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REDESCRIPTION AND GENERIC REALLOCATION OF *RANA MAWPHLANGENSIS* PILLAI & CHANDA, 1977 (AMPHIBIA: RANIDAE)

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(with two text figures)

ABSTRACT.– The species *Rana mawphlangensis* Pillai and Chanda, 1977, is placed in the genus *Odorrana* based on morphological characters of the holotype. The species is formally redescribed, with inclusion of notes on observations in the wild and photos of live specimens are made available for the first time. It differs from all currently recognized congenerics and superficially similar *Amolops* species by the following combination of characters: large adult size (males SVL 80 mm, females 84.3–106 mm), head longer than wide, snout considerably longer than eye diameter, presence of wide glandular but incomplete dorsolateral fold, presence of humeral glands, presence of dorsal and ventral spinules in males (no ventral spinules observed in females), absence of outer metatarsal tubercle and external vocal pouch, dorsally primarily green anteriorly, with large randomly space brown spots, lip-stripe yellow to bronze/brown in adults, slightly expanded disks on all toes and fingers III and IV, with ventral circummarginal grooves on all digits. *O. mawphlangensis* resembles most closely *O. grahami*, which, based on the vague descriptions of the latter species from the literature, differs in a few characters, and future studies may prove the two to be conspecific.

KEYWORDS.– Anura, *Rana*, *Limnonectes*, *Odorrana mawphlangensis*, *grahami*, redescription, India.

INTRODUCTION

The species *Rana mawphlangensis* Pillai and Chanda (1977), was described based on a single specimen from Mawphlang, Khasi Hills, Meghalaya State in north-east India, and deposited at the Zoological Survey of India. The original description was based solely on the holotype and misleadingly placed this species as a close relative of several species now allocated to the genus *Limnonectes* (Anura: Dicroglossidae), namely *L. doriae* (Boulenger, 1887) and *L. modestus* (Boulenger, 1882). This initial misjudgment, repeated almost identically by Tiwari (1981), perhaps led to the species being placed in the genus *Limnonectes* (*Bourretia*) by Dubois (1987 ("1986")). Subsequently, it was transferred to *Limnonectes* (*Elachyglossa*) (Anderson, 1916), by Ohler and Dubois (1999) which included its originally proposed "possible relative" *L. modestus*. This generic placement was then followed by Dutta (1997), Das and Dutta (1998), Chanda et al. (2000), and Frost (2007). However Ao et al. (2003) did mention that this species is closely allied to *Rana* (*Odorrana*) *andersoni,* with no further discussion to support this. Due to the previous taxonomic confusion regarding this species, it has not been included in any recent revisions of the stream frog genera *Huia*/*Odorrana*/*Rana* (e.g., Bain et al., 2003; Bain and Truong, 2004; Bain and Stuart, 2005; Bain et al., 2006; Stuart and Bain, 2005; Stuart and Chan-ard, 2005; Stuart et al., 2005; Stuart et al., 2006; Matsui and Jaafar, 2006).

There is currently much unresolved confusion regarding the taxonomy of many members of these stream frog genera (Dubois, 1992; Bain et al., 2003; Chen et al., 2005; Frost et al., 2006; Ngo et. al, 2006; Cai et al., 2007; Che et al., 2007), and species have variously been moved between *Eburana*, *Odorrana*, *Amolops*, *Rana* and *Huia* over the last three decades.

In September 2006, during a short visit to Mawphlang Sacred Forest near Shillong, Meghalaya, several large ranids were found along forest streams. As I had recognised at that time, that no currently known north Indian ranids fitted the description of these individuals, detailed photographs were taken. During photography, it was further noted that secretions produced by individuals had a distinct odour, thus narrowing down its possible genus to *Odorrana*. During a subsequent visit to the ZSI/K, comparative material was examined with particular emphasis on the two species having the type locality of Mawphlang. Only then was it discovered that the holotype of *Rana mawphlangensis*, currently allocated to the genus *Limnonectes*, corresponded in morphological characters and general proportions to the *Odorrana* species photographed from the same locality.

The aim of this paper is to formally clarify the generic taxonomy of at least one poorly known species and compare it to all similar congenerics within the currently recognised genus *Odorrana* (Che et al., 2007). The species is redescribed to include presence or absence of morphological features now considered significant, previously not mentioned in the original species description of Pillai and Chanda, (1977).

MATERIALS AND METHODS

Observations in the wild were carried out during two visits to the Mawphlang Sacred Forest Grove and a separate forest patch directly below the sacred forest in a valley, on the western edge (ca. 1,500–1,800 m asl). Survey period was 6–9 September 2006 and 2–4 June 2007. During these dates, both day and night opportunistic surveys of the local streams were carried out. As no collection permits could be issued at the time of these surveys, individuals were photographed in detail and some in-situ basic morphometrics were taken prior to release. As these measurements can not be verified independently, they are only mentioned in the "Observations in the wild and local threats" section and omitted from further discussions on morphometry.

Morphometric measurements on the holotype were carried out using a vernier caliper (to the nearest 0.1 mm). Measurements of live individuals were rounded to the nearest ca. 1 mm. Measurement and character abbreviations are as follows: SVL (snout to vent length, excluding additional fleshy region which extends posteriorly below the vent), HW (head width at posterior axis of mandible), HL (head length, from center of snout tip to posterior axis of mandible), ED (horizontal eyeball diameter), TyD (maximum diameter of tympanum), E-T (posterior border of eye to anterior border of tympanum), E-N (anterior border of eye to posterior edge of nostril), N-S (distance from nostril to centre of snout tip), E-S (anterior border of eye to centre of snout tip), IO (interorbital distance, minimum distance between inner edge of eyelids), ELW (maximum width of eye lid), IN (internarial distance), FLL (forearm length from elbow to posterior edge of palmer tubercle), HAL (hand length from posterior edge of palmar tubercle to tip of 3rd finger), TbL (tibia length), TbW (maximum width of tibia), FL (femur length, from anus to knee), IMT (length of inner metatarsal tubercle), D-L fold (dorsolateral fold). In this paper the use of the term "disk" with reference to the fingers tips of *O. mawphlangensis* is based on the presence of distinct enlargement of the finger tip relative to adjoining finger width and the presence of a basal groove on the posterior ventral surface of the pad as illustrated in Ohler (1995). Webbing formulae between toes follows Savage and Heyer (1997). Sexual dimorphism was assessed by the presence of external dimorphic characteristics mentioned below. The author will follow Che et al. (2007) and Cai et al. (2007) for recognition of *Odorrana* as a distinct genus. All morphological characters mentioned in the comparisons were obtained from relevant literature only, and all listed in the Literature Cited section. The exceptions to the above statement are *O. lungshenensis* and *O. wuchuanensis*. Relevant morphological data on these species was provided to the author based on translations from Chinese literature (R. Bain, pers. com.). Altitudinal range of Mawphlang was estimated based on the highest point of Mawphlang Village at 1,942 m asl (T. Lyngdoh, pers. com., based on the latest survey with GPS by Community Facilitator, on 15 March 2006). The holotype of *Rana mawphlangensis* was examined at the Zoological Survey of India, Kolkata (ZSI/K). As only the holotype was available for study, osteological details could not be examined (e.g., terminal phalange shape). All photographs were taken using a Sony Cybershot DSC H1 digital camera. Colour in life and additional sex related morphological features (not observable in the holotype) were described in part based on these photographs of live uncollected individuals from the type locality.

SYSTEMATICS

Odorrana mawphlangensis
(Pillai and Chanda, 1977)

Rana mawphlangensis. R. S. Pillai and S. K. Chanda, 1977. J. Bombay Nat. Hist. Soc. 74:138–140.

Limnonectes (*Bourretia*) *mawphlangensis*. A. Dubois, 1987 ("1986").

Limnonectes (*Elachyglossa*) *mawphlangensis*. A. Ohler and A. Dubois. 1999.

(Figs. 1 and 2)

Holotype.– ZSI A6979 (ex ZSI/ERS 803) "from stream at Mawphlang (1,535 m), Khasi Hills" (= East Khasi Hills), Meghalaya, north-east India, collector R. S. Pillai, 13 December, 1973, adult female. Condition: lower mandible broken below the eye on both sides, longitudinal mid-ventral incision from the anterior chest to posterior abdomen.

Diagnosis.– This species from north-east India is included as a member of the genus *Odorrana*, based on its close morphological affinities to *O. grahami*. It is characterized by a combination of the following attributes: SVL of males 80 mm, females 84.3–106 mm; head longer than wide, snout rounded to bluntly obtuse in profile; lip stripe yellow to bronze/brown, two large rictal glands; tympanum distinct, circular, TyD = 52.5% ED in the female holotype, supratympanic fold indistinct; dorsal skin smooth to finely granular anteriorly, to heavily granular posteriorly and laterally with large pustular dorsal tubercles, lateral tubercles present, wide and pustular D-L fold on anterior half of back, continues to the vent as a broken row of pustular warts, ventrally smooth on throat and chest, abdomen granular laterally; dorsum primarily green with large brown spots, laterally grey/brown with black spots on lower edge of warts; forelimbs and hind limbs with transverse bands to the tips of digits; fingers III and IV and all toe tips slightly expanded, with distinct disks (largest disk on finger III, < 1.5 times distal phalange width), ventral circummarginal grooves present on all; finger II slightly shorter than fingers IV and I, relative length of fingers II < IV < I < III; toes mostly webbed (I0–1II0–1.5III0–1.5IV1.5–0V), extending to disk on toe IV as fringe, post axial fringe on toe V present, extending from the disk to half way between proximal subarticular tubercle and the base of the metatarsal tubercle, webbing dark grey/brown, with or without minimal lighter patches; male with velvety nuptial pad on thumb, no external vocal pouches, and presence of two longitudinal ventrolateral patches of microspinules in males, white horny dorsal spinules present in both sexes.

Redescription of holotype.– Adult female of SVL 84.3 mm, body robust; head dorsally round, longer than wide (HW 31.0 mm, HL 34.4 mm, HL/HW ratio 1.11), flat above; snout rounded and protruding in profile, its length (E-S 14.3 mm), longer than the horizontal diameter of the eye (ED 10.1 mm); canthus rostralis rounded, loreal region weakly concave; interorbital space flat, interorbital distance (IO 6.8 mm) less than width of the eye lids (ELW 7.5 mm), and narrower than the internarial distance (IN 10.8 mm); nostrils laterally positioned, vertically ovular with slightly raised rim anteriorly, slightly closer to the eye (EN 7.1 mm) than to the snout (NS 7.3 mm); pupil indistinct behind lids (horizontal in live specimens); tympanum distinct (TyD 5.3 mm), circular, 52.5% of the eye diameter, tympanum-eye distance (E-T 4.4 mm), 83% of the tympanum diameter; pineal ocellus indistinct; vomerine ridge distinct, oval, bearing numerous small teeth, with an angle of ca. 80° to the body axis, positioned posteriorly relative to choanae, slightly closer to each other than to the choanae, longer than the distance between them; tongue chordiform, deeply notched posteriorly, free for about two-thirds its length; tooth like projections on lower jaw absent.

Arms moderately long, thick, forearm enlarged, length (FLL 20.8 mm) shorter than the hand (HAL 24.7 mm); finger II slightly shorter than fingers IV and I, relative length of fingers II < IV < I < III; finger tips on III and IV dilated slightly with disks becoming bluntly pointed distally, fingers I and II without distinct disks or dilation in relation to adjoining finger width, all

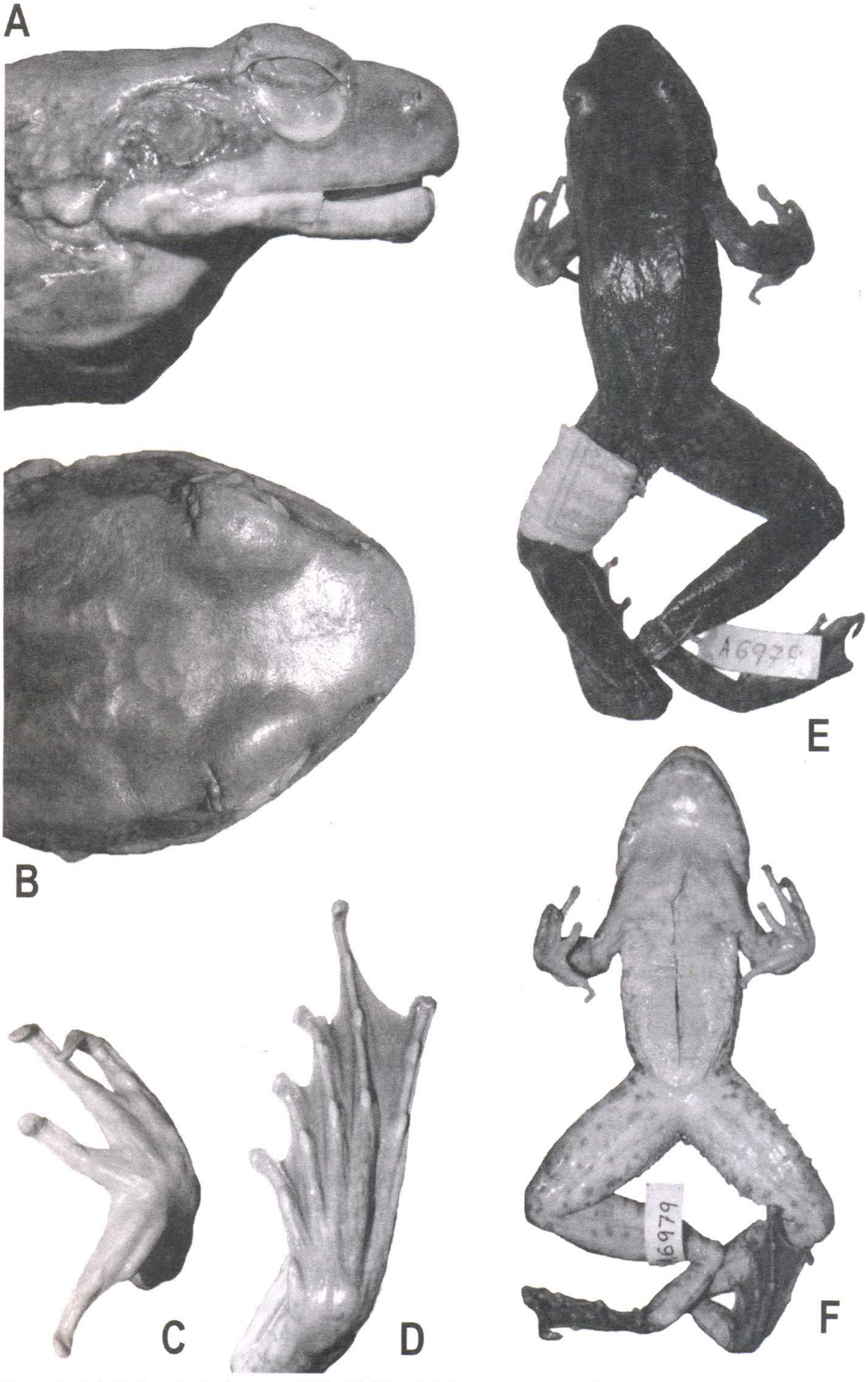

Figure 1. Adult female holotype (ZSI 6979) of *Odorrana mawphlangensis*; A – profile view of snout, B – dorsal view of head, C – palmer view of hand, D – plantar view of foot, E – dorsal view, F – ventral view.

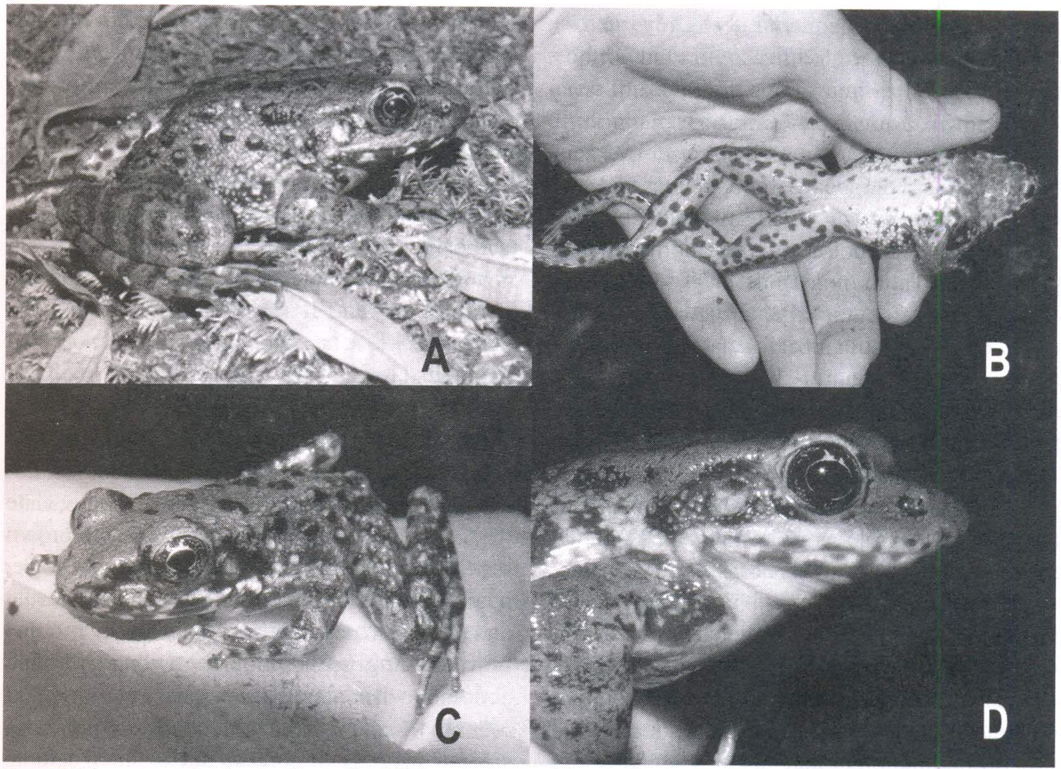

Figure 2. Live examples (not collected) of *Odorrana mawphlangensis* from the type locality, Mawphlang Sacred Forest, East Khasi Hills, Meghalaya; A & B – dorsolateral and ventral view of a subadult female, C – juvenile, D – profile view of adult male.

with ventral circummarginal grooves; terminal phalange shape unknown; fingers II and III with shallow furrows from disks to basal subarticular tubercles, webbing on fingers absent; subarticular tubercles rather prominent, longitudinally ovoid, prepollex distinct, oval, outer and inner palmer tubercles flat, small, and barely visible; supernumerary tubercle on the base of fingers III and IV distinct, on II barely visible but present.

Hind limbs long, tibia 4 times longer (TbL 51.6 mm) than wide (TbW 12.9 mm), longer than thigh (FL 47.5 mm); toes long and thin, relative lengths I < II < III < V < IV; tips of all toes rounded, slightly enlarged with distinct disks, all with ventral circummarginal grooves; toes mostly webbed, I0–1II0–1.5III0–1.5IV1.5–0V; post axial fringe on toe V present, extending from tip of toe, to half way between the proximal subarticular tubercle and the base of the metatarsal; subarticular tubercles all present, prominent, and longitudinally ovoid; inner metatarsal tubercle prominent, oval and relatively long (IMT 5.5 mm); tarsal fold, outer metatarsal, supernumerary and tarsal tubercles, all absent.

Skin on dorsal and lateral surfaces of head and anterior back finely granular with granule size increasing posteriorly, posterior portion also with several enlarged glandular warts; flanks and ventral trunk, heavily granular with several large glandular warts on the upper flanks; thick, glandular dorsolateral fold is present, uninterrupted from the posterior edge of the eye to half way to the vent, remaining length broken into a longitudinal row of glandular warts; supratympanic fold indistinct, co-ossified skin absent; dorsal surface of forearms finely granular; thigh, tibia and tarsus heavily granular, with granular and glandular warts on outer surfaces; throat, chest, and ventral portion of the thigh smooth, area surrounding anus with large dense granules; two large rictal glands, anterior most at posterior axis of mandible; humeral gland barely distinguishable and flat; fine white horny spinules are evident on the posterior half of the back, upper flanks, lateral portion of D-L folds and posterior eyelids.

Colour in preservative: entire dorsal portion of the head, back, and limbs primarily uniform dark bluish-brown, lightening slightly on the tarsus, hands and feet; entire ventral surface of throat, chest, belly and limbs faded yellow, with faded brown spots on the outer edge of the lower mandible, thighs, tibia and inner dorsal surface of tarsus; ventral surface of tarsus, feet and webbing light brown; lores, tympanic region and upper flanks dark brown fading to creamy yellow ventrolaterally to blend with ventral colouration; lateral tubercles with distinctly darker lower edges and considerable brown mottling on the lighter portion of the lower flanks; dark patch is present in the humeral region; upper lips and rictal glands a dirty cream colour; outer surface of tibia, tarsus and feet with broad darker brown bands, dark bands on outer surface of thighs barely visible, posterior surface of thighs brown with darker brown speckling.

Variation.– Colour in life is not based on that of the holotype to which relevant information was not made available in the original description. This description is presented solely on live specimens photographed at the type locality of *O. mawphlangensis*, that share all characters outlined in the diagnosis for the species; dorsal portion of head, upper arms, loreal region and anterior half of back vivid green fading to brown posteriorly; D-L folds, lateral surfaces of canthus rostralis, and anterior portion of snout metallic light bronze-brown, lip-stripe yellow to bronze-brown; green portion of back also with large randomly positioned circular brown spots; outer surfaces of hind limbs and forearms olive green to brown with darker brown banding, usually three on thigh, four or five on tibia, four or five on the tarsus/foot, and two on forearm; tympanum edged with dark grey/brown, pale centrally; flanks light grey/brown becoming lighter ventrally to become creamy white, glandular warts in this region are light brown dorsally and dark grey/brown on the lower surface; humeral gland mottled dark and light grey/brown and lower lip white with dark grey/brown blotches; ventral colouration appears to be highly variable with varying degrees of dark grey/brown mottling or spots on an otherwise white background (see Figure 2); skin on ventral surface of thigh, tibia and inner surface of tarsus opaque white, usually mottled or spotted with dark grey/brown blotches; ventral surfaces of tarsus, feet, hands and webbing either uniform dark grey/brown or may contain minimal olive green or brown mo tling; pupil surrounded by an almost continuo golden yellow edge in all individuals examine iris otherwise dark brown with varying degree of golden yellow flecking.

Chanda (1994) provides SVL 60.0–90.0 m (n = 3, including holotype), and Ao et al. (2003 states SVL 80 mm for males (n = 2) and 96–10 mm for females (n = 6).

Snout may sometimes be more bluntly obtuse than rounded; relative finger lengths of some individuals II = I < IV < III (II < IV < I < III in holotype), webbing on toe IV extends to the distal subarticular tubercle and not beyond in some individuals; all adult males found (and photographed, n = 2) in life were ventrally immaculate white on throat, chest and abdomen with brown spots on the distal edge of the lower mandible, whereas on the adult female (n = 1) the throat and anterior chest portion was primarily mottled brown fading to white on the lower chest and abdomen with faded brown spots anteriorly and laterally (Fig. 2), this difference is not here considered sexually dimorphic due to small sample size and absence of dark mottling on the ventral surface of the holotype; the juveniles (n = 2) and subadult (n = 1) ventral colouration was similar to that of the female but lighter; Ao et al. (2003) stated "throat and chest dark brown" (see Discussion for further comment on these specimens colouration); dorsally, males, females and juvenile were similarly coloured, however, the juvenile differed in having a white lip bar that was broken with extensive brown blotches; D-L fold on the juvenile less pronounced than in adults, consisting of rows of closely spaced pustular warts; arms and legs with more vivid green pigmentation than observed in adults.

Male secondary sexual characters: nuptial pad present, thickest proximally, becoming thinner abruptly beyond the knuckle and extending as a narrow ridge almost to the tip, velvety in texture and darker than surrounding area; forearms considerably enlarged when compared to females; humeral gland darker and more prominent in males; external vocal pouch absent; males often with more obtusely pointed snout than females (Fig. 2); microspinules extend from below the pectoral region ventrolaterally on both sides of the abdomen of males in two longitudinal patches barely noticeable to the eye but produces a rough texture to the skin in these regions; dorsally prominent white horny spinules are present, most obvious on males on the tips of tubercles on the posterior back, upper surface of flanks, thighs, tibia, upper and lower forearms, on the lores, in a line below the eye, tympanic region (but not on inner surface of tympanum), rictal gland, posterior eye lid and D-L fold; ventral spinules were not observed on any adult females examined but dorsal spinules are apparent on the holotype (as described above), however these are considerably reduced in size in comparison to those on males found.

Comparisons.– *Odorrana mawphlangensis* is here compared with all species of the genus *Odorrana* that share the following combination of morphological characters: presence of ventral spines in males, absence of external vocal pouch, flanks heavily granular with warts, and disks on digits < 2 X the width of the basal phalange.

Odorrana mawphlangensis is morphologically most similar to *O. grahami* (in brackets) but differ in the following morphological characters: relative finger lengths II < IV < I < III (vs. II < I < IV < III); webbing to distal subarticular tubercle or half way between the tubercle and disk on toe IV (vs. beyond distal subarticular tubercle on toe IV); presence of slightly expanded disks on fingers III and IV (vs. absence of disks on finger tips: Boulenger, 1920); vomerine teeth, with an angle of ca. 80° to body axis, positioned posteriorly relative to choanae, slightly closer to each other than to choanae, longer than distance between them (vs. vomerine teeth in transverse or slightly oblique series between choanae or extend a little beyond level of their posterior borders); dorsally, white horny spinules are present most prominently on males on the tips of tubercles of the posterior back, upper surface of flanks, thighs, tibia, upper and lower forearms, lores, in a line below the eye, tympanic region but not on inner surface of tympanum, rictal gland, posterior eye lid and D-L fold (vs. sides granulate with large warts, some of which may bare minute white, spinose tubercles: Boulenger, 1920; note, however, the presence of spinules on other areas may simply have been overlooked in Boulenger's description and requires further confirmation). Microspinules extend from below the pectoral region ventrolaterally along both sides of abdomen of males in two texturally distinct patches (vs. white spinules completely covering belly, some reaching chest in a non uniform shape: Fei et al., 2005). Snout longer, ED = 71% E-S (vs. "snout" ≤ ED: Boulenger 1920; again note that snout length as per measurements in Boulenger (1920) may not be representative of that defined in this paper).

Further differences regarding colouration are based on comparison of live specimens of *Odorrana mawphlangensis* with the description of Boulenger (1920), and on figures presented in Fei and Ye (2001) and Fei et al. (2005), representing *O. grahami*. They are as follows: dorsally primarily vivid green with large randomly space brown spots (vs. olive with black spots: Boulenger, 1920, however dorsal colouration appears to match figures in Fei and Ye, 2001); flank colouration grey/brown with black spots on lower edge of warts fading to white with darker marbling ventrolaterally (vs. yellow with black spots: Boulenger, 1920, and as per *O. mawphlangensis* but with distinctly yellow rather than white ventrolaterally: Fei and Ye, 2001); lip-stripe yellow to bronze/brown in adults, without dark patches (vs. gold-green marbling from tip of snout, some with dark brown patches: Fei et al., 2005); webbing in all individuals uniform dark grey/brown, with or without minimal olive green or brown mottling restricted to the tarsal area, basal toes and webbing between toes IV and V (vs. extensively covered with light and dark mottling: Fei et al., 2005), and finally, tympanum in all live specimens observed with distinct light inner surface (vs. uniformly dark coloured tympanum: Fei et al., 2005). Fei et al. (2005) provided a figure (Fig. 42) of the ventral surface of a male. Its only deviation from live individuals examined is the dense and extensive ventral spinule/granulation, whereas males of *O. mawphlangensis* examined did not have such extreme ventral spinulation/granulation throughout the abdomen as the central portion was both visually and texturally smooth. It should be considered, that the sample size examined by the author was small and from a single locality, it is important to point out that the differences listed in this paragraph may well be considered as variation within or amongst different populations and not diagnostic characters of either species.

The following comparisons are for all other species from the genus *Odorrana*, sharing a combination of the above mentioned characters, with the exceptions of *O. leporipes* and *O. sinica* in which males are currently unknown and *O. wuchuanensis* regarding the imprecise description of disk size and no available information as to the presence or absence of ventral spines. These three species are included here for completeness, regardless of prior grouping with more similar species by other authors. From *O. andersoni*, *O. mawphlangensis* differs by relative finger lengths II ≤ I (vs. I < II), lateral warts mostly tipped by pointed white horny spinules (vs. lateral wart flat), D-L fold present, wide and pustular anteriorly (vs. D-L fold absent), lips without (vs. with) dark vertical bars and IO < ELW (vs. ELW < IO). From *O. exiliversabilis*, *O. mawphlangensis* differs by larger size SVL 80 mm male, 84.3 –106 mm females (vs. SVL 43–52 mm males, 52–62 mm females), D-L fold present, wide and pustular anteriorly (vs. present, narrow), outer metatarsal tubercle absent (vs. present). From *O. jingdongensis*, *O. mawphlangensis* differs by D-L fold present, wide and pustular anteriorly (vs. D-L fold absent), and absence (vs. presence) of vertical lip bars in adults. From *O. junlianensis*, *O. mawphlangensis* differs by D-L fold present, wide and pustular anteriorly (vs. D-L fold absent), microspinules extend from below the pectoral region ventrolaterally on both sides of the abdomen of males in two texturally distinct patches (vs. white spinules on the chest of males, in a form similar to the figure "8"), relative finger lengths II ≤ I (vs. I < II), webbing not to disk on preaxial side of toe III (vs. webbing full to disk on preaxial side of toe III), and lip-stripe plain yellow to bronze/brown in adults (vs. yellow with brown bars). From *O. leporipes*, *O. mawphlangensis* differs by D-L fold present, wide and pustular anteriorly (vs. D-L fold present, slight), lip stripe yellow to bronze/brown (vs. white), legs banded (vs. no bands on legs), and supratympanic fold absent (vs. present, white). From *O. margaretae*, *O. mawphlangensis* differs by D-L fold present, wide and pustular anteriorly (vs. absent), absence (vs. presence) of vertical lip bars in adults, snout rounded or bluntly obtuse in profile (vs. depressed) and microspinules extend from below the pectoral region ventrolaterally on both sides of the abdomen of males in two texturally distinct patches (vs. white spinules form a crescent shape with apex pointing anteriorly on chest). From *O. sinica*, *O. mawphlangensis* differs by D-L fold present, wide and pustular anteriorly (vs. absent), relative finger lengths II ≤ I (vs. I < II) and distinctly visible tympanum (vs. indistinct, covered with a layer of skin). From *O. wuchuanensis*, *O. mawphlangensis* differs by relative finger lengths II ≤ I (vs. I < II), female TyD = 52.5% ED (vs. "TyD = 4/5th ED" (= ca. 80%)), flank colouration grey/brown with black spots on lower edge of warts fading to white with darker marbling ventrolaterally (vs. flanks distinctly green, fading ventrally to yellow with brown blotches; based on figure presented in Fei, 1999) lips without (vs. with) dark vertical bars and by possessing weakly expanded disks on toes and fingers III and IV, all digits with ventral circummarginal grooves (vs. "large disks with grooves").

Distribution and habitat.– This species is currently known in the literature from four localities, all in north-east India, Mawphlang Sacred Forest Grove and adjoining forest, vicinity of Mawphlang Village, East Khasi Hills, Meghalaya (25°5'–26°10'N, 89°47'–92°47'E, ca. 1,500–1,800 m asl, in Pillai and Chanda, 1977, and this paper), Churachandpur, Manipur, Chanda (1994), Dzuna (25°37'N, 94°06'E), 1,980 m, Nagaland in Ao et al. (2003) and Mirik, Darjeeling, West Bengal in Chanda, (1986). It should be noted that Chanda (1994) did not mention Darjeeling in the distribution of this species, without providing a reason for omitting his previous record. However, Sarkar et al. (1992) and Dutta (1997) did include Darjeeling but, at least by the former, by implication of Chanda (1986), thus this locality should be reconfirmed by examination of relevant material.

The habitat at the Mawphlang locality consists of a mostly primary broadleaf deciduous and semi-deciduous forest patch with sparse undergrowth. Thicker patches of undergrowth occurs near some parts of streams and around the outer forest borders and borders of forest clearings. Several small clearing are found within the forest, consisting of primarily short varieties of grasses. Undergrowth within the forest contains largely fern species and herbaceous plants. The forest floor substrate has an apparently year round thin layer of leaf litter. Stream beds consist of rocky/gravel substrate with accumulations of leaf litter and sandy soil in pools of lesser flow velocity. This species was not found in a nearby coniferous forest patch (T. Lyngdoh, pers. com.) or from a mixed coniferous and semideciduous broadleaf forest patch bordering Shillong (personal observation). The above mentioned literature does not provide details of the habitat at the specific localities.

Field observations.– Most individuals were found on steep banks of small streams next to larger pools (ca. 1.5–2 m wide, maximum depth ca. 40 cm), except two individuals found on a slightly undulating stream bank consisting of rocks and gravel. The streams were of medium flow rate within the forest, in apparently little disturbed areas under full canopy. Individuals could be found during both day and night searches in the open. One subadult was found beneath a rock during the day. One female ((Figure 2) SVL ca. 66 mm, HW 24 mm, ED 8 mm, TyD 4 mm, IN 8 mm, IO 6 mm), when molested assumed an apparent "defensive posture" (not shown in the photograph). The hind legs were extended somewhat to raise the posterior portion of the body, and the snout dipped to the ground to present the heavily glandular portion of the D-L fold towards the potential aggressor. When handled an obvious odour was produced and relatively large quantities of an opaque white secretion oozed from pustules on the dorsum. This secretion when in contact with broken skin would cause an irritating sharp pain and white discolouration of the adjacent skin, which would last ca. 30 minutes. Another adult male (located at 1835 h, 21.5°C, 92% humidity) (SVL ca. 75 mm, Fig. 2) was found in the open, perched on the horizontal trunk of a fallen tree which transected the upper banks of a fast flowing stream. When handled, it emitted a barely noticeable release/distress call, inflating a shallow, bi-lobed extension of the throat, which was otherwise not observable when deflated. No other vocalizations that could be directly assignable to this species were heard during either survey periods.

Tadpoles and egg colouration of this species are currently unknown. Sympatric frog species found during the combined surveys were *Xenophrys* cf. *parva*, *Sylvirana danieli, Philautus* sp., *Duttaphrynus melanostictus, Amolops* cf. *gerbilis*., *Fejervarya* cf. *teraiensis* and another unidentified megophryid species. Additional species collected previously in the general Mawphlang locality and deposited and identified at the ZSI ERS are *Sylvirana leptoglossa, Polypedates leucomystax, Rhacophorus bipunctatus, Hyla annectens, Euphlyctis "hexadactylus"* and *Amolops formosus*. From the above listed species, *A*. cf. *gerbilis* is the only species likely to be confused with *O. mawphlangensis* at this locality, as both species are quite similar in general appearance, particularly as juveniles. They can best be separated by the presence of considerably enlarged disks on the digits of the former (> 2 X basal phalange width). Regarding other species of the genus *Odorrana* currently recorded from India, there are two, *O. livida* and *O. chloronota*. Both species can easily be distinguished from *O. mawphlangensis* by lacking the combination of characters outlined at the beginning of the 'Comparisons' section.

Although Mawphlang Sacred Forest is protected as a sacred place by the local village members, the major threat faced by all amphibian species here is the excessive use of detergents by local people in washing clothes. On two occasions, dead fish (*Channa* species) were observed floating downstream while people were washing cloths several hundred meters upstream. In fact, for ca. 300 m downstream of two popular washing areas, no frogs or tadpoles and only the occasional fish were observed. Although the solution of this problem is the use of non-toxic alternatives to the detergents currently used, local education and implementation is the only key to improving the situation. Outside the Sacred Forest, the forest patch in the valley to the west has experienced obvious selective felling of trees as dense patches of undergrowth and patchy canopy are evident. Despite this, local environmental awareness events are taking place with tree planting being a key part of the programmes. Several frog species are eaten on occasion by locals, however, this species was not one of them as it is considered poisonous. In contrast, Kiyasetuo (1986) and Ao (1986) listed *Rana mawphlangensis* and tadpoles as commonly eaten in Nagaland.

DISCUSSIONS

Ao et al. (2003) include a character in their brief description of their specimens that differ from specimens of *Odorrana mawphlangensis* from the type locality, "dorsal colour brownish with bluish brown (green in life) spots" (vs. in life, dorsal colour primarily green anteriorly, with brown spots, in *O. mawphlangensis*). This colouration may be simply due to differences in authors perceptions, but due to the current recognition of many new species previously confused within loosely diagnosed taxa, the Nagaland specimens should be reassessed morphologically based on new information provided here. Ao et al. (2003) referred *Rana mawphlangensis* as a new state record, despite previously being listed in Ao (1986) and Kiyasetuo (1986) as an edible species in Nagaland. There was no comment as to why they omitted previous records from Nagaland which adds further questionability to the identification of this population. Additionally, the brief description in Chanda (1986) could apply to a number of ranid species and thus, requires reevaluation of this single specimen. Considering the close overall similarities shared between *Odorrana mawphlangensis* and *O. grahami*, these species should be compared phylogenetically, to assess true affinities with each other, and other co-generics. It is possible that *O. mawphlangensis* is a junior synonym of *O. grahami*. Furthermore, the patchy distribution currently known for this prominent species further emphasizes the lack of knowledge regarding local herpetofaunal communities in northeast India.

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ON THE SYSTEMATICS OF THE GEKKONID GENUS *TERATOLEPIS* GÜNTHER, 1869: ANOTHER ONE BITES THE DUST

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(with two text-figures)

ABSTRACT.– **A molecular phylogenetic analysis (cyt *b*, ND4, RAG-1 and PDC genes) of the two recognized species (*fasciata* and *albofasciata*) of *Teratolepis* and representatives of all major clades of *Hemidactylus* reveals that *Teratolepis* is embedded within the Tropical Asian clade of the latter genus. Its closest relatives are the other small terrestrial South Asian species, *H. reticulatus* and *H. gracilis*. The monophyly of Tropical Asian *Hemidactylus* as a whole is not supported, but the terrestrial clade including *Teratolepis* is well supported as the sister-group to *H. brookii* among the taxa sampled. *Hemidactylus anamallensis* and *H. scabriceps* are likely members of this clade as well. Synonymization of *Teratolepis* with *Hemidactylus* follows earlier actions sinking other small (*Cosymbotus*) or monotypic (*Dravidogecko*, *Briba*) genera that rendered *Hemidactylus* paraphyletic. This action necessitates a new specific epithet for *Hemidactylus fasciatus* (Blyth, 1853) which is a junior secondary homonym of *Hemidactylus fasciatus* Gray 1842, a widespread and common West African gecko. We therefore here erect the replacement name *Hemidactylus imbricatus* nomen novum.**

KEY WORDS. – **Gekkonidae, *Hemidactylus*, *Teratolepis*, molecular phylogeny, taxonomy.**

INTRODUCTION

The '*Hemidactylus* group' of geckos (*Hemidactylus*, *Briba*, *Cosymbotus*, *Dravidogecko*, *Teratolepis*) was identified by Russell (1972, 1976, 1979) on the basis of internal digital anatomy. Bauer and Russell (1995) formally synonymized the monotypic peninsular Indian genus *Dravidogecko* with *Hemidactylus* based on a more detailed consideration of pedal anatomy. A recent species level phylogeny of *Hemidactylus* based on the mitochondrial genes cytochrome *b* and 12S (Carranza and Arnold, 2006) revealed that two other members of the *Hemidactylus* group-*Cosymbotus* (two species, tropical Asia) and *Briba* (monotypic, Brazil)- were in fact embedded deeply within it, rendering *Hemidactylus* paraphyletic and consequently requiring taxonomic action. Although Carranza and Arnold (2006) did not take this action themselves, Zug et al. (2007) formally included the species previously allocated to *Cosymbotus* in *Hemidactylus* and similar action is required in the case of *Briba*. Until now the phylogenetic position of the remaining small genus in the group, *Teratolepis* (two species, India and Pakistan), has not been formally assessed.

The taxonomic history of *Teratolepis* is disproportionately convoluted and complex, given that only two species, *T. fasciata* (Blyth, 1853) and *T. albofasciata* (Grandison and Soman, 1963) are presently recognized (Rösler, 2000; Kluge, 2001). Although the latter is poorly known, the former is fairly common in the pet trade (Mudrack, 1977, 1986; Girard, 1993; Klarsfeld, 2001; Poulíček, 2002; Henkel and Schmidt, 2003).

Teratolepis fasciata (Blyth, 1853) was originally described as *Homonota fasciata* from an unstated locality in British India. Blyth's (1853) allocation to *Homonota*, however, was inconsistent with Gray's (1845) generic diagnosis of that genus, and Günther (1869) subsequently erected the new genus *Teratolepis* to accommodate the species, emphasizing its bizarre scalation (relatively large, flat, weakly imbricate polygonal scales on the dorsum and very large imbricate scales on tail, which is typically swollen basally).

Kluge (1964), in revising the genus *Homonota*, now restricted to South America, moved *Gymnodactylus fasciatus* Duméril and Bibron, 1836 into *Homonota*, creating the new combination *H. fasciata* — a junior secondary homonym of Blyth's (1853) name. Kluge (1964) was aware of the earlier name and indicated "[*non*] *Homonota fasciata:* Jerdon [sic], 1853, p. 468" in his account of this species. Wermuth (1965) subsequently provided a replacement name for *G. fasciatus*, *G. pasteuri*, in order to deal with another instance of secondary homonymy, that between *G. fasciatus* Duméril and Bibron, 1836 and *Uromastix fasciatus* Ménétriès, 1832, a junior subjective synonym of *Gymnodactylus caspius* Eichwald, 1831 (now *Tenuidactylus caspius*). In an addendum to the same work, Wermuth (1965) incorporated Kluge's (1964) generic reallocations and transferred *G. fasciata* Duméril and Bibron, 1836 to *Homonota*, as *Homonota pasteuri* (nomen novum). Although neither name was cited extensively in the following decades, Vanzolini (1968) and Cei (1978) used Wermuth's replacement name, whereas Kluge (1991, 1993) continued to use *H. fasciata*. Abdala and Lavilla (1993) provided further evidence to support Kluge's usage and subsequently, most authors (e.g., Abdala, 1993, 1998; Dirksen and de la Riva, 1999; Rösler, 2000; Kluge, 2001) have employed this name. Abdala and Lavilla (1993) based their argument on the fact that the removal of *H. fasciata* to *Teratolepis* by Günther (1869) obviated the need for a replacement name.

Annandale (1906) described a second species, *Teratolepis scabriceps* from Rámanád [= Ramnad], Madura [= Madurai] District, Tamil Nadu but this species, which has subsequently been collected in Sri Lanka as well (Mariccukatti [= Marichchukkaddi], Northern Province), was removed to a new genus, *Lophopholis*, by Smith and Deraniyagala (1934) on the basis that it possessed the imbricate scales, but not the undivided scansors of *T. fasciata*. Smith (1935) also reported the locality Adiyar [= Adayar] near Madras [= Chennai] for this species. Deraniyagala (1953) recognized the affinity of *Lophopholis* to *Hemidactlyus* by including both genera (along with the dissimilar *Calodactylodes*) in his subfamily Hemidactylinae and most subsequent authors have allocated *L. scabriceps* to the genus *Hemidactylus* (e.g., Loveridge, 1947; Kluge, 1991, 1993, 2001; Das and Andrews, 1997; de Silva, 1996, 1998; Rösler, 2000; Das and de Silva, 2005) although it has been retained as a separate genus by some workers (e.g., Murthy, 1990; Tikader and Sharma, 1992).

Grandison and Soman (1963) described the small terrestrial gecko *Hemidactylus albofasciatus* from the villages of Dorle, Dabhil and Gavkhadi in the Ratnagiri District of Maharashtra. This species has only partly divided subdigital scansors and imbricate scales on the tail. Grandison and Soman (1963) suggested that the affinities of *H. albofasciatus* were with *H. reticulatus*, another small terrestrial *Hemidactylus* with undivided proximal subdigital lamellae. More recently Murthy (1990) suggested a close relationship to another Indian endemic, *H. prashadi*, although the basis for this is unclear as the two taxa exhibit size, colour, scansor, and body and tail scalation features that are greatly dissimilar to one another. Kluge (1967) first transferred *H. albofasciatus* to *Teratolepis* based on a personal communication from Jerry A. Anderson. Subsequent workers have either retained *albofasciatus* in *Hemidactylus* (Murthy, 1990; Tikader and Sharma, 1992; Sharma, 2002), or removed it to *Teratolepis* (e.g., Das et al., 1998; Das, 2001; Rösler, 2000; Kluge, 2001), although none have presented explicit justifications for their allocations.

The recent taxonomic history of both *T. albofasciata* and *H. scabriceps* thus suggests that *Teratolepis* and *Hemidactylus* are closely allied. Indeed, as early as 1876 Theobald noted the similarity of *Teratolepis* to *Hemidactylus* spp., especially with respect to head scalation. The close relationship of these two genera was recently confirmed by Han et al. (2004) and Feng et al. (2007), who found that *Hemidactylus* and *Teratolepis* shared, along with *Agamura*, *Crossobamon*, *Cyrtodactylus* and *Geckoella*, a 9 bp insertion and a 21 bp deletion in the nuclear gene c-mos. Unfortunately, however, this analysis used only generic exemplars and an even more recent species-level phylogeny of *Hemidactylus* based on mitochondrial genes (Carranza and Arnold, 2006) did not include any specimens of *Teratolepis* spp., nor any other endemic South Asian taxa.

The recent rediscovery of *Teratolepis albofasciata* by one of us (VG) at Dorle village provided genetic material to assess the relationships of this taxon and precipitated a reinvestigation of the status of *Teratolepis* and its affinities with respect to *Hemidactylus*.

MATERIALS AND METHODS

Based on preliminary results from a broad scale phylogenetic analysis of all gekkotan lizards (Bauer, Jackman and Greenbaum, unpublished) the affinities of *Teratolepis* with *Hemidactylus* (Han et al., 2004; Feng et al., 2007) were confirmed. For this study, we thus included in our ingroup the two species currently assigned to *Teratolepis,* as well as representatives of Carranza and Arnold's (2006) five major clades, as well as the West African species *H. fasciatus*, which they sampled but did not include in any of their named clades. As geographic proximity suggested that affinities of *Teratolepis* would most likely be with Carranza and Arnold's "Tropical Asian Clade", we included representatives of all of the constituent taxa reported on by Carranza and Arnold (2006), as well as the Indian endemics *H. reticulatus* and *H. gracilis*. These two species have been proposed to be closely allied to one another (Bauer et al., 2005) and the former species had previously been predicted to be allied to *Teratolepis albofasciata* (Grandison and Soman, 1963). We used three representatives of the chiefly southeast Asian/Indo-Australian genus *Cyrtodactylus* as outgroup taxa based on the results of Han et al. (2004) and Feng et al. (2007). Specimens sampled and their associated clade membership based on Carranza and Arnold (2006) are listed in Table 1.

Genomic DNA was isolated from 95–100% ethanol-preserved tail or liver samples with the Qiagen DNeasy tissue kit (Valencia, CA, USA). We used double-stranded PCR to amplify 3733 aligned bases of mitochondrial (ND2, ND4, cyt *b*) and nuclear (RAG1, PDC) gene sequence data with five different pairs of published primers (Table 2). For some key taxa, not all five genes could be sequenced: ND2, ND4 and RAG1 lacking for *Hemidactlyus reticulatus*; cyt *b*, ND4, RAG-1 and PDC lacking for *H. gracilis* and *Teratolepis albofasciata*).

Amplification of 25 µl PCR reactions was executed on an Eppendorf Mastercycler gradient thermocycler. Amplification of genomic DNA occurred with an initial denaturation step of 95°C for 2 min, followed by denaturation at 95°C for 35 s, annealing at 50°C for 35 s, and extension at 72°C for 95 s with 4 seconds added to the extension per cycle for 32 cycles for mitochondrial DNA and 34 cycles for nuclear DNA. When necessary, annealing temperatures were adjusted to increase or decrease specificity on a case by case basis, and products were visualized with 1.5% agarose gel electrophoresis. Target products were purified with AMPure magnetic bead solution (Agencourt Bioscience) and sequenced with either the BigDye® Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems) or the DYEnamic™ ET Dye Terminator Kit (GE Healthcare). Sequencing reactions were purified with CleanSeq magnetic bead solution (Agencourt Bioscience) and analyzed with an ABI 3700 automated sequencer. The accuracy of sequences was ensured by incorporating negative controls and sequencing complementary strands. Sequences were aligned by eye in the computer program SeqMan, and protein-coding genes were translated to amino acids with MacClade (Maddison and Maddison, 1992) to confirm conservation of the amino acid reading frame and check for premature stop codons.

Phylogenetic relationships among the samples were assessed with maximum parsimony and Bayesian optimality criteria. Based on the missing data indicated above, three datasets were analyzed: RAG1, PDC, ND2, ND4 and cyt *b* (all taxa except *T. albofasciata*, *H. reticulatus* and *H. gracilis*), PDC and cyt *b* (all taxa except *T. albofasciata* and *H. gracilis*), and ND2 alone (all taxa except *H. reticulatus*).

Maximum parsimony (MP) analyses were conducted in PAUP*4.0b10 (Swofford, 2002). The heuristic search algorithm was used with the following conditions: 25 random-addition replicates, accelerated character transformation (ACCTRAN), tree bisection-reconnection (TBR) branch swapping, zero-length branches collapsed to yield polytomies, and gaps treated as missing data. Each base position was treated as an unordered character with four alternate states. We used nonparametric bootstraps (1000 pseudoreplicates) to assess node support in resulting topologies.

The Akaike Information Criterion (AIC) in ModelTest 3.06 (Posada and Crandall, 1998) was used to find the model of evolution that best fit the data for subsequent Bayesian inference (BI) analyses. The GTR + γ + I model was used with the most parsimonious tree to estimate the parameters, and the same conditions as the parsimony search were used to find the Bayesian trees with the best likelihood scores.

Partitioned Bayesian analyses were conducted with MrBayes 3.1 (Ronquist and Huelsenbeck, 2003) with default priors. Separate models for each gene and codon position of protein-coding genes were estimated (Brandley et al., 2005). A total of 10 partitions were made: RAG1, 3 codons; PDC, 3 codons, ND2, ND4 and cyt *b*, 3 codon positions; and mitochondrial tRNAs. Analyses were initiated with random starting trees and run for 2,000,000 generations; Markov chains were sampled every 100 generations. Convergence was checked by plotting likelihood scores against generation, and 125 trees were discarded as "burn in." Two separate analyses with two independent chains were executed to check for convergence of log-likelihoods in stationarity (Huelsenbeck and Ronquist, 2001). Both analyses ended with the standard deviation of split frequencies less than 0.01.

RESULTS

The dataset based on all genes yielded a Bayesian tree (Fig. 1) in which each of Carranza and Arnold's (2006) clades except the 'Tropical Asian Clade' were monophyletic with posterior probabilities of 1.0. The *H. angulatus* clade was sister to the remaining members of the genus, which were themselves divided into two weakly supported clades (pp < 0.90): one consisting of *H. fasciatus* as the sister group of a subset of the Tropical Asian clade comprising *H. garnotii*, *H. karenorum*, *H. bowringii* and *H. platyurus* (we here follow Zug et al., 2007 in formally allocating the members of the genus *Cosymbotus* to *Hemidactylus*), and another with the remaining Tropical Asian forms as the sister group to the Arid clade plus the African-Atlantic and *H. mabouia* clades. Support for interclade relationships was generally weak, with only the union of *H. mabouia* with the African-Atlantic clade receiving strong support (pp = 1.0). Within the Tropical Asian species, all relationships in both clades, except the sister group relationship of *H. garnotii* and *H. bowringii* were supported by posterior probabilities of 1.0. In this analysis, *Teratolepis fasciata* was strongly supported as the sister species of *H. brookii,* with *H. frenatus* and *H. flaviviridis* as sequentially more distant relatives.

In the Bayesian analysis of ND2 alone, all of Carranza and Arnold's (2006) clades were monophyletic, although the Tropical Asian clade had no significant support (pp = 0.62). All other interclade relationships were well-supported, but the tree topology differed greatly from that of the previous analysis: Arid clade ((*H. mabouia*, African-Atlantic clade) ((*H. fasciatus*, *H. angulatus* clade) Tropical Asian clade)). Within the Tropical Asian clade, the same two groupings revealed by the larger data set were recovered, but in this case *H. karenorum* was weakly supported as the sister of *H. garnotii* (pp = 0.60). In the *H. brookii* subclade, relationships among the species dealt with in the previous analysis were identical. The added taxa, *Teratolepis albofasciata* and *H. gracilis* were strongly supported as sequential sister taxa to *Teratolepis fasciata*, with all three taxa sister to *H. brookii* (Fig. 2A).

In the PDC and cyt *b* analyses, all higher order relationships, except the monophyly of *Hemidactylus* sensu lato and the union of *H. mabouia* with the African-Atlantic clade (pp = 1.0), received weak support and were different from both previous analyses: *H. angulatus* clade (Arid clade (*H. fasciatus* (*H. mabouia*, African-Atlantic clade) Tropical Asian clade))). Relationships also differed within the Tropical Asian clade, with *H. flaviviridis* more closely related to the *H. bowringii* group than to the *H. brookii* group. However, the remaining relationships within the *H. brookii* group were identical to both other analyses with respect to shared taxa (Fig. 2B). The additional taxon for which only PDC and cyt *b* were available, *H. reticulatus*, was strongly supported as the sister to *T. fasciata*.

Maximum parsimony analyses of the same datasets yielded less well-resolved trees that were, however, fully consistent with the Bayesian analyses. Parsimony bootstrap support was high (> 90%) for all clades that also had high posterior probabilities (Fig. 1). In the ND2 and PDC + cyt *b* analyses, *H. gracilis* and *Teratolepis albofasciata*, and *H. reticulatus*, respectively, were likewise strongly supported as constituting a monophyletic group with *T. fasciata* (Fig. 2).

DISCUSSION

Phylogeny.– With respect to the monophyly of each of the clades identified by Carranza and Arnold (2006), our results are consistent with these authors' own findings of moderate to high support values. On the other hand, our different analyses yielded different patterns of relationship among these clades, an unsurprising result, given that Carranza and Arnold (2006) reported no significant support values for inter-clade relationships in their analyses. However, our data did yield consistent support for the sister group relationship of *H. mabouia* and the African-Atlantic clade. The position of *H. fasciatus* remains problematic, grouping weakly with the *bowringii* group of the Tropical Asian clade (all genes) or the *H. mabouia*/African-Atlantic clade + all Tropical Asian taxa (PDC and cyt *b*), or strongly with the *H. angulatus* clade (ND2).

Patterns within the Tropical Asian clade are more consistent. The two clades reflected in Carranza and Arnold's (2006) results, the *H. bowringii* and *H. brookii* groups, are always retrieved, although in the PDC/cyt *b* tree, *H. flaviviridis* clustered weakly with the *H. bowringii* group, rather than with the *H. brookii* group. Patterns within the *H. bowringii* group varied slightly between analyses and from those reported by Carranza and Arnold (2006). However, patterns within the *H. brookii* group were consistent and in the five-gene analysis, *Teratolepis fasciata* was the sister group to *H. brookii*. Based on the ND2 data, the two species of *Teratolepis* are each other's sister species and are nested deep within the *Hemidactlyus* tree, closer to *H. gracilis* than to *H. brookii*. Although we lack ND2 data for *H. reticulatus*, this species is strongly supported as the sister group to *Teratolepis* by cyt *b* data (lacking for *H. gracilis* and *T. albofasciata*). With the available data, it is not possible to resolve the relationships of *H. gracilis*, *H. reticulatus* and *Teratolepis* to one another, but it is clear that all four are members of a single, well-supported clade.

Teratolepis is just one of several small genera of geckos that have long been recognized as allied to *Hemidactylus*, but which have been segregated because of their possession of one or more recognizable features, which although diagnostic, are probably best regarded as autapomorphic and not indicative of higher relationships. Parker (1942), who studied the speciose and morphologically diverse *Hemidactylus* of the Horn of Africa, considered generic arrangements that partitioned *Hemidactylus*-like genera into different groups to be largely arbitrary. However, prevailing systematic views of the period favored the recognition of morphologically distinctive groups, even if this rendered other groups paraphyletic.

The strongly supported inclusion of *Teratolepis* within *Hemidactylus* is not surprising. Earlier authors (Grandison and Soman, 1963; Murthy, 1990) hypothesized close relationships between *T. albofasciata* and South Asian *Hemidactylus*, and Anderson (1964) noted similarities in the vocalizations of *T. fasciata* in the Indus Delta plain to those of sympatric *Hemidactylus*. Russell (1972, 1976, 1979), who argued that internal digital anatomy was a more reliable indicator of homology and affinity than external form, defined a '*Hemidactylus* group' of geckos (*Hemidactylus*, *Briba*, *Cosymbotus*, *Dravidogecko*, *Teratolepis*) based on a series of apparently derived internal digital structures: dorsal interossei muscles robust — with fleshy bellies extending as far as the digital inflection, tendinous insertion of dorsal interossei muscles onto distal margin of each scansor, and antepe-

Table 1. List of samples used in this study and their membership in the clades of *Hemidactylus* identified by Carranza and Arnold (2006). Collection abbreviations: AMB = Aaron M. Bauer field series, BNHS = Bombay Natural History Society, CAS = California Academy of Sciences, FK = Fred Kraus field series, FMNH = Field Museum of Natural History, ID = Indraneil Das field series, JFBM = James Ford Bell Museum, University of Minnesota, St. Paul, JS = Jay Sommers (Kansas City), KU = University of Kansas Natural History Museum, LLG = L. Lee Grismer field series, LSUMZ = Louisiana State University Museum of Natural Sciences, MCZ = Museum of Comparative Zoology, Harvard University, MVZ = Museum of Vertebrate Zoology, University of California, Berkeley, MZUSP = Museu de Zoologia da Universidade de São Paulo, WRB = William R. Branch field series.

Sample	Clade Membership (Carranza & Arnold, 2006)	Museum No.	Locality	GenBank Accession Numbers				
				cyt b	ND2	ND4	RAG-1	PDC
Cyrtodactylus ayeyawardyensis	—/outgroup	CAS 216446	Myanmar, Rakhine State, vic. Kanthaya Beach	EU268380	EU268348	EU268411	EU268287	EU268317
Cyrtodactylus consobrinus	—/outgroup	LLG 4062	Malaysia, Sarawak, Niah Cave	EU268381	EU268349	EU268412	EU268288	EU268318
Cyrtodactylus loriae	—/outgroup	FK 7709	Papua New Guinea, Milne Bay Province, Bunisi, N slope of Mt. Simpson	EU268382	EU268350	EU268413	EU268289	EU268319
Hemidactylus cf. *angulatus*	H. angulatus	MVZ 245438	Nigeria, Togo Hills, Nkwanta	EU268399	EU268367	EU268430	EU268306	EU268336
Hemidactylus bowringii 1	Tropical Asian	CAS 206649	Myanmar, Sagaing Division, Alaungdau Kathapa Natl. Park	EU268405	EU268373	EU268436	EU268312	EU268342
Hemidactylus bowringii 2	Tropical Asian	CAS 228109	China, Yunnan Province, Nujang District, Liuku	EU268406	EU268374	EU268437	EU268313	EU268343
Hemidactylus brasilianus	African-Atlantic	MZUSP 92493	Brazil, Piauí, Parque Nacional Serra das Confusões	EU268383	EU268351	EU268414	EU268290	EU268320
Hemidactylus brookii 1	Tropical Asian	LLG 6755	Malaysia, Pulau Pinang, Empangon Air Hitam	EU268398	EU268366	EU268429	EU268305	EU268335
Hemidactylus brookii 2	Tropical Asian	LLG 6754	Malaysia, Pulau Pinang, Empangon Air Hitam	EU268397	EU268365	EU268428	EU268304	EU268334
Hemidactylus brookii 3	Tropical Asian	CAS 206638	Myanmar, Mandalay Division	EU268407	EU268375	EU268438	EU268314	EU268344
Hemidactylus fasciatus 1	not placed in clade	WRB no number	Gabon, Rabi	EU268402	EU268370	EU268433	EU268309	EU268339
Hemidactylus fasciatus 2	not placed in clade	CAS 207777	Equatorial Guinea, Bioko Island, 3.6 km N of Luba	EU268403	EU268371	EU268434	EU268310	EU268340
Hemidactylus flaviviridis 1	Tropical Asian	FMNH 245515	Pakistan, Punjab Province	EU268387	EU268355	EU268418	EU268294	EU268324
Hemidactylus flaviviridis 2	Tropical Asian	ID 7626	India, Rajasthan, Kuldhara	EU268388	EU268356	EU268419	EU268295	EU268325

Hemidactylus frenatus 1	Tropical Asian	LLG 6745	Malaysia, Pulau Pinang, Empangon Air Hitam	EU268390	EU268358	EU268421	EU268297	EU268327
Hemidactylus frenatus 2	Tropical Asian	AMB 7411	Sri Lanka, Pidipitiya	EU268389	EU268357	EU268420	EU268296	EU268326
Hemidactylus frenatus 3	Tropical Asian	AMB 7420	Sri Lanka, Rathegala	EU268391	EU268359	EU268422	EU268298	EU268328
Hemidactylus garnotii 1	Tropical Asian	CAS 223286	Myanmar, Rakhine State, Taung Gok Township, Ma Ei Ywa Ma Village	EU268395	EU268363	EU268426	EU268302	EU268332
Hemidactylus garnotii 2	Tropical Asian	CAS 222276	Myanmar, Mon State, Kyaihto Township, Kyait Hti Yo Wildlife Sactuary	EU268396	EU268364	EU268427	EU268303	EU268333
Hemidactylus gracilis	not included	BNHS 1592	India, Maharashtra, Pune	—	EU268379	—	—	—
Hemidactylus greeffii	African-Atlantic	CAS 219044	São Tome and Principe, São Tome Island, Praia da Mutamba	EU268401	EU268369	EU268432	EU268308	EU268338
Hemidactylus haitianus	H. angulatus	CAS 198442	Dominican Republic, Nacional Dist., near Santo Domingo	EU268404	EU268372	EU268435	EU268311	EU268341
Hemidactylus karenorum	Tropical Asian	CAS 210670	Myanmar, Mandalay Division, Kyaukpadaung Township, Popa Mt. Park	EU268394	EU268362	EU268425	EU268301	EU268331
Hemidactylus mabouia	H. mabouia	MCZ R-184446	South Africa, Limpopo Province	EU268393	EU268361	EU268424	EU268300	EU268330
Hemidactylus palaichthus	African-Atlantic	LSUMZ H-12421	Brazil, Roraima State	EU268400	EU268368	EU268431	EU268307	EU268337
Hemidactylus persicus	Arid	CAS 227612	Oman, Wilayat Nazwa, 4.5 km N. of Tanuf, Wadi Tanuf	EU268409	EU268377	EU268440	EU268316	EU268346
Hemidactylus platyurus	Tropical Asian	KU 304111	Philippines, Lubang	EU268384	EU268352	EU268415	EU268291	EU268321
Hemidactylus reticulatus	not included	AMB 5730	India, Tamil Nadu, Vellore	EU268410	—	—	—	EU268347
Hemidactylus robustus	Arid	MVZ 248437	Pakistan, Thatta District, 40 km S of Mipur Sakro	EU268408	EU268376	EU268439	EU268315	EU268345
Hemidactylus turcicus	Arid	LSUMZ H-1981	USA, Louisiana, Baton Rouge	EU268392	EU268360	EU268423	EU268299	EU268329
Teratolepis albofasciata	not included	BNHS 1579	India, Maharashtra, Ratnagiri District, Dorle Village	—	EU268378	—	—	—
Teratolepis fasciata	not included	JS 11	Pakistan (captive specimen)	EU268385	EU268353	EU268416	EU268292	EU268322
Teratolepis fasciata	not included	JFBM 2	Pakistan (captive specimen)	EU268386	EU268354	EU268417	EU268293	EU268323

Table 2. Primers used in this study.

Primer	Gene	Reference	Sequence
ND4f11	ND4	Jackman et al. (2008)	5'-GCAAATACAAACTAYGAACG-3'
Leur1	Leu tRNA	Arevalo et al. (1994)	5'-CATTACTTTTACTTGGATTTGCACCA-3'
PHOF2	PDC	Bauer et al. (2007)	5'-AGATGAGCATGCAGGAGTATGA-3'
PHOR1	PDC	Bauer et al. (2007)	5'-TCCACATCCACAGCAAAAAACTCCT-3'
L4437b	Met tRNA	Macey et al. (1997)	5'-AAGCAGTTGGGCCCATACC-3'
L5002	ND2	Macey et al. (1997)	5'-AACCAAACCCAACTACGAAAAAT-3'
ND2f101	ND2	Greenbaum et al. (2007)	5'-CAAACACAAACCCGRAAAAT-3'
ND2r102	ND2	Greenbaum et al. (2007)	5'-CAGCCTAGGTGGGCGATTG-3'
Trpr3a	Trp tRNA	Greenbaum et al. (2007)	5'- TTTAGGGCTTTGAAGGC-3'
H5934a	COI	Macey et al. (1997)	5'- AGRGTGCCAATGTCTTTGTGRTT-3'
R13	RAG1	Groth and Barrowclough (1999)	5'- TCTGAATGGAAATTCAAGCTGTT-3'
R18	RAG1	Groth and Barrowclough (1999)	5'-GATGCTGCCTCGGTCGGCCACCTTT-3'
RAG1 F700	RAG1	Bauer et al. (2007)	5'-GGAGACATGGACACAATCCATCCTAC-3'
RAG1 R700	RAG1	Bauer et al. (2007)	5'-TTTGTACTGAGATGGATCTTTTTGCA-3'

nultimate phalanx on digits III and IV of manus and III-V of pes short and erect. In addition, all members of this group that have paraphalanges possess the *Hemidactylus* type, lying within the lateral digital tendons (Russell and Bauer, 1988).

Subsequent phylogenetic work has borne out the evolutionary reality of this cluster of genera; Carranza and Arnold (2006) demonstrated that both *Cosymbotus* and *Briba* were embedded within major clades of *Hemidactylus* — a fact corroborated here. Both of these groups have typical *Hemidactylus*-type divided subdigital scansors and are arboreal.

The two *Hemidactylus* that are particularly closely related to *Teratolepis*, *H. gracilis* and *H. reticulatus* are poorly known, but both are primarily terrestrial (Sanyal et al., 1993; Murthy, 1990; Bauer et al., 2005) as are the *Teratolepis* species (Grandison and Soman, 1963; Anderson, 1964; Minton, 1966). As early as 1912 Annandale suggested that *H. gracilis* (as *H. platyceps*) was most closely related to *H. reticulatus*, and in 1972, Russell had identified a group within *Hemidactylus* that shared a distinctive pattern of digital anatomy — this comprised *H. albofasciatus*, *H. gracilis* and *H. reticulatus*, as well as the Socotran species *H. pumilo*, which is also terrestrial (Rösler and Wranik, 2000, 2003). The remaining member of Russell's *Hemidactylus* group, *Dravidogecko anamallensis*, is also chiefly terrestrial or rupicolous (Gvoždik and Veselý, 1998; Henkel and Schmidt, 2003). All of these taxa share a number of morphological features in common with each other that are associated with their terrestrial habitus. Bauer and Russell (1995) demonstrated that undivided subdigital scansors were shared by *T. fasciata*, *H. reticulatus* and *Dravidogecko anamallensis* and that an intermediate pattern of divided distalmost scansors occurred in *T. albofasciata*, as well as a few *Hemidactylus* sensu stricto, such as *H. bouvieri* and *H. somalicus*. Based on the continuum between divided and undivided scansors, the fact that at least one *Hemidactylus* has completely undivided scansors, and their shared internal digital anatomy, Bauer and Russell (1995) synonymized *Dravidogecko* with *Hemidactylus*. Although they did not explicitly address the taxonomic status of *Teratolepis*, identical arguments could be made for its synonymization with *Hemidactylus*. Unfortunately, we lacked tissue samples of *Hemidactylus* (formerly *Dravidogecko*) *anamallensis* and are unable to assess whether it is also a member of the *Teratolepis* clade or if its undivided scansors represent a convergent morphology within the Tropical Asian clade of *Hemidactylus*, although on biogeographic grounds, we suspect the former interpretation. Bauer and Russell (1995) concluded that *H. anamallensis* was a relatively primitive *Hemidactylus*, but if we are correct in our conjecture, it represents part of a highly derived lineage that has undergone secondary loss of some scansorial features. *Hemidactylus scabriceps* may well also be a member of this radiation as it shares imbricate scalation with *Teratolepis* spp. This taxon is particularly poor-

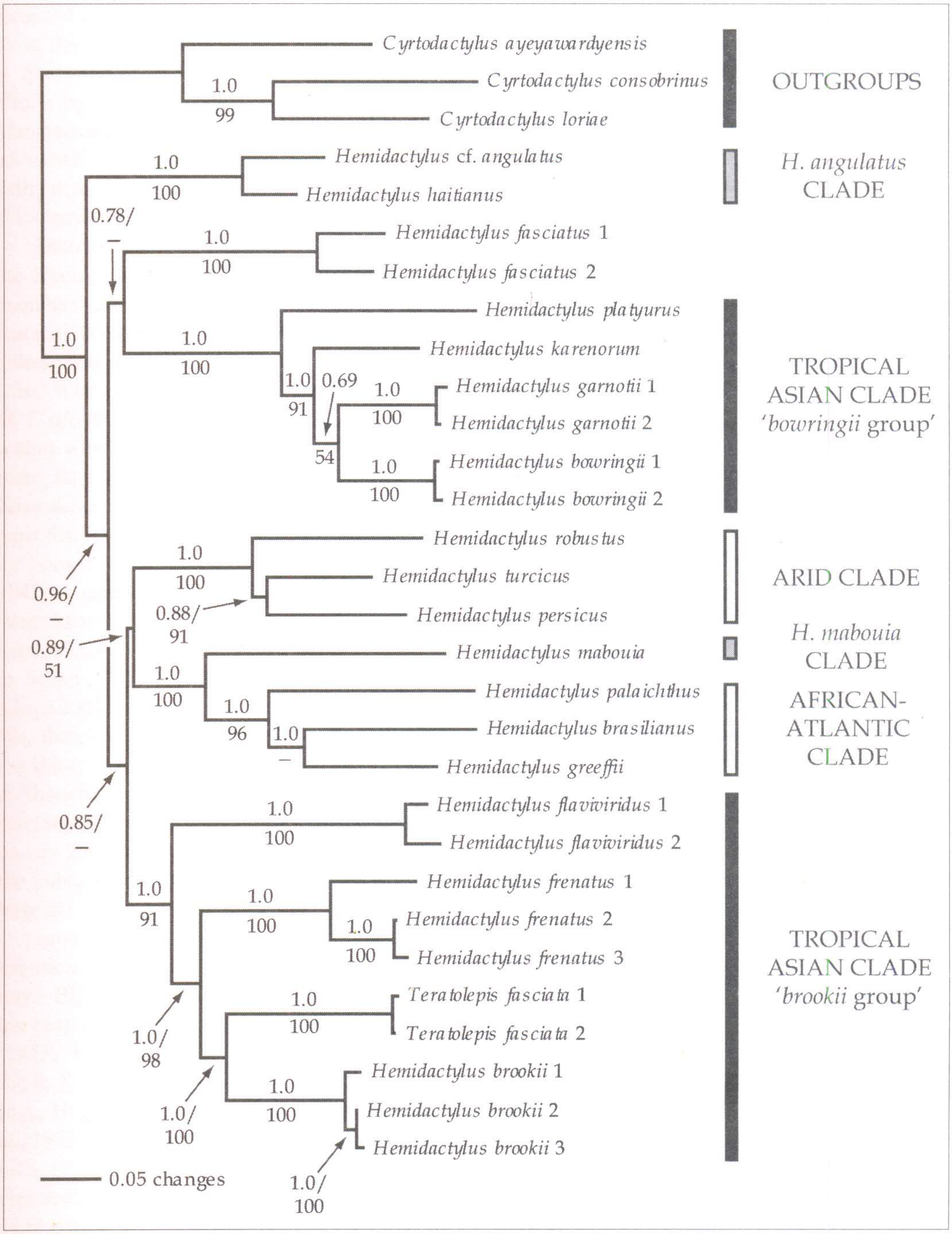

Figure 1. Phylogenetic relationships among *Teratolepis fasciata* and representative species of *Hemidactylus* based on the combined analysis of the mitochondrial genes ND2, ND4 and cyt *b*, and the nuclear genes RAG1 and PDC. Bayesian inference tree with branch lengths corresponding to those of tree with best likelihood score. Bayesian posterior probabilities indicated above the branches and maximum parsimony bootstraps indicated below. Bars at right indicate membership in the main clades of *Hemidactylus* identified by Carranza and Arnold (2006). Note the lack of support for a monophyletic Tropical Asian Clade and the strong support for the inclusion of *Teratolepis fasciata* within the *brookii* group.

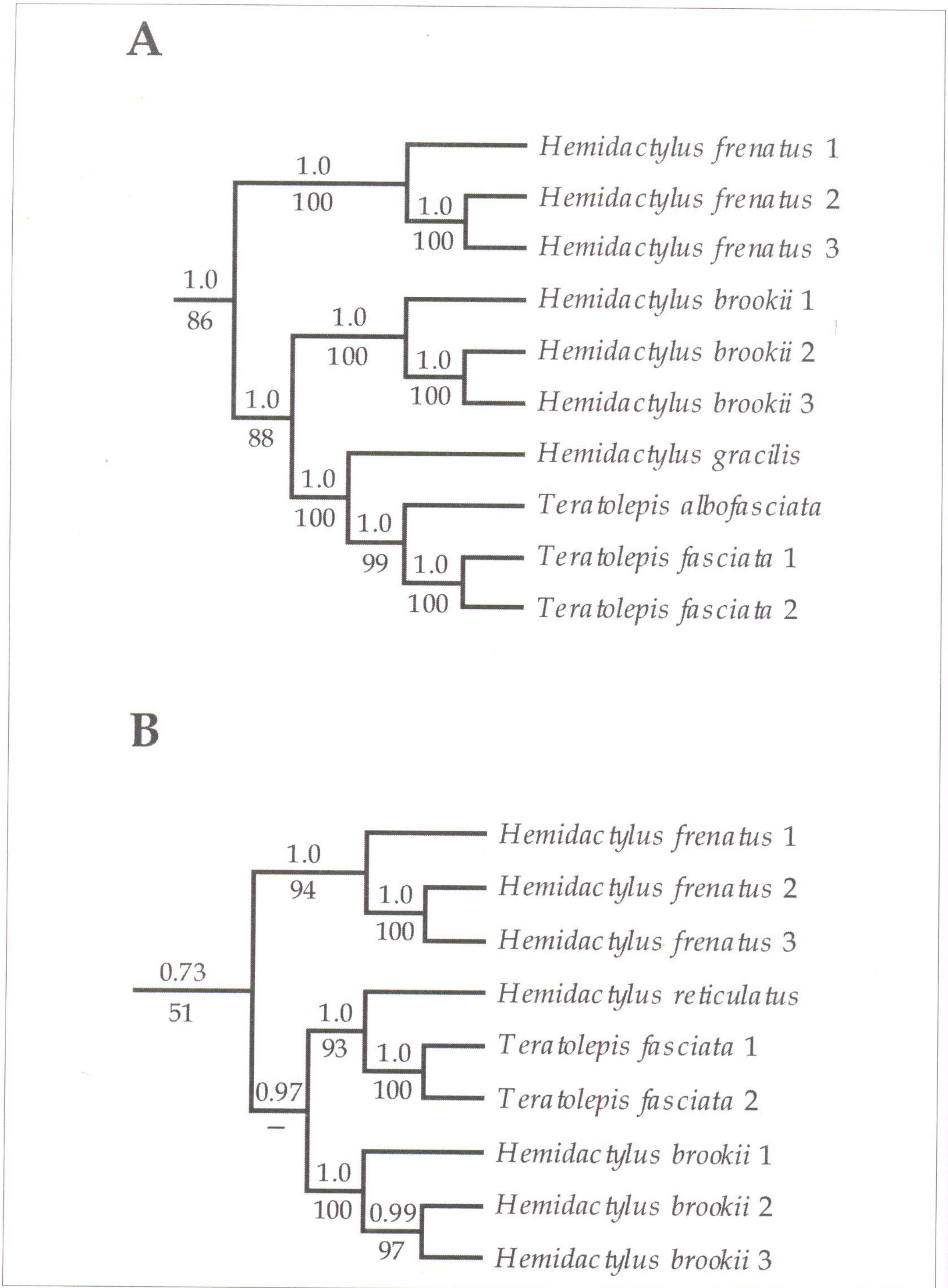

Figure 2. Phylogenetic relationships among members of the *Hemidactylus brookii* group based on ND2 alone (A) and cyt *b* and PDC alone (B). The analyses of these particular partitions permitted the inclusion of key taxa for which complete data were lacking: *H. gracilis* and *Teratolepis albofasciata* (A) and *H. reticulatus* (B). Results of the phylogenetic analyses of all taxa sampled are presented in the text. Topologies depicted are from the Bayesian tree and do not show likelihood branch lengths. Bayesian posterior probabilities indicated above the branches and maximum parsimony bootstraps indicated below. The added taxa are strongly supported as members of the *brookii* group and as close relatives of *Teratolepis fasciata* in particular.

ly known, with no new specimens having been recorded since Smith (1935). Indeed, the validity of the Sri Lankan record, dating from 1933, is questionable and relatively intense search efforts by several groups of researchers (e.g., Manamendra-Arachchi, 1997) have yielded no additional specimens. It has been considered extirpated by some authors (Somaweera and Wickramasinghe, 2006).

Taxonomic Implications.– Regardless of the precise pattern of relationships among the members of the *Teratolepis* group, it is clear that maintenance of monophyletic groupings requires their collective inclusion into *Hemidactylus*. While this poses no problem in the case of *T. albofasciata*, which reverts to the genus within which it was initially described, it has more far-reaching taxonomic implications for *Teratolepis fasciata* which becomes *Hemidactylus fasciatus* (Blyth, 1853), a secondary junior homonym of *Hemidactylus fasciatus* Gray, 1842, a common and widespread species of West African gecko. There are no junior synonyms available for *T. fasciata* (see synonymies in Smith 1935; Wermuth 1965; Rösler 2000; Kluge 2001) so a replacement name is required. We, therefore, propose *Hemidactylus imbricatus* Bauer, Giri, Greenbaum, Jackman, Dharne & Shouche as a *nomen novum* for *Hemidactylus fasciatus* (Blyth, 1853) in order to prevent secondary homonymy. The specific epithet refers to the imbricate scales of the dorsum, and particularly the tail of this species.

Comments on original description and distribution of *Hemidactylus imbricatus*, nom. nov.– Blyth's description of *Homonota fasciata* has been cited as Blyth or Blyth in Jerdon "1854 (1853)" by several recent authors (e.g., Das et al., 1998; Kluge, 2001) and many modern authors (e.g., Hoge and Romano Hoge, 1981; Golay et al., 1993; McDiarmid et al.,1999; David and Ineich, 1999) have given the date of 1854 to species described by Jerdon in the same paper. The 1854 date is almost certainly based on that on the title page of the entire volume in which the paper appeared. However, the original wrappers on the specific part of the journal containing this paper (Volume 22[VI] = issue CCXXXVII) are dated 1853 and in the absence of information to the contrary, we follow Bauer (2003) and accept this date as correct.

Although Blyth (1853) did not specify the origin of the types of *Homonota fasciata*, Theobald (1876) subsequently stated that the type locality was "Jaulnah," Hyderabad Province [= Jalna, Maharashtra]. It is unclear from the description if there was more than one type specimen, but ZSI 5981, now in terrible condition, has been regarded as the holotype. Das et al. (1998), however, noted that BMNH 69.8.28.32, presented by Dr. A. H. Leith from Sind, might be a syntype. This assertion was based on a penciled note in the BMNH loose-leaf catalogue, but is not substantiated by any other data (C. J. McCarthy in litt. April 2007). Indeed, it is clear that this specimen is that examined and discussed by Günther (1869).

Boulenger (1890) and Annandale (1905) considered *T. fasciata* to be distributed in Sind and the Deccan — the latter based solely on Theobald's (1876) Jalna record. The populations in Pakistan are well documented. Smith (1935), Anderson (1964), Minton (1962, 1966), Mertens (1969), and Khan (2002, 2004) reported *T. fasciata* from the Indus Delta of Sind and Minton (1966) considered it restricted to the Tatta and Hyderabad districts of the province. Khan (1999) characterized its habitat as tropical thorn forest and sand dunes in semi-desert areas of the Thar Desert and later (Khan, 2006) as *Salsola* and grass-dominated areas of desert scrub vegetation on silt. Although some of the reported localities to the east of the Indus River approach the Indian border quite closely, there have been no records from adjacent Rajasthan.

Aside from the Jalna record, the only locality in the current territory of the Republic of India is that reported by Smith (1935) from Shillong in the Khasi Hills of north-eastern India. Both Indian localities were considered erroneous by Minton (1966) and Khan and Mirza (1977), and Das (2001) considered only Pakistani records to be valid. Nonetheless, *Teratolepis fasciata* has continued to be listed as part of the Indian fauna by many subsequent authors (e.g., Daniel, 1983, 2002; Murthy, 1990; Tikader and Sharma, 1992; Mathew, 1995; Sharma, 2002). Tikader and Sharma (1992) added an unspecified record from Tamil Nadu and also incorrectly included Sri Lanka in the range of the species. All these records are almost certainly incorrect. However, one of the authors (VBG) has recently discovered a new species of *Hemidactylus* clearly allied to *H. imbricatus* from Maharashtra (to be described elsewhere) and it is possible that this species (or *H. albofasciatus* or *H. scabriceps*) might have been responsible for at least the doubtful peninsular localities, particularly if identification was based on the imbricating caudal scalation shared by all of these taxa.

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EXPLOITATION OF SEA TURTLES ALONG THE SOUTH-EASTERN AND SOUTH-WESTERN COASTS OF INDIA

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ABSTRACT.– **Clandestine sea turtle trade was noticed during the present study in Vizhinjam area in Kerala and Tuticorin Gulf of Mannar in Tamil Nadu. During the course of observation, a total of 45 turtles belonging to 3 species were found to be traded in the fish market of Kattakada in Kerala. Olive ridley *Lepidochelys olivacea* (57.7%) followed by the green turtle *Chelonia mydas* (31.1%) and the hawksbill turtle *Eretmochelys imbricata* (11.2%) were the species traded. Of them, 44% were sub adults, 24% males and 32% females. A maximum trade was witnessed during the breeding season (December–March) (65.4%) and only 34.6% of turtles were recorded during the non-breeding season. In Tuticorin fish markets a total of 33 turtles was found to be traded. The green turtle constituted 63.6%, which included 7 males (33.3%), 11 females (52.3%) and 3 sub adults (14.4%). A total of 12 olive ridleys (36.4%) were traded of which 58.4% were females, 25% males and 16.6% were sub adults. Trade of egg bearing females were also noticed in the fish markets during the breeding seasons. There were no incidences of turtle poisoning during the entire period of observations either at Vizhinjam area or at Tuticorin.**

KEY WORDS.– **Sea turtles, clandestine trade, turtle poisoning, Gulf of Mannar, Vizhinjam.**

INTRODUCTION

Of late, sea turtle population is adversely affected by human activity by direct exploitation for their meat, blood and eggs. Particularly, in developing countries, the need for protein and income generated by sea turtles and their by-products greatly exceeds any desire for their preservation. Moreover, all sea turtle life stages have been exploited, perhaps with the exception of hatchlings. Breeding adults, sub adults and their eggs have been most vulnerable (Lutz and Musick, 1991). Sea turtle population is faced with problems of over harvest or even population collapse and commercial extinction. In every documented case, it is large scale exploitation by man that has lead to drastic reduction in numbers. Due to this reason, turtles now are listed as threatened (Ross, 1982). The exploitation of sea turtles for meat continues without any stoppage. In the Indian Ocean, sea turtles are exploited by subsistence hunters (Frazier, 1980). Among sea turtles the green turtle is considered the most valuable since its flesh is a delicacy and the main source of the famous turtle soup on account of which the turtle itself is called by Germans as 'Supenchild Krote' (soup turtle). Demand for the green turtle blood in Southern part of Tamil Nadu India, where it is believed by the locals to be an elixir (Rajagopalan, 1984). Turtles are sought after primarily for their meat. Demand for international commerce is now an insignificant factor, but has been replaced by increasing demand for subsistence and local markets by indigenous people, whose population is increasing day by day. In spite of the Wildlife Protection Act (1972) to protect sea turtles, the clandestine trade has been significant over the years and some illegal trade continues still today. Based on the foregoing account, it is evident that despite the long-standing value of this resource, its future is in jeopardy. Many turtle populations have declined to the point where they are no longer a significant resource. In some areas these reptiles are not just diminished in number but they are endangered. There is an unrelenting urgency to understand the status of sea turtles and the pressure to which they are being subjected. Exploitation is one of the most direct threats and easily identified of problems. In some cases, it causes tremendous strains on a population, especially where commercial ventures are involved. If these natural resources are to be available and significant in the future, they must be managed, and management problems must therefore to be identified. Available literature on the sea turtle trade states that the trade was flourishing in the east coast of India and Gulf of Mannar coast. No comprehensive report is available regarding the trade of sea turtles from the west coast of India. Therefore, the present investigation was carried out in the markets around Vizhinjam in Kerala, Tuticorin in Tamil Nadu and Saurashtra coast in Gujarat. It was observed that trade for all the three species of sea turtles, olive ridley, and green turtle, hawksbill, which were landed either incidentally or targeted, was prevalent during the study period.

STUDY AREA

Observations on the trade of sea turtles were made between December 1998 and October 2001 in Vizhinjam in Kerala and Tuticorin in Tamil Nadu. During the months of May 1999, December 2001 and January 2002, observations were made at Saurashtra coast of Gujarat state. Totally 13 markets were visited, of which seven were in and around Thiruvananthapuram, two markets in Tuticorin and four markets in Saurashtra coast. Among the markets surveyed, the Kattakada near Thiruvananthapuram and Tuticorin markets were identified as the major markets where sea turtle trade occurred illegally on regular basis.

MATERIALS AND METHODS

Kattakada fish market was visited on Monday and Thursday nights of every week, because the turtles were held for slaughtering on the following morning and the Tuticorin fish market on Sunday of every week. On the day of visit, information on the total number of turtles kept, the species, size, and sex of each individual were all collected and the actual location where the turtle was caught, craft and gear responsible for the catch were noted by interviewing the fishermen. Further the number of vendors offering sea turtles, which species frequently traded, what size and sex, list of items were sold in the market, frequency and seasonality and availability of species, popularity and demand of turtle products were also collected. The other information such as prices of items were sold, source of turtles, turtle parts and products, including the location of turtle collection from the ocean, seasonality the buyer and seller details were collected. Moreover the intention of consumer, purpose and reason for turtle purchasing were observed. The structure and organization of the fish markets, role of turtles, and attitude to turtles as a commodity, any conservation programme, and seasonality of turtles were also collected. Observations in Saurashtra coast of Gujarat indicated that there was no sea turtle trade during the study period. Information was also collected on any occurrence of turtle poisoning in the area of study during the period of observation.

RESULTS

Sea turtles were captured incidentally and some time fished through out the coastal belt of Vizhinjam coast, Kerala. Adult and sub adult turtles were captured in the coastal waters adjacent to nesting beaches. A major portion of the turtles, which were caught, incidentally in Vizhinjam coast was transported to Kattakada fish market by van. Mostly the fishing communities of Kerala coast were engaged in turtle catching operation. Large number of turtles was captured every year. The incidentally caught turtles were kept alive by turning them upside down and sometimes tying their flippers quite securely with wires and nylon ropes and put in a stream near the fish-landing center. Then they were transported to the nearest markets for trade. Apart from the incidental catch, sea turtles were captured from coastal waters of Vizhinjam during the peak mating seasons and were sent by trucks to the nearest fish markets.

Table 1. Trade of incidentally caught sea turtles in Kattakada fish market, Kerala.

Month and year	Details of turtle trade				Price of turtle
	Species	Number	Range of carapace length (cm)	Range of weight (kg)	Indian rupees
December 1998	*Lepidochelys olivacea*	5	61–70	42.5 – 46 .5	200–250
March 1999	*Lepidochelys olivacea*	10	46–69	34 – 45	150–250
December 2000	*Lepidochelys olivacea*	2	40.5–66	18– 44.5	100–200
May 2001	*Lepidochelys olivacea*	9	54 –72	39. 5 – 49	150–250
	Eretmochelys imbricata	1	67. 5	35	150
July 2001	*Chelonia mydas*	7	49–94	26–85	250–350
August 2001	*Chelonia mydas*	7	49–94	63– 89	250–350
September 2001	*Eretmochelys imbricata*	2	37–42	9– 14.5	125–200
October 2001	*Eretmochelys imbricata*	2	46.5–49	17–25	100–200

Table 2. Trade of incidentally caught sea turtles in Tuticorin fish market.

Month andYear	Name of the market	Details of turtle trade				Price Indian Rupees
		Species	Number	Range of carapace length (cm)	Range of Weight (kg)	
December 1998	Therespuram Tuticorin	*Lepidochelys olivacea*	5	61.5–71.5	25–40	200–250
		Chelonia mydas	3	79–103	39–52	250–300
December 1998	Pudhutheru Tuticorin	*Chelonia mydas*	8	85–104	43 –60	250–350
March 1999	Pudhutheru Tuticorin	*Chelonia mydas*	6	60–80	26–42	250–350
	Threspuram Tuticorin	*Lepidochelys olivacea*	2	64–67	43–44	250–300
August 1999	Threspuram Tuticorin	*Lepidochelys olivacea*	3	52–59	30–36	175–250
	Pudhutheru Tuticorin	*Chelonia mydas*	2	84 –95	63–88	200–350
December 2000	Pudhutheru Tuticorin	*Chelonia mydas*	2	71–78	53 –60	275–350
December 2000	Therespuram Tuticorin	*Lepidochelys olivacea*	2	62–68	42–46	200–250

During mating, the turtles are extremely sluggish, swimming mostly on the surface. They become an easy prey to the fishermen. The fishermen capture them in different fishing gear. Soon after capturing a turtles, the flippers were tied with wires and plastic nylon ropes; the animal was put in to the boat by placing them in upside down position. Since the injured, dead and dying turtles won't fetch enough money in the market, such turtles are usually discarded and thrown back in to the sea. As a result, turtles cannot swim freely and may die of suffocation and contribute to the increased stranding along the coast. The incidentally caught turtles are sent to various fish markets particularly to Kattakada market, where two shops sold sea turtle meat. The turtle were slaughtered by cutting the throat and the carapace is separated from the plastron by a knife. The head is separated and the digestive tract is removed. The fishermen and the people living around the fish market favour sea turtles meat. It is evident from the consumer that the green turtle meat tastes better because it feeds on sea grass, while the olive ridley eats crabs and other organisms, and the hawksbill eats jellyfish, hence low demand for the meat of the hawksbill. Two turtles per week were slaughtered in the fish market of Kattakada, Kerala and Tuticorin, Tamil Nadu. Turtle trade was noticed along with other commodities such as fish, vegetables in Kattakada and in Tuticorin it was fully under cover in a particular place due to vigilance by the Wildlife Department since this area falls under Gulf of Mannar Biosphere Reserve. Consumers prefer turtle meat since it is cheaper compared to the meat of goat and chicken. The coastal people believe that consuming turtle meat giving more energy than other meat to do their hard work for fishing. The number of sea turtles in the fish markets of Kerala appeared to increase towards the breeding season. A total of 45 turtles belonging to 3 species were found to be slaughtered in the fish market of Kattakada in Kerala during the study period i.e., December 1998 and October 2001 in Vizhinjam, Kerala state (Table 1). Of these, olive ridleys numbering 26 (57.7%), which included seven males (27%), eight females (30.7%) and 11 subadults (42.3%) were slaughtered. Green turtles numbering 14 (31.1%), of which five males, six females and three subadults were slaughtered. A total of five hawksbills (11.2%), which included two females and three subadults were traded. Trade of turtles was more during the breeding seasons (65.4%) than that of the non-breeding season (34.6%). Egg bearing females were also slaughtered in the fish market during the breeding and winter seasons. The green turtles were the most preferred species followed by the olive ridleys and rarely the hawksbills in Kattakada fish market, Kerala. The leatherbacks were traded only on availability. A maximum of 28 turtles were slaughtered during 2001 (62.4%), followed by 10 in 1999 (22%), 5 in 1998 (11.2%) and 2 in 2000 (4.4%) were slaughtered. During the study period from 1998 to 2001 the wholesale price of the olive ridley at Kattakada fish market ranged from Rs. 100–250 (US$ 2.08–5.20) per turtle and the meat was sold at Rs. 50 (US$ 1.04) per kilogram, apart from meat, the head, flippers and eggs were sold for Rs. 30, 25 and 10 respectively. Consumers are purchasing these items alone for their utilization. The wholesale price of the green turtle ranged from Rs. 250–350 (US$ 5.20–7.29) and the meat was sold at Rs. 65 (US$ 1.35) per kilogram and head, flippers and eggs were sold for Rs. 40, 25, and 10 respectively. The hawksbill turtle was sold for Rs. 100–200 (US$ 3.12–4.16) and the meat for Rs. 50 (US$ 1.04) per kilogram, and head and flippers were sold for sold for Rs. 20 and 15, respectively. The price of individual turtles was also subjected to daily fluctuation based on the species and its availability in the market. In Kattakada fish market, the size of olive ridley were in the range 40.5–72 cm curved carapace length and weight from 18–49 kg. The curved carapace length of the green turtles ranged from 49 to 94 cm and the weight from 9–25 kg. The curved carapace length of hawksbills was in the range 37–67.5 cm and the weight 9–35 kg (Table 1).

In Tuticorin fish markets, a total of 33 turtles was found slaughtered. The green turtle constituted 63.6%, which included 7 males (33.3%), 11 females (52.3%) and 3 sub adults (14.4%). A total of 12 olive ridleys (36.4%) were traded of which 58.4% were females, 25% males and 16.6% were sub adults. The curved carapace length of green turtle ranged from 60–104 cm and weight from 26–88 kg. In olive ridleys, the curved carapace length ranged 52–71.5 cm and weight 30–46 kg. In Tuticorin fish market live green turtle priced for Rs. 250–350 (US$ 5.20–7.29) and Rs. 175–300 (US$ 3.64–6.25) for the olive ridleys. The green turtle meat was costlier than that of the olive ridleys meat. Per kilogram of green turtle meat was sold for Rs. 60 (US$ 1.25) than that of the olive ridleys. The head, flippers and eggs were also sold (Table 2). The price of meat varied according to the turtle species and its availability in the market.

INCIDENCE OF TURTLE POISONING

In India, incidences of turtle poisoning at Tuticorin were recorded in the fishing village off North Beach during January 1961 where 9 persons were affected by consuming hawksbill meat and out of these, casualties of three persons were reported. Again in June 1980, ten persons were affected by consuming hawksbill meat and casualties of all the 10 persons were reported. Turtle poisoning at Punnaikayal of Tamil Nadu were recorded on 3 August 1977. Over 300 persons were affected by consuming hawksbill meat and there were 10 casualties. Turtle poisoning at Moolachi, Kanyakumari district, Tamil Nadu were recorded during 1979. Casualties of 4 children were recorded after consuming the meat of a turtle. Turtle poisoning along the Gulf of Mannar Coast and adjacent area indicates that despite the Indian Wildlife Protection Act (1972), green turtle, olive ridley and hawksbill are still being caught for consumption. Along the Kerala coast, turtle poisoning at Sakthikulankara, Quilon, was recorded on 27 May 1961. There were 130 persons affected by consuming hawksbill meat, out of which casualties of 18 persons were reported. In some of the incident it is seen that death had occurred among children while adults showed delayed symptoms and gradually got over the same. The burning sensation in the mouth and deep fissures in the tongue appearing a few days after the consumption of poisoned turtle meat is characteristic. While the general symptoms of chelonitoxin are known, there is yet to develop an effective treatment for the same. A wide spectrum of medication has been administrated to those affected at various centers whether there are any long-range effects on them or irreversible damage done to their vital organs is not known. Perhaps in the interest of the medical science, with the dispensation from the Wildlife Department, a programme of examining periodically a few hawksbill turtles from the Gulf of Mannar for analyzing their body tissues for toxicity and related studies should be carried out. While prevention is better than cure, if an incident occurs we should by all means be prepared to face such an eventuality by developing an efficacious treatment for the malady. All species of sea turtles have been eaten, though there seems to be a greater chance of food poisoning from the hawksbill turtle meat. Most of the people do not prefer the leatherback meat probably because of the taste of the meat was not for their liking. During the entire period of observation from December 1998 to October 2001 in Vizhinjam and Tuticorin and in the months of May 1999, December 2001 and January 2002 at Saurashtra coast, no incidences of turtle poisoning were noticed. This can be attributed to limited trade of turtle meat, which in turn was due the ban on the trading of sea turtles.

DISCUSSION

Harvesting of adult and sub adult turtles can have devastating effect on marine turtle populations (Crouse, 1999; Crouse et al., 1987; Eckert, 1995; Frazer, 1989; 2001). In Tuticorin fish market, there are 33 turtles were recorded which includes 63.6% green turtles and 36.4% of olive ridleys. Changes in species composition, and size class of green turtle compared to earlier studies (Agastheesapillai and Thiagarajan, 1979; Prabavathy, 1992) were considered to predict the decline over years. According to Kuriyan (1950), before 1950 majority of the turtles caught in the Gulf of Mannar were green turtles. This species contributed a bulk of 89% of all turtles caught in the Gulf of Mannar and Palk Bay during 1971–76 (Agastheesapillai and Thiagarajan, 1979). However, the present study revealed that the proportion of the green turtle declined from 89 to 63.6%. The reduction of green turtles could be mainly due to continuing exploitation in the past. Kuriyan (1950) stated that before 1950, other species were seldom consumed in this area. This shows that green turtle has depleted beyond sustainable level, and locals are forced to use other species of sea turtles. Recording of sub adults during the study period indicated that the major reason for more number of sub adult which were caught incidentally in fishing gears could be due to over exploitation of adults and scarce (Leon and Diez, 1999a; 1999b). Frequently one of the first signs of overexploitation is a reduction in the number of adults, or even their elimination, leaving a population consisting of immature turtles (Carr, 1952). In India, the sea turtles are protected under Schedule I of the Indian Wildlife (Protection) Act, 1972 and killing, trading or any activity that harms the turtles is banned. The status of Indian turtles was well described by Davis et al. (1978), Bhaskar (1978), Kar and Bhaskar (1982), Subba Rao et al. (1983), Rajagopalan (1984) and Subba Rao (1998). All the above authors saw a bleak future for the sea turtle and felt that unless the large scale commercial exploitation and slaughter is stopped, the species may be soon in peril of extinction. Despite highest protection under the Indian Wildlife Protection Act, (1972), the slaughter of sea turtles continue to go unchecked in India. Most of the fishermen were of the opinion that the turtle fishing is their birthright and their livelihood, but none of them were involved in large-scale commercial exploitation but it was only subsistence hunting. Unless and until such a sort of mentality is changed, the illegal trade for sea turtle will go unchecked. Therefore there is need for monitoring the illegal trade of seat turtles and to take suitable steps to control or even to prevent them, which can go as an important step in the conservation of sea turtle population.

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HUMAN ENVENOMING BY *ATRACTASPIS CORPULENTA CORPULENTA* (REPTILIA: ATRACTASPIDIDAE) IN GABON, WESTERN CENTRAL AFRICA: A FIRST CASE REPORT

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ABSTRACT.– **The first documented case of envenoming by *Atractaspis* in Gabon is described. The patient, an adult male, suffered local lymphangitis and paraesthesiae, but following immediate medical monitoring and proper treatment, recovered completely within five hours.**

KEY WORDS.– **Atractaspididae, *Atractaspis corpulenta*, envenomation, treatment, Gabon, Ogooué-Maritime, Africa.**

INTRODUCTION

One of the main objectives of the Smithsonian Institution's Monitoring and Assessment of Biodiversity Program in Gabon is the increase of knowledge on the local biodiversity. Species inventories organized by the Smithsonian Biodiversity Centre in Vembo, Gamba, in Ogooué-Maritime Province, aim to build reference collections for the local biodiversity. On 22 January 2007, a snake of the genus *Atractaspis* caught in a pitfall trap in dense secondary forest in Vembo was brought back alive to the Centre in order to gather biological observations. On 23 January 2007, a group of unexpected visitors entered the Centre. Unnoticed to have left the group, a Caucasian male of French nationality (born 1957, height 1.7 m, weight 70 kg) approached the terraria and, confusing the *Atractaspis* with the harmless and locally common legless skink, *Feylinia grandisquamis* Müller, 1910 (Scincidae), put his hand in the terrarium. He was bitten on the right index finger before he could even grab the snake. Immediate squeezing of the bitten finger oozed out a drop of blood from the bite mark. Reported cases of envenoming by *Atractaspis* spp. are rare (Barrière et al., 2005), and the present case is the first documented one for Gabon. Following are the signs and symptoms observed and the management regime taken. It is to be noted that the medical team in charge is not specialized in snake bite treatment.

RESULTS

Identification of the snake.– The adult male had a total length of 460 mm, including a tail of 43 mm. The head is small and the neck is not marked. The dorsal and ventral colour is uniformly black. The fangs are well developed and erectile. Main morphological characters are: 26–27–19 dorsal scale rows, counted respectively at one head length behind head, at midbody (above the ventral corresponding to half of the total number of ventrals), and at one head length before vent; 4 preventrals and 186 ventrals (counted after Dowling, 1951); single anal scale; 1 divided + 23 undivided subcaudals (terminal pointed scute excluded); 5/5 supralabials, 3rd and 4th reach eye; 4th supralabial the largest; 6/6 infralabials, the first pair widely in contact medially behind the mental scale, the second pair fused with the first and only pair of sublinguals, the third pair separated by 5 small gular scales; 2 internasals; 2 prefrontals; nasal divided; no loreal; 1/1 preocular; 1/1 postocular, about the same size of the preocular; 1/1 supraocular; 1+3/1+3 temporals, the anterior one much larger than the 3 posterior ones. The dorsals, ventrals and subcaudals are all smooth and shiny. The vertebral row is not enlarged. The rostral scale is large and visible from above. The frontal scale is subtriangular and wider than long. The eye is small, slightly larger than the postocular. These characters all agree with the description and keys provided by Chippaux (2006) and Meirte (1992) for *Atractaspis corpulenta corpulenta* (Hallowell, 1854), except that the present specimen has a completely black tail, while Chippaux (loc. cit.) said it to be partly white. The specimen will be deposited in the herpetological collections of the United States National Museum, Washington, D.C.

Symptoms and treatment.– The bite, by a single fang as is typical of *Atractaspis* spp., occurred at 0750 h. Within a minute after the bite, one of us (ET) squeezed the patient's index finger in order to bleed as much as possible. However, only a large drop could be eliminated. The patient was immediately advised by the Centre's biologists to go as quickly as possible to the nearby Hervé Morand Clinic. He was thus driven there by car and arrived and was admitted at 0805 h (15 min after the bite). The whole upper surface of the right index had already turned to dark purple, confirming envenoming. The patient was then administered 4 mg of Celestene (betamethasone) by direct intravenous injection at 0815 h and kept under observation, lying on a bed. His body temperature was 36ºC and remained stable with no fever. A lymphangitis appeared and a dark reddish patch extended from the index to the forearm, and reached the level of the elbow at 0840 h. This patch did not spread above this point. The progression of the patch was accompanied by a disagreeable sensation of formication and a slight but continuous pain. Examination for the blood one hour after the bite was normal (no decrease of the blood platelets with 383 10^3/mm^3). The lymphangitis began to slowly regress at 0915 h, but at the same time a paresthesis on the upper surface of the whole right hand appeared. Both lymphangitis and paresthesis had significantly regressed at 0930 h, when a plaster with Fucidine (sodium fucidate) was applied. All symptoms and pain had stopped at 1015 h, but a pain on the whole right hand reappeared at 1100 h, and the patient was then given two tablets of 500 mg Paracetamol. The pain mostly disappeared around 1130 h, except at the bite site, and the patient left the clinic. At 1300 h (five hours after the bite) the colour of the right hand and arm had completely turned back to normal, but the pain at the bite site persisted until 1500 h. The patient could however do his administrative work from 1400 h, and the total work interruption due to the incident was thus half a day.

DISCUSSIONS

When disturbed, all the specimens of *Atractaspis c. corpulenta* we caught in Gamba systematically adopted the typical *Atractaspis* defense behaviour. They arched their neck with the snout oriented towards the ground, forming an inverse U-shape with their forebody. They then laterally and violently project the head towards anything approaching too closely, the venomous fang being laterally positioned between the closed lips and ready to strike.

In Gabon, this nocturnal, slow moving, terrestrial and semi-fossorial snake is found in dense primary forest as well as in highly degraded secondary forest and in galery forest in coastal savanna. It is the only member of this genus which seems to be locally common in Gabon, although it is known so far with certainty only from Ogooué-Maritime and Woleu-Ntem provinces, from localities situated between near sea level and 530 m asl (Angel, 1933:220; Burger et al., 2004:153, 171; Laurent, 1950:41; Pauwels et al., 2002:62; 2006a:93, 97; 2006b:184).

Besides *Atractaspis c. corpulenta*, Gabon is home to *Atractaspis boulengeri* Mocquard, 1897, known from a few specimens from Ogooué-Ivindo, Moyen-Ogooué, Ogooué-Maritime and Woleu-Ntem provinces (Boulenger, 1900:456; 1919:298; Knoepffler, 1966:19: as *A. boulengeri matschiensis* Werner, 1897 and *A. b. mixta* Laurent, 1945; Laurent, 1950:29; Mocquard, 1897a:54–55; 1897b:16–17; Pauwels et al., 2006a:93, 97; Perret, 1960:133) and *A. reticulata* Sjöstedt, 1896, recorded from a single specimen from Ogooué-Ivindo Province (Knoepffler, 1966:20, as *A. reticulata heterochilus*). As indicated by the widely dispersed localities from where they are currently known, *A. boulengeri* and *A. c. corpulenta* are certainly widespread in the country. Although few data exist concerning the danger represented by *Atractaspis* spp. (and all other venomous snakes) in Gabon, *Atractaspis c. corpulenta* is regarded as a highly venomous snake by villagers in the Cristal Mounts (Pauwels et al., 2002:62). A common and widespread belief in Gabon concerning these "little black snakes, is their ability to envenom people by the sand they project with their head", relating to the defensive behaviour of *Atractaspis* spp., as one of us (OSGP) noted in the Cristal Mounts. When biting, the fang of *Atractaspis* is nearly invisible, and sand or soil can indeed be sometimes projected by the violent lateral movement of the head. Since, unlike all other snakes, the *Atractaspis* do not bite nor open their mouth when striking, it is understandable that locals believe that the venom is contained in the soil particles projected. This belief seems to be widespread amongst the local inhabitants, and no Gabonese would manipulate them. Incidents would likely happen when villagers walk with bare feet at night and step near or on the snake, and when collecting firewood. The incident that is reported here led to the decision not to keep live venomous snakes in the Biodiversity Centre, to avoid any such incidents in the future.

Spawls and Branch (1995) indicated that the few reported bite cases for *A. corpulenta* involved "only pain, local swelling, fever and lymphadenopathy", based on the data provided by Corkill and Kirk (1954) and "Franz (1960)" (the actual authors are Gunders et al., 1960). Corkill and Kirk (1954) reported two cases of bite on two different persons by the same snake individual in 1913, first in Sierra Leone, second at London Zoo where the specimen had been sent alive. The first bite was described as such : "There was a burning pain, and one hour after the bite a sense of feverishness. Six hours after the bite there was swelling of the axillary glands, and at the site swelling and a continued pain like that of a bee-sting. He sucked the finger, went out to dinner, and felt well next morning." Concerning the second bite, the patient was ill for a week to ten days. The case reported by Gunders et al. (1960) only implied local pain and swelling and other minor symptoms, but was medically treated within half an hour of the bite. Based on the collecting localities of the two above-listed specimens, respectively Kennema, Sierra Leone, and Harbel, Liberia, these snakes can be identified as *Atractaspis corpulenta leucura* Mocquard, 1885. The case reported here seems thus to be the first documented one referring to the eastern subspecies, *Atractaspis c. corpulenta*.

Regarding the treatment that was applied in the present bite case, it should be noted that squeezing the bitten part is not recommended in first-aid for snake bite; moreover, the use of betamethasone was inappropriate (David Warrell, pers. comm.).

CONCLUSIONS

The danger represented by *Atractaspis* spp. in Gabon has never been evaluated. The genus being widespread in the country, and the toxicity and typical bite method being familiar to the Gabonese people, it is certain that many cases of envenomation occur throughout the country to maintain its reputation. Only the large cities of Gabon have the medical facilities to treat envenoming cases, and medical treatment is not accessible to all; these facilities do not exist in the countryside, where villagers also lack roads and transportation to medical centres, or refer only to traditional medicine practitioners (Tchoua et al., 2002). The above-described case shows the symptom evolution when the case is medically treated from its beginning, but it is probable that most cases are not treated and must lead to medical complications.

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THE SYSTEMATIC STATUS OF *CATHETORHINUS MELANOCEPHALUS* DUMÉRIL & BIBRON, 1844 (SERPENTES: TYPHLOPIDAE)

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(with one text-figure)

ABSTRACT.– Examination of the holotype of *Cathetorhinus melanocephalus* reveals that it cannot be allocated to any presently diagnosed genus or species. The history of the Baudin Expedition is retraced in reference to the collection of *Cathetorhinus melanocephalus* without any significant clues as to its origin. The genus *Cathetorhinus* is resurrected as a valid taxon in the family Typhlopidae. The provenance of the species remains unknown: it is certainly Old World and may be from (in order of probability) Timor, Australia, Mauritius, or Tenerife.

KEY WORDS.– Typhlopidae, *Cathetorhinus melanocephalus,* **Baudin Voyage.**

INTRODUCTION

The black-headed blind snake, *Cathetorhinus melanocephalus,* described by Duméril and Bibron (1844) has a mysterious and unsettled history. The specific locality of the holotype (MNHN 138) and only known specimen is unknown. The original invoice data reporting that the specimen originated in Peru is in error (R. Roux-Estève *in* Dixon and Hendricks, 1979:8). It was actually collected on the Nicolas T. Baudin Expedition, consisting of two ships, the *Géographe* and the *Naturaliste*, which F. Péron and C. A. Lesueur joined as naturalist and artist, respectively, between 19 October 1800 and 25 March 1804 (Girard, 1857). The round trip voyage went from France to the Canary Islands (Tenerife), around (but not landing on) the Cape of Good Hope to Mauritius, to Australia and finally Timor (Kupang). If *Cathetorhinus melanocephalus* was collected on the Baudin Expedition, it had to have originated from either Timor, Australia, Mauritius, or Tenerife. Although snakes are unknown from the Canary Islands, a small typhlopid like *Cathetorhinus melanocephalus* could possibly exist there and escape detection. There is a remote possibility that association with the Péron voyage is erroneous.

Partly because of its unknown origin, but also in part due to its unusual features, the taxon has had a tumultuous history and is currently classified *incertae sedis* (Hahn, 1980; McDiarmid et al., 1999). Jan (1863, 1864) and Jan and Sordelli (1860) transferred *Cathetorhinus* to *Typhlops,* recognizing *melanocephalus* as a valid species in the subgenus *Typhlina (=Ramphotyphlops),* presumably because of a similar absence of a preocular shield and superficial resemblance to *Ramphotyphlops lineatus.* Peters (1865, 1881) then recognized *Cathetorhinus* as a valid genus. Boulenger (1893) once again synonymized *Cathetorhinus* with the genus *Typhlops* and recognized *T. melanocephalus* as a valid species of unknown origin. This arrangement was followed by Werner (1921) and Loveridge (1957). Roux-Estève (1974) transferred *Cathetorhinus* to the synonymy of *Rhinotyphlops* without mentioning to which species she was referring it or the reasoning for the change. Dixon and Hendricks (1979) suggested *Cathetorhinus* was a *Ramphotyphlops* with affinity to the *R. guentheri* group of Indonesia. Hahn (1980) also considered it probably belonging to the genus *Ramphotyphlops*. However, Broadley (1983) offered the opinion that it was a *Typhlops*. Williams and Wallach (1989) again transferred *Cathetorhinus* to *Ramphotyphlops*, considering it a synonym of *R. olivaceus*. Shea examined the type in Paris and concluded that it definitely was not a *Ramphotyphlops* (pers. comm., 1998).

BAUDIN VOYAGE

Captain Baudin's *Géographe* explored alongside the *Naturaliste* for part of the voyage but it also explored alone and in the company of the *Casuarina* at other times. It is not known which ship collected *Cathetorhinus* but Péron was stationed on the *Géographe* with Capt. Baudin, and Duméril (1853) attributed the snake as Peron's new species. The *Géographe* participated in three campaigns, the first two with the *Naturaliste* and the last one with the *Casuarina.* The first campaign (October 1800–December 1801) took the ships to Santa Cruz, Tenerife Island in the Canaries (2 Nov. 1800) and Port North-West, Mauritius for supplies (16 Mar.–25 Apr. 1801). Then on to Australia where landfall was first made at Cape Leeuwin, Western Australia (31 May 1801). Exploration northward along the coast included Rottnest Island (18 June 1801), Louis Napoleon Island (14–28 June 1801), Bernier and Dorre Islands in Shark Bay (28 June–12 July 1801), Dirk Hartog Island and the Péron Peninsula (18 July–5 Sept. 1801), Cape Murat (19 July 1801), Depuch and Forestier Islands (Amiraux Islands) in the Dampier Archipelago (28–30 July 1801), and the Bonaparte Archipelago (19 Aug. 1801). The ships then travelled to Kupang, Timor (22 Aug.–13 Nov. 1801) for supplies (Baudin and Cornell, 1974).

The second campaign (Nov. 1801–June 1802) began with a voyage to Tasmania (Nov.–Dec. 1801) where exploration included the d'Entrecasteaux Channel and Bruny Island (13–17 Jan. 1802), Port North-West and upriver to the north (17 Jan.–17 Feb. 1802), then along the eastern coast of Tasmania to Maria Island (18–26 Feb. 1802), Schouten Island (27 Feb. 1802), Swan Island (9–14 Mar. 1802), and Waterhouse Island (19–28 Mar. 1802). Crossing the Bass Strait, coastal Victoria localities included the Wilson Promontory (28 Mar. 1802), Port Western (30 Mar. 1802), Alouette and Dragon Islands, and Cape Marengo and Duquesne (1–2 Apr. 1802). Continuing westward along the South Australian coast, the explorers stopped at Baudin Rocks and Lacépède Bay (7 Apr. 1802), Encounter Bay and Flinders (8–9 Apr. 1802), Kangaroo Island (9 Apr. 1802), St. Vincent Gulf (12–14 Apr. 1802), Spencer Gulf (15–16 Apr. 1802), Eyre Peninsula (26 Apr. 1802), St. Francis Islands and the Nuyts Archipelago (1–8 May 1802), and St. Peters Island (9 May 1802). Adventure Bay and Bruny Island (20–22 May 1802) were explored in Western Australia and then the ships returned to Tasmania (4 June 1802) and on to Port Jackson, New South Wales (20 June–17 Nov. 1802) (Baudin and Cornell, 1974). Other specific localities where animals were collected include Kupang Bay, Géographe Bay, the coasts of Edels, de Witt, and Eendracht, Dorre Island, Perdrix Island, and the Sonde Islands (Jangoux, 2005).

The third campaign (Nov. 1802–Aug. 1803) began with exploration of King Island and Bass Strait (7–13 Dec. 1802), Sea Elephant Rock (10–24 Dec. 1802), and Sea Elephant Bay of Victoria (27–31 Dec. 1802); the south coast of Kangaroo Island (1–3 Jan. 1803), the north coast of Kangaroo Island and Eastern Cove and Pelican Lagoon in St. Vincent Gulf (5–6 Jan. 1803), the south coast of Eyre Peninsula (3–6 Feb. 1803), Nuyts Archipelago, St. Francis Island, and St. Peter's Island (6 Feb. 1803), and Denial and Murat Bays of South Australia (7–11 Feb. 1803); King George Port (17 Feb. 1803), Royal Princess Bay, Huitres Bay, Cape Vancouver, and Two People Bay (17–28 Feb. 1803), King George Sound (1 Mar. 1803), Cape Leeuwin, St. Allouran Island, and Géographe Bay (9–10 Mar. 1803), Péron Peninsula (16–22 Mar. 1803), Shark Bay (23 Mar. 1803), the North-West Cape (23–26 Mar. 1803), and Delambre Islanda and the Dampier Archipelago (26–30 Mar. 1803), Depuch Island (1–7 Apr. 1803), Cape Gantheaume and Roebuck Bay (7–12 Apr. 1803), Dampier Land, Lacépède Island, and the Buccaneer Archipelago (12–24 Apr. 1803), and Cape Voltaire, the Bonaparte Archipelago, Cassini Island, and the Holothurian Bank (24–29 Apr. 1803) of Western Australia. The expedition then sailed again to Kupang, Timor for a month (6 May–3 June 1803). Returning to Australia, exploration began with the North-West Cape, Holothurian Bank, Joseph Bonaparte Gulf of Western Australia, Cape Dombey, and Péron Island of the Northern Territory (3–27 June 1803), Melville Island and Cape Van Diemen (27 June 1803), and finally into the Arafura Sea. On 7 July 1803 the *Géographe* was 200 miles west of Cape Vals (Walsh), Papua New Guinea. The return trip from the Arafura Sea to Mauritius took one month (7 July–7 Aug. 1803). Capt. Baudin died of tuberculosis while in Mauritius (16 Sept. 1803). The *Géographe* set sail for France on 16 Dec. 1803 and finally returned home to Lorient, France on 25 Mar. 1804 (Baudin and Cornell, 1974).

There is no mention of a small blind snake or lizard comparable to *Cathetorhinus* in the records of the Baudin Expedition or Péron (Girard, 1857; Baudin and Cornell, 1974; Ly-Tio-Fane, 2003; Jangoux, 2005) so it appears that the Muséum is responsible for attributing *Cathetorhinus* to the Baudin Expedition.

REDESCRIPTION

Snout-vent length 178 mm, tail length 5 mm, tail/total length ratio 2.7%, midbody diameter 2 mm, body width contained in total length 91.5 times, midtail diameter 2 mm, tail length/width ratio 2.5. There are 18 scale rows throughout, ca. 524 middorsals, and 20 subcaudals. Dorsal head profile rounded, head narrower than neck, rostral subcircular, its midpoint diameter 2/3 the width of the head at eye level, nearly extending to interocular level; frontal with rounded posterior border, twice as broad as deep, slightly broader than equally rounded supraoculars, which are transversely oriented and insert between the postocular and ocular; postfrontal as broad as frontal (Fig. 1). Lateral head profile with weak rostral beak consisting of a corneal keel tapering to a blunt point (as in *Ramphotyphlops multilineatus* or *Typhlops depressiceps* but not acutely pointed), nasal large, semidivided with inferior nasal suture contacting second supralabial, lacking superior nasal suture, nostril directed laterally and oriented at a 60° angle to the horizontal; preocular absent (presumably fused with nasal), ocular with vertical orientation and faintly discernible eyespot in middle of shield, one elongate postocular; supralabials 4 with a T-II imbrication pattern, second and third supralabials twice as long as tall and twice the size of first supralabial, fourth supralabial three times as large as second and third, with ventral notch (indicating fusion with lowermost postocular). Ventral rostral very broad and flat, lacking preoral concavity, mental pentagonal, infralabials 3, tail with a minute terminal spine. Colouration in preservative (probably faded): head blackish-brown, dorsum tan with lighter venter.

DISCUSSION

In comparing *Cathetorhinus* to other typhlopid genera, mention must be made of certain recent changes in generic nomenclature of the Typhlopidae. Worldwide members of the Typhlopidae were considered to belong to a single genus, *Typhlops* Oppel (1811), by all early workers (Boulenger, 1893; Werner, 1921). Robb (1966) was the first researcher to subdivide *Typhlops* when she resurrected the name *Ramphotyphlops* Fitzinger (1843) for the mainly Australian and East Indian species (but also a few Southeast Asian forms) of the genus. Roux-Estève (1974) then revived another Fitzinger (1843) name, *Rhinotyphlops,* for several groups of derived African species with broad ventral rostrals, most species also having a corneal ridge on the ventral rostral and a tapered lateral head profile. For the next 20 years those three genera remained stable (Hahn, 1980) until In den Bosch and Ineich (1994) described *Cyclotyphlops* of Sulawesi, Indonesia. This was followed by Wallach (1995) establishing *Acutotyphlops* for the derived New Guinea-Solomon Island species group and Wallach and Ineich (1996) erecting *Xenotyphlops* for a bizarre Malagasy species. Six genera were recognized until the end of the Twentieth Century (McDiarmid et al., 1999). Broadley and Wallach (2000, 2007) resurrected *Letheobia* Cope (1869) from the synonymy of *Rhinotyphlops* for the groups of small, mainly blind and pigmentless, African typhlopids. Wallach (2003) revalidated the genus *Grypotyphlops* Peters (1881) for the giant Indian species *Typhlops acutus* that had recently been transferred to *Rhinotyphlops* (Wallach, 1994). Finally, *Austrotyphlops* was established for the clade of Australian-New Guinea snakes previously known as *Ramphotyphlops* (Wallach, 2006).

In their description of *Cathetorhinus melanocephalus,* Duméril and Bibron (1844) erroneously list the type as having 388 middorsals and

Table 1. Comparison of *Cathetorhinus* characters with other typhlopid genera and the *Typhlops ater* species group. *ACU* = *Acutotyphlops, AUS* = *Austrotyphlops, CAT* = *Cathetorhinus, CYC* = *Cyclotyphlops, LET* = *Letheobia, GRY* = *Grypotyphlops, RAM* = *Ramphotyphlops, RHI* = *Rhinotyphlops, TYP* = *Typhlops, XEN* = *Xenotyphlops, ater* = *Typhlops ater* species group. Afr. = Africa, E. I. = East Indies (Indonesia, Philippines, Papua New Guinea, Solomons), Ind. = India, O.W. = Old World, Mad. = Madagascar, N.G. = New Guinea, N.W. = New World, Sula. = Sulawesi, W = worldwide, "/" separates variable conditions, "()" indicate rare condition.

Taxon	CAT	ater	XEN	LET	RHI	GRY	AUS	RAM	ACU	CYC	TYP	TYP
Character Year	1844	—	1996	2000	1974	2003	2006	1966	1995	1994	1811	1811
Range	O.W.	E. I.	Mad.	Afr.	Afr.	Ind.	Aust.	E. I.	N.G.	Sula.	O.W.	N.W.
Midbody scale rows	18	16-24	20-22	18-30	18-44	24-34	16-24	18-28	26-36	22	16-36	16-24
Ant.-post. reductions >1	0	0 / +	0 / +	0 / +	+	+	0	0 / +	+	0	0 / +	0 (+)
Total middorsals	524	263-780	469-482	345-732	234-624	448-526	263-750	209-709	334-526	299	216-600	195-566
Length/width ratio	92	20-89	64-86	27-120	18-56	38-79	20-120	18-104	18-58	32	20-130	16-77
Subcaudals	20	8-29	20-22	5-17	5-13	7-13	8-29	7-45	12-30	15	5-28	5-16
Relative tail length (%)	2.7	1.0-5.1	3.2-3.7	0.7-2.3	0.8-2.6	0.8-1.9	0.9-6.4	1.3-9.0	1.0-3.1	3.1	0.4-4.4	0.8-4.3
T-II supralabial pattern	+	+ (0)	0	0 (+)	0 (+)	0	0	0	0	0	0	0 (+)
Relative rostral width (%)	70	20-45	70-85	45-85	50-70	50-80	25-75	35-65	10-25	45	25-65	20-45
Multiple rostral glands	0	+	0	0	0	0	0	0	0	0	0	0
Preocular absent	+	0	+	0 (+)	0	0	0	0 (+)	0	+	0	0
Postoculars	1	1-4	3	2-4	2-7	3-4	1-3	1-4	3-5	3	2-7	1-2 (3)
Superior nasal suture absent	+	0	+	0	0	0	0	0	0	+	0	0
Ventral rostral beaked	+	+ / 0	+	0	0	+	0 (+)	0 (+)	0	0	0	0
Eye visible	+	+ (0)	0	0 (+)	+	0 (+)	+ (0)	+ (0)	+	0	+	+
Head black	+	0	0	0	0	0	0 (+)	0	0	0	0	0

22 scale rows. Inaccurate counts are not surprising given the small size of the type and the optics of the period, not to mention that the specimen has sloughed off scales and body distortions. Jan (1863) and Boulenger (1893) corrected the number of scale rows from 22 to 18. We counted 525 middorsals in the type and Glenn Shea (pers. comm., 1998) counted 523.

Table 1 compares various features of *Cathetorhinus* with the other typhlopid genera and the *Typhlops ater* species group. *Cathetorhinus* shares more characters with the *T. ater* species group than with any other taxon; the one feature that differs is the lack of light head glands dispersed beneath the rostral shield, a synapomorphy of the *T. ater* group. In dorsal view, the superficial resemblance is to *Typhlops mansuetus,* now considered a valid species (Wallach, 2003). In lateral view, the resemblance is to *Typhlops depressiceps* of Papua New Guinea which has a T-V SIP pattern. Some species that have also presumably lost the preocular in fusion with the nasal include *Ramphotyphlops lineatus* and *Letheobia uluguruensis* whereas in *Letheobia lumbriciformis* the ocular has presumably fused with the preocular and nasal.

The supralabial imbrication pattern (Wallach, 1993) is a relatively stable taxonomic character in typhlopids that defines species, species groups, and even genera, and the T-II pattern is the rarest among the Typhlopidae, being known in only seven species of African *Letheobia,* eight species of African *Typhlops,* and 10 species of the *Typhlops ater* species group of the East Indies. *Cathetorhinus* is excluded from membership in the *T. ater* group by the length/width ratio, relative rostral width, absence

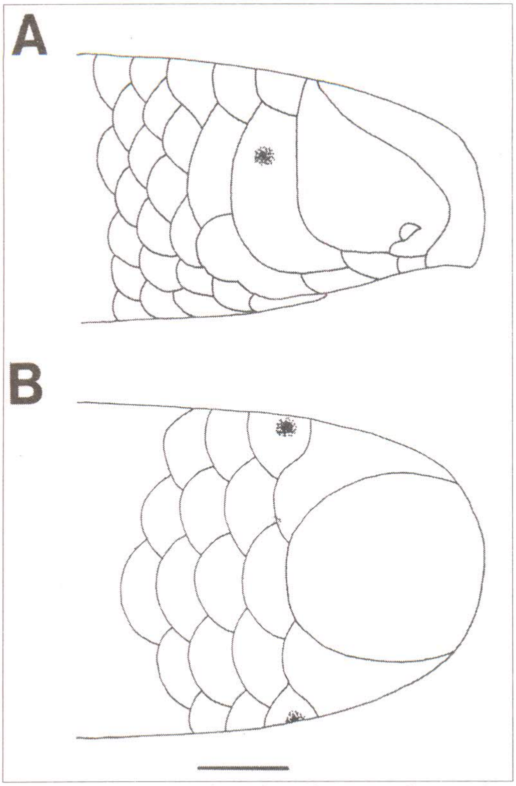

Figure 1. Holotype of *Cathetorhinus melanocephalus* (MNHN 138), A) lateral view, B) dorsal view, scale bar = 1 mm.

of multiple glands beneath the head shields, lack of preocular, absence of a superior nasal suture, and black head.

Characters that exclude membership in *Acutotyphlops* are the scale rows lacking reduction, length/width ratio, T-II SIP, absence of a preocular, single postocular, absence of a superior nasal suture, broad rostral with ventral beak, lack of visible eye, and black head. Characters that exclude membership in *Austrotyphlops* include the T-II SIP, lack of discrete preocular, and absence of superior nasal suture. Characters that exclude membership in *Cyclotyphlops* include midbody scale rows, number of middorsals, length/width ratio, number of subcaudals, T-II SIP, broad rostral with ventral beak, single postocular, and black head. Characters that exclude membership in *Grypotyphlops* are midbody scale rows with lack of reduction, length/width ratio, number of subcaudals, relative tail length, T-II SIP, absence of preocular, single postocular, lack of superior nasal suture, and black head. Characters that exclude membership in *Letheobia* include the number of subcaudals, relative tail length, absence of preocular, single postocular, lack of superior nasal suture, ventral rostral beak, and black head. Characters that exclude membership in *Ramphotyphlops* include the T-II SIP, broad rostral, lack of a superior nasal suture, and black head. Characters that exclude membership in *Rhinotyphlops* are absence of scale row reduction, length/width ratio, number of subcaudals, relative tail length, absence of preocular, single postocular, absence of superior nasal suture, lack of ventral rostral beak, absence of visible eye, and black head. Characters that exclude membership in *Typhlops* include the broad rostral with pointed ventral apex, lack of a visible eye, lack of a superior nasal suture, and the fusion of the preocular and nasal. Characters that exclude membership in *Xenotyphlops* are the midbody scale rows, total middorsals, length/width ratio, T-II SIP, single postocular, and black head.

The usefulness of the revalidation of a generic name for a species whose provenance is unknown might be questioned. However, unless *Cathetorhinus melanocephalus* is recognized as a valid species, the possibility of recognizing a future specimen remains doubtful. A precedent is seen in the case of *Xenotyphlops madagascariensis* (Mocquard, 1905), a monotypic species bearing the type locality of the island of Madagascar since the only two known specimens have no specifically designated locality (Wallach and Ineich, 1996).

TAXONOMY

Cathetorhinus Duméril and Bibron

Type species.– *Cathetorhinus melanocephalus* Duméril and Bibron, by monotypy.

Onychophis Duméril and Duméril, 1851:204; Gray *in* Duméril, Bibron and Duméril, 1854:17.

Cathetorinus Duméril and Bibron, 1844:268; Van der Hoeven, "1855":289, 1858:280, 1859:502; Chenu and Desmarest, 1857:111; Hoffmann, 1890:1605, 1609, 1619, 1624; Sherborn, 1924:1140; Schulze et al., 1927:569; Neave, 1939:605.

Typhlops (*Typhlina*) Jan and Sordelli, 1860 *in* 1860–1866:livr. 1, pl. 5, fig. 8; livr. 1, pl. 6, fig. 8; Jan, 1863:10; Jan, 1864:8.

Typhlops Boulenger, 1893:7; Romer, 1956:569; Loveridge, 1957:240; FitzSimons, 1962:63; Broadley, 1983:37, 1990:37; McDiarmid et al., 1999:89.

Rhinotyphlops Roux-Estève, 1974:157; Welch, 1994:57.

Ramphotyphlops Dixon and Hendricks, 1979:8; Hahn, 1980:77; Williams and Wallach, 1989:27; Smith and Smith, 1993:497, 725; Mattison, 1999:146.

Typhlopidae *incertae sedis* Hahn, 1980:77; McDiarmid et al., 1999:126.

Diagnosis.– *Cathetorhinus* can be distinguished from all typhlopid genera by the presence of a T-II supralabial imbrication pattern in conjunction with the absence of a discrete preocular (presumably fused with the nasal).

Cathetorhinus melanocephalus
Duméril and Bibron, 1844
(Fig. 1)

Holotype.– MNHN 138, an adult specimen of unknown sex, collected on the Capt. Baudin Expedition (voyage of Péron and Lesueur on the *Géographe*, October, 1800–March, 1804).

Type locality.– unknown but in the Old World; landfalls during the Péron and Lesueur voyage with known snake faunas include Timor, Australia, and Mauritius.

Cathetorhinus melanocephalus Duméril and Bibron, 1844:270; Duméril and Duméril, 1851:203; Duméril, 1853:422; Duméril, Bibron and Duméril, 1854:17; Girard, 1857:143; Peters, 1862:43, 1865:263, pl. fig. 6–6c; 1881:70; Hoffmann, 1890:1624; Bauer et al., 1995:210D (fig. 6), 211, 411.

Onychophis olivaceus, Duméril and Duméril, 1851:204; Gray *in* Duméril, Bibron and Duméril, 1854:17.

Typhlops (Typhlina) melanocephalus, Jan and Sordelli, 1860 *in* 1860–1866:livr. 1, pl. 5, fig. 8, livr. 1, pl. 6, fig. 8; Jan, 1863:10; Jan, 1864:8.

Typhlops melanocephalus, Boulenger, 1893:15–16; Werner, 1921:289; Loveridge, 1957:240; Hahn, 1980:77; Frank and Ramus, 1995:254; McDiarmid et al., 1999:126.

Ramphotyphlops cf. *guentheri,* Dixon and Hendricks, 1979:8.

Ramphotyphlops olivaceus, Williams and Wallach, 1989:27.

Rhinotyphlops melanocephalus, Welch, 1994:57.

Ramphotyphlops melanocephalus, Mattison, 1999:146.

Definition.– *Cathetorhinus melanocephalus* is readily separable from all members of the Typhlopidae by the following combination of characters: head black, dorsal rostral broad (70% head width), ventral rostral beaked in lateral profile, scale rows 18–18–18, middorsals greater than 500, and lacking discrete preocular and superior nasal suture.

CONCLUSIONS

Examination of the holotype of *Cathetorhinus melanocephalus* reveals that it cannot be relegated to any current genus or species and should be recognized as a valid taxon. The Baudin Expedition made landfall at Santa Cruz Island (Tenerife), Mauritius (Port North-West), Australia (western, southern, and northern coasts and offshore islands), and Timor (Kupang). It is possible that *Cathetorhinus* originated from any of these four localities, with Australia being the most likely based upon collecting time and known scolecophidian fauna. Regardless of its unknown provenance, the recognition of *Cathetorhinus melanocephalus* seems warranted since it cannot be allied with any known genus or species and it is here considered a valid monotypic genus.

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A NEW *CYRTODACTYLUS* (SQUAMATA: GEKKONIDAE) FROM CENTRAL VIETNAM

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(with six text-figures)

ABSTRACT.– **A new species of *Cyrtodactylus* is described from central Vietnam. The new species, which is phenetically most similar to *C. irregularis* and *C. quadrivirgatus*, is characterized by its medium size (SVL up to 84 mm), 37–55 interorbital scales, 16–24 rows of dorsal tubercles, 41–57 longitudinal rows of ventral scales at midbody, 5–9 precloacal pores in angular series, 9–13 lamellae under first digit, 10–13 lamellae under first toe, 16–25 lamellae under toe IV, and by the absence of a precloacal groove, enlarged femoral scales, and of transversely enlarged subcaudals. The dorsal pattern of the new species is highly variable and consists of a combination of a striped and banded pattern, however, individuals may show a striped or banded pattern only. The new taxon is known only from the central Vietnamese provinces of Quang Tri, Thua Thien-Hue, Da Nang and Kon Tum. A key to the *Cyrtodactylus* species of Vietnam is provided.**

KEY WORDS.– **Vietnam, Squamata, Gekkonidae, *Cyrtodactylus pseudoquadrivirgatus* sp. nov., *C. irregularis*, *C. quadrivirgatus*, morphology, taxonomy, natural history.**

INTRODUCTION

The genus *Cyrtodactylus* has been the subject of intensive research in Vietnam in recent years, and in the last five years alone, no less than four new species have been described: *Cyrtodactylus badenensis*, *C. cryptus*, *C. nigriocularis* and *C. phongnhakebangensis* (Ziegler et al., 2002; Nguyen et al., 2006; Heidrich et al., 2007). Prior to this, *C. condorensis*, *C. intermedius*, *C. irregularis* and *C. paradoxus* were known from the country. Currently, eight *Cyrtodactylus* species are known from Vietnam, and the descriptions of several more species are currently under preparation (Nguyen et al., 2005; Ngo and Grismer, 2006). In addition, *C. interdigitalis* and *C. jarujini*, which were originally described from

Thailand (Ulber, 1993), have been recently recorded from adjacent Laos (Stuart, 1999), and *C. buchardi* has been described from near the Lao-Vietnamese border (David et al., 2004); thus new country records are expected for Vietnam in the future. One of the least known and rarely collected Vietnamese species is *C. irregularis*. Several years ago, we studied a poorly preserved *Cyrtodactylus* specimen from central Vietnam and tentatively allocated it to the aforementioned species (Ziegler et al., 2004; see also Ho Thu Cuc, 2002). More recently, another related *Cyrtodactylus* was collected from Vietnam, that resembled the phenetically variable *C. quadrivirgatus* (see Vu et al., in press, in Heidrich et al., 2007: 6, 14). As a result of increased surveys, additional specimens of *Cyrtodactylus* have been collected in central Vietnam by different teams, which permit a study of variability. Our subsequent evaluation lead us to conclude that both specimens formerly allocated by us and by Ho Thu Cuc (2002) to *C. irregularis* and *C. quadrivirgatus*, together with the recently collected bent-toed geckos from central Vietnam, are apparently related to *irregularis* and *quadrivirgatus*, represent a distinct species, which is described here.

MATERIAL AND METHODS

Specimens studied are deposited in the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany, the South Australian Museum (SAMA), Adelaide, the University of Natural Sciences (UNS), Ho Chi Minh City, Vietnam, the Institute of Ecology and Biological Resources (IEBR), Vietnamese Academy of Science and Technology, and in the private collection of the senior author (CPHR). Besides the type series of the new *Cyrtodactylus* species described herein, we studied the following specimens of *C. quadrivirgatus* sensu lato: CPHR 2259–60 (two adult females from Cameron Highlands, Malaysia), CPHR 2262 (adult male from Cameron Highlands, Malaysia); SAMA R36783 (adult female from Tampin, Malaysia); ZFMK 86751 (adult male from Cameron Highlands, Malaysia). The following measurements were taken to the nearest millimeter (mm) using a digital vernier caliper, interpolated to the nearest 0.1 mm: Snout vent length (SVL) from tip of snout to vent; tail length (TL) from vent to tip of tail; snout to eye distance (SE) measured from tip of snout to anteriormost point of eye (including ciliaria); eye to ear distance (EE) from hind margin of eye to hind margin of ear (including ciliaria); maximum head width (HW); maximum head height (HH); head length (HL) from tip of snout to hind margin of ear; maximum ear diameter (EAD); horizontal eye diameter (ED). Scale counts were taken as follows: supralabials (SPL); sublabials / infralabials (SBL); granular scales behind upper labials to angle of mouth (GBUL); granular scales behind lower labials to angle of mouth (GBLL); nasals (N) from rostral to labial (nasorostral, supranasal, postnasals); internasals (IN); postmentals (PM); scales between fifth supralabials (S5S); gular scales bordering the postmentals (GP); interorbitals (IO); dorsal tubercle rows (DTR); ventrals (V); subdigital lamellae under the first (LF1) and fourth digit (LF4); subdigital lamellae under the first (LT1) and fourth toe (LT4); precloacal pores of males (PP) / precloacal scales in females (PS); postcloacal tubercles (PAT); dorsal scale rows in the centre of the third caudal whorl (S3R); enlarged precloacal scales (EPS); enlarged femoral scales (EFS); tubercles on the lateral fold (TLF); granules surrounding dorsal tubercles (GST); tubercle rows in the first caudal whorl (TR1); dorsal tubercles in the first and fifth caudal whorl (DT1 and DT5). Bilateral scale counts were given as right / left. Numerical differences in scalation were statistically supported by the parameter variation coefficient (V%), Kolomogorov-Smirnov-adaptation test and *t*-test (Lozán and Kausch, 1998; Lamprecht, 1992). Colour descriptions followed colour plates in Grallert and Roland (1960).

SYSTEMATICS

Cyrtodactylus pseudoquadrivirgatus sp. nov.

Holotype.– adult female (ZFMK 83895), from A Luoi, Thua Thien-Hue Province, central Vietnam, leg. Vu Ngoc Thanh, 20 July 2005, at an altitude of 800 m above sea level (Fig. 1–2a–d).

Diagnosis.– A medium-sized *Cyrtodactylus* that can be distinguished from all congeners from the Oriental and Australian regions on the basis of the following combination of characters: 1) SVL up to 84 mm (TL > SVL); 2) head depressed, distinct from body, snout with medial concavity; 3) 37–55 interorbital scales; 4) body rounded in cross-section, belly flat, not wider than head; 5) lateral fold narrow, with enlarged lateral tubercles; 6) tubercles present on dorsum of head, body, forearm, hind limbs and tail; 7) 16–24 rows of dorsal tubercles; 8) 41–57 longitudinal rows of ventral scales at midbody; 9) rounded tail in cross-section, tail base not enlarged; 10) 5–9 precloacal pores in angular series and 1–12 enlarged precloacal scales; 11) absence of enlarged femoral scales, lack of femoral pores and a precloacal groove; 12) absence of transversely enlarged subcaudals; 13) 9–13 lamellae under first digit, 10–13 lamellae under first toe, and 16–25 lamellae under 4th toe; 14) body dorsum light brown with dark brown pattern (head mottled, dorsum mottled, striped or with bands); 15) neck band medially interrupted; 16) limbs striped or mottled, tail with dark and light bands.

Description of holotype.– SVL 72.0 mm; TL 82.5 mm; HL 20.0 mm; HW 13.0 mm; HH 9.0 mm; SE 8.0 mm; EE 7.6 mm; ED 4.4 mm; EAD 0.9 mm; SVL:TL 0.87; SVL:HL 3.60; HL:HW 1.50; HL:HW 2.22; SE:EE 1.05; ED:EAD 4.89. Rostral scale x 1.4 wider than high, above V-shaped, concave, with a median reverse Y-shaped suture; 9/9 supralabials and 9/7 granular scales extending to the corner of the mouth; 8/9 sublabials and 6/6 granular scales extending to the corner of the mouth; nares in contact with rostral, first supralabial and 4/4 nasals; nasorostrals (see Rösler, 1995:20), ca. x 4 larger than postnasals; one internasal, pentagonal, only somewhat smaller than nasorostrals; two snout scales, posteriorly in contact with internasal; interorbital region slightly depressed, snout medially distinctly depressed; snout scales blunt, cone-shaped, juxtaposed; snout scales contacting nasorostrals and internasal about the same size as head tubercles; 42 scales between fifth supralabials across dorsum of snout (Fig. 2a); pupil vertical, anteriorly slightly, posteriorly distinctly serrated; ciliaries anteriorly slightly keeled; head scales granular, half as large as median snout scales; 48 interorbital scales, with some enlarged scales in the orbital region; parietal region with tubercles up to ear opening; head tubercles rounded, arched to cone-shaped, x 2–3 size of surrounding granules; temporal region not convex, ear opening oval, somewhat angular; mental triangular, broader than rostral scale; two postmentals, trapezoidal, longer than wide; postmentals in contact with four scales; gular scales granular, the granules being as large as median snout scales (Fig. 2b); dorsals granular, as large as median snout scales; dorsal tubercles oval to triangular, conical, medially keeled, ca. x 3 as large as dorsals, surrounded by ten dorsal scales, and arranged in 24 irregular longitudinal rows; lateral fold feebly developed, with ca. -/16 tubercles, which are distinctly arched to conical, ca. x 1.25–2 wider than dorsally adjoining lateral scales; ventrals flat, smooth, juxtaposed, medial ventrals twice the size of dorsal scales, in 41 longitudinal rows at midbody; upper and lower arm dorsally granular, lower arm with rounded, arched tubercles that are smooth to slightly keeled and x 2 larger than surrounding scales; upper and lower leg dorsally granular with scattered round, conical tubercles, smooth on upper leg, keeled on lower leg, x 3 as large as surrounding scales; enlarged femoral scales lacking; gradual transition between large anterior and smaller posterior femoral scales; 11/11 subdigital lamellae below first finger, 17/17 below fourth finger, 12/12 below first toe, and 19/20 below fourth toe (8/7 of which are basally enlarged); except fifth toe, all digits and toes basally connected by narrow skin webs; claws surrounded by a small dorsal and a large ventral scale; nine precloacal pores forming a right-angled V; ca. six large scales immediately posterior to the precloacal scales; 3/3 conical postanal tubercles, arranged in an oblique row; original tail not enlarged at base, round in cross-section; anteriorly with weakly developed whorls; dorsal tail scales flat, smooth, subimbricate, up to x 1.5 size of dorsal scales, arranged in more or less regular transverse rows; the third tail whorl with ten scale rows; basal tail tubercles oval to triangular, slightly arched, medially keeled, in part posteriorly acute, 2–2.5 the size of the surrounding scales; the first whorl with ten and the fifth whorl with four tubercles in a transverse series; altogether ca. twelve rows of tubercles proximal to the tenth tail whorl (Fig. 2c); subcaudals flat, smooth, imbricate, x 2–5 larger than dorsal tail scales, four rows per basal tail whorls; underside of tail lacking tubercles (Fig. 2d).

The dorsum of the ethanol-preserved holotype is olive with a blackish brown pat-

Table 1. Measurements and pholidosis of the paratype series of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. Abbreviations are as follows: n = number; min/max = minimum/maximum; ξ ± s = $\overline{x}$ ± standard deviation; for remaining abbreviations see material and methods.

	n	min/max	ξ ± s		n	min/max	ξ ± s
SVL	31	48.6–83.3	70.35 ± 9.51	S5S	24	44–61	54.67 ± 4.11
TL	6	55.7–65.5	61.13 ± 3.37	IO	25	37–55	45.24 ± 5.07
HL	31	13.0–23.0	18.74 ± 2.36	PM	31	2	0
HW	31	9.4–17.0	13.71 ± 1.97	GP	31	4–7	5.16 ± 1.00
HH	31	5.8–10.4	8.28 ± 1.16	DTR	31	16–22	18.77 ± 1.41
SE	31	5.5–9.4	7.96 ± 0.94	GST	31	9–11	9.61 ± 0.72
EE	31	4.6–9.1	6.83 ± 1.00	TLF	55	7–23	13.84 ± 4.01
ED	31	2.8–5.4	3.96 ± 0.63	V	28	42–57	48.07 ± 3.42
EAD	31	0.6–1.7	1.06 ± 0.22	LF1	60	9–13	10.73 ± 0.76
SVL:TL	6	0.95–0.99	0.97 ± 0.01	LF4	61	15–21	18.15±1.28
SVL:HL	31	3.53–4.00	3.75 ± 0.11	LT1	61	10–13	11.74 ± 0.75
HL:HW	31	1.27–1.51	1.37 ± 0.06	LT4	60	16–25	20.48 ± 1.77
HL:HW	31	1.92–2.51	2.27 ± 0.11	PP	15	5–9	7.53 ± 0.99
SE:EE	31	1.02–1.40	1.17 ± 0.08	PS	14	5–10	7.07 ± 1.21
ED:EAD	31	2.65–6.57	3.85 ± 0.92	EPS	31	1–12	5.03 ± 2.26
SPL	61	9–13	10.59 ± 1.02	PAT	60	1–3	2.37 ± 0.55
GBUL	61	6–12	8.84 ± 1.14	TR1	22	1–2	1.45 ± 0.51
SBL	60	8–10	9.10 ± 0.77	DT1	22	4–11	7.64 ± 2.22
GBLL	58	5–9	7.67 ± 1.10	DT5	18	0–5	3.50 ± 1.20
N	60	3–5	4.05 ± 0.29	SR3	20	8–10	8.85 ± 0.75
IN	30	0–2	1.03 ± 0.32				

tern; labials partially buff; parietal region with seven oval blotches with inconspicuous buff edges; a narrow curved stripe extends from the posterior corner of the eye towards the back of the head (left) / the neck (right); nuchal band interrupted, on the left side with an irregular blotch, on the right with a ca. 6 mm long, narrow stripe; shoulders blotched; vertebral region with five elongate or transversely arranged, more or less rectangular blotches; dorsal blotches partially connected with narrow, interrupted stripes on both sides; below these stripes, two rows of oval to elongate blotches, with the lowermost only apparitional discernible; sacral band rectangular; dorsal stripes and blotches sharply separated from ground colouration by adjacent, light dorsal tubercles; limbs, fingers and toes striped, and with small blotches in the light areas; venter buff, chest pale brown; ventral scales and lateral granula of throat with tiny black dots; these black dots only sporadically, if at all, discernible in the enlarged precloacal scales; tail dorsally with twelve blackish brown, and eleven pale brown bands or annuli; the pale basal tail bands with indistinct pattern in their centre; ventral side of basal half of tail marbled with light and dark; the second half of the tail annulated, with the dark annuli being distinctly broader than the light ones. For the colouration and pattern in life see Fig 1. Here, an indistinct marbling stretching towards the orbital region is discernible; in addition, the vertebral region is lighter and the posterior light annuli of the tail are white.

Paratypes.– one adult male, four adult females (IEBR 377, 379, 381–83), from A So, A Luoi, Thua Thien-Hue Province, central Vietnam, leg. Ho Thu Cuc, 14–16 August 2001, at an altitude of 600–800 m above sea level (listed as *C. irregularis* in Ho Thu Cuc 2002); four adult males, four adult females (IEBR 2260–67), from Huong Hoa, Quang Tri Province, central Vietnam, leg. Nguyen Quang Truong et al., March to April 2005, at an altitude of 400 m above sea level; two adult males (UNS 0249–50), from Ba Na Nature Reserve, Hoa Vang District, Da Nang City, central Vietnam, leg. Ngo Van Tri, 20 November 2006, at an altitude of 500–600 m above sea level; three adult males, three adult females (IEBR 1669–74), from Kon Plong, Kon Tum Province, central Vietnam, leg. Ho Thu Cuc et al., March to April 2005, at an altitude of

Table 2. Intraspecific variation of measurements and pholidosis of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. Abbreviations are as follows: n = number; min/max = minimum/maximum; ξ ± s = x̄ ± standard deviation; V = variation coefficient; for remaining abbreviations see Material and Methods.

	n	min/max	ξ ± s	V (%)
SVL	33	48.6–83.3	69.82 ± 9.81	14.05
TL	7	55.7–82.5	64.19 ± 8.64	13,64
HL	33	13.0–23.0	18.64 ± 2.44	13.09
HW	33	8.7–17.0	13.55 ± 2.09	15.46
HH	33	5.8–10.4	8.24 ± 1.19	14.47
SE	33	5.5–9.4	7.91 ± 0.95	11.96
EE	33	4.6–9.1	6.78 ± 1.06	15.59
ED	33	2.8–5.4	3.94 ± 0.63	16.09
EAD	33	0.6–1.7	1.05 ± 0.22	20.88
SVL:TL	7	0.87–0.99	0.96 ± 0.04	4.05
SVL:HL	33	3.53–4.00	3.74 ± 0.111	3.05
HL:HW	33	1.27–1.61	1.38 ± 0.07	5.28
HL:HW	33	1.92–2.51	2.27 ± 0.11	4.84
SE:EE	33	1.02–1.40	1.18 ± 0.09	7.66
ED:EAD	33	2.65–6.57	3.88 ± 0.91	23.56
SPL	63	9–13	10.63 ± 1.04	9.75
GBUL	65	6–12	8.78 ± 1.15	13.12
SBL	64	8–10	9.05 ± 0.79	8.68
GBLL	62	5–10	7.66 ± 1.14	14.94
N	64	3–5	4.05 ± 0.28	6.86
IN	32	0–2	1.03 ± 0.31	30.01
S5S	26	42–61	54.27 ± 4.70	8.65
IO	27	37–55	45.30 ± 4.91	10.83
PM	33	2	0	0
GP	33	4–7	5.15 ± 1.00	19.49
DTR	33	16–24	18.97 ± 1.65	8.69
GST	33	9–11	9.67 ± 0.74	7.61
TLF	58	7–23	13.72 ± 3.99	29.11
V	30	41–57	47.80 ± 3.55	7.42
LF1	64	9–13	10.75 ± 0.73	6.83
LF4	65	15–21	18.12 ± 1.26	6.93
LT1	65	10–13	11.75 ± 0.73	6.21
LT4	64	16–25	20.50 ± 1.75	8.56
PP	15	5–9	7.53 ± 0.99	13.15
PS	16	5–10	7.25 ± 1.24	17.08
EPS	33	1–12	5.03 ± 2.20	43.75
PAT	62	1–3	2.35 ± 0.55	23.19
TR1	24	1–2	1.42 ± 0.50	35.55
DT1	24	4–11	7.71 ± 2.18	28.24
DT5	20	0–5	3.55 ± 1.15	32.28
SR3	22	8–10	8.86 ± 0.77	8.74

ca. 1,100 m above sea level; one juvenile (IEBR 2822), from Kon Plong forest complex, Kon Tum Province, central Vietnam, leg. Nikolai Orlov et al., 14 May 2006, at an altitude of 800 m above sea level; five adult males, four adult females (IEBR [ROM field nrs.] 39296–99, 39301, 39321, 39364–66), from Kon Plong, Kon Tum Province, central Vietnam, leg. Nikolai Orlov et al., 10 May to 26 June 2006, at an altitude of 800 m above sea level; see Figs. 3–4.

Variation of paratypes.– The measurements, proportions and scalation of the paratype series of *C. pseudoquadrivirgatus* are presented in Table 1.

Most of the 31 paratype specimens show, similar to the condition described for the holotype, a combination of a striped and banded pattern, with stripes being predominant in the shoulder region. In contrast, some show a distinct striped pattern, some a banded pattern exclusively (Fig. 3). Additionally, the width of the tail bands varies in *C. pseudoquadrivirgatus* sp. nov. The light tail bands may be broader or narrower than the adjacent dark bands. In the dark pattern elements, the tubercles are also dark. Tubercles in the border area of the dark pattern may be dark or light in different degrees. Preocular stripes of less than half the distance of the nares-anteriormost point of eye may be present or absent. The ground colouration of the snout surface typically is darker than the dorsum colouration. Distinct pattern elements (rounded, oval or irregular blotches) are only infrequently found on the snout surface. The lateral fold tubercles are often light or white, and are thus separated in colouration from the adjacent lateral and ventral scales.

Size and shape of the ear openings ranged from oval to slit-shaped, triangular, and round. We regard the oval shape as the normal condition, and the variation may be preservation artefact. This may also be the reason why the proportion ED/EAD (n = 33) with 2.65–6.57 (3.88 ± 0.91) has the largest coefficient of variation (V = 23.56%) of all body proportions (V < 8%, see Table 2). Of the paratype series, six specimens had an original tail, and 13 showed a partially or fully regenerated tail. The distinctiveness of the dorsally and laterally recognizable whorls decreases distally. In original tails, tubercles are at least discernible in the anterior half, however, their number decreases towards the tail tip. Whorls and tubercles are lacking in regenerated tails, which bear flat, smooth and subimbricate dorsal scales, that are not arranged in regular transverse rows and are somewhat smaller than

Table 3. Species specific scalation differences between *Cyrtodactylus pseudoquadrivirgatus* sp. nov. and *C. quadrivirgatus*. Abbreviations are as follows: n = number; min/max = minimum/maximum; ξ ± s = $\bar{x}$ ± standard deviation; *p* = significance niveau (t-values > significance limit 5%, 1% or 0.1% of the student distribution), ns = not significant; for remaining abbreviations see Material and Methods.

	Cyrtodactylus pseudoquadrivirgatus **sp. nov.**			*Cyrtodactylus quadrivirgatus*			
	n	**min/max**	**ξ ± s**	**n**	**min/max**	**ξ±s**	***p***
SPL	63	9–13	10.63 ± 1.04	12	9–12	10.33±0.89	ns
GBUL	65	6–12	8.78 ± 1.15	8	8–13H	10.50±1.51	0,001
SBL	64	8–10	9.05 ± 0.79	12	9–11	9.67±0.65	0,01
GBLL	62	5–10	7.66 ± 1.14	12	7–10	8.08±1.00	ns
N	64	3–5	4.05 ± 0.28	8	4–5	4.25±0.46	Ns
IN	32	0–2	1.03 ± 0.31	5	1–2	1.60±0.55	0,01
S5S	26	42–61	54.27 ± 4.70	6	53–65	59.33±4.76	Ns
IO	27	37–55	45.30 ± 4.91	6	47–59	53.83±4.71	0,001
PM	33	2	0	6	2	0	Ns
GP	33	4–7	5.15 ± 1.00	6	7–9	8.33±1.03	0,001
DTR	33	16–24	18.97 ± 1.65	6	17–24	20.00±2.45	Ns
GST	33	9–11	9.67 ± 0.74	5	9–12	10.20±1.10	Ns
TLF	58	7–23	13.72 ± 3.99	6	4–25	16.67±7.63	Ns
V	30	41–57	47.80 ± 3.55	6	40–45	42.00±2.10	0,001
LF1	64	9–13	10.75 ± 0.73	9	9–13	10.67±1.41	Ns
LF4	65	15–21	18.12 ± 1.26	9	15–19	17.56±1.24	Ns
LT1	65	10–13	11.75 ± 0.73	10	9–13	11.00±1.05	0,01
LT4	64	16–25	20.50 ± 1.75	12	17–20	19.17±1.19	0.05
PP	15	5–9	7.53 ± 0.99	3	3–6	4.33±1.53	0.001
PS	16	5–10	7.25 ± 1.24	3	3	3	0.001
EFS	66	0	0	10	4–21	16.00±4.71	0.001
EPS	33	1–12	5.03 ± 2.20	5	> 15	-	-
PAT	62	1–3	2.35 ± 0.55	10	2	0	Ns
TR1	24	1–2	1.42 ± 0.50	5	1–2	1.80±0.45	Ns
DT1	24	4–11	7.71 ± 2.18	5	4–10	7.20±2.28	Ns
DT5	20	0–5	3.55 ± 1.15	3	0–4	2.00±2.00	Ns
SR3	22	8–10	8.86 ± 0.77	4	8–10	9.50±1.00	Ns

in the original tail. Subcaudal scales are flat, smooth, and imbricate in the regenerated tail, and are distinctly smaller than in the original tail.

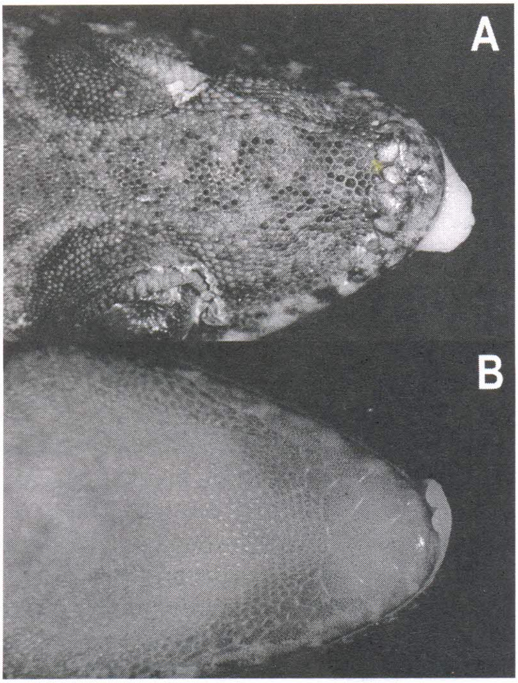
The temporal region in part is slightly convex and the head tubercles can reach to the temporal region. The postcloacal tubercles, in part, are separated by flat scales (compare Rösler, 2000a). The size of the internasals can vary from being subequal to the nasorostrals to distinctly smaller. The lateral fold tubercles also vary in size, but are always discernible and more densely arranged (partially juxtaposed) in the hind part of the body. Only the numbers of postmentals do not show any variation (see Table 2). Of the remaining numerical scalation features, the variation of the following scale counts are the largest (V > 15%): internasals, gulars bordering postmentals, lateral fold tubercles, precloacal scales in females, enlarged precloacal scales, tubercle rows in the first caudal whorl, dorsal tubercles in the first and fifth caudal whorl, and dorsal scales in the middle of the third whorl.

The 31 preserved paratypes did not show sexual dimorphism in colouration and pattern. With a maximum SVL of 83.3 mm (72.88 ± 10.11), females (n = 17) grow larger than males (n = 15), with a maximum SVL of 78.0 mm (67.75 ± 7.41). In males, the tail base is more massive and the postcloacal tubercles are more strongly developed than in females. The active male precloacal pores are often filled with secretion. The epithelial layer of the female precloacal scales is structured, and the scales show minute pores. Sexually numerical differences in scalation are insignificant (*t*-test). However, males (n = 15)

Figure 1. Dorsal view of the holotype in life of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. (ZFMK 83895) from A Luoi, central Vietnam. Photograph by Vu Ngoc Thanh.

have 5–9 (7.53 ± 0.99) precloacal pores, females (n = 16) 5–10 (7.25 ± 1.24) precloacal scales (t 0.692, $p > 0.05$). In addition, males (n = 15) show 0–2 (1.07 ± 0.46) internasals, whereas all females investigated (n = 16) only have a single internasal scale (t 0.609, $p > 0.05$).

Finally, we could not find geographic variation in the dorsal pattern and size (SVL). However, we found that some scalation features changed significantly with geographic distribution (Kolomogorov-Smirnov adaptation test):



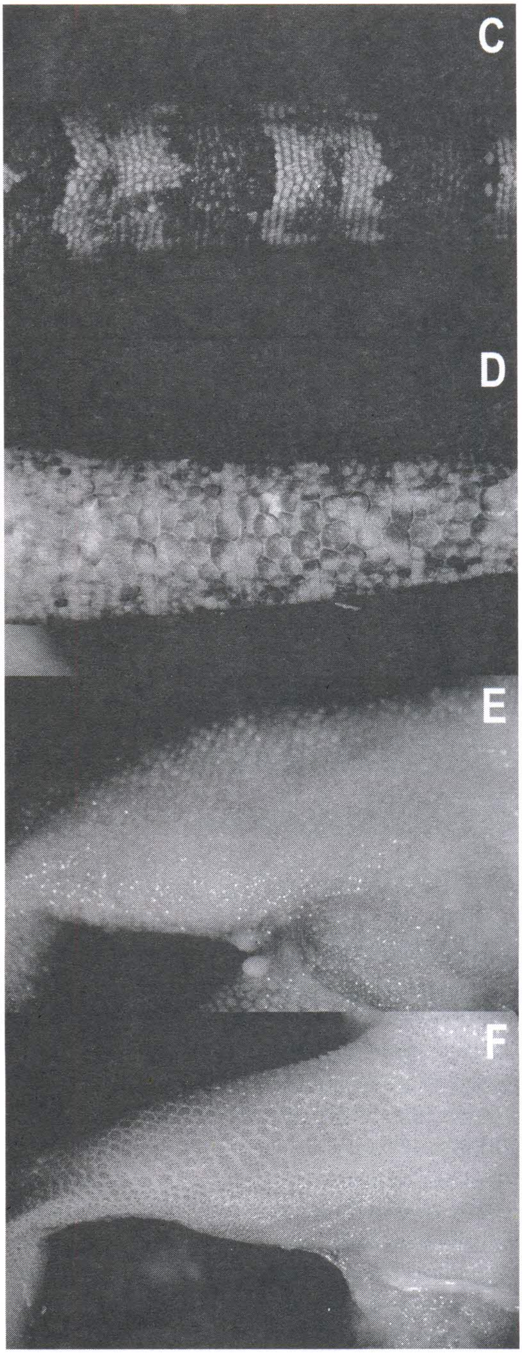


Figure 2. a–d) Holotype of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. (ZFMK 83895) from A Luoi, central Vietnam: **a)** dorsal snout region; **b)** throat; **c)** dorsal view of tail; **d)** ventral view of tail; **e)** femoral region of the preserved paratype IEBR (ROM field nr.) 2264 of *C. pseudoquadrivirgatus* sp. nov. from Huong Hoa, Quang Tri Province, central Vietnam; and **f)** femoral region of *Cyrtodactylus quadrivirgatus* (CPHR 2259) from Cameron Highlands, Malaysia. Photographs by Herbert Rösler

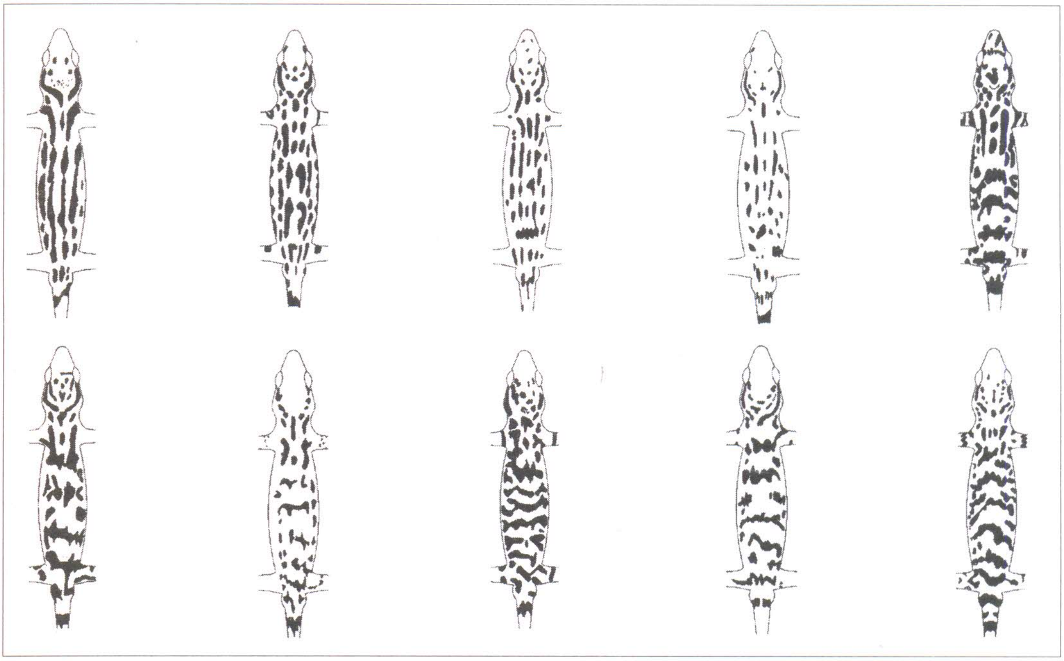


Figure 3. Variation of the dorsal pattern in *Cyrtodactylus pseudoquadrivirgatus* sp. nov., based on 12 selected specimens from the paratype series. Drawing by Herbert Rösler

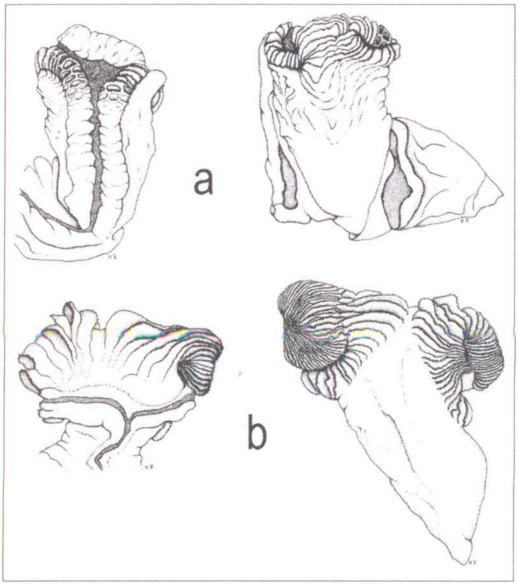


Figure 4. Hemipenis of **a)** the preserved paratype IEBR 2264 of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. from Huong Hoa, Quang Tri Province, central Vietnam; and **b)** *C. quadrivirgatus* (CPHR 2262) from Cameron Highlands, Malaysia (left: sulcal, right: asulcal view). Drawings by Herbert Rösler

the number of supralabials (Dk 0.906, $p < 0.01$), the number of granular scales surrounding the dorsal tubercles (Dk 0.896, $p < 0.01$), the enlarged precloacal scales (Dk 0.818, $p < 0.01$), and the dorsal tubercles in the first caudal whorl (Dk 0.871, $p < 0.01$) decrease from north to south, and the number of gulars bordering the postmentals (Dk 0.797, $p < 0.01$) increases in a northward direction.

Comparisons.– *Cyrtodactylus pseudoquadrivirgatus* sp. nov. differs from the Vietnamese species *C. badenensis* Nguyen, Orlov and Darevsky, 2006, in the absence of transversely enlarged subcaudals, in having higher ventral counts and lower numbers of precloacal pores; from *C. condorensis* (Smith, 1921) in the absence of transversely enlarged subcaudals and femoral scales, as well as in having higher ventral scale counts; from *C. cryptus* Heidrich, Rösler, Vu, Böhme and Ziegler, 2007, in having a lower number of precloacal pores, an interrupted nuchal band and narrow dorsal bands or stripes; from *C. intermedius* in the absence of transversely enlarged subcaudals and femoral scales, as well as in having narrow dorsal bands or stripes; from *C. irregularis* (Smith, 1921), in lacking enlarged femoral scales and having an interrupted nuchal band; from *C. nigriocularis* Nguyen, Orlov and Darevsky, 2006, in the absence of transversely enlarged subcaudals and having higher number of precloacal pores and narrow dorsal bands or stripes; from *C.*

paradoxus (Darevsky and Szczerbak, 1997), in the absence of transversely enlarged subcaudals, higher ventral scale counts and a higher number of precloacal pores; from *C. phongnhakebangensis* Ziegler, Rösler, Herrmann and Vu 2003, in lacking transversely enlarged subcaudals and lower number of precloacal pores and narrow dorsal bands or stripes (after Smith, 1935; Darevsky and Szczerbak, 1997; Ziegler et al., 2002; Nguyen et al., 2005).

C. pseudoquadrivirgatus sp. nov. can be distinguished from the externally similar *C. quadrivirgatus* Taylor, 1962, by its higher SVL and lack of enlarged femoral scales (see below).

In lacking enlarged subcaudals, *C. pseudoquadrivirgatus* sp. nov. differs from *C. aaroni* Günther and Rösler, 2003; *C. aequalis* Bauer, 2003; *C. annandalei* Bauer, 2003; *C. chanhomeae* Bauer, Sumontha and Pauwels, 2003; *C. cracens* Batuwita and Bahir, 2005; *C. consobrinoides* (Annandale, 1905); *C. consobrinus* (Peters, 1871); *C. darmandvillei* (Weber, 1890); *C. deveti* (Brongersma, 1948), which has enlarged but medially divided subcaudals; *C. elok* Dring, 1979; *C. edwardtaylori* Batuwita and Bahir, 2005; *C. feae* (Boulenger, 1893); *C. fraenatus* (Günther, 1864); *C. ingeri* Hikida, 1990; *C. jarujini* Ulber, 1993; *C. khasiensis* (Jerdon, 1870); *C. louisiadensis* (De Vis, 1892); *C. malayanus* (De Rooij, 1915); *C. malcolmsmithi* (Constable, 1949); *C. mimikanus* (Boulenger, 1914); *C. murua* Kraus and Allison 2006; *C. oldhami* (Theobald, 1876); *C. peguensis* (Boulenger, 1893); *C. ramboda* Batuwita and Bahir, 2005; *C. redimiculus* King, 1962; *C. russelli* Bauer, 2003; *C. soba* Batuwita and Bahir, 2005; *C. subsolanus* Batuwita and Bahir, 2005; *C. sumonthai* Bauer, Pauwels and Chanhome, 2002; *C. tuberculatus* (Lucas and Frost, 1900); and *C. variegatus* (Blyth, 1859) (after De Rooij, 1915; Smith, 1935; Taylor, 1963; Dring, 1979; Hikida, 1990; Ulber, 1993; Bauer et al., 2002, 2003; Bauer, 2003; Batuwita and Bahir, 2005; Couper et al., 2006; Rösler et al., 2007).

In lacking a precloacal groove in both sexes, *C. pseudoquadrivirgatus* sp. nov. differs from *C. agamensis* (Bleeker, 1860); *C. aurensis* Grismer, 2005; *C. baluensis* (Mocquard, 1890); *C. cavernicolus* Inger and King, 1961; *C. marmoratus* Gray, 1831; *C. papuensis* (Brongersma, 1934); *C. philippinicus* (Steindachner, 1867); *C. pulchellus* Gray, 1828; *C. pubisulcus* Inger, 1957; *C. rubidus* (Blyth, 1861); *C. sadleiri* Wells and Wellington, 1985; *C. semenanjungensis* Grismer and Leong, 2005; and *C. tiomanensis* Das and Lim, 2000 (after Das and Lim, 2000; Grismer, 2005; Rösler et al., 2007; Tikader and Sharma, 1992; Youmans and Grismer, 2006).

In lacking preanofemoral pores, *C. pseudoquadrivirgatus* sp. nov. differs from *C. fumosus* (Müller, 1895), which has 42–52 of such pores; *C. loriae* (Boulenger, 1898), having 30–81; *C. novaeguineae* (Schlegel, 1837), having 24–34; and *C. seribuatensis* Youmans and Grismer 2006, having 42–45.

C. pseudoquadrivirgatus sp. nov. can be differentiated in the combination of precloacal and femoral pores from *C. agusanensis* (Taylor, 1915), that has 7–11 precloacal and 3–14 femoral pores; *C. biordinis* Brown and McCoy, 1980, having 11–14 precloacal and 15–28 femoral pores in two rows; *C. brevipalmatus* (Smith, 1923), having 6–7 precloacal and 9–10 femoral pores; *C. gubernatoris* (Annandale, 1913), having 9 precloacal and 6 femoral pores; *C. interdigitalis* Ulber, 1993, having 14 precloacal and 8–9 femoral pores; *C. slowinskii* Bauer, 2002, having 11–12 precloacal and 9–1 femoral pores; *C. tigroides* Bauer, Sumontha and Pauwels, 2003, having 5–7 precloacal and 8–9 femoral pores; *C. wetariensis* (Dunn, 1927), having 11–12 precloacal and 12–13 femoral pores (after Annandale, 1913; Dunn, 1927; Rösler et al., 2007; Ulber, 1993; Youmans and Grismer, 2006).

C. pseudoquadrivirgatus sp. nov. differs in showing a larger SVL from *C. jellesmae* (Boulenger, 1897); *C. laevigatus* (Darevsky, 1964); and *C. thirakhupti* Pauwels, Bauer, Sumontha and Chanhome 2004; the new species differs in being smaller (in terms of SVL) from *C. sermowaiensis* (De Rooij, 1915); from the aforementioned species, *C. pseudoquadrivirgatus* sp. nov. differs additionally in showing precloacal pores (after Boulenger, 1897; Darevsky, 1964; De Rooij, 1915; Pauwels et al., 2004).

C. pseudoquadrivirgatus sp. nov. differs by its larger SVL (83.3 mm versus 68.5 mm) and a higher number of dorsal tubercle rows (16–24 versus 11) from *C. adleri* Das, 1997; by its larger SVL (83.3 mm versus 66 mm) and lack of a U-shaped nuchal band from *C. angularis* (Smith, 1921); by enlarged scales behind the precloacal pores and a medially divided nuchal band from *C. annulatus* (Taylor, 1915); by a higher ventral scale count (41–57 versus 32–37) and a lower number of precloacal pores (5–9 versus 10–28) from *C. ayeyarwadyensis* Bauer, 2003; by a smaller SVL (83.3 mm versus 88 mm) and a lower number of dorsal tubercle rows (16–24 versus 27) from *C. brevidactylus* Bauer, 2002; by a lower number of dorsal tubercle rows (16–24 versus 25) and more ventrals (41–57 versus 30) from *C. buchardi* David, Teynié and Ohler 2004; by a larger SVL (83.3 mm versus 79.1 mm) and more ventrals (41–57 versus 37) from *C. chrysopylos* Bauer, 2003; by a smaller SVL (83.3 mm versus 112 mm) and a lower lamellae number below the fourth toe (16–25 versus 24–26) from *C. derongo* Brown and Parker, 1973; by a larger SVL (83.3 mm versus 63 mm) and fewer precloacal pores (5–9 versus 16–29) from *C. gansi* Bauer, 2003; by a smaller SVL (83.3 mm versus 163 mm) and fewer subdigital lamellae below the fourth toe (16–25 versus 28–35) from *C. irianjayaensis* Rösler, 2000; by a smaller SVL (83.3 mm versus 85 mm), fewer ventral scales (41–57 versus 60–64) and fewer precloacal pores (5–9 versus 13) from *C. lateralis* (Werner, 1896); by a smaller SVL (83.3 mm versus 104.5 mm) and enlarged scales behind the precloacal pores from *C. matsuii* Hikida, 1990; by a smaller SVL (83.3 mm versus 93 mm) and more ventral scales (41–57 versus 30–34) from *C. papilionoides* Ulber and Grossmann, 1991; by a larger SVL (83.3 mm versus 77 mm) and a different dorsal colouration and pattern (buff with blackish brown blotches or stripes versus dark brown above, with small, irregularly-shaped white spots) from *C. sworderi* (Smith, 1925); by a larger SVL (83.3 mm versus 64 mm) and fewer precloacal pores (5–9 versus 12) from *C. wakeorum* Bauer, 2003; by a smaller SVL (83.3 mm versus 96.2 mm) and a lower number of subdigital lamellae below the fourth toe (16–25 versus 25–30) from *C. yoshii* Hikida, 1990 (after Brown and Parker, 1973; Das, 1997; Rösler et al., 2007; Smith, 1925; Ulber and Grossmann, 1991; Youmans and Grismer, 2006).

The new species differs from the species of the subgenus *Geckoella* sensu Rösler (2000b) in having a larger SVL and in having precloacal pores, which are lacking in *C.* (*Geckoella*) *albofasciatus* (Boulenger, 1885); *C.* (*Geckoella*) *collegalensis* (Beddome, 1870); *C.* (*Geckoella*) *deccanensis* (Günther, 1864); *C.* (*Geckoella*) *jeyporensis* (Beddome, 1877); *C.* (*Geckoella*) *nebulosus* (Beddome, 1870); and *C.* (*Geckoella*) *yakhuna* (Deraniyagala, 1945); the new species differs from *C.* (*Geckoella*) *triedrus* (Günther, 1864) in having a larger SVL (83.3 mm versus 62 mm) and in the absence of femoral pores (after Deraniyagala, 1953; Smith, 1935; Tikader and Sharma, 1992).

Comparisons with *Cyrtodactylus irregularis* and *C. quadrivirgatus*.– Based on the character analysis presented above, *Cyrtodactylus pseudoquadrivirgatus* sp. nov. can be distinguished from most *Cyrtodactylus* species by the combination of size and scalation features. Congeners that are more difficult to separate from *C. pseudoquadrivirgatus* sp. nov. are treated in more detail in the following para, including the Vietnamese species *C. irregularis* and *C. quadrivirgatus* from Thailand and Malaysia.

Cyrtodactylus irregularis was described as a subspecies of *Gymnodactylus peguensis* (currently *C. peguensis*) by Smith (1921) from the central Vietnamese type locality, "Camly, 3500 feet, Langbian Plateau, S. Annam". The holotype measured 79 mm SVL and the paratype 80 mm SVL. Characteristic features include small, irregular blotches, in combination with 8–9 supralabials, 8–9 sublabials and 5–7 precloacal pores (the tail was lacking). Subsequently, *irregularis* was treated by Smith (1935) as a full species, and the following features were listed: 11 supralabials; 9 sublabials; body and limbs with small granular scales, and larger conical or subtriangular tubercles; lateral folds with distinctly enlarged scales; 41–46 ventral scale rows; 5–7 precloacal pores in males, arranged in angular series; a group of enlarged precloacal scales posterior to the precloacal pores; 7 or 8 enlarged femoral scales, separated from precloacal pores by small, smooth scales; femoral scales are pitted, and in one specimen one scale perforated; tail scales not known. A third specimen was provisionally allocated by Smith (1935: BMNH 1931.6.12.3) to *C. irregularis*, because of a somewhat different scalation (i.e., 33 ventral scales) and an unusual pattern (i.e., nuchal band broken in the middle). The tail of this additional specimen was described as complete and "covered with small, flat, juxtaposed scales and series of enlarged tubercles above, with larger imbricate scales below, those on the median line being larger than the other". According to Darevsky and Szczerbak (1997), *C. irregularis* is the sole Vietnamese species lacking transversely enlarged subcaudal scales: "Underside of tail with numerous roundish scales" (see also Youmans and Grismer, 2006).

Cyrtodactylus irregularis arguably represents the least known Vietnamese bent-toed gecko, as further records or specimens are not known. Another Vietnamese species with small, imbricate scales was described recently as *C. cryptus* (Heidrich et al., 2007). Based on the features known from the *irregularis* type series and from the specimen "Brit. Mus. 1931.6.12.3", Ziegler et al. (2004) published another report of *C. irregularis*, an adult female (ZFMK 80080) from Bach Ma, Thua Thien-Hue, Vietnam. They noted that the pattern of the specimen was somewhat different from the original description, although the neck and back pattern corresponded well with the specimen "Brit. Mus. 1931.6.12.3", tentatively identified as *C. irregularis* by Smith (1935). In addition, Ziegler et al. (2004) recognized, that the scalation features of ZFMK 80080 "largely correspond with the characters given in Smith (1935), except for the lack of enlarged femoral scales", and concluded "Apparently, *Cyrtodactylus irregularis* is a rarely collected and therefore (is a) barely known bent-toed gecko species". With the series of *Cyrtodactylus* now available from central Vietnam, it is obvious, that the variations recognized by Ziegler et al. (2004) for their single specimen (which include, among others, the lack of enlarged femoral scales and the variation shown in the dorsum pattern) constitute diagnostic features of *C. pseudoquadrivirgatus* sp. nov. The specimen ZFMK 80080 (*C. irregularis* sensu Ziegler et al., 2004), thus, is conspecific with *C. pseudoquadrivirgatus* sp. nov. However, due to the poor state of preservation of this specimen, we refrain from adding it to the type series.

Cyrtodactylus quadrivirgatus, which is phenetically similar to *C. pseudoquadrivirgatus* sp. nov., was described by Taylor (1962) based on an adult female holotype No. 387, from Khao Chong Forest Experiment Station, Trang Province, Thailand. Besides a topotypic paratype, the paratype series also contained specimens from several locations in Malaysia (see also Taylor, 1963). *C. quadrivirgatus* is known to occur from southern Thailand through Malaysia, Singapore to northern Sumatra (Manthey and Grossmann, 1997). With a maximum SVL of 83.3 mm, *C. pseudoquadrivirgatus* sp. nov. grows somewhat larger than *C. quadrivirgatus* which has a maximum SVL of 71 mm (Taylor, 1962; Manthey and Grossmann, 1997; Youmans and Grismer, 2006). A faint ventrolateral fold exists in both *C. pseudoquadrivirgatus* sp. nov. and *C. quadrivirgatus* (Taylor, 1962), although the lateral fold tubercles are more strongly developed in the new species. According to Taylor (1962), caudal tubercles are absent in *C. quadrivirgatus* (see also Manthey and Grossmann, 1997). However, all five Malaysian *C. quadrivirgatus* studied by us (CPHR 2259–60, 2262, SAMA R36783, ZFMK 86751) showed tubercles in the first tail whorl and two of them also

Figure 5. Map showing the distribution of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. in central Vietnam; from north to south: Quang Tri Province (Huong Hoa), Thua Thien-Hue Province (A Luoi, type locality, marked by a large dot), Da Nang City (Ba Na), and Kon Tum Province (Kon Plong).

Figure 6. Habitat of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. in A Luoi, Thua Thien-Hue Province. Photograph by Nguyen Quang Truong.

in the fifth caudal whorl, corresponding to the data provided by Youmans and Grismer (2006). In scalation, *C. pseudoquadrivirgatus* sp. nov. and *C. quadrivirgatus* differ significantly ($p < 0.001$) in the number of granular scales behind upper labials to angle of mouth; internasals; scales between fifth supralabials; gular scales bordering postmentals; ventral scales; enlarged femoral scales and precloacal pores in males, as well as precloacal scales in females (see Table 3). However, the size of the femoral scales serves best for a diagnosis. Whereas in the femoral region of *C. pseudoquadrivirgatus* sp. nov., the anteriorly largest scales gradually pass over to the posteriorly smallest scales in both sexes, there exists a sharp separation in between these scales in *C. quadrivirgatus* (Figs. 2e–f). In the latter species, independent of sex, the large (femoral) scales are ca. x 3 larger than small posterior scales. Counts of 17–25 single-sided femoral scales are known for *C. quadrivirgatus* (Taylor, 1962; Manthey and Grossmann, 1997); the specimens studied by us have 4–21 unilateral femoral scales. Whereas the male precloacal pores are relatively large and easily discernible in *C. pseudoquadrivirgatus* sp. nov., the pores were hardly detectable in male specimens of *C. quadrivirgatus,* CPHR 2262 and ZFMK 86751. Also, the structured epithelial layer of the small pores in female *C. pseudoquadrivirgatus* sp. nov. was usually clearly discernible, whereas such depressions were hardly recognizable in the scales of the female *C. quadrivirgatus,* specimen CPHR 2259–60. However, such a difference could also be related to reproductive phase. Taylor (1962), Manthey and Grossmann (1997) and Youmans and Grismer (2006) mention 0–4 precloacal pores; the *C. quadrivirgatus* males studied by us show 3 and 6 precloacal pores.

Cyrtodactylus pseudoquadrivirgatus sp. nov. and *C. quadrivirgatus* show a similar hemipenes morphology (Fig. 4): in both species, the sulcus spermaticus is a deep groove, bordered by bulging lips; on the pedicel, the sulcus runs nearly crossways, to turn in an angle of maximum 90° in the truncus region; in the upper truncus region, the sulcus bifurcates beneath a transverselly raised skin bulge; both arched sulcus branches stretch towards concentric depressions of the apical lobes; in *C. quadrivirgatus*, these lobes bear serrated skin rims, that extend towards the concentric depressions; in *C. pseudoquadrivirgatus* sp. nov. (IEBR 2264), these apical lobes are not fully everted, but show a similar structure. However, the serrated apical lobes are medially separated by a smooth area in *C. quadrivirgatus*, which is not the case in *C. pseudoquadrivirgatus* sp. nov. In addition, *C. quadrivirgatus* and *C. pseudoquadrivirgatus* sp. nov. distinctly differ from *C. phongnhakebangensis* by having groove-shaped apical ornamentation, whereas the latter species shows a typical apical calyx-ornamentation, that also can be found in *C. aaroni* and *C. mimikanus* (Ziegler et al., 2002; Günther and Rösler, 2003).

Finally, *C. pseudoquadrivirgatus* sp. nov. and *C. quadrivirgatus* show an unusual dorsal pattern variability. In both species, the pattern on dorsum may consist of stripes, bands or blotches, and an uninterrