition of a publication under Article 9.7 of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1999). We here formally designate Uppsala University (ZMUU) 313 in the reptile type collection, the surviving of Thunberg's two original specimens, as the lectotype of *Boa variegata*. The purpose of this designation is to unambiguously link the name *Boa variegata* to an extant specimen that can be reexamined in light of ongoing revisions of the genus *Candoia* (H. M. Smith, in litt.). Although currently regarded as a junior subjective synonym of *Candoia carinata*, and believed on the basis of scalation to be derived from the same source population as the lectotype of *Boa carinata* Schneider (see above), the possibility remains that further investigations may warrant the recognition of additional taxa in the *C. carinata* complex, to which the name *Boa variegata* may be applicable. Thunberg's a specimen, which also appears to be referable to *Candoia carinata* from the South Moluccas, and which is now apparently lost, is a paralectotype of *B. variegata*.

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THE POTENTIAL SIGNIFICANCE OF GROUND-BORNE VIBRATION TO PREDATOR-PREY RELATIONSHIPS IN SNAKES

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(with seven text-figures)

ABSTRACT.– **The magnitude of vibrational stimuli generated during predator/prey encounters involving snakes was determined using a 2.4 x 2.4 m recording chamber, a geometric array of geophones, and a variety of substrates and live organisms. For each situation a radius of detection was calculated based on the magnitude of the stimulus and the vibrational sensitivity of snakes. These radii of detection exhibited a clear pattern, increasing with body mass and more dynamic locomotion (hopping versus walking). The substrate had a significant influence; when compared to compact soil, the radius of detection was decreased by 30% on a surface of leaf litter, and increased by 77% by a wood substrate. The results suggest that not only do vibrational stimuli play an important role in predator avoidance, but that in some circumstances they may play a significant role in prey detection.**

KEY WORDS.– **Ophidia, acoustics, communication, behaviour, seismic, sensory system.**

INTRODUCTION

Studies of prey detection in snakes have focused on the chemosensory system; in particular, the vomeronasal organ and the associated tongue flicking behaviour (see Halpern, 1992; Ford and Burghardt, 1993). Other studies have shown the importance of visual or infrared stimuli in prey capture (e.g., Chiszar et al., 1988; Kardong, 1992; Mullin and Cooper, 1998). The potential role of vibrational stimuli has been largely overlooked, although it has been hypothesized to play a role in ambush hunting in *Crotalus horridus* (Reinert et al., 1984). Most of these studies demonstrated the relative importance of one or more sensory modalities to prey capture; however, the relationship between the absolute sensitivity of the modality and the strength of stimuli in nature remains uncertain.

The complete pathways for vibration reception in snakes are still not known; however it is clear that snakes can perceive both air-borne and ground-borne vibrations (Wever, 1978). These vibrations can be detected either by the inner ear or by a somatic sensory system along the body, and possibly via the lungs (Hartline, 1971a, b). While the somatic hearing is less sensitive (Hartline, 1971b), both mechanisms have a restricted frequency range. While there are some species-specific differences, vibratory reception in snakes appears to be most sensitive over the range of 50 - 200 Hertz (Hartline, 1971a; Wever, 1978; Hetherington, pers. com.).

The goal of this study was to investigate experimentally the vibrations produced by a variety of potential ophidian prey items and predators, and to determine from what is known about the sensitivity of snakes whether these vibrations are detectable, and, if so, over what distances. Understanding the distances over which these vibrations are detectable may provide some insight into the potential contribution of vibrational stimuli to prey capture and predator avoidance, and identify the environmental fac-

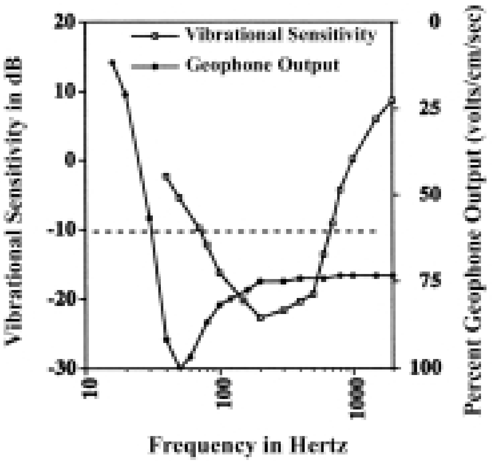

FIGURE 1: Generalized curve of vibrational sensitivity in snakes produced by averaging values determined by Wever (1978) and converting them to particle velocity (reference 1 cm/sec). Superimposed on this curve is the frequency response of the GSC-20DH geophone (data from GeoSpace, Corp.). Note the general overlap of the two curves, and the designated -10 dB threshold for auditory sensitivity.

tors that might influence the perception of vibrational signals.

MATERIALS AND METHODS

Snake vibratory sensitivity.- In recognition of the dearth of published vibratory sensitivity curves, and the different techniques used to produce these curves, data on snake vibration sensitivity was restricted to the curves published by Wever (1978). Since Hartline (1971a) found the somatic hearing to be less sensitive than the auditory for both ground-borne and air-borne vibrations, use of data from the auditory system should provide a more conservative estimate. Wever found little variation in vibrational sensitivity among snakes; taking the mean of the vibrational sensitivities across all of the species for which Wever (1978) provided frequency response curves produced a generalized frequency response curve for snakes (Fig. 1). Wever reported sensitivity in sound pressure (in dB with a reference of 1 dyne/ cm2), which was converted to particle velocity (reference 1 cm/sec) following Christensen-Dalsgaard and Narins (1993).

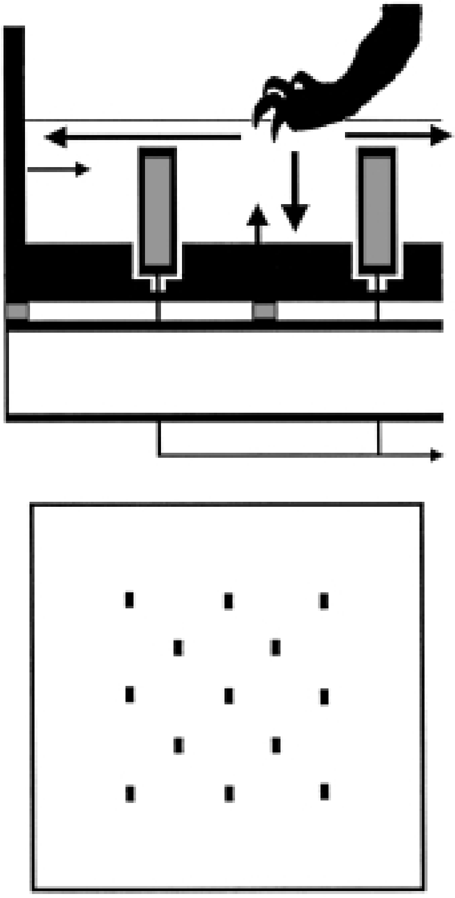

FIGURE 2: Schematic of the data recording chamber showing geophones. (Top) Cut away view showing the geophones (vertical light grey rectangles) mounted on the plywood base (black), which rests on the vibration dampening pads (small grey squares) and the support braces (open). Locomotor impact produces vertical S waves which would deflect the plywood and geophones, and horizontal P waves and surface waves would pass over the surface of the geophone. Both waves could reflect from the bottom (S waves) and sides (P and surface waves) of the recording chambing. (Bottom) Arial view showing the positioning of the geophones (black squares) in the recording chamber.

Ground vibration detection.- To record ground vibrations a 2.4 x 2.4 m recording chamber was constructed. The floor of the chamber was 2.0 cm thick plywood (Fig. 2A). This plywood rested on vibration dampening pads

(Fisher), which rested on a series of wooden joists. The joists rested on four (10 x 10 cm) wooden posts; between the wooden posts and the floor were dense rubber pads. The combination of the pads, the joists, and the wooden posts elevated the plywood to 70 cm above the ground. A series of 2.5 cm diameter holes were drilled in the plywood to house geophones. Thirteen geophones were placed in a geometric array; nine geophones were placed in a square with 61 cm between each geophone and between the geophones and the edge of the plywood, and an additional four geophones were placed in a square pattern (61 cm apart) in the center of the plywood and the other nine geophones (Fig. 2B). Each geophone (GSC-20DH, GeoSpace Corp.) was mounted vertically onto the plywood using silicone adhesive. These geophones have a frequency response curve that closely matches that of the generalized frequency response curve for snake audition (Fig. 1); although designed for vertical use, the geophones have an axis of sensitivity greater than 25° from the vertical. The geophones were connected to a 100B Analog/Digital converter (G.W. Instruments) that was coupled to a G3 computer (Apple) with an Instrunet data acquisition board (G.W. Instruments). Signals from the 13 geophones were recorded simultaneously (sample rate = 5,000 Hz) for 10 seconds.

The ground vibration chamber was designed to maximize the strength of the vibration signal. A footfall onto the substrate could produce radiating waves of vibration. There are three potential waves that could be produced during locomotion. Two of these waves, the P (compression) waves and the surface waves, could be detected by the geophones as they pass through the thin substrate layer over the geophone (Fig. 2A). The third wave, the S (shear) wave, could produce vertical movement in the plywood; since the geophones were mounted on the plywood this could generate a signal in the geophones (Fig. 2A). Depending on their initial strength, these signals could echo or bounce off the walls and base of the recording chamber.

A 20 cm tall strip of 1 cm thick plywood formed the sides of the recording chamber. These sides were not anchored to the base, but did function to retain the substrate and test subjects. The recording chamber was initially filled with commercial topsoil that was free of rocks and large aggregates. The topsoil was lightly compacted and roughly leveled to a depth of approximately 4 cm, which just covered the 3.5 cm tall geophones. Surface markers were placed on the soil to indicate the exact location of each geophone. Four groups of potential prey items were examined: *Rana pipiens* (n = 10; mean mass = 38.4 g; s.e. = 1.2 g); *Mus musculus*, (n = 10; mean mass = 24.3 g, s.e. = 0.4 g); *Rattus norveigicus* (n = 5; mean mass = 131 g; s.e. = 4 g); and an assortment of lizards including two specimens of *Mabuya macularia* (mass of 20.1 g and 36.0 g); two specimens of *Sceloporus undulatus* (mass = 36.1 g and 38.2 g); a specimen of *Iguana iguana* (mass = 76 g); and a specimen of *Physignathus concincinus* (mass = 62 g). The specimens were placed individually on one side of the recording chamber and allowed to move freely across the substrate. The specimens were timed while moving over a known distance to determine locomotor velocity. Once regular locomotion was observed (defined by velocity for the mouse, rat, and lizards, and hops of 40-65 cm for the frogs), the position of a footfall was marked on the substrate, and the time of that footfall was noted for data analysis. Linear measurements were taken of the distance between each geophone and the marked position of the footfall. A single trial was taken of each frog and mouse, two independent trials were taken from each rat and lizard.

Following these recordings, two groups of potential predators were examined. The first group consisted of dogs, *Canis domesticus* (n = 5; mean mass= 11.7 kg; s.e. = 1.6 kg), the second of *Homo sapiens* (n = 5; mean mass = 61 kg; s.e. = 5.6 kg). Data were collected as before except that for safety considerations the human locomotion was restricted to only the perimeter of the recording chamber.

Once the predator and prey recordings were completed, all but approximately 1 cm of the topsoil was removed from the recording chamber. The chamber was then filled with dried leaves to a depth of roughly 6 cm. A grid system suspended over the leaves marked the precise location of each geophone. A second series of recordings was taken from another group of *Rana pipiens* (n = 10; mean mass = 36.7 g; s.e. = 1.2 g). A small takeoff platform rested on top of the leaves to ensure a clean jump; only data from hops of 40-65 cm were analyzed. Subsequently the leaves were removed and approximately 3 cm of topsoil (non-compacted) was returned to the recording chamber; in this configuration the top of the geophones extended slightly above the surface of the topsoil. A 122 x 122 cm piece of 2 cm thick plywood was glued to the top of eight of the geophones (excluding the five geophones around two sides of the array). A third group of *R. pipiens* (n = 10; mean mass = 37.7 g; s.e. = 1.4 g) was allowed to hop on the surface of the top plywood sheet, with hops of 40-65 cm used for data analysis.

The experimental procedures employed in this study were reviewed and approved by Lafayette College's Institutional Animal Care and Use Committee, and Review Board.

Data analysis.- Using SoundScope wave analysis software (G.W. Instruments), the frequency and maximum amplitude of the vibrations were determined; amplitude was converted directly into particle velocity. The distance and particle velocity values were analyzed using Systat 5.2.1. Linear regression was performed using particle velocity as the dependent variable. Radii of detection were determined by extrapolating this regression line (when necessary) until it crossed the -10dB threshold line; the distance where the two line cross was defined as the radius of detection. In addition to calculating the mean and standard error of the entire particle ve-

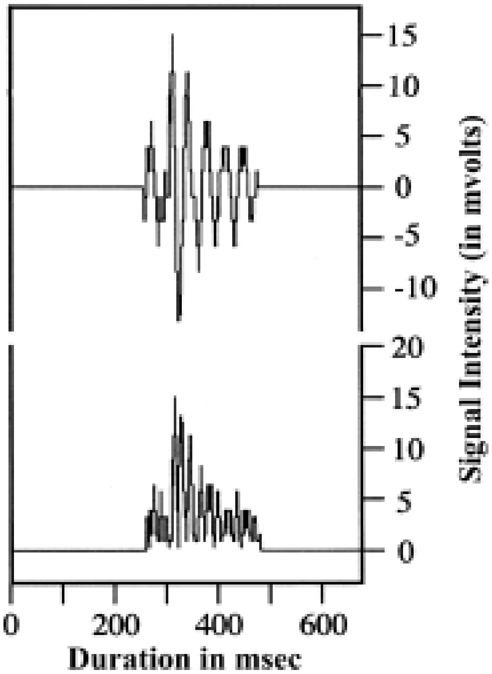

FIGURE 3: Stimulus recorded from the geophone during impact of a frog on soil (recorded at a distance of 37 cm). Top tracing is the original signal, bottom tracing has been rectified. Note the symmetry of the signals and the presence of harmonics.

TABLE 1: Statistical summary of the particle velocities recorded during locomotion in potential snake prey items. Linear regression coefficients and particle velocities (mean and 70-80 cm) are given in dB (reference 1 cm/sec).

	Frog	Mouse	Rat	Lizard
Regression Coefficient	-0.083	-0.173	-0.149	-0.128
R-squared	0.845	0.874	0.87	0.829
s.e.	0.003	0.006	0.006	0.005
T	26.51	29.85	24.44	27.81
N	130	130	90	160
Mean Velocity	7.33	0.06	2.14	3.45
s.e.	0.3	0.33	0.37	0.29
Mean Vel. 70-80	7.83	-0.86	2.4	1.99
s.e.	0.68	1.11	0.96	0.704
N	15	12	9	15

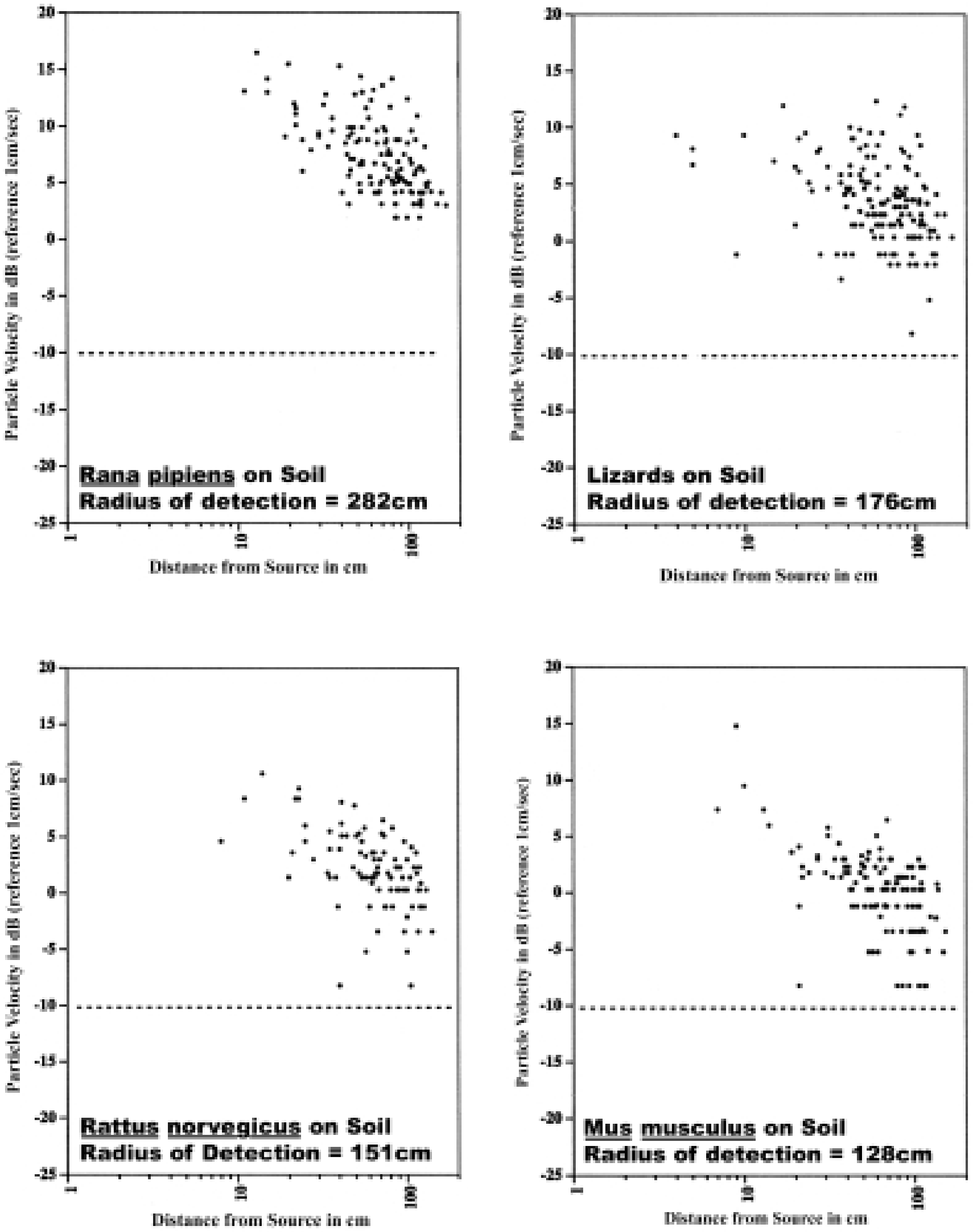

FIGURE 4: Relationship of locomotor vibrations to distance in four potential snake prey items moving on compact soil; in each graph the dashed line represents the -10 dB auditory threshold. Top left *Rana pipiens* (b = -0.083, R^2 = 0.845, T = 26.51, N = 130); Bottom left *Rattus norvegicus* (b = -0.149, R^2 = 0.87, T = 24.44, N = 90); Top right Lizards (b = -0.128, R^2 = 0.829, T = 27.81, N = 160); *Mus musculus*; Bottom right (b = -0.173, R^2 = 0.874, T = 29.85, N = 130).

TABLE 2: Statistical summary of the particle velocities recorded during locomotion in potential snake predators. Linear regression coeficients and particle velocities (mean and 70-80 cm) are given in dB (reference 1 cm/sec).

	Dog	Man
Regression Coefficient	-0.009	-0.035
R-squared	0.202	0.634
s.e.	0.004	0.002
T	2.14	14.95
N	109	130
Mean Velocity	11.64	10.17
s.e.	0.4	0.32
Mean Vel. 70-80	11.19	9.89
s.e.	1.12	0.35
N	10	6

locity data, the mean and standard error were also determined for a subset composed of particle velocities recorded 70-80 cm from a geophone, which removed most of the variation due to distance. Statistical differences among prey items, potential predators, and substrates, were performed using ANOVA and Bonferroni probability analyses on SYSTAT 5.2.1.

RESULTS

Prey items.- The vibratory waves produced by the prey items had dominant frequencies from 50-100 Hz, and were generally symmetrical with a distinct pattern of harmonics and decay (Fig. 3). Of the four prey items examined, the *Rana pipiens* produced the highest amplitude vibratory signal; and the *Mus musculus* the lowest (Table 1). A similar ranking of vibrational strength was present in the 70-80 cm data set. There was significant difference among the means both in the full data set (ANOVA, N = 510, F-ratio = 93.92, df = 3, $p < 0.00$) and in the 70 - 80 cm data set (ANOVA, N = 51, F-ratio = 20.05, df = 3, $p < 0.00$). A matrix of pairwise Bonferroni comparisons revealed each prey item to have a significantly different ($p < 0.05$) mean particle velocity in the full data set, while only the mean particle velocity of the frog was significantly different in the smaller 70-80 cm data set. The regression coefficients for particle velocity against distance were all negative, and all significantly (at $p = 0.05$) different from zero (Table 1). The variation accounted by these regression lines ranged from 0.829 to 0.874 (Table 1). If a particle velocity of -10 dB is taken as a conservative estimate of the limit of snake vibratory sensitivity (Fig. 1), then hopping in *R. pipiens* would produce a detectable signal within a radius of roughly 280 cm (Fig. 4A). The lower vibratory signals produced by *Rattus norveigicus* and the lizards examined would only be detectable over radii of less than 151 and 176 cm, respectively (Fig. 4B,C). The low amplitude vibratory signals produced during locomotion in *M. musculus* could only be detected by a snake within a radius of approximately 130 cm (Fig. 4D).

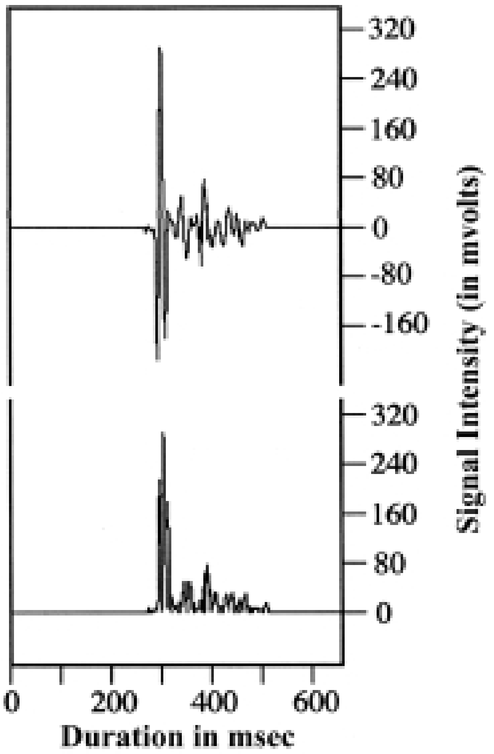

FIGURE 5: Stimulus recorded from the geophone during impact of a human on soil (recorded at a distance of 42 cm). Top tracing is the original signal, bottom tracing has been rectified. Note the asymmetry of the signals and the absence of distinct harmonics.

Predators.- The vibratory waves generated by the potential predators had dominant frequencies below 200 Hz, and were generally asymmetric

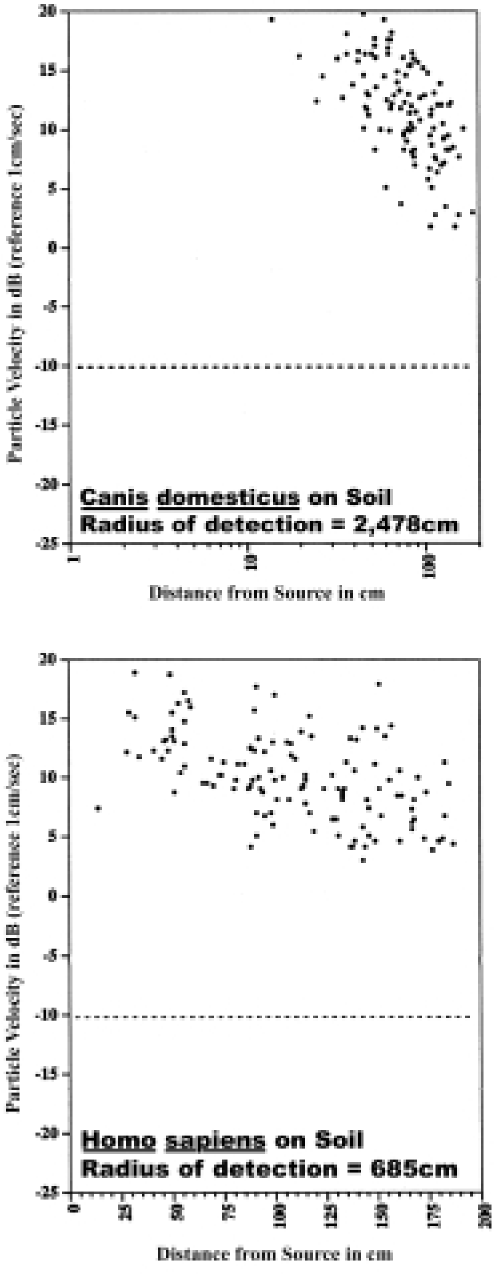

FIGURE 6: Relationship of locomotor vibrations to distance in two potential snake predators moving on compact soil; in each graph the dashed line represents the -10 dB auditory threshold. A- *Canis domesticus* (b = -0.009, R2 = 0.202, T = 2.14, N = 109); B- *Homo sapiens* (b = -0.035, R2 = 0.634, T = 14.95 N = 130).

with no clear pattern of harmonics or decay (Fig. 5). The ground vibrations recorded from *Canis domesticus* were higher than those from *Homo sapiens*, and were only slightly lower within the 70-80 cm data subset (Table 2). The mean particle velocities were significant different in both the full data set (ANOVA, N = 239, F-ratio = 58.33, df = 1, $p < 0.00$) and in the 70 - 80 cm data set (ANOVA, N = 16, F-ratio = 5.84, df = 1, p = 0.03). A matrix of pairwise Bonferroni comparisons revealed each potential predator to have a significantly different ($p < 0.05$) mean particle velocity in both data sets. The vibrational signals in both groups decreased with distance; although significantly different from zero, this decrease was very low in *C. domesticus* (Table 2). Using a -10 dB particle velocity as the threshold for snake vibratory sensitivity (Fig. 1), the locomotor stimuli examined suggests that snakes could detect *C. domesticus* and *Homo sapiens* within radii of 25 and 7 m, respectively (Fig. 6A,B).

Substrate influence.- The three groups of *Rana pipiens* used for the substrate experiments were not significantly different (t-test, $p < 0.05$) in body mass. During all three trials, data were only examined if the frog had hopped between 40-65 cm. In both the full data set, and the subset of data recorded at 70-80 cm, the magnitude of particle velocity was highest on the wood and lowest on leaf litter (Table 3). In both data sets the differences among the mean particle velocities were significant; for the full data set (ANOVA, N = 340, F-ratio = 90.51, df = 2, $p < 0.00$), in the 70 - 80 cm data set (ANOVA, N = 35, F-ratio = 5.84, df = 2, $p < 0.00$). In both cases the pairwise matrix of Bonferroni comparison indicated each mean to be significantly different (at p = 0.05). In all three substrates the magnitude of the particle velocity decreased with distance, although with the wood substrate the regression was only slightly below zero (Table 3). With a particle velocity of -10 dB taken as the threshold for detection, the different substrates result in different radii of detection. For the soil, the radius of detection is roughly 115 cm (Fig. 4A), for the leaf litter 76 cm (Fig. 7A), and locomotion on the wood has a detection radius of approximately 200 cm (Fig. 7B).

TABLE 3: Statistical summary of the particle velocities recorded during locomotion in *Rana pipiens* over different substrates. Linear regression coefficients and particle velocities (mean and 70-80 cm) are given in dB (reference 1 cm/sec).

	Soil	Leaves	Wood
Regression Coefficient	-0.083	-0.116	-0.046
R-squared	0.845	0.842	0.305
s.e.	0.003	0.004	0.008
T	26.51	26.19	5.89
N	130	130	80
Mean Velocity	7.33	3.54	10.29
s.e.	0.3	0.3	0.47
Mean Vel. 70-80	7.83	2.09	9.97
s.e.	0.68	0.35	1.4
N	15	17	6

TABLE 4: Estimated radii of detection determined by extrapolating the determined regression coefficients to intersect the –10 dB threshhold of auditory sensitivity.

	Radius of Detection (in cm)
Prey Items	
Rana pipiens	282.2
Mus musculus	128.2
Rattus norvegicus	150.8
Lizards	175.8
Predators	
Canis domesticus	2478
Homo sapiens	684.9
Substrate Influence (*Rana*)	
Soil	282.2
Leaves	194.5
Wood	499.9

DISCUSSION

Several features of the vibration recording chamber design served to increase the magnitude of the recorded signal beyond what would be obtained in a natural setting. The ability of the plywood base (and the attached geophones) to deflect, the relative shallowness of the substrate, the ability of the vibrations to echo off the floor

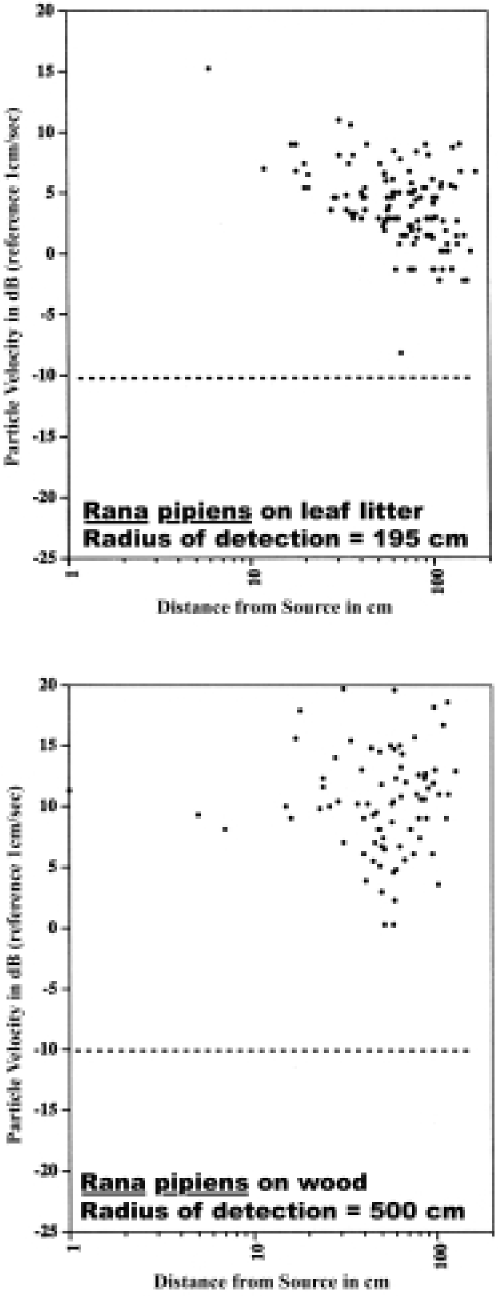

FIGURE 7: Relationship of locomotor vibrations to distance in *Rana pipiens* moving over different substrates; in each graph the dashed line represents the -10 dB auditory threshold. (Top) locomotion over leaf litter (b = -0.116, R^2 = 0.842, T = 26.19, N = 130); (bottom) locomotion over wood (b = -0.046, R^2 = 0.305, T = 5.89, N = 80); for locomotion over soil see Fig. 4A.

and sides of the chamber, and the potential for the amplitudes of different waves (surface, S, and P) to be additive, would all produce an overestimation of the actual particle velocity produced during locomotion. Since all of these factors are related to the intensity of the vibrational source, the overestimate should be greater with increased mass and with more dynamic locomotor styles. Accordingly, all of the values presented herein for particle velocity and radii of detection are likely higher than would be expected in nature.

The four prey classes examined represent the most common items taken by snakes. A pattern is evident within the particle velocities and radii of detection. *Mus musculus* had the lowest body mass, relatively slow locomotion, the lowest particle velocity (Table 1), and the smallest radii of detection (Table 4). Although *Rattus norveigicus* were significantly heavier, they also moved slower; the end result was a slightly higher mean particle velocity (Table 1) and a slightly larger radius of detection (Table 4). Although the lizards had body masses between the mice and rats, they had a slightly higher particle velocity (Table 1) and radius of detection (Table 4). Presumably this is a reflection of their more dynamic locomotor style, including bipedal running in *Physignathus,* which would produce greater vibrational signals. The highest particle velocities determined for lizards (Fig. 4C) were all produced by specimens moving bipedally. *Rana pipiens,* which had a body mass less than that of the *Mus* or *Rattus*, produced significantly higher particle velocities (Table 1) and had a higher radius of detection (Table 4). Presumably this reflects the greater vertical force associated with saltatory locomotion and the resultant increased deflection of the plywood base.

The results of the two predator classes examined reflect the limitations of the recording chamber design and the significant influence of locomotor variation. For safety considerations the human subjects were restricted to the perimeter of the recording chamber, where the plywood base was well supported and difficult to deflect (when compared to the middle of the chamber). This was coupled with a tendency on the part of the human subjects to step rather gingerly. The combined effects produced a curve with more noise than those of the prey items and a low particle velocity and radius of detection (Tables 2, 4). The vibrational data recorded from *Canis domesticus* reflect almost the opposite problem; the body mass of the dogs was large enough that they produced significant deflection of the plywood base, resulting in very noisy signals (Fig. 5) and large particle velocity values (Table 2). The vibrational signals recorded from *C. domesticus* were so large that little decay was observed over the size of the recording chamber. This produced a regression coefficient that was only slightly (though significantly) below zero, a regression line that explained only 20% of the observed variation (Table 2), and a high radius of detection (Table 4).

The vibrations recorded as *Rana* hopped over three different substrates clearly reflect the relative dampening effect of the substrates. The stiffness of the wood, and the coupling of the two plywood layers by way of the geophone, resulted in strong propagation of the vibrations as evident by the low decay over distance and noise in the regression equation (Table 3), high mean velocity (Table 3), and high radii of detection (Table 4). Landing on a substrate of soil or leaves dampened the vertical force applied to the plywood base, and reduced the horizontal propagation of the seismic waves (thus significantly reducing the particle velocities, Table 3). Owing to its lower density, this dampening was more pronounced on the leaf litter.

The radii of detection calculated using the estimates of particle velocity (Table 4) suggest that while vibrational stimuli may play a role in prey capture, other sensory modalities would likely detect the potential prey item before it got close enough to be detected through reception of the vibrational signal alone. This is particularly true for snakes in environments characterized by dense vegetation or other substrates which would reduce the propagation of the vibrational signal. While this would hold for most snakes, our results suggest that there are at least four situations where ground-borne vibrations may be particularly important for prey detection. Vibration detection may be important for snakes that feed on prey items whose body mass and locomotor style combine to produce a significant vibrational signal, such as *Sylvilagus* predation by *Crotalus adamanteus* (Klauber, 1972). Snakes such as *Cerastes cerastes*, which can ambush prey after burying themselves in sand (where the other sensory modalities may be blocked) could exploit the radii of detection produced by their prey items, as has been shown for sand-dwelling lizards (Hetherington, 1989, 1992). Some snakes forage for prey that produce strong vibrational signals either as part of a regular acoustic communication, as a special defense against snakes, or under unusual circumstances (e.g., Wharton, 1969; Gloyd and Conant, 1990; Randall and Martocq, 1997; Claridge et al., 1999). Lastly, snakes could exploit the higher radii of detection produced by the low vibration dampening of wood by using logs as ambush sites, or possibly even responding to arboreal vibration (e.g., Reinert et al., 1984; Barnett et al., 1999). Interestingly, Roche et al. (1999) have argued that *Peromyscus* preferentially travels over logs and compact soil as opposed to leaf litter as a means of reducing auditory cues; while this strategy would minimize air-borne vibrations, it would maximize ground-borne vibration (Table 4).

Vibrational stimuli, while probably of little value in prey detection, could play a key role in avoiding predators or other dangers. The radii of detection calculated for *Canis domesticus* seems inflated due to the design of the vibration chamber; that for *Homo sapiens* may be more accurate due to the limited deflection of the plywood and the timid locomotion exhibited. This would suggest that a radius of detection of at least 7 m is reasonable for normal human locomotion. Since this radius of detection would increase with body mass, snakes should be able to detect, and avoid, large ungulates at a considerable distance.

There are few previous studies of acoustic performance in snakes with which the values presented herein can be compared. Wall (1921) and Klauber (1972) estimated that snakes could detect a human footfall from 4.5 m away. Randall and Martocq (1997) documented behavioural responses in snakes to an artificial "thumper" placed approximately 10 m away; however, the amplitude of the signal produced by the "thumper" was not given. The acoustic sensitivity values produced by Wever (1978) were defined based on electrical signals recorded from the cochlea and auditory nerve. As such, the sensitivity levels we have used are an approximation of the physiological response of the auditory system, not a behavioural response on the part of the snake. After documenting the physiological response of this system, Hartline (1971b) noted that at the mid-brain level the snake was "not well suited" for rapid analysis of vibratory signals. The results of this study indicate that vibrational cues could be a component of the sensory information used by snakes, and suggest the conditions where vibrational cues may be most important. To fully demonstrate the biological significance of vibrational signals will require combined field recordings and behavioural observations.

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AMPHIBIANS AND REPTILES OF LUZON ISLAND, II: PRELIMINARY REPORT ON THE HERPETOFAUNA OF AURORA MEMORIAL NATIONAL PARK, PHILIPPINES.

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(with 33 text-figures)

ABSTRACT.– **We present species accounts for 19 amphibians (frogs) and 30 reptiles (19 lizards, 10 snakes, and one turtle) collected at localities within the central Sierra Madre Mountains in Aurora Province, Luzon, Philippines. Despite its close proximity to Manila, this heavily forested site produced several significant discoveries. Specimens collected during this expedition contributed to the type series of the newly-described *Rana tipanan*, *Platymantis sierramadrensis*, and *Sphenomorphus tagapayo*. Notable collections of poorly known species include specimens referable to *Brachymeles bicolor* and *Sphenomorphus leucospilos*, two species previously known only from two specimens each.**

Unidentified and possibly undescribed species include two unusual specimens referable to the genus *Platymantis* and a single specimen of the genus *Sphenomorphus*. That so many discoveries could be produced in such a short survey effort (less than two weeks) further emphasizes the degree to which the amphibian and reptile populations in the mountains of Luzon are drastically understudied. We discuss patterns of montane endemism on Luzon and argue for an immediate and exhaustive herpetofaunal survey of the Sierra Madre Mountains.

KEY WORDS.– **Amphibians; Aurora Memorial National Park; herpetofauna; Luzon Island; Philippines; reptiles; Sierra Madre Mountains.**

INTRODUCTION

It is now known but not widely appreciated that the major Philippine Island of Luzon (Fig. 1) is a composite island, formed from several paleoislands that have only recently accreted into a single land mass (Adams and Pratt, 1911; Feliciano and Pelaez, 1940; Rutland, 1968; Hashimoto, 1981a, 1981b; Auffenberg, 1988; Hall, 1996; 1998). As a result of this unique history, we can make at least two predictions: (1) intra-island biological diversity should be substantial, and (2) the regions corresponding to the former paleoislands (the Zambales massif, the Cordillera Central, the Sierra Madres, and highland volcanic portions of the Bicol Peninsula) are likely to be inhabited by faunas characterized by substantial degrees of endemism - especially among montane species that are unlikely to pass through the lowland habitats that now connect these former islands. Recent herpetological survey work (Ross and Gonzales, 1991; W. C. Brown et al., 1997a; 1997b; 1997c; 1999; Alcala, et al., 1998; R. M. Brown et al. 1995a; 1995b; 1996; 1999a; 2000; Diesmos, 1998; Diesmos, Brown, Crombie and Alcala, unpublished data) suggests that both of the above predictions are likely to hold true. These studies indicate that local montane endemism is much more extensive (on a much finer scale) than previously considered by investigators utilizing patterns of mammalian (Heaney and Rickart 1990; Heaney et al., 1991; 1998; Rickart et al., 1991; Rickart and Heaney, 1991) and avian (Dickerson et al., 1990; Kennedy et al., 2000) taxonomy and geographical species distributions. Most of Luzon Island remains poorly sampled for herpetofauna. Given the inadequacy of the current data, it is premature to assert strong conclusions regarding biodiversity estimates; additional intensive biotic sampling is absolutely essential if we are to gain a proper understanding of Luzon's diversity. The data that we present represent a preliminary view of the herpetological diversity of one forested area in the Sierra Madre Mountains and indicate that much work is needed before we can conclude that the herpetofauna of this biogeographical subprovince is well known.

The Sierra Madre is an elongate chain of mountains that extend down the eastern coast of north and central Luzon island (14°–19° N; Fig. 1). Perhaps because earlier evidence suggested that the separate mountain ranges of Luzon support only low levels of herpetological diversity (Inger, 1954; W. Brown and Alcala, 1978; 1980; but see Taylor, 1920, 1922a; 1922b; 1922c; 1922d), virtually no herpetological field work was conducted on Luzon between Edward Taylor's Philippine field career (1915-1920) and the early 1990's (see R. Brown et al., 1996). Moreover, many intervening studies, conducted within the framework of a polytypic species concept (Inger, 1954; W. Brown and Alcala, 1978; 1980; 1994; Leviton 1961; 1962; 1963; 1964a; 1964b; 1964c; 1964d; 1965a; 1965b; 1967; 1968; 1979, 1983) recognized Luzon endemics as island "races" of widespread Philippine or SE Asian species and discounted the possibility that these "subspecies" might actually represent independent evolutionary lineages belonging to larger species complexes. Recent work, however, has renewed interest in patterns of montane endemism on Luzon and has bolstered the notion that the zoogeography of this complex island is much more interesting than was thought for most of the past century (Ross and Gonzales, 1992; W. Brown et al., 1997a; 1997b; 1997c; 1999; Diesmos, 1998; Alcala, et al., 1998; R. Brown et al., 1995a; 1995b; 1996; 1999a; 2000).

In a previous study on the herpetological diversity and endemism of Luzon Island (R. Brown et al., 1996), we reported on herpetofaunal communities of the Zambales Mountains, (Zambales and Bataan Provinces; Fig. 1). In this paper, we report on a significant collection of amphibians and reptiles taken near Baler Bay in forested regions in and around Aurora Memorial National Park (Aurora Province). Although a comprehensive analysis of the herpetofaunal communities of the entire Sierra Madre range is not possible at this time due to inadequate surveying, we take this opportunity to present a preliminary report on this important site. We do so because our collection contained many new and notable species and because of the importance of having adequate knowledge of the herpetofauna of Aurora Memorial National Park for the enactment of future conservation initiatives in the Sierra Madres.

MATERIALS AND METHODS

The National Museum of the Philippines/Cincinnati Museum of Natural History Philippine Biodiversity Inventory (PNM/CMNH PBI) team conducted field studies at four sites in Aurora Province (Fig. 1) from 14 May to 1 June, 1997. We established altitudinal transects (Ruedas et al., 1994, as modified by R. Brown et al., 1995a, 1996) and utilized standard collection and specimen preservation techniques (Simmons 1987; Heyer et al., 1994). Specimens were photographed, fixed in 10% buffered formalin, and transferred to 70% ethanol (1 mo later).

Detailed examination of all material was conducted by RMB, JWF and JAM and measurements are based on preserved material. We follow the taxonomy of Taylor (1922b), W. Brown and Alcala (1978, 1980) and R. Brown et al. (1995; 1995b) for gekkonid and scincid lizards. The taxonomy of Inger (1954), Frost (1985), Duellman (1993), W. Brown and Alcala

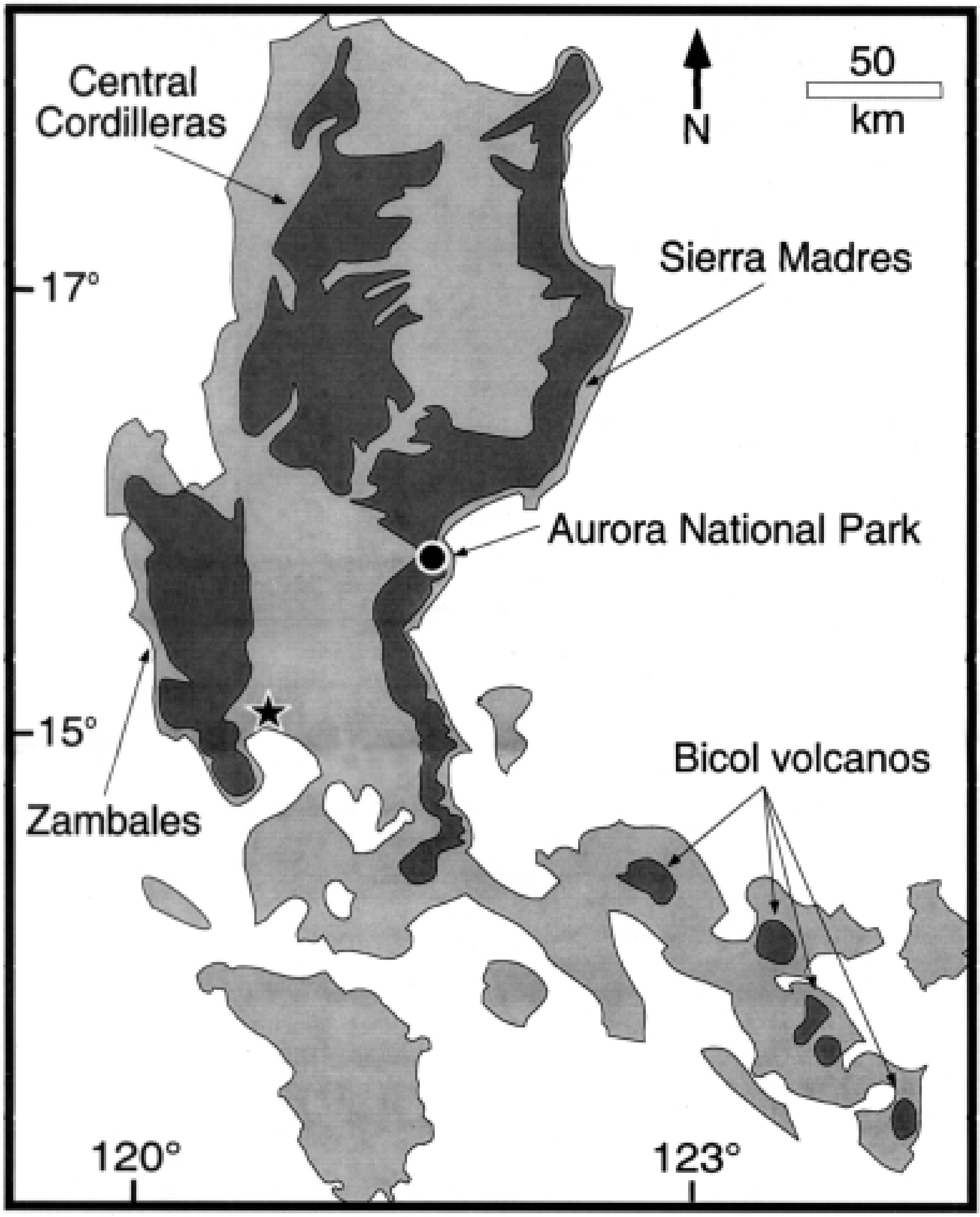

FIGURE 1: Luzon Island, northern Philippines. The four major montane components that form Luzon (the Zambales, the Sierra Madres, the Cordilleras, and the volcanoes of the Bicol Peninsula) are dark stippled. The position of Aurora Memorial National Park within the Sierra Madres is indicated; star = Manila.

FIGURE 2: Habitat on the Dipiningan branch of the Cobatangan River (Location 1a), Aurora Memorial National Park.

FIGURE 3: Small tributary of the Dipiningan branch of the Cobatangan River; habitat of *Rana tipanan*, *Rana luzonensis,* and *Limnonectes macrocephalus*. Note large boulders, where *Rana tipanan* were perched.

FIGURE 4: Characteristics of high elevation forest above 1000 m at Location 1b.

FIGURE 5: Typical stream side habitat of *Rana luzonensis, R. woodworthi, R. similis* and *Limnonectes macrocephalus* at Location 3.

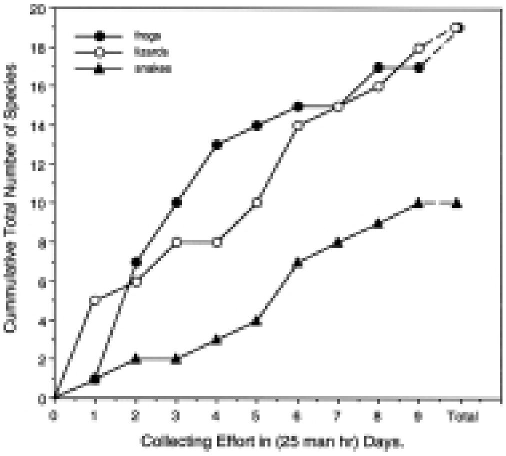

FIGURE 6: Species accumulation curves for amphibian and reptilian taxa surveyed at Aurora Memorial National Park (exclusive of turtles). The extensive systematic sampling effort (of approximately 25 man hr per day) lasted nine days. The dashed line added to the end of each curve leads to the final totals for Aurora Memorial National Park. The specimens (two additional species of frogs and one additional lizard) represents incidental collections during the last few days after the systematic collecting effort had been discontinued.

FIGURE 7: *Kaloula kalingensis* from Location 1b.

FIGURE 8: *Kaloula picta* from Location 2.

FIGURE 9: *Platymantis corrugatus* from Location 1a.

FIGURE 10: *Platymantis dorsalis* from Location 1b.

FIGURE 11: *Platymantis* sp. from Location 1b.

FIGURE 12: *Platymantis* cf. *sierramadrensis* from Location 1a.

FIGURE 13: *Rana luzonensis* from Location 1a.

FIGURE 14A: *Rana tipanan* (male) from Location 1b.

FIGURE 14B: *Rana tipanan* (female) from Location 1b.

FIGURE 15: *Rana similis* from Location 1a.

FIGURE 16: *Polypedates leucomystax* from Location 1a.

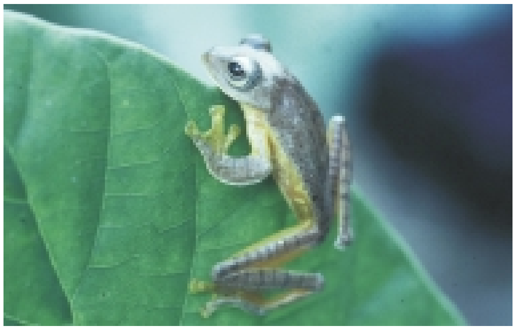

FIGURE 17A: *Rhacophorus pardalis* from Location 1a (male).

FIGURE 17B: *Rhacophorus pardalis* from Location 1a (female in amplexus with recently-deposited foam nest).

FIGURE 18: *Philautus surdus* from Location 1b.

FIGURE 19: *Gonyocephalus* sp. from Location 1b.

FIGURE 20: *Cyrtodactylus philippinicus* at Location 1a.

FIGURE 21: *Brachymeles bicolor* from Location 1b.

FIGURE 22: *Brachymeles bonitae* from Location 1a.

FIGURE 23: *Dasia grisea* from Location 1a.

FIGURE 24: *Mabuya multicarinata borealis* from Location 1a.

FIGURE 25: *Sphenomorphus abdictus aquilonius* from Location 1a.

FIGURE 26: *Sphenomorphus cumingi* from Location 1a

FIGURE 27: *Sphenomorphus tagapayo* from Location 1b.

FIGURE 28: *Calamaria bitorques* from Location 1b.

FIGURE 29: *Dendrelaphis pictus pictus* from Location 1a.

FIGURE 30: *Oxyrhabdium leporinum leporinum* from Location 1a.

FIGURE 31: *Psammodynastes pulverulentus* from Location 1a.

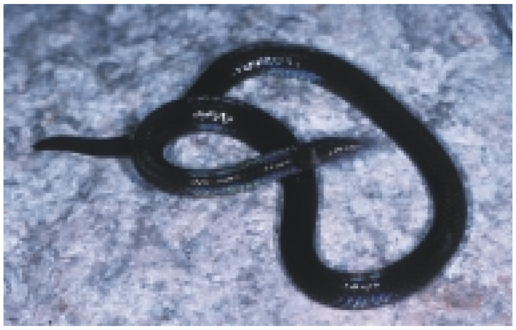

FIGURE 32: *Pseudorabdion oxycephalum* from Location 1a.

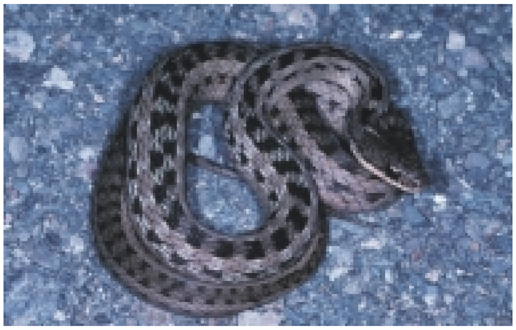

FIGURE 33: *Rhabdophis spilogaster* from Location 1a.

(1994) and Alcala and W. Brown (1998) was utilized for amphibians and we include (in parentheses) the largely unsubstantiated taxonomic hypotheses of Dubois (1992) for reference. While no suitable taxonomy currently is available for Philippine agamids as a whole, we consulted McGuire and Alcala (2000) for identification of *Draco* specimens. Snake taxonomy was based on Taylor (1922a), Leviton's "Contribution to a Review of Philippine Snakes" series (Leviton 1961, 1962, 1964a-d, 1965a-c, 1968, 1970, 1979, 1983), Leviton and W. Brown (1958), Inger and Marx (1965), McDiarmid et al. (1999), McDowell (1974), Wynn and Leviton (1993) and R. Brown et al. (1999a). Scale counts were taken using the methods of Dowling (1951a, 1951b).

Finally, we attempted to assess the adequacy of field sampling by constructing species accumulation curves for frogs, lizards, and snakes. In this procedure, we plotted total collecting effort against cumulative number of species collected, treating days (of approximately 25 combined man hr per day) as an indicator of sampling effort.

STUDY SITES/COLLECTION LOCALITIES

Location 1a. Philippines, Luzon, Aurora Prov., Municipality of San Luis; Dipiningan branch of the Cobatangan (= "Kabatangan" of R. Brown et al., 1999b) River drainage; 1.2 km S, 1.3 km E of Barangay Villa Aurora; 15° 40.2 N, 121° 20.8 E; ca. 410–650 m above sea level (Figs. 2-3).

Location 1b. Philippines, Luzon, Aurora Prov., Municipality of San Luis; Mt. Ma-aling-aling, Dipiningan branch of the Cobatangan River drainage, 3.5 km S, 3.0 km E of Barangay Villa Aurora; 15° 39.6 N, 121° 21.7 E; ca. 880–1320 m above sea level (Fig. 4).

Location 2. Philippines, Luzon, Aurora Prov., Municipality of Dinalungan, Talaytay River watershed; ca 6.5 km N, 6.0 km W Municipality of Dinalungan; 16° 12.3' N, 121° 54.0 E; ca. 110–440 m above sea level (Fig. 5).

Location 3. Philippines, Luzon, Aurora Prov., Municipality Maria Aurora; 0.5 km S, 2.6 km W of Barangay Villa Aurora; 15° 40.6' N, 121° 18.6' E; ca. 600–900 m above sea level.

RESULTS

We collected 19 amphibians (frogs) and 30 reptiles (19 lizards, 10 snakes, and one turtle; see species accounts, below). Species accumulation curves (Fig. 6) for the nine days of intensive collecting apparently did not level off in an asymptotic fashion, indicating that not all (or even a knowable percentage of) the species in Aurora Memorial National Park were recorded within the survey period.

SPECIES ACCOUNTS
AMPHIBIA

ANURANS (frogs)

Microhylidae

Kaloula kalingensis Taylor, 1922 (Fig. 7)

Kaloula kalingensis calls from tree holes, hollow bamboo trunks, and wild banana axils in forested and slightly disturbed areas (Diesmos, 1998). Although most calling individuals can be heard from tree holes 2–5 m above the ground, several specimens have been observed calling from holes in logs laying horizontally in contact with the forest floor (Diesmos and R. Brown, pers. obs.). A full series of larvae of this species were collected in water that had collected in the pulp and sheathes surrounding the trunk of wild bamboo plants.

Specimens: (Location 1a) CMNH 5956–65; PNM 5859–66; (Location 2) PNM 5867.

Kaloula picta (Duméril and Bibron, 1841) (Fig. 8)

These specimens were collected in flooded rice fields and adjacent pools in disturbed, non-forested areas. Choruses vary from a few to hundreds of individuals (RMB, pers. obs.)

Specimens: (Location 2) PNM 5867; CMNH 8125–8127.

Ranidae

Occidozyga laevis (Günther, 1859)

We collected this species in small forest streams, in stagnant pools beside a large river, and in drainage ditches in disturbed habitat near rice plantations.

Specimens: (Location 2) CMNH 5986–93; PNM 5881–87.

Platymantis corrugatus (A. Duméril, 1853) (Fig. 9)

This species was collected along the forested banks of the Dipiningan branch of the Cobatangan River and specimens were located 10–30 m from the water's edge. No specimens were collected at locations deeper in the forest and no calls of this species were heard away from the proximity of the river.

Specimens: (Location 1a) CMNH 5928–5935; PNM 5832–36; (Location 2) CMNH 5937–38; PNM 5837–39, 5841; (Location 3) PNM 5840.

Platymantis dorsalis (A. Duméril, 1853) (Fig. 10)

Specimens of *Platymantis dorsalis* were collected in a variety of microhabitats ranging from the banks of the Dipiningan branch of the Cobatangan River to mid-montane, higher elevation forests at Locations 1 and 3. *Platymantis dorsalis* calls from the forest floor but has also recently been observed calling from low vegetation (< 1 m) or from on the tops of stumps and fallen logs (Diesmos, R. Brown and McGuire, pers. obs.). The recent discovery of numerous cryptic species in the *P. dorsalis* complex (W. Brown et al., 1997c, 2000) suggests that morphological data alone may not be sufficient to confidently diagnose these species. In our case, at Location 1a, we recorded the distinctive brief whistling vocalizations that precisely match the known advertisement call for *P. dorsalis* and so we confidently refer these specimens to that species (see W. Brown et al., 1997c for sonogram). In the case of specimens collected at Location 2, advertisement calls were not heard or recorded, so the possibility that some of these specimens represent additional species (with the larger specimens possibly representing *P. taylori*) can not be discounted.

Specimens: (Location 1a) CMNH 5912, 5914–17, 5919–24; PNM 5816–17, 5819–20, 5822–24, 5827–28; (Location 1b) CMNH 5918; PNM 5821, PNM 5825–26; (Location 2) CMNH 5911, 5913; PNM 5814-15, 5818.

Platymantis cf. *mimulus* Brown, Alcala, and Diesmos, 1997

Recently described from Mt. Makiling (W. Brown et al., 1997c), populations related to this species may require further taxonomic partitioning once advertisement recordings become available for several S. Luzon populations currently under study (A. Diesmos, pers. comm.).

Specimens: (Location 1b) CMNH 5925–27; PNM 5829; (Location 1b) PNM 5830–31.

Platymantis sp. (Fig. 11)

Two unidentified male specimens referable to the *guentheri* species group (sensu W. Brown et al., 1997a, 1997b) were collected from separate arboreal ferns (2–3 m above the forest floor) during the day. The specimens most closely resemble *P. banahao* but we hesitate to identify them to species on the basis of a so few specimens and the absence of any data on advertisement calls. We can not be certain that the two specimens belong to the same species.

Specimens: (Site 1b) CMNH 8128–29.

Platymantis pygmaeus Brown, Alcala, and Diesmos, 1998

While no specimens were collected, the distinctive vocalizations of this newly described species (Alcala et al., 1998) were heard (by RMB and JAM) between the hours of 1830 and 2000 h above 800 m above sea level. The area where these species were heard was the upper limit of midmontane forest at this site.

Specimens: (Location 1b): none.

Platymantis cf. *sierramadrensis* Brown, Alcala, Ong, and Diesmos, 1999 (Fig. 12)

Five specimens (four males and one female) seemingly related to this recently-described species (W. Brown et al., 1999) were collected from leaves of shrub layer vegetation within 20 m of the banks of the Dipiningan branch of the Cobatangan River. This species called from the exposed upper surface of leaves and was only observed immediately following rain. Three of our specimens (PNM 5780, CMNH 5678–9) were included as paratypes in the description of W. Brown et al. (1999) and were incorrectly reported as having originated in "Sitio Mapidjas, Barangay Umiray, Municipality of Dingalan, Aurora Province" (W. Brown et al., 1999). In fact these specimens were collected 1.2 km S, 1.3 km E of Barangay Villa Aurora, Municipality of San Luis, Aurora Province, on the slopes of Mt. Ma-aling-aling, along the Dipiningan branch of the Cobatangan River drainage (15° 40.2' N, 121° 20.8' E). Furthermore, W. Brown et al. (1999) reported that the female for this species currently was unknown but one of our specimens that they did not include as a paratype (CMNH 5904) clearly is a female (SVL = 33.7 mm) with enlarged oviductal eggs. The specimen was collected at midday from a large tree fern where it was concealed in leaf detritus that had collected in the fern axils.

The advertisement call of the Aurora population referred to this species is distinct from that reported at the type locality (Mt. Cetaceo, northern Sierra Madres; W. Brown et al., 1999). At the type locality, *P. sierramadrensis* produces a series of brief, pure tonal notes, while the population referred to this species from Aurora Memorial National Park (and Polillo Island; pers. comm. with K. Hampson) produces a series of chirps, each with several subpulses per note. For this reason, we find it likely that future studies will necessitate further taxonomic partitioning within W. Brown et al.'s (1999) concept of *P. sierramadrensis* once additional specimens and quality call recordings become available from throughout its range (including Polillo Island).

Specimens: (Location 1a) CMNH 5678–9, PNM 5780, 5808 (Location 1b) CMNH 5904.

Rana (="*Chalcorana*") *luzonensis* Boulenger, 1896 (Fig. 13)

This species was collected within 0.1–0.5 m of running water on the banks of both the Dipiningan and Divinawan branches of the Cobatangan River. Numerous pairs in amplexus were observed and collected, vocalizations were recorded, and side pools in the river contained thousands of tadpoles and metamorphosing froglets. When pursued by collectors, frogs jumped into the water of the Cobatangan River.

Specimens: (Location 1a) CMNH 5605–30; PNM 5742–43, 5745–49, 5751–65; (Location 3) PNM 5744, 5750.

Rana (="*Chalcorana*") *tipanan* Brown, McGuire, and Diesmos, 2000 (Fig. 14)

The discovery of this new species (R. Brown et al., 2000) in a small, rapidly cascading tributary of the Dipiningan branch of the Cobatangan River was not wholly unexpected as it was observed but not collected in 1992 (by A. Diesmos) at Mt. Cetaceo in the northern Sierra Madre range. *Rana tipanan* was only collected along smaller tributaries of the Cobatangan River, never in the river itself, and specimens were collected from the tops of large boulders set back from the steeply sloping banks of these mountain creeks. (Fig. 3) When disturbed the new species jumped away from the water (as opposed to the escape tactic of *R. luzonensis* which invariably jumps in to the water); no breeding, amplexus or vocalizations were recorded.

Specimens: (Location 1a) CMNH 5581–88, 5590–5602; PNM 5719–36, 5738–41; (Location 3) CMNH 8011.

Rana woodworthi Taylor, 1923

This species is known from a variety of forested riparian habitats in southern Luzon (Taylor, 1920; Inger, 1954; Diesmos, 1998) and is usually found on midstream boulders and bank rocks.

Specimens: (Location 2) CMNH 5982–83; PNM 5878.

Rana (="*Fejervarya*") *vittigera* Wiegmann, 1834

This species was collected in flooded rice fields near Barangay Villa Aurora where it congregates in very large choruses (estimated in the hundreds of individuals).

Specimens: (Location 2) CMNH 5984–85; PNM 5879–80.

Limnonectes macrocephalus Inger, 1954

This large species of "fanged" frog was collected on the rocky banks (on gravel and small rocks as well as on large boulders above the water's surface) of the Dipiningan and Divinawan branches of the Cobatangan River. This species frequently is decimated as a food source by humans. However, populations within the protected confines of the Park included males among the largest (100 mm SVL) ever observed by us.

Specimens: (Location 1a) CMNH 5545–57; PNM 5694–704; (Location 2) PNM 5693.

Rana (="*Pulchrana*") *similis* Günther, 1872 (Fig. 15)

Males of this species were recorded in small choruses of 3–6 individuals congregated within 0.5 m of the banks of the Dipiningan and Divinawan branches of the Cobatangan River and several females were also collected as they approached aggregations of males. This species previously was considered a subspecies of the widespread *Rana signata* (Inger, 1954; 1966) until Dubois (1992) and Duellman (1993) listed it as a full species without comment. Recent biochemical data (R. Brown and Guttman unpublished data R. Brown, 1997) demonstrate unequivocally that *Rana similis* is a full, genetically distinct evolutionary species.

Specimens: (Location 1a) CMNH 5939–53; PNM 5842–56; (Location 2) CMNH 5954–55; PNM 5857–58.

Rhacophoridae

Polypedates leucomystax Gravenhorst, 1829 (Fig. 16)

We collected this common species along the edges of flooded rice plantations near Barangay Villa Aurora. Numerous foam nests were observed on overhanging vegetation and on muddy banks of rice fields.

Specimens: (Location 1a) CMNH 8004; (Location 2) CMNH 5996–98; 8005–21; PNM 5888–98.

Rhacophorus pardalis Günther, 1859 (Fig. 17)

This species was collected in groups of several calling males and a few females in vegetation suspended 2–3 m above water buffalo wallows near Barangay Villa Aurora. This species builds foam nests suspended above the water and larvae drop to the stagnant pools below following normal development (Inger, 1954; 1966; RMB pers. obs.). Tadpoles were collected in the pools below arboreal chorus locations. The colouration of the Luzon populations appears to be distinctive (see Alcala and W. Brown, 1988) suggesting that future studies should reconsider the taxonomic arrangements of Inger (1954, 1966) and the possibility that Philippine populations referred to *R. pardalis* may in fact represent Philippine endemics.

Specimens: (Location 1a) CMNH 5972–75; PNM 5871–5874.

Philautus surdus Peters, 1863 (Fig. 18)

Males of this species were collected while calling from lower branches of understory vegetation between 400 and 600 m on Mt. Ma-aling-aling. No females were observed or collected and no eggs were located. We note that this species produces highly unpalatable skin secretions, possibly as a predator defense mechanism.

Specimens: (Location 1a) CMNH 5905–10; PNM 5809–10, 5813; (Location 1b) PNM 5811; (Location 3) CMNH 5970-71; PNM 5868–70.

REPTILIA

TESTUDINES (turtles)

Bataguridae

Cuora amboinensis (Daudin, 1801)

Specimens of this species were collected in second growth forest bordering agricultural areas. This species is common in disturbed agricultural as well as forested areas and appears to be nocturnal.

Specimen: (Location 2) CMNH 5756; PNM 5784.

SQUAMATA (Lizards)

Agamidae

Draco spilopterus (Wiegmann, 1834)

This species was collected from coconut trees bordering agricultural areas; no specimens were detected in forested areas despite extensive searches. This habitat preference is well known for this species (McGuire and Alcala, 2000).

Specimens: (Location 1a) CMNH 5761; (Location 2) PNM 5786.

Gonyocephalus sp. (Fig. 19)

The single specimen was collected in a head-up position on the trunk of a dipterocarp tree at midday. The absence of a suitable taxonomy for Philippine populations of *Gonyocephalus* precludes the identification of this specimen to the species level.

Specimens: (Location 1b) CMNH 5764.

Gekkonidae

Cyrtodactylus philippinicus (Steindachner, 1867) (Fig. 20)

Our specimens were collected at night on fallen logs and tree branches suspended over tributaries of the Cobatangan River.

Specimens: (location 1a) CMNH 5795–96; PNM 5800.

Hemidactylus frenatus Duméril and Bibron, 1836

A single specimen was taken from a tree trunk at 1900 h. on the banks of the Cobatangan River. *Hemidactylus frenatus* usually is found on man-made structures such as houses; this species is common in non-forested areas of the Philippines while the "house gecko" usually encountered in the forest is *Gehyra mutilata* (RMB, pers. obs., not collected in this survey).

Specimens: (location 1a) CMNH 5794.

Scincidae

Brachymeles bicolor (Gray, 1845) (Fig. 21)

Until recently (Crombie and Ota, unpublished data), this species was known from only two specimens in the Natural History Museum, London accompanied by the locality data "The Philippines" (Brown and Alcala, 1980). This species is very distinctive and possesses an unusually elongate habitus, reflected in the possession of the longest axilla-groin distance of all know *Brachymeles* The colouration is also distinctive, with a stratified dark (above) and light (below) colour pattern (see the reproduction of Gray's plate in Taylor, 1922b and Brown and Alcala, 1980). While this species can not possibly be confused with any other Philippine scincid lizard, a full study of the range of its morphological variation has not yet been provided. When disturbed by collectors, *B. bicolor* moved in a rapid serpentine manner (no use of their legs was observed) and attempted to escape by "swimming" down into dry woody loam in and under rotting logs.

Specimens: (Location 1a) PNM 5785 (Location 1b); CMNH 5759; (Location 3) CMNH 5760.

Brachymeles bonitae Duméril and Bibron, 1839 (Fig. 22)

One of Brown and Alcala's (1980) "non-pentadactyl" species *B. bonitae* is well known from Luzon and its associated land-bridge islands. Our specimen was encountered under a dry coconut log where it attempted to escape by rapidly swimming into dry coconut loam.

Specimens: (Location 1a) CMNH 5793.

Dasia grisea (Gray, 1845) (Fig. 23)

This species appears confined to lowland forest on Luzon and its satellite islands as well as Mindoro Island. It occurs throughout the Sunda Shelf islands of the Philippines and Malaysia (Brown and Alcala, 1980). Our specimen was collected 2 m high on a tree trunk in well-regenerated secondary forest bordering first growth.

Specimens: (Location 1a) CMNH 5769.

Lamprolepis smaragdina philippinica Mertens, 1829

One specimen was taken on a sand bar in the Cobatangan River while the other was taken on a trunk of a small tree in regenerated forest.

Specimens: (Location 1a) CMNH 5763; PNM 5787.

Lipinia pulchella Gray, 1845

Using W. Brown and Alcala's (1980) key, this specimen conforms to their diagnosis of the Negros subspecies (*L. p. taylori*) by virtue of possession of 6 large supraoculars (vs 4–5 in the Luzon subspecies *L. p. pulchella*), 22 midbody scale rows (vs 24–26) and by presence of a vertebral stripe (absent in *L. p. levitoni* from Negros Island). Previously (R. Brown et al., 1996) noted similar difficulties with application of W. Brown and Alcala's (1980) key to Zambales Mountains specimens of *L. pulchella*, perhaps indicating that a revision of W. Brown and Alcala's treatment of the Luzon populations of this species is warranted.

Specimens: (location 2) CMNH 5779.

Mabuya cumingi Brown and Alcala, 1980

We found this species in patches of open sun at midday on a log at the forest edge. Many other specimens eluded capture by out running collectors on fallen logs or on the ground.

Specimens: (Location 2) CMNH 5765.

Mabuya multicarinata borealis Brown and Alcala, 1980 (Fig. 24)

This species is common on the ground, and on rocks and logs within the forest and at the forest's edge and is active in the morning and afternoon. When disturbed, specimens either ran away at high speed or took refuge under rocks and logs.

Specimens: (location 1a) CMNH 5766–67; PNM 5788–90; (Location 2) CMNH 5768.

Sphenomorphus abdictus aquilonius Brown and Alcala. 1980 (Fig. 25)

This species is common on the ground, and associated with fallen logs in patches of sunlight within the forest and is active in the morning and afternoon. When disturbed, specimens took refuge under logs or retreated into leaf litter.

Specimens: (location 4a) CMNH 5773–76, 5778; PNM 5792–95; (location 3) CMNH 5777; PNM 5996.

Sphenomorphus cumingi (Gray, 1845) (Fig. 26)

This large species is common in forest gaps and at the forest edge. We collected specimens on tree buttresses and fallen logs and most specimens attempted to climb trees when pursued by collectors, although some attempted to escape by running through leaf litter.

Specimens: (Location 1a) CMNH 5752–4; PNM5758; (location 3) CMNH 5755; PNM 5782–83.

Sphenomorphus decipiens (Boulenger, 1895)

This species was found in leaf litter and under fallen logs where it was active in the morning on the forest floor in patches of sunlight. We have never found this species in warmer forest edge or gap microhabitats.

Specimens: (Location 1a) 5788; PNM 5791 (Location 1b) CMNH 5770, 5789–91; (location 3) CMNH 5771.

Sphenomorphus leucospilos (Peters, 1872)

This extremely rare species previously was only known from two specimens in European collections; previous locality data only indicated that specimens were collected on Luzon Island (W. Brown and Alcala, 1980). Our unique specimen was found in mature second growth forest (bordering primary forest) and was active at midday on the surface of fallen leaves.

Specimens: (location 1a) CMNH 5792.

Sphenomorphus sp. (Brown and Alcala Group I)

A single specimen of an undescribed scincid species of *Sphenomorphus* was collected in leaf litter on the forest floor at 1050 m. This population is phenotypically most similar to *S. beyeri* (Taylor, 1922a; R. Brown et al., 1995a; 1995b) but midbody and paravertebral scale counts fall well outside the range of variation exhibited by other Group I *Sphenomorphus* (R. Brown et al., 1995a; 1995b; Brown et al., unpublished data) and all other Philippine *Sphenomorphus* (W. Brown and Alcala, 1980).

Specimens: (location 1a) CMNH 5772.

Sphenomorphus steerei Stejneger, 1908

We collected this species in leaf litter and from under fallen logs in primary forest and specimens were taken from patches of sunlight as well as shaded areas. When disturbed, *S.*

steerei attempted to escape by burrowing into forest floor detritus.

Specimens: (location 1a) PNM 5799; (Location 1b) CMNH 5789–90; PNM 5797–98.

Sphenomorphus tagapayo Brown, McGuire, Ferner, and Alcala, 1999 (Fig. 27)

The discovery of this new species (R. Brown et al., 1999b) brought the number of Philippine "Group II" *Sphenomorphus* species (W. Brown and Alcala, 1980) to six (excluding W. Brown and Alcala's *Sphenomorphus palawanensis* which was transferred to the genus *Parvoscincus* by Ferner et al., 1997). The type series of *Sphenomorphus tagapayo* was collected under small stones, leaf litter, and other forest debris between elevations of 720 and 1175 m above sea level in the transition zone between mixed dipterocarp and mossy upper montane forest. Most specimens were collected on level areas of stepped slopes; only one specimen was taken on an adjacent steeply sloping region of the forest. When attempting to escape, this species runs through leaf litter; the extremely small size of this species (23.1–32.1 mm SVL) renders them extremely difficult to see and capture.

Specimens: (location 1a) CMNH 5631–32; PNM 5766–68; (Location 4) CMNH 5633.

Varanidae

Varanus salvator marmoratus (Wiegmann, 1834)

This common lowland Luzon subspecies was observed in the disturbed and primary forest approximately 300 m from the Dipiningan branch of the Cobatangan River but no specimens were collected.

Specimens: (locations 1a, and 2): none.

SQUAMATA (Snakes)

Colubridae

Calamaria bitorques Peters, 1872 (Fig. 28)

This species was invariably collected under fallen and partially rotten logs on the forest floor.

Specimen: (location 1a) CMNH 5798–99; PNM 5801.

Calamaria gervaisi Duméril and Bibron, 1854

This species also was collected under fallen and partially rotten logs on the forest floor.

Specimen: (Location 1a) CMNH 5801.

Dendrelaphis pictus pictus (Gmelin 1789) (Fig. 29)

This specimen was collected on a small shrub layer sapling overhanging small stagnant pools in disturbed forest.

Specimen: (Location 1a) CMNH 5758.

Dendrelaphis caudolineatus luzonensis Leviton, 1961.

This specimen was collected on seedlings overhanging the bank of a the Cobatangan River at midday. When pursued, it retreated into root masses of shrubs on the bank of the Cobatangan River at the river's edge.

Specimen: (Location 1b) CMNH 5757.

Elaphe erythrura manillensis Jan, 1863

This specimen was first observed in primary forest on shrub layer vegetation at midday. When pursued, it jumped from its perch and attempted to escape through leaf litter.

Specimen: (Location 1a) CMNH 5751.

Oxyrhabdium leporinum leporinum (Günther, 1858) (Fig. 30)

One specimen was collected from the gravel shingle on the bank of the Cobatangan River at 2100 hr; the other was found in the morning, freshly killed, on a road traversing a well-regenerated secondary forest.

Specimens: (Location 1a) CMNH 5803; (Location 2) PNM 5802.

Psammodynastes pulverulentus (H. Boie, 1827) (Fig. 31)

This specimen was collected 10 m from the bank of the Cobatangan River in second growth forest. When captured it was attempting to prey on frogs (held in plastic bags) captured the night before.

Specimen: (Location 1a) CMNH 5762.

Pseudorabdion oxycephalum (Günther, 1858) (Fig. 32)

This specimen was collected from under a rotten log in primary forest.

Specimen: (Location 1a) CMNH 5802.

Rhabdophis spilogaster (H. Boie, 1827) (Fig. 33)

This specimen was captured on riverbank gravel where it was active at midday; when pursued, it attempted to escape into the water of the Cobatangan River.

Specimen: (Location 1a) CMNH 5800.

Typhlopidae

Typhlops lozonensis Taylor, 1919

This specimens was collected under a rotten log in primary forest and moved sluggishly when disturbed. Wynn and Leviton (1993) did not distinguish *T. lozonensis* from *T. ruber* Boettger 1897 (following McDowell, 1974) but McDiarmid et al. (1999) asserted that *T. lozonensis* should be recognized until evidence that it is conspecific with *T. ruber* is represented.

Specimen: (Location 3) CMNH 5797.

DISCUSSION

Our collections provide a preliminary view of the amphibian and reptilian fauna from the forested vicinities of Aurora Memorial National Park. The collection of specimens reported herein contains numerous records that are noteworthy for their biogeographical as well as taxonomic significance within the context of our present knowledge of the Luzon herpetofauna. First, several specimens represent records of species that presently are considered Sierra Madres endemics (e.g., *Platymantis pygmaeus, P. sierramadrensis, Rana tipanan, Sphenomorphus tagapayo*, and possibly *S. leucospilos, S.* sp., and *Brachymeles bicolor*). Other species are also known from other geological components of Luzon but we suspect will eventually be regarded as Sierra Madres endemics (currently unrecognized or undescribed) with further taxonomic work (e.g., specimens we refer to *Platymantis* cf. *mimulus* and *Platymantis* sp.). The remainders are species that have been reported from two or more of Luzon's geological components. Some are frequently-encountered species that we expected to find and others (e.g., *Brachymeles bonitae, Typhlops luzonensis*, *Lipinia pulchella*) are considered moderately common by knowledgeable herpetologists (pers. comm. with A. Diesmos, R. Crombie, and A. Alcala). The species that we did not record but suspect are present in and around Aurora Memorial National Park are too numerous to list and consist of species that fall into each of the categories listed above as well as common low elevation forms found in nearly every habitat throughout the Philippines (i.e., house geckos) and recently introduced species (i.e., *Rana erythraea*, *Hoplobatrachus rugulosus* and *Bufo marinus*). Not only do we expect numerous forest species to be discovered in Aurora Memorial National Park with future fieldwork, but we also assume numerous common, low elevation species will be discovered as well. We suspect that additional survey efforts will reveal numerous species that were missed by our survey and we point to low elevation disturbed sites and high elevation montane mossy forests as the two general habitats that particularly are in need of further sampling in Aurora Memorial National Park.

Our data are at present too limited to provide an analysis of abundance and species richness; nor can we provide an analysis of spatial, temporal or elevational variation in herpetofaunal communities in Aurora Memorial National Park. It is quite clear from the lack of an asymptote in all three species accumulation curves (frogs, snakes, lizards; Fig. 6) that we did not collect all of the amphibian and reptilian species at this site. Cumulative species totals steadily increased in all faunal groups sampled through the final days of our field work, indicating that we did not exhaustively sample populations within the park. It would be difficult to speculate regarding the true number of species present for each taxonomic group because it appears that the species accumulation curves may not have even been approaching the point of leveling off. The one assertion that we can make is that further intensive sampling efforts will be needed to determine the true number of amphibian and reptilian species within the confines of Aurora Memorial National Park. We urge future investigators to undertake these studies for their intrinsic value as contributions to Philippine herpetology and because such data are necessary for generating informed conservation and management strategies within protected areas of the Philippines. Nevertheless, we hope that the information provided here will provide baseline information for future studies and will encourage field workers to undertake similar surveys in Aurora Memorial National Park as well as numerous other overlooked yet easily accessible forested sites on Luzon Island. In particular, we hope that our data will contribute to the general effort among Philippine conservation biologists to catalog and document the diversity and endemism of the Sierra Madres before its forests are too drastically fragmented or felled completely.

Recently, national and international attention has been piqued by several popularized “faunal inventories”, “biodiversity surveys”, and “conservation initiatives” centering on the Sierra Madres of Luzon Island. While the value of these efforts (towards improving our knowledge of the respective taxa involved) can not be disputed, they have exclusively been oriented towards recording avian and mammal faunal diversity, despite claims to the contrary. Thus, it seems reasonable for us to draw attention to this potentially rich center of herpetological diversity and endemism and to stress the poor status of our knowledge of its amphibian and reptilian communities. We do so because we fear the herpetological diversity of the Sierra Madres will be neglected by disproportionate attention to other more accessible (easily identified and unobtrusively observed) and aesthetically pleasing (attractive to humans) taxa. One potentially disadvantageous outcome of the recent burgeoning attention to the birds and mammals of the Sierra Madres is that government, non-government, and the international conservation community may be lulled into the mistaken impression that the faunal diversity of the Sierra Madres is “reasonably well known”, that no further basic research is necessary, or that priorities elsewhere are more deserving of the provision of scarce research and conservation resources.

In fact, if appreciating and preserving the diversity and unique evolutionary history of the entirety of Philippine biodiversity is one genuine goal of conservation efforts, amphibians and reptiles may be more appropriate model (or “indicator”) taxa than volant mammals or birds because of their lower relative dispersal abilities and their apparent tendency towards finer scale differentiation on local centers of endemicity (i.e., single isolated mountain tops; W. Brown et al., 1997a; 1997b; 1997c; 1999, 2000; Alcala and Brown, 1998; Alcala, et al., 1998; R. Brown et al., 1995a, 1995b, 1996; 1999a, 2000; Diesmos, 1998; Diesmos, Brown and Alcala, unpubl. data). Unfortunately, with regards to the Sierra Madres ecosystem, the degree to which this pattern may be true will remain unknown until large scale herpetofaunal inventories are conducted by qualified herpetologists and results are compared to the well-developed avian and mammalian data sets. As previously mentioned, we are impressed by the numerous discoveries of new and rare species generated by this brief survey and we urge exhaustive herpetological survey efforts throughout the imperiled Sierra Madres of eastern Luzon.

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Laceration of prey integument by *Varanus prasinus* (Schlegel, 1839) and *V. beccarii* (Doria, 1874)

Varanid prey handling techniques have been discussed by numerous authors (e.g., Loop, 1973; Auffenberg, 1978, 1981, 1984, 1988, 1994; Greene, 1986; Phillips, 1992; Traeholt, 1993; Kaufman, et al. 1994; Hartdegen, et al. 1999), but our knowledge of this aspect of monitor biology remains rudimentary. According to Greene (1986) "two-week old mice were seized by the nape of the neck, slammed against the substrate, raked and eviscerated with the claws, and swallowed headfirst", by *Varanus prasinus*. Bennett (1995) remarked that some varanids (*V. gouldi* and New Guinea tree monitors) are known to eviscerate larger mammalian prey. Prey handling data collected from captive specimens of *V. prasinus* and *V. beccarii* revealed prey specific behavioural feeding responses. Laceration, not evisceration, of mammalian prey's integument by *V. prasinus* and *V. beccarii* is not based exclusively on prey size but also the presence or absence of fur.

Six specimens, three *Varanus beccarii* (one male and two females) and three *V. prasinus* (two males and one female) were used in this experiment. Five animals were wild-collected. The male *V. beccarii* was captive hatched at the Dallas Zoo. All specimens were long term captives 1.5–4.0 years in captivity). *Varanus beccarii* had a mean mass of 278.7 g (s.d. = 32.3 g), an SVL (snout vent length) of 280.0 mm (s.d. = 18.7 mm), and a TL (tail length) of 486.0 mm (s.d. = 53.7 mm). *Varanus prasinus* had a mean mass of 236.8 g (s.d. = 21.6 g), an SVL of 245.3 mm (s.d. = 31.5 mm), and a TL of 438.3 mm (s.d. = 34.8 mm). Each specimen was housed in a glass-fronted fiber glass terrarium measuring approximately 1.0 x 1.0 x 1.5 m inside the Dallas Zoo bird and reptile building. Information concerning environmental and housing conditions are described in detail in Hartdegen et al. (1999).

Repeated measures, consisting of four trials per condition per lizard, were conducted from 1 March to 1 May, 1996. Each lizard was randomly offered one of three different live prey types. Type 1 were non furred neonatal mice (*Mus musculus*, = 2.8 g, s.d. = 0.7 g). Type 2 were furred subadult mice (*M. musculus*, = 8.3 g, s.d. = 2.7 g). Type 3 were non furred neonatal rats (*Rattus norvegicus*, = 12.0 g, s.d. = 3.5 g). Prey items were grasped by the nape of the neck and presented to the lizards, using 56.0 cm stainless steel surgical forceps. Prey handling time (starting with the monitor's initial contact with prey, and ending when the prey was no longer visible in the monitor's mouth) and feeding observations were recorded for each episode. Although the observer was partially visible to the lizards, movement and disturbances were minimized. Due to the nervous nature of these varanids, when specimens held prey for longer than two consecutive minutes without any movement, data were not used in analysis.

Overall, 97% (n = 70) of the furred prey's integument were lacerated while 100% of non furred prey were ingested intact. The size of prey items did not affect this behavior as smaller neonatal mice were handled in the same manner as neonatal rats, which were approximately four times larger. Prey were seized at multiple points of the body. They were manipulated occasionally by being pushed and slammed against the substrate or the enclosure furniture. During several trials, prey was held in the mouth and positioned by the forelimbs, facilitating ingestion. All prey items were swallowed whole. Depending on the presence or absence of fur, the prey's integument was lacerated by the monitor's foreclaws. Although the sample size was relatively small (six lizards) the possible affect of sex was minimal as no differences were found among individuals' prey laceration behavior.

Prey handling times were as follows; 23.8 sec (s.d. = 7.0 sec) for neonatal *Mus musculus*, 270.9 sec (s.d. = 80.3 sec) for subadult *M. musculus*, and 165.8 sec (s.d. = 98.3 sec) for neonatal *R. norvegicus*. Repeated-measures ANOVA revealed that the three prey conditions exerted a significant effect on the latency data ($F = 33.23$, df = 2, 10, $P < 0.01$). Duncan's New Multiple Range Test applied to the three handling time means showed that 23.8 sec (neonatal *M. musculus*) was significantly less than 165.8 sec (neonatal *R. norvegicus*), which was significantly less than 270.9 sec (subadult *M. musculus*). The difference between 23.8 sec and 165.8 sec may represent the effect of increased mass on handling time of such prey items. The difference between 165.8 sec and 270.9 sec may reflect the extra handling time associated with the presence of fur.

According to optimality theory, predators in resource abundant habitats should be more selective in pursuit of prey which yield a greater caloric benefit (usually correlated with relative prey size). Costs associated with prey pursuit and handling have also been suggested as important in predator selectivity (e.g., Jaegar and Barnard, 1981; Pastorok, 1981; Formanowicz, 1986). The increased prey handling time associated with the presence of fur may affect prey selection of *V. prasinus* and *V. beccarii*.

The scarcity of vertebrate prey in the natural diet of *Varanus prasinus* and *Varanus beccarii* is evidence of the importance of prey handling costs. Greene (1986) examined gut content of 29 specimens including *V. prasinus*, *V. beccarii* and *V. bogerti*. A total of 47 prey items were identified, 46 of which were invertebrates. The presence of one partly digested rodent (40.0 g) indicates that rodents occupy a small portion of the natural diet of these species, while they are readily accepted by captive specimens.

Although the presence or absence of fur is a factor in the laceration of prey, ultimate factors are unclear. Laceration may provide a digestive advantage. As fur is relatively indigestible, opening of the prey's integument may facilitate penetration of digestive enzymes into the body cavity, thereby allowing for more efficient digestion. However, integumentary raking may be another degree of predatory response that is only elicited by encounters with certain prey, where the presence of fur triggers a more aggressive predatory response.

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Incubation of *Aspideretes gangeticus* eggs and long term sperm storage in females

Several species of turtles are housed in the Indian gharial (*Gavialis gangeticus*) enclosure at the Madras Crocodile Bank. These species include *Melanochelys trijuga*, *Lissemys punctata* and *Aspideretes gangeticus* among others. The pond, a natural aquifer with a sand substrate, measures 45.3 x 10.6 m at the longest and widest points, and varies seasonally from 150-220 cm maximum depth. Vegetation of the enclosure consists of *Pandanus* spp. and various large shade trees. The substratum of the land area consists of sand and leaf litter.

An *Aspideretes gangeticus* female was observed covering a nest on 16 January 1999. The nest was under a *Pandanus* spp bush on a steep slope which faced north , and was 230 cm from the main water body. It has been observed in the natural habitat of *A. gangeticus*, in the Chambal River, that when comparing distribution of nests and vegetation, it was apparent that nesting follows the distribution of *Prosopis juliflora*, which forms the dominant vegetation on the banks of the 5.4 km stretch of riverine habitat surveyed (Vasudevan, 1994). Nests found were often under this vegetation. In another report of *A. gangeticus* nesting in captivity, Vyas and Patel (1992) report that eggs were laid in an area with vegetation. This is consistent with the sites chosen by the two *A. gangeticus* females to nest at Madras Crocodile Bank, where most nests are found under *Pandanus* spp bushes.

The female which laid the clutch of eggs on 16th January 1999 had been measured on 29 October 1998. Straight carapace length (SCL) was 45.1 cm, straight carapace width (SCW) 35.2 cm and weight (Wt) 14.5 kg. The clutch of eggs was collected on the second day of incubation and were measured and observations on chalking of the eggs was taken note of. The total clutch size was 15 eggs. Average length of the eggs was 33.28 (range 31.9-34.5 mm), average width 32.22 (range 30.4-34.0 mm) and average weight 20.78 (range 18.3-22.3 g). The mean of these dimensions are larger than those quoted by Vyas and Patel (1992) where they gave morphometric

TABLE 1: Morphometric measurements of three *Aspideretes gangeticus* hatchlings from T1 measured on 13 July 1999

Code	Carapace length (mm)	Carapace width (mm)	Plastron length (mm)	Plastron width (mm)	Weight (g)	Carapace ocelli
1	38.75	36.25	32.5	25.5	9.8	5
2	43.6	37.0	34.2	30.05	14.0	4
3	43.2	36.9	34.5	33.0	13.7	4
Mean	41.85	36.71	33.73	29.51	12.5	-

monitor, *Varanus bengalensis* (Sauria: Varanidae). *Herpetologica* 30(2): 123-127.

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Incubation of *Aspideretes gangeticus* eggs and long term sperm storage in females

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2	43.6	37.0	34.2	30.05	14.0	4
3	43.2	36.9	34.5	33.0	13.7	4
Mean	41.85	36.71	33.73	29.51	12.5	-

measurements for two clutches of *A. gangeticus* eggs of 13 and 22 eggs. The mean egg length of both clutches quoted by them was 32.1 mm, mean width of both clutches 31.8 mm, and mean weight 11.65 g. Therefore, the eggs of the single clutch of *A. gangeticus* in 1999 from the Madras Crocodile Bank were 1.18 mm longer , 0.42 mm wider, and 9.13 g heavier than the combined mean of the two clutches reported by Vyas and Patel (1992). On 18 January 1999 (day 2 of incubation), seven of 15 eggs from the clutch laid at Madras Crocodile Bank were aerially chalked (i.e., chalking initially occurs as a small opaque patch on the uppermost surface of the egg, and spreads downwards until the entire egg is opaque). Unlike the oval hard shell batagurid eggs in which the band originates in the middle of the egg as a small opaque spot and increases to either end of the pole of the egg. The remaining eight eggs were candled for presence or absence of subembryonic (SE) fluid (Andrews and Whitaker, 1993). Six of the eight eggs candled contained SE fluid in the upper circumference of the egg, and two eggs contained neither SE fluid nor were they chalked. All chalked eggs were segregated from unchalked eggs and underwent different incubation treatments. Chalked eggs (n = 7) were placed in a shallow plastic tray, "T1", and half of each egg was immersed in vermiculite. The incubation trays were covered with a thin film of plastic with holes punched irregularly. Moisture content of the medium was such that upon squeezing it would form into a compact ball, but no drops of water would be released. Eggs containing SE fluid or no SE fluid (n = 8) were incubated in a separate tray, "T2", using the same incubation substrate. T1 was maintained at room temperature which ranged from 29–30º C from days 2-14 of incubation. From days 14-37, a period of 23 days, T1 was maintained in the lower shelf of a refrigerator where temperature ranged from 13-15º C. T1 was removed from the fridge on day 37 and transferred to an air-conditioned room maintained at 24-25º C. On 24 March the eggs were candled and four eggs from T1 were discarded as both the calcareous outer layer of the shell and the shell membrane had ruptured. Of the four remaining eggs, three hatched on 12 July 1999, a 174 day incubation period. Das (1991) quoted an incubation period for four eggs which hatched between 217-287 days, whereas the successful batch of eggs from the January 1999 clutch of eggs had all three live hatchlings hatching at the same time. Vyas and Patel (1992) quoted an incubation period of 260 days for a clutch of 22 eggs. No other information on incubation period for this species is reported. The single remaining egg in this set did not hatch and revealed a full term dead embryo when dissected. Morphometric measurements of the three live hatchlings along with observations on the number of spots on the carapace are given in Table 1.

The seven *Aspideretes gangeticus* hatched at the Sayaji Baug Zoo (reported by Vyas and Patel, 1992) from the larger clutch of 22 eggs averaged 44.4 mm SCL, 38.0 mm SCW, and averaged 10.4 g in Wt. Despite being larger and heavier eggs from the clutch laid at the Madras Crocodile Bank, the hatchling size is smaller than those of the seven hatchlings hatched at the Sayaji Baug Zoo. The three successfully hatched juveniles from the Madras Crocodile Bank were 2.55 mm smaller in SCL, and 1.29 mm smaller in SCW. However, the three Madras Crocodile Bank *A. gangeticus* hatchlings average weight was 12.5 g, or 1.8 g heavier than mean weight of the seven hatchlings from Sayaji Baug Zoo. One possible reason for this is that the *A. gangeticus* from Madras Crocodile Bank hatched prematurely, although all three hatchlings had yolk sacs completely drawn into the body cavity. All seven eggs from T2 which was maintained at a temperature of 29-30º C failed to hatch.

Not all *Aspideretes gangeticus* nests laid at the Crocodile Bank were collected. Hatchlings have not been found in the natural enclosures where the two *A. gangeticus* females are held'. One possibility is that the diapause period is necessary for the eggs to develop further , and the warm Chennai temperatures do not provide that opportunity. There is scope for study on the diapause period, its effects on pre-natal development, and how much successful hatching depends on the diapause period in *A. gangeticus*. Ahsan and Saeed (1992) discovered that

Aspideretes nigricans, had no developmental arrest taking place.

Neither of the two *Aspideretes gangeticus* females have been in the same enclosure for any period of time with a male of the same or closely related species from 1986 to April 1999. However, fertile clutches of eggs were acquired in November 1986, December 1986, September 1987, June 1988, August 1988, September 1988, August 1989, September 1990, January 1991, April 1991, May 1991, August 1991, October 1991, December 1993, September 1994, October 1994, November 1994, and January 1999. Clutches containing fertile eggs were laid from November 1986-January 1999. Therefore we can conclude that *A. gangeticus* females possess the capability to store viable sperm for up to 13 years. Seminal receptacles are present in the infundibular region of *A. gangeticus* females, and all specimens examined by

Rao (1988) contained varying amounts of sperm in the receptacles (Das, 1991). From observations of past records maintained by the Uttar Pradesh Forest Department, Vasudevan (1995) found that nesting in the Chambal region for *A. gangeticus spans* from mid-July to early November with a peak in late October. This is at variance with the aforementioned observations at the Madras Crocodile Bank where nesting has occurred in all months except Febuary, March, and July.

I am grateful to Harry V. Andrews, Indraneil Das and Romulus Whitaker for commenting on earlier drafts of this note. I acknowledge Harry V. Andrews, V. Karthikeyan, Farida Tampal, and Chandini Abraham for maintaining records of freshwater turtle nesting for the respective years they spent here.

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Notes on the breeding habits of *Chirixalus dudhwaensis* Ray 1992, from Uttar Pradesh, northern India

Chirixalus is a genus constituting small to medium-sized (30-40 mm SVL), Old World tree frogs (family: Rhacophoridae), distributed widely from Japan in the east to India in the west (Frost, 1999; Liem, 1970). Ten nominal species are recognised, of which four occur in India: *C. doriae* (Arunachal Pradesh), *C. dudhwaensis* (Uttar Pradesh), *C. simus* (Assam and West Bengal) and *C. vittatus* (Nagaland and Mizoram) (Dutta, 1997). *C. dudhwaensis* was described from the Dudhwa Tiger Reserve in Uttar Pradesh by Ray (1992) and is known from the type locality (Dutta, 1997). The species was found in the outskirts of Dehradun city, which is ca. 320 km north-west of the type locality. Here, I summarize observations made mostly opportunistically on the breeding habits of *C. dudhwaensis* from areas in and around the campus of Wildlife Institute of India, Chandrabani, near Dehradun between 1997-99.

Aspideretes nigricans, had no developmental arrest taking place.

Neither of the two *Aspideretes gangeticus* females have been in the same enclosure for any period of time with a male of the same or closely related species from 1986 to April 1999. However, fertile clutches of eggs were acquired in November 1986, December 1986, September 1987, June 1988, August 1988, September 1988, August 1989, September 1990, January 1991, April 1991, May 1991, August 1991, October 1991, December 1993, September 1994, October 1994, November 1994, and January 1999. Clutches containing fertile eggs were laid from November 1986-January 1999. Therefore we can conclude that *A. gangeticus* females possess the capability to store viable sperm for up to 13 years. Seminal receptacles are present in the infundibular region of *A. gangeticus* females, and all specimens examined by

Rao (1988) contained varying amounts of sperm in the receptacles (Das, 1991). From observations of past records maintained by the Uttar Pradesh Forest Department, Vasudevan (1995) found that nesting in the Chambal region for *A. gangeticus spans* from mid-July to early November with a peak in late October. This is at variance with the aforementioned observations at the Madras Crocodile Bank where nesting has occurred in all months except Febuary, March, and July.

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The campus is situated in the Doon Valley at an altitude of 650 msl and receives an annual precipitation of 2,150 mm (Pangtey and Joshi, 1987). Annual temperature varies from 0^{o} C in winter to 40^{o} C in summer but fluctuates within a narrow range of 23-33^{o} C during the monsoon, which commences around mid-June and continues till the end of August. The campus vegetation is dominated by regenerating young sal (*Shorea robusta*) trees associated with *Lantana camara, Woodfordia fruiticosa* and *Xylosma longifolia* shrubs. Agricultural fields surrounds the campus, while a contiguous patch of sal forest is located on the south-western part of the campus.

Chirixalus dudhwaensis, the only tree frog in the campus, occurs sympatrically with eight other species of amphibians: *Hoplobatrachus tigerinus*, *Euphlyctis cyanophlyctis, Fejervarya "limnocharis"*, *Sphaerotheca* sp*., Tomopterna* sp, *Microhyla ornata*, *Uperodon systoma*, *Bufo melanostictus* and *B. stomaticus*. *C. dudhwaensis* start breeding activity at the onset of the monsoon when they call from shrubs, the intensity increasing as the monsoon peaks. These frogs are explosive breeders (sensu Wells, 1977), reproducing only around temporary water bodies where they make foam nests on overhanging vegetation. The availability of these sites restricts their breeding to a period of 4-6 weeks, synchronized with the peak monsoon in the area. The species used the same breeding sites for all the three years but stopped using one of them when it became unsuitable for breeding. *C. dudhwaensis* used areas around a reservoir and a stream for calling but not for making foam nests. At nights during the monsoon, many males and females aggregate to form breeding groups around the temporary pools. Up to 35 individuals (males and females) were located around one of these sites. Males start calling soon after dusk and continue calling till 0300-0400h in the morning. They sit on branches or leaves of shrubs at heights between 0.6-2 m above the surface of water. Between calling bouts, males move around from one branch to another, probably in search of females or for better calling sites. According to Wells (1977), the males of species which breeds for a short period often shifts between two strategies, calling from stationary location and actively searching for females, depending on the density of the males. Properties of calling sites could also be an important influence affecting mating success of males, as also seen in some hylid frogs (Mitchell, 1991).

Interaction between males was in the form of male-male mounting in which case the mounted male emitted a release call, following which the mounting male moved away. The male and the female associates to form amplexus, which is axillary (Duellman and Trueb, 1986). During this event, one to six males associate with a gravid female, which suggests high male-male competition and a male-biased sex ratio. Once the amplexus is formed, the pair finds moves to habitats such as an overhanging leaf over the water (at heights varying from 0.6-1.83 m) and the female starts depositing eggs. The average time spent by a pair to choose a suitable site after amplexus could not be observed. The female starts building the foam nest either with a single male or multiple males. In the latter case, the other males position themselves on the sides of the pair and occasionally anterior to the pair or even on the other side of the leaf. The eggs are laid in a foam nest located on the ventral side of leaves, or sometimes on stems in case of soft-bodied plants like *Ipomoea cornea*. On one occasion, two nests were found on either side of the same leaf. Females use two kinds of leg movements to build a foam nest. The first is a kicking motion, which involve moving both legs, starting below the vent and flexing it in an outward direction up to the anterior part of the nest. The second is a whipping action along the nearest outer margin of the nest and moving along the surface of the nest up to its bottom. Males showed only the first type of leg motion which probably help in the transport of sperm into the foam. Morgan-Davies (1958) observed similar leg movements in *Polypedates cruciger* males, were individuals were thought not to keep their feet away from the expanded foam of the nest. Females use both kinds of leg movement and more frequently than the males. The other males positioned nearby move their hind limbs like the principal male, but what role they play in the process of fertilization and nest making remains unknown. During a multi-male amplexus the males were found calling many times, which was uncoordinated and not while beating the nest. Towards the end of nest making, the males start leaving the pair with the peripheral males starting first followed by the closely seated ones. The principal male is the last male to leave, followed by the female. The whole event of nest making takes at least an hour.

Two foam nests measured 67–55–17 mm and 30–27–13 mm in length, breadth and depth respectively. Whether the size of the nest influences the clutch size is not known, but two nests contained almost same number of eggs though one was about one-fifth the volume of the other. Three clutches had 201, 205 and 231 small yellow eggs, each encased in a transparent thin envelope and the whole clutch deposited at one side of the nest. The clutch size along with the examination of gravid females before and after egg laying suggested that a female lays a single clutch of eggs per season. Moreover, the breeding season is for a period of 3-4 weeks during which it is unlikely that a female would develop another batch of eggs. The eggs drop after hatching into the water below within 48 h of nest construction, which is triggered by the action of rain in the next few days. Tadpoles develop in temporary pools varying in depth between 15-60 cm. Information on the larval development could not be collected.

The breeding habits of *Chirixalus dudhwaensis* is similar to the widespread breeding mode seen in many other rhacophorids in terms of its breeding period, male calling sites, place of ovipositing, clutch size, habitat where tadpoles develop like that of *Chiromantis*, *Rhacophorus* and *Polypedates* (Coe, 1974; Duellman and Trueb, 1986; Morgan-Davies, 1958). Multiple males amplexing with a female is reported also from *Polypedates dennysi* and *Chiromantis rufescens* (Coe, 1974; Duellman and Trueb, 1986). Within in the genus *Chirixalus,* four distinct modes of ovipostion are known (Duellman and Trueb, 1986; Frost, 1999; Kuramoto and Wang, 1987; Liem, 1970). *C. vittatus,*and *C.simus* make foam nests on tall grasses in swampy areas or vegetation over temporary pools of water (Liem, 1970; pers. observ.). *C. nongkhorensis* is known to make foam nests on the surface of the pond water (Duellman and Trueb, 1986). In the case of *C. idiootocus* and *C. eiffingeri,* the breeding habits are fundamentally different compared to their congenerics (Kuramoto and Wang, 1987). While the former lays eggs on the soft mud beside ponds where the tadpoles move into the pond with rain water, the latter uses inner walls of bamboo stumps or tree holes for egg-laying and the accumulated water in those for the development of larvae (Kuramoto and Wang, 1987). Moreover, these last two species are probably erroneously placed under the genus *Chirixalus,* as noted by Kuramoto and Wang (1987). Detailed information is not available for remaining five species of *Chirixalus*.

Much more remains to be learnt about the reproductive ecology of these and other rhacophorids living in the tropics, and there is little doubt that the diversity of reproductive modes is a major factor in the evolution of this group as a whole.

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Comments on 'A synopsis of the reptiles of Gujarat, India'

Recently, a synopsis on the reptiles of Gujarat State, western India, was published by Gayen (1999), which record a total of 66 species belonging to 50 genera and 18 families. Three squamate species- *Hemidactylus triedrus, Lygosoma lineata* and *L. albopunctata* were purported to be first records for the state. The synopsis was said to be the result of the study of a large numbers of specimens of collected between 1989-93 by the author, along with older collections deposited at the National Zoological Collection, Zoological Survey of India, Calcutta and a survey of the literature. The synopsis is useful, but has several major weakness which have been dealt with here. For instance, the author had examined materials for 28 species of reptiles; the remaining 38 species were derived from the literature, although no further details, nor sources were provided.

The claim of three new state records is not correct, as all have been earlier recorded. *Hemidactylus triedrus* was reported by Vyas (1998a) and Bhatt et al. (1999) from Victoria Park, Bhavnagar; Gir Forest, Junagadh and Hingolgadh, Rajkot. *Lygosoma lineata* was recorded from Kevadia, Bharuch District, by Naik and Vinod (1994), and *L. albopunctata* was reported earlier from Ahmedabad District by Acharya (1949).

Diagnostic keys to families, genera and species are useful for identification. However, in the work being reviewed, the key to species of the genus *Hemidactylus* does not match the given description of species. In addition, some simple character states are not used: two species- *Oligodon taeniolatus* and *O. arnensis*- can be more easily identified on the basis of midbody scale rows (15 vs 17), rather than hemipeneal and maxillary teeth count differences. This also applies to the key to the genera in Elapidae, with the genera *Naja* and *Bungarus* being easily identified on the basis of external characters, such as shape of body scales, rather than cranial differences.

Distributional remarks on some species are sometimes confusing. For *Melanochelys trijuga*, Gayen (1999) writes "This subspecies is distributed in Gujarat, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh", but do not mention the subspecies. According to Das (1991), seven subspecies have been described, five of which occur in the Indian subcontinent. In Gujarat, only *trijuga* has been recorded from the Dangs District. *Chamaeleo zeylanicus* is reported only from the dryer part of Kachchh. Present literature record shows the *C. zeylanicus* is distributed over the entire state of Gujarat (Acharya, 1949; Daniel and Shull, 1963; Sharma, 1982 and Vyas, 1998b). The statements that there are no specific records of *Python molurus* "….but likely to occur in the state" and *Eryx conicus,* which is "Likely to occur in Gujarat, from where there are at present no confirmed records" are inaccurate: Sharma (1982) and Jasdan (1953) have recorded

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TABLE 1: Systematic list of the reptiles reported from Gujarat state. Taxa marked with asterisks are in need of verification.

Sl. No.	Taxon	Reference
	CROCODYLIDAE	
1	*Crocodylus palustris*	—
	DERMOCHELYIDAE	
2	*Dermochelys coriacea*	Bhaskar, 1978
	CHELONIIDAE	
3	*Caretta caretta**	McCann, 1938
4	*Chelonia mydas*	Bhaskar, 1978
5	*Eretmochelys imbricata**	Das, 1985
6	*Lepidochelys olivacea*	Bhaskar, 1978
	BATAGURIDAE	
7	*Kachuga tecta*	Moll & Vijaya, 1986
8	*Kachuga tentoria circumdata*	Bhatt, 1989
9	*Melanochelys t. trijuga*	Daniel & Shull, 1963
	TESTUDINIDAE	
10	*Geochelone elegans*	Murray, 1886
	TRINYCHIDAE	
11	*Aspideretes gangeticus*	Kapadia, 1951
12	*Aspideretes leithii**	Acharya, 1949
13	*Lissemys p. punctata*	—
	EUBLEPHARIDAE	
14	*Eublepharis fuscus*	Daniel, 1983
	GEKKONIDAE	
15	*Cyrtopodion k. kachhensis*	Stoliczka, 1872
16	*Geckoella collegalensis*	Vyas, 1998a
17	*Hemidactylus brookii*	Gleadow, 1887
18	*Hemidactylus flaviviridis*	Murray, 1886
19	*Hemidactylus gracilis*	Gleadow, 1887
20	*Hemidactylus leschenaultii*	Murray, 1886
21	*Hemidactylus m. maculatus*	Acharya, 1949
22	*Hemidactylus porbandarensis*	Sharma, 1981
23	*Hemidactylus t. triedrus*	Vyas, 1998b
	AGAMIDAE	
24	*Brachysaura minor*	Stoliczka, 1872
25	*Calotes v. versicolor*	—
26	*Calotes rouxii*	Daniel & Shull, 1963
27	*Psammophilus blanfordanus*	Vyas, 2000
28	*Sitana ponticeriana*	—
29	*Trapelus agilis**	Murray, 1886
30	*Uromastyx hardwickii*	Günther, 1864
	CHAMAELEONIDAE	
31	*Chamaeleo zeylanicus*	Stoliczka, 1872
	SCINCIDAE	
32	*Ablepharus grayanus*	Stoliczka, 1872
33	*Eumeces s. schneiderii*	Stoliczka, 1872
34	*Eumeces t. taeniolatus*	Stoliczka, 1872
35	*Lygosoma albopunctata*	Acharya, 1949
36	*Lygosoma guentheri*	Acharya, 1949
37	*Lygosoma lineata*	Naik & Vinod, 1994
38	*Lygosoma punctatus*	—
39	*Mabuya carinata carinata*	Stoliczka, 1872
40	*Mabuya dissimilis*	Vyas & Patel, 1992
41	*Mabuya macularia*	Boulenger, 1890
42	*Ophiomorus tridactylus*	Stoliczka, 1872
	LACERTIDAE	
43	*Acanthodactylus cantoris*	Stoliczka, 1872
44	*Ophisops jerdoni*	Stoliczka, 1872
45	*Ophisops microlepis*	Stoliczka, 1872
	VARANIDAE	
46	*Varanus bengalensis*	Stoliczka, 1872
47	*Varanus griseus konicznyi*	Boulenger, 1890
	TYPHLOPIDAE	
48	*Ramphotyphlops braminus*	Murray, 1886
49	*Rhinotyphlops acutus*	Smith, 1943
50	*Typhlops porrectus*	Kapadia, 1951
	UROPELTIDAE	
51	*Uropeltis elliotii*	Vyas, 1988a
52	*Uropeltis m. macrolepis*	Vyas & Jala, 1988
53	*Uropeltis ocellatus**	Naik et. al., 1993
	BOIDAE	
54	*Eryx conicus conicus*	—
55	*Eryx johnii johnii*	—
56	*Python molurus molurus*	Jasdan, 1953
	ACROCHORDIDAE	
57	*Acrochordus granulatus*	Murray, 1886
	COLUBRIDAE	
58	*Ahaetulla nasutus*	Kapadia, 1951
59	*Ahaetulla pulverulenta*	Vyas, 1988a
60	*Amphiesma stolatum*	Murray, 1886
61	*Argyrogena fasciolatus*	Acharya, 1949
62	*Boiga forsteni*	Daniel, 1962
63	*Boiga trigonatus*	Stoliczka, 1872
64	*Cerberus rynchops*	Vyas, 1996
65	*Chrysopelea ornata*	Vyas, 1990
66	*Coluber ventromaculatus*	Boulenger, 1890
67	*Dendrelaphis pictus**	Kapadia, 1951
68	*Dendrelaphis tristis*	Daniel & Shull, 1963
69	*Elaphe helena helena*	Murray, 1886
70	*Gerarda prevostiana*	Wall, 1921
71	*Lycodon aulicus*	Murray, 1886

72	*Lycodon flavomaculatus*	Vyas, 1987
73	*Lycodon striatus striatus*	McCann, 1938
74	*Macropisthodon plumbicolor*	Wall, 1921
75	*Oligodon arnensis*	Acharya, 1949
76	*Oligodon taeniolatus*	Sharma, 1982
77	*Oligodon venustum**	Patel & Reddy, 1995
78	*Psammophis c. condanarus**	Murray, 1886
79	*Psammophis leithii*	Stoliczka, 1872
80	*Psammophis longifrons*	Gleadow, 1894
81	*Psammophis schokari**	Stoliczka, 1872
82	*Ptyas mucosus*	Wall, 1921
83	*Sibynophis sagittaria*	Daniel & Shull, 1963
84	*Spalerosophis d. diadema*	Murray, 1886
85	*Xenochrophis piscator*	Acharya, 1949
	ELAPIDAE	
86	*Bungarus caeruleus*	
87	*Bungarus s. sindanus*	Boulenger, 1890
88	*Calliophis m. melanurus*	Vyas, 1993
89	*Maticora nigrescens*	Vyas, 1988b
90	*Naja naja*	Günther, 1864
91	*Naja oxiana**	Akhatar & Tiwari, 1991
92	*Ophiophagus hannah**	Wall, 1924
	HYDROPHIDAE	
93	*Enhydrina schistosus*	Murray, 1886
94	*Hydrophis caerulescens*	Smith, 1926
95	*Hydrophis cantoris*	Smith, 1926
96	*Hydrophis cyanocinctus*	Murray, 1886
97	*Hydrophis lapemoides*	Gayen, 1999
98	*Hydrophis gracilis*	Murray, 1886
99	*Hydrophis mamillaris*	Smith, 1926
100	*Hydrophis spiralis*	Murray, 1886
101	*Lapemis curtus*	Stoliczka, 1872
102	*Pelamis platurus*	Murray, 1886
	VIPERIDAE	
103	*Daboia russelii russelii*	Wall, 1921
104	*Echis carinata*	Stoliczka, 1872
105	*Trimeresurus gramineus*	Acharya, 1949

both species from here. The distribution of *Amphiesma stolatum* is given as 'The whole of India. It may occur in the Andaman Islands and Gujarat'. Mugger crocodile is the only species, which is well documented and records are from all parts of Gujarat but only the reference of Vyas (1994) is mentioned in the work.

The record of the rare sea snake *Hydrophis lapemoides* from Gujarat is the only first from the State but the author did not provide a locality. Also, the author has quoted some of the references in text (e.g., Daniel and Shull, 1963; Sharma, 1982) that are not listed in the references section, and providing some of citation references, which are not mentioned in the text (e.g., Annandale, 1912; Biswas and Sanyal, 1977; Daniel, 1983; Das, 1991; Frazier and Das, 1994; Gleadow, 1887; Himmatsinghji, 1985; Kapadia, 1950; McCann, 1938; Murthy, 1986 and Tikader and Sharma, 1985, 1992).

A large amount of literature exists on the reptile fauna of Gujarat State, showing that at least 105 species, including one species of crocodile, 12 species of turtles and tortoise, 34 species of lizards and 58 species of snakes occur in the state. These are listed in Table 1.

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A new record of a spiny hill turtle, *Heosemys spinosa* in a kerangas forest, Brunei Darussalam

About 0.6% (3,455 hectares) of the land surface of Brunei is covered by kerangas or heath forest (Anderson and Marsden, 1984). These forests occur on nutrient poor acidic (pH 4) sandy soils with coarse texture and low water holding capacity. The sandy soils are covered with leaf litter over a thin layer of peat or humus (Whitmore, 1984). The leaf litter has a high concentration of phenol which when leached is toxic and can inhibit uptake of nutrients by plants (Whitmore, 1998) Plants therefore have special structural adaptations to survive in this poor habitat. Some of the common plants are ant-plants, pitcher plants *Nepenthes* spp. trees like tulong conifer *Agathis borneensis*, and the fir-like *Gymnostoma nobile*. This forest is highly susceptible to fires because of the thick litter layers and humus in the soil and probably the high resin content in the roots (Janzen, 1974)and when burnt does not regenerate easily. Extensive fires have mostly occurred in the kerangas and peat swamp forests of Brunei recently- in 1992 (Becker and Wong, 1992; Becker and Hj Ruslan, 1994) and from September 1997 to May 1998 (Padolina, 1999).

During a two-week period of small mammal trapping with cage traps in February 2000 in a kerangas (heath) forest at the 13th kilometre, Labi Road, Belait District, Brunei Darussalam, a female *Heosemys spinosa* was trapped on three different nights in the same trap that was baited with banana. Most of the leaves in the leaf litter on the forest floor were about the size of the turtle's carapace- this made the turtle highly cryptic with the background. About 25 m from the cage trap, the ground on one side sloped gradually to a wet area that was part of a swamp forest while the rest was kerangas. The kerangas forest in this region gives way to pockets of swamp whenever there are depressions. It is possible that this turtle has ranged over both kerangas and swamp in search of food. It was also interesting to note that it returned to the same cage trap on three different occasions attracted by the banana bait. In captivity it is reported to accept animal matter (Lim and Das, 1999).

There was a patch of an unpigmented area on the tip of the nose- there was also a spot of blood on the nose where the animal had rubbed itself against the cage. The unpigmented area on the nose was not a scar tissue and appeared to be lack of dermal pigmentation. It was hard to conclude if it was caused by burning during the widespread fires of 1997 in the kerangas and peat swamp forests. That burning did affect the turtle is evident in the presence of scar tissues on the left pectoral and anal and right femoral. This turtle was probably burned in the smouldering fires that usually persist within the leaf litter and peat even after the fires are put out. Carapace length was 215.9mm (8 1/2 inches). It was an adult female, with a relatively short tail and a flat plastron. The carapace was brownish-orange while the plastron was yellowish in colour. There was a yellowish-red stripe on either side of the neck. Before the animal was released, the dorsal left marginals were marked with permanent black dye and the spine of the left eleventh marginal was clipped.

A herpetological survey carried out in Brunei (Das, 1995) recorded this turtle in a lowland dipterocarp forest at Batu Apoi, Belalong. Lim and Das (1999) state that this species is found in both lowland and hill forests but make no mention of its occurrence in kerangas forests. This is therefore the first record of the species from kerangas forest.

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The Assam roofed turtle *Kachuga sylhetensis* in Kaziranga National Park - a new locality record

Kaziranga National Park (KNP), the home of Indian greater one-horned rhinoceros (*Rhinoceros unicornis*), is situated on the southern bank of river Brahmaputra (93° 50' - 94° 40' E; 26° 30' - 26° 45' N). KNP is the only grassland in the Terai region that contains the entire guild of extant large herbivores known from tall grasslands- the Asian elephant (*Elephas maximus*), greater one-horned rhinoceros, swamp deer (*Cervus duvaucelli*) and wild buffalo (*Bubalus bubalis*). Turtle species recorded from KNP by Das (1995) include the Indian peacock softshell turtle (*Aspideretes hurum*), the Malayan box turtle

(*Cuora amboinensis*), the spotted pond turtle (*Geoclemys hamiltonii*), the brown roofed turtle (*Kachuga smithii*), the Indian roofed turtle (*K. tecta*), the Indian tent turtle (*K. tentoria*) and the tricarinate hill turtle (*Melanochelys tricarinate*). The use of fire as a management tool appears to benefit herbivores in the protected areas (Laurie, 1978). However, little is known about effects of fire on the herpetofauna of tall grasslands locally.

On 18 March 2000, while looking for tiger pugmarks near Jalki beel while on a tiger census in the Jalki area under Kahora Range of KNP, we came across a freshly burnt turtle in a burnt patch of *Erianthus ravanie* ('Ikora' in Assamese). The burnt specimen was collected. It was an adult female, measuring (in mm): straight carapace length 166.45; curved carapace length 195.0; straight carapace width 127.0; curved carapace width 184.0; shell height 91.0. The plastron length was 180.0 mm and plastral scute measurements (midline) were as follows: gular 20, humeral 26.5; pectoral 27; abdominal 32.5; femoral 33.5 and anal 25.5. It is characterised by an elevated carapace with the third vertebral resembling a projecting spike; marginals number 13 pairs, and are distinctly serrated posteriorly; carapace is olive brown with a pale brown vertebral keel, plastron with large black blotches. From these characteristics, it was identified as *Kachuga sylhetensis* (Jerdon 1870). The largest specimen of this species recorded was also a female of 197.0 mm carapace length (Moll, 1987). When the present specimen was dissected, five developed eggs were obtained, indicating the commencement of the breeding season.

Kachuga sylhetensis is one of the rarest fresh water turtles in southern Asia, and endemic to north-eastern India and Bangladesh (Das, 1995; Moll, 1987; Bhupathy et al., 1992). The species is confined to the Khasi and Garo Hills of Meghalaya and adjacent regions of Cachar in Assam and Bangladesh, Gorumara in northern West Bengal (Das, 1997) and Nagaland (Das, 1990; Moll, 1987). The species has also been recorded from Manas National Park (Sarma, 1988), Sibsagar (Das, 1990), Nameri National Park (Bhupathy et al., 1992), Dibru Siakhowa National Park (Choudhury, 1995b), North Lakhimpur (Choudhury, 1993) and in Kamrup District (Choudhury et al., 1997). Choudhury et al. (1997) suggest that the species is restricted to the hill-streams and following heavy precipitation, individuals are washed downstream to the plains. However, the records from Kaziranga National Park and also from various localities of Assam, suggest that the species has a widespread distribution in Assam on both banks of the Brahmaputra, and as believed earlier, it is not restricted to hills and hill-streams in evergreen forests.

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A colour pattern of the softshell turtle *Amyda cartilaginea* observed in West Kalimantan (Indonesian Borneo)

(with two text-figures)

A field survey “Status, Population Biology, and Conservation of the water monitor (*Varanus salvator*), the reticulated python (*Python reticulatus*), and the blood python (*Python curtus*), in Sumatra and Kalimantan, Indonesia” was carried out in 1996-1997 (Abel, 1998; Riquier, 1998; Auliya and Abel, 1999; Auliya and Erdelen, 1999). Two major study sites were selected in West Kalimantan, in order to collect data on the taxa mentioned above. The herpetofaunal community of the study areas was also examined. Among the turtles, two softshells were recorded- *Dogania subplana* and *Amyda cartilaginea*. The latter revealed a distinct and regular colour pattern of the carapace, that probably can separate populations of West Kalimantan (Borneo) from those on the mainland.

The Asian softshell turtle *Amyda cartilaginea* Boddaert, 1770, is a large-sized taxon, attaining a carapace length of 83 cm and a weight of 35 kg (Lim and Das, 1999; Jenkins, 1995). Local names in Indonesia are “Kuaya emas” (Java), “Labi labi Super” (West Kalimantan), or “Lelabi” (by the Iban tribe in Borneo). It is a species distributed widely, from Indochina and Malaysia, to the Greater Sundas of Indonesia (Lovich, 1994), not occurring beyond the Wallace’s Line. Characteristics include longitudinal ridges on the carapace, especially on juveniles and yellow dotted limbs, forehead and chin (Boulenger, 1912; Nutaphand, 1979; Das, 1995; Chan-Ard et al., 1999). Additional characters are mentioned below.

One of the study sites was located adjacent to Putussibau (00°52’N, 112°55’E), an outpost on the Kapuas River, the other in the Sambas region (01°20’N, 109°15’E). In Sambas, a skinnery for the commercial harvest of reptile skins is established, in particular for the taxa under study. Here the author could collect additional data on morphology, prey items and reproduction biology. Additionally, enormous quantities of turtles are brought in from the catchment area, comprising batagurids and softshells for the medical and food market in China. At this locality, *A. cartilaginea* is abundant.

At a preliminary study site, the Pengkaran River (01°02’N, 112°58’E), an tributary of the Sibau River north of the village Tanjung Lhasa, nets with 4 cm mesh were stretched across selected river sections - a capture method of the re-

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FIGURE 1: *Amyda cartilaginea* showing the characteristic straight proboscis and enlargened tubercles at anterior edge of carapace.

FIGURE 2: A black-marked carapace of *Amyda cartilaginea* from West Kalimatan.

ticulated python used by hunters in South Kalimantan. The abundance of softshell turtles at the Pengkaran River, situated in a transition zone between lowland and hilly lowland forest, was proven by half-eaten fish trapped in the fishing nets. This clear and strongly meandering river was slow flowing and comprised many diverse microhabitats such as overhanging banks undermined by water, and revealing root systems of riparian vegetation.

The first specimen of *Amyda cartilaginea* was recorded on 19 July 1996, in Tanjung Lhasa (00°58'N, 112°57'E), a remote village in the lower reaches of the Sibau River, north of Putussibau. It was captured by the villagers at the same site, where the river width was ca. 50–80 m wide. According to Inger and Tan (1996), these softshells favour large rivers. The habitat of *A. cartilaginea* as described by Pritchard (1979) comprises muddy and slow flowing lowland streams as well as mountain rivers. Small populations of the species inhabit primary and secondary habitats (Kiew et al., 1996). According to van Dijk (1992), the species is ecological flexible in terms of niches selection, inhabiting all types of fresh water, including hill streams and lowland rivers.

In West Kalimantan, softshell turtles are captured with baited fishing hooks attached underwater at the edge of forest rivers, preferably where overhanging banks amid dense root systems occur (cf. Meier, 2000). These traps operate with a snare mechanism. Capture techniques also include lines with baited hooks used by fishermen (Inger and Tan, 1996).

The colour description of the carapace provided by Ernst and Barbour (1989), "numerous yellow-bordered black spots and yellowish dots in younger individuals" does not match with the specimens from West Kalimantan. Bourret (1941) states that his colour description refers only to specimens of former Indochina, and adds that individuals from other localities differ in colour pattern. Boulenger (1912) provides a vague colour description, only mentioning that *A. cartilaginea* is "olive brown above."

Of the specimens observed in West Kalimantan, all had distinct black markings covering an olive-brownish ground colour (Figs. 1-2). These markings resemble a wing-like figure, characterizing the 20-30 cm sized individuals recorded. In adults, especially the old ones, none of these markings appear, which is commonly known (Ernst and Barbour, 1989; van Dijk, 1992; Manthey and Grossmann, 1997). Lim and Das (1999) indicate that occasionally specimens possess dark markings, and de Rooij (1915) reports that some individuals have "black spots or a black transverse band on the back." De Rooij (1915) cites the illustrations of *A. cartilaginea* by "(Bodd.)" referring to Boddaert (1770). Considering the drawing of the carapace, the wing-shaped marking can be suspected. However, the illustrations in Boddaert do not show specimens with this wing-marked carapace (Hoogmoed, pers. comm.). Within the collections of the "Zoologisch Museum Amsterdam", where de Rooij worked, the specimen illustrated in de Rooij (1915) could not be traced (van Tuijl, pers. comm.).

Manthey and Grossmann (1987) more precisely speak of 4-5 star-like markings, which may occasionally be distinct in some individuals, but they do not describe geographical variation. Van Dijk (1992), who compiled detailed information on the taxon, points out that the carapaces of Bornean specimens are distinctly coloured, describing the wing-like shaped figure as a "saddle-shape" and composed of symmetrical and curved arranged dots on the anterior part of the carapace. He explicitly expresses that these colour morphs are confined to the islands Borneo and Sumatra.

In specimens originating from West Kalimantan, these black markings are arranged symmetrically on both sides of a blackish broken vertebral streak covering the median ridge, which widens in the posterior part of the carapace (Fig. 1). This dark medial line is always broken in the anterior part of the carapace, sometimes more or less, as opposed to the Malayan Softshell turtle (*Dogania subplana*), which is characterized by a dark uneven medial streak running vertically across the whole carapace, and 4 to 6 ocelli, in particular pronounced in young specimens (Boulenger, 1912).

For old specimens of both taxa, other morphological criteria are used by way of comparison because colour patterns fade. Two of these, related to *A. cartilaginea,* is the straight pronounced proboscis, and the enlarged tubercles visible at the anterior edge of the carapace (Fig. 1). *Amyda nakornsrithammarajensis* described by Nutaphand (1979), possesses a yellow dotted carapace, equal to the head and legs. Meylan (1987) synonymised this taxon with *A. cartilaginea.* This colour morph corresponds with that of individuals without any black markings on the carapace as described above.

However, additional findings are necessary, in order to support the hypothesis of this paper, that populations in West Kalimantan (probably in the whole of Borneo), all can be characterized (referring to the corresponding age classes) with this distinct wing-like colour pattern of the carapace, in some specimens more in others less pronounced (Fig. 2).

Van Dijk (1992), who examined geographical variation in osteology and pigmentation of the taxon, suggests to attribute the presently recognized three forms to the species complex *Amyda cartilaginea*. He recommends DNA-studies on the basis of a larger collection of specimens within the range.

The verification of the systematic status of populations in West Kalimantan is urgently required, as this taxon is heavily exploited for the food (van de Bunt, 1990; van Dijk, 1992; Jenkins, 1995; Kuchling, 1995; Manthey and Grossmann, 1997; Valentin, 2000) as well as the pet trade (Yuwono, 1998), but the impact of the latter may be negligible.

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Record of *Kaloula pulchra* (Gray, 1831) (Anura : Microhylidae) from Cachar District, Assam, north-eastern India

Kaloula pulchra, the painted frog, was first reported from India by Romer (1949) from the state of Nagaland. Subsequently, Dutta (1997) reported it from north of Tinsukia, north-eastern Assam. This note reports the occurrence of K. pulchra from Cachar District, southern Assam. This area is located ca. 600 km and ca. 450 km south-west of Tinsukia and Nagaland, respectively.

Five specimens of *Kaloula pulchra* (three juveniles, two adults:, one male, one female) were collected from localities in Cachar District. Measurements were made with vernier calliper, mm ruler and/or ocular micrometer fitted to a dissecting microscope (Table 1). One of the specimens was deposited in the collection of the Zoological Survey of India, Calcutta (ZSI A9094).

All specimens show a black dorsum with a bright orange patch on tip of snout between eyes

TABLE 1: Morphometric measurements (in mm) of juveniles (± SD; range in parenthesis) and adults of *Kaloula pulchra* from Cachar District, Assam, north-eastern India.

	Juveniles (n = 3)	Adult Male	Adult Female
Snout-vent length	33.73 ± 6.01 (28.0-40.0)	61.5	69.9
Head length	4.66 ± 1.15 (4.0-6.0)	10.0	9.75
Head width	10.83 ± 1.61 (9.0-12.0)	22.0	22.0
Maximum body width	15.83 ± 1.61 (14.0-17.0)	35.0	41.5
Snout-orbit distance	2.83 ± 0.28 (2.5-3.0)	4.0	4.5
Snout-narial distance	0.58 ± 0.14 (0.5-0.75)	1.0	1.0
Internarial distance	2.83 ± 0.76 (2.0-3.5)	5.0	5.0
Interorbital distance	8.66 ± 0.57(8.0-9.0)	15.0	17.0
Eye diameter	3.66 ± 0.76(3.0-4.5)	6.0	6.0
Femur length	14.16 ± 1.75(12.5-16.0)	25.0	27.0
Tibia length	13.0 ± 1.73(12.0-15.0)	26.0	26.0
Tibia width	3.9 ± 0.96(3.2-5.0)	9.0	10.0
Forelimb length		47.0	45.0

that extend as a wide band on either side of body to end of trunk. Two distinct triangular white patches at base of fore- and hindlimbs. Ventral surface greyish with small white spots. Dorsum rough and snout obtuse with nostrils closer to tip of snout than to eyes. Tongue large; tympanum indistinct. Body balloon shaped. Tips of fingers and toes dilated. Fingers and toes in order of length are 3 > 4 > 2 > 1 and 4 > 3 > 5 > 2 > 1, respectively. Fingers with rudimentary webs in juveniles, free in adult. Toes with rudimentary webbing in both juveniles and adult. Tibio-tarsal articulation reaches shoulder; heels do not overlap when folded at right angle to body. Both inner and outer metatarsal tubercles present.

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Rediscovery of *Chirixalus simus* Annandale, 1915 (Anura: Rhacophoridae) from Assam and West Bengal, eastern India

(with one text-figure)

The genus *Chirixalus* includes nine nominal species and is distributed from Japan in the east to India in the west (Frost, 1985). In India, the genus is represented by four species (Dutta, 1997). The least well-known of these, *Chirixalus simus* Annandale, 1915 is known from the holotype, ZSI 17971, collected by S. W. Kemp, from Mangaldai, Assam on 6 January 1911. On 8 and 15 October 1998, two females (by MFA) and two males (by MFA and SKD) respectively of *Chirixalus* (Fig. 1) specimens were collected from the Orang Wildlife Sanctuary, Darrang District, Assam. In addition, on 8 September,

TABLE 1: Measurement (in mm) of *Chirixalus simus* specimens.

Characters	**ZSI 17971 (holotype)**	**ZSI A9122**	**ZSI A9123**	**ZSI A9124**	**ZSI A9125**	**ZSI A9130**	**ZSI A9131**	**ZSI A9132**	**ZSI A9133**
Location	Mangaldai	W. Bengal	W. Bengal	W. Bengal	W. Bengal	Assam	Assam	Assam	Assam
Sex	–	male	male	male	male	female	female	male	male
Snout-vent length	20.75	22.37	21.5	22.4	23.3	26.87	26.8	20.15	19.3
Head length	6.92	6.37	6.4	6.1	6.55	7.17	7.0	5.27	5.77
Head width	7.0	7.07	7.2	7.07	7.0	7.8	7.87	6.1	6.27
Snout length	3.42	3.3	3.45	3.75	3.35	3.37	3.52	2.87	3.2
Eye diameter	3.27	3.37	3.4	3.1	3.4	3.15	3.57	2.95	3.05
Tympanum diameter	1.55	1.75	1.5	1.37	1.45	1.4	1.32	1.35	1.15
Inter-orbital distance	3.77	3.77	3.62	3.4	3.55	3.8	3.55	2.75	3.0
Internarial distance	2.2	2.32	2.12	2.72	2.42	2.5	2.65	1.87	1.9
Tibia length	11.6	12.17	12.07	11.75	11.3	12.67	12.55	9.55	9.87

1999, at 20 h, we (SKD, KD and SB) collected four specimens of the genus *Chirixalus* from a marshland in Rajpur, South 24 Parganas District, West Bengal, six km south of Calcutta. They were all calling males. All the specimens were identified as *C. simus*, after comparison with the holotype. Thus, this finding is a rediscovery of the species, 83 years after its description, from two other localities; Assam ca. 40 km away from the type locality and West Bengal ca. 600 km away from its type locality.

While comparing with the holotype, certain minor morphological differences were found both in the holotype and the collected specimens. Annandale (1915) mentioned "the head is broader than long and the snout is considerably shorter than the diameter of the orbit". However, our measurement of the holotype and the referred specimens (Table 1) suggested the following: The head is almost as long as broad and the snout length is equal to the maximum diameter of the eye. Annandale (1915) mentioned of a slight rudiment of web between the inner fingers, but we did not find any webbing between fingers.

The type locality (Mangaldai: 26º 28' N; 92° 05' E) is a low-lying flood plain area, with patchy marsh vegetation. The second locality in Assam (Orang Wildlife Sanctuary: 26° 30'-40' N; 92º 15'-30' E) is ca. 40 km in aerial distance from the type locality. The specimens from Orang were collected at night, from tall grasses (*Saccharum* sp.) at a height of ca. 1.5 m above ground. The West Bengal specimens were found in a marshy area, close to human habitation. The water depth in the marsh was ca. 0.5 m and the area is dominated by the grass, *Saccharum spontaneum*. The frogs were calling from the grasses, at a height of ca. 1 m above the level of

FIGURE 1: *Chirixalus simus* Annandale, 1915 from Rajpur, South 24 Parganas District, West Bengal, eastern India. (Photo: K. Mookherjee)

water. The call of the species was a metallic "trrik..trrik..trrik". Other species of frogs, found syntopically at the West Bengal site are, *Euphlyctis cyanophlyctis*, *Fejervarya* sp. and *Hoplobatrachus tigerinus*. Foam nests of the species were found hanging from the reeds, ca. 0.5 m above water level. The foam was pendulous in shape, measuring 65 mm in length and one of the nests contained 100 white eggs.

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REVIEWERS FOR *HAMADRYAD*

Vol. 25 (1 & 2)

K. Adler, A. M. Bauer, S. K. Chanda, P. P. van Dijk, A. Dubois, S. K. Dutta, W. Erdelen, M. A. Ewert, R. Gemel, R. F. Inger, J. B. Iverson, C. J. McCarthy, P. K. Mallick, E. O. Moll, H. Ota, S. M. A. Rashid, P. Ray, G. Underwood, H. K. Voris, V. Wallach, A. Wynn, B. A. Young.

ERRATUM

In Volume 25(1), 2000, the email address for Karthikeyan Vasudevan ('A new species of *Rhacophorus* (Anura: Rhacophoridae) from the Western Ghats, India', p. 21) is <karthik@wii.gov.in> and not as indicated.

BOOK REVIEW

GOANNAS, THE BIOLOGY OF VARANID LIZARDS by Dennis King and Brian Green. 1999. Second edition. Krieger Publishing Company, Malabar, FL/University of New South Wales Press. 116 pp. Paperback. ISBN 1-57524-112-9. Available from: Krieger Publishing Company, P. O. Box 9542, Melbourne, FL 32902-9542, USA; Fax ++321 951 3671; Email: . Price: US$ 25.50.

This concise work by two globally acknowledged experts on monitors (ok, goannas as Aussies insist on calling them), is actually a revised reprint of the 1993 work. As the publishers' flier indicates, a lot of research on monitors has revealed new findings since the first edition came out. New information on taxonomy, diet, breeding, behaviour and thermal biology are included and even a bit of research which proves that monitors can count "better than a lot of small children"!

The nice thing about a book like this is that someone else has gone to the immense trouble of sifting through the masses of varanid literature to produce an easy-to-read, concise work loaded with facts.

Australia is varanid heaven with over 25 species of a remarkable diversity so it's no surprise that much of the best research on these very engaging lizards has emerged from Down Under.

The only New World lizard with at least a vague taxonomic connection to the Old World varanids are the venomous helodermids. Another relative, the fossorial earless lizard (*Lanthanotus borneensis*) was rumoured to be venomous; a Sri Lankan tradition is that water monitor saliva is venomous and a North Indian belief is that young, colourful Bengal monitors are a different, highly venomous species. And the strongest candidate for "venomous" saliva is, of course, the Komodo monitor. The saliva of the Komodo dragon does contain pathogenic bacteria and severe (even fatal) infections in animals, including humans, have been documented. But what the hell, *Homo sapiens* saliva can be a pretty toxic brew itself. King and Green leave these toxic questions alone, but I couldn't resist getting into it.

The book looks suspiciously like a text book at first with its chapter organization, graphs and charts and it should be required reading for any herp course. Perhaps the most disappointing aspect of the book are the ten short pages on general behaviour. Just think of all the nuggets of behaviour these two authors have tucked away in their heads and publications that we are missing. But the feeding and breeding chapters partly make up for it being full of meaty facts. Much of it we've seen in the journals but very useful again, to have it all together in this format.

The book ends with a good (though brief) chapter on parasites and one on conservation. It was most interesting to read about a mite which is commonly found parasitizing ticks on varanids in India! It was also good to read that varanids in Australia have a secure future, as compared to their unfortunate Asian brethren which are slaughtered by the millions each year to feed the Japanese, European and American fashion industry. It wouldn't be so bad if there were some serious attempts at sustainable harvests and farming. Alas, the animals will have to become near extinct before bureaucratic lethargy is shaken.

The 'Suggested Readings' section is useful and in general this is a highly recommended summary source book of varanids in the world.

I forgot to mention the good to excellent colour photographs of 14 species of monitors and the excellent line drawings. To me the most evocative drawing is the one showing the puny figure of a man (with a short handlebar moustache) next to the enormous bulk of a formidable (now extinct) varanid called *Megalania*. This 25 foot long thunder dragon must have curdled the blood of early Australian humans. Imagine a huge fierce predatory lizard that can move fast and even climb! Ouch!

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SEA SNAKES by Harold Heatwole. 1999. UNSW Press, Sydney, Australia/Krieger Publishing Company, Malabar, Florida. 167 pp. ISBN 0 86840 776.3 Available from: Krieger Publishing Company, P. O. Box 9542, Melbourne, FL 32902-9542, USA; Fax ++321 951 3671; Email: . Price: US$ 29.95.

'Sea Snakes' is another solid gem from the Australian Natural History series. The original title was published in 1987 and was received with fervour by the ophiological community. A lot has been added to our knowledge of sea snakes since then, though they still remain among the most enigmatic of the world's serpents.

No one is better qualified than Hal Heatwole to render this complete introduction to the sea snakes which he began working with in the mid 1960's.

There are 57 species of true sea snakes and sea kraits in the world, all distinguishable by their flat, paddle like tails and pair of fangs which can deliver usually very toxic venom. The book also covers the 13 other snakes that inhabit the coastal salt or brackish water areas of the Asia-Pacific including nine, which are rear fanged and mildly venomous, and the file snakes.

The book begins with a good general summary of what sea snakes are all about: sea snake species, evolution and a bit about "sea serpent" myths. Following chapters detail sea snake regional distribution, natural history, food and feeding behaviour, population ecology, chapters on diving, saltwater adaptation, venom and finally a long and fascinating chapter "Sea snakes and Humans".

This concise work may seem too brief for a comprehensive coverage of this important group of snakes but it is both a satisfying read as well as an excellent reference work. The latter purpose is assisted by appendices on classification and distribution and a list of sea snake books and references for "Further Reading".

'Sea Snakes' is amply illustrated with black and white photos, charts, figures and 29 excellent colour plates of some of the remarkable sea snake species and the people who work with them.

Sea snake ecology and behaviour is still largely a mystery and hardly any research has been done on this group in the Indian Ocean region since the 1935 sea snake monograph by M. A.Smith. It is hoped that the availability of Hal Heatwole's excellent book will encourage more sea snake work. No herp library is complete without it!

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SHERMAN ANTHONY MINTON

(1919-1999)

Dr. Sherman Anthony Minton Jr., M.D., died of cancer in Indianapolis, USA, 15 June 1999, at age 80. Born on 24 February 1919 in New Albany, Indiana, he was the eldest child of Senator Sherman Minton Sr., also the Governor and Associate Justice of the U.S. Supreme Court. Young Minton attended school in New Albany and developed a liking for animals, especially snakes. He wanted to take up zoology for further studies. His father, himself a lawyer and judge, advised young Minton to choose between medicine and law; medicine was promptly chosen since it was closer to zoology.

Minton obtained a B.S. in Zoology in 1939 and an M.D. in 1942 at Indiana University. During World War II, he served in the U.S. Navy as a lieutenant from 1943-1946. After the war, he spent 1947-1948 at the University of Michigan Zoology Department, taking up Herpetology and Microbiology. He later joined the Faculty of Indiana University School of Medicine, Department of Microbiology and Immunology, where he remained for the remainder of his career. He retired in 1984 as Emeritus Professor. Dr. Minton's career presents a perfect amalgamation of medicine, microbiology and herpetology.

Sherman married Madge Alice Shortridge Rutherford on 10 October 1943, while both were in military service, he in the Navy, she with the Women's Air Force Service Pilots (WASPs). Interestingly, Madge was also interested in snakes from childhood. Minton contributed significantly to the study of snakes of Indiana. He was Research Associate of the American Museum of Natural History.

From 1958 to 1962, Sherman Minton took a break from Indiana to teach at the Basic Medical Sciences Institute (now Jinnah Postgraduate Medical Center), Karachi, Pakistan, under the US AID Program. He taught at the institute and reorganized the medical teaching courses in Pakistan, and headed the institute for some time.

Sherman Minton pioneered herpetological studies in Pakistan, both he and Madge devoting weekends and vacations to field work. They travelled 44,000 miles in different parts of Pakistan, collecting amphibians and reptiles and information about them from people. His well illustrated paper on the amphibians and reptiles of Sindh and Las Bela was published in 1962. He revisited Pakistan, when he also visited Iran, in 1965 under the sponsorship of American Museum of Natural History and collected material for his main treatise on the herpetology of Pakistan, that was published in 1966. The Mintons, during their collection trips in southern Balochistan, discovered an ancient ceremonial site believed to have been used in 2,000 BC, which was part of the Harappan Civilization.

Sherman Minton pioneered the study of venomous reptiles and toxicology. He was President of the International Society of Toxicology and chairman of a committee of scientists who advised Congress on the importation of reptiles and endangered species. Minton was on the Editorial Board of the journals *Toxicon* and *Clinical Toxicology*. He authored three sections of the current edition of Encyclopedia Britannica. He was a member and once served as President of the Society for the Study of Amphibians and

Reptiles. He headed the committee which was entrusted the task of writing the Navy Manual for the identification of venomous snakes of the world. Sherman, sometimes with Madge's support, produced over 170 articles, books and monographs. They coauthored eight publications including two books, Venomous Reptiles (1969, 1980) and Giant Reptiles (1973). From 1972-1980, he joined several expeditions to different oceans to study the biology of sea snakes and other venomous sea animals. He was Visiting Professor in the Department of Zoology, University of New England in Australia during 1980.

In remembrance of their services to the herpetology of Pakistan, the following amphibian and reptile species have been named after the Mintons:

† *Proacris mintoni* Holman, 1961
Cyrtodactylus mintoni Golubev & Szczerbak, 1981
Typhlops m. madgemintoni Khan, 1999
Typhlops m. shermanai Khan, 1999
Coluber rhodorachis mintonorum Mertens, 1969

Dr. Sherman A. Minton, Jr., is survived by his widow Madge Rutherford Minton, and three daughters: Brooks, April and Holly. An obituary of Sherman Minton is in Bechtel (1999), and Stewart (2000) wrote an essay on the herpetological accomplishments of the Mintons.

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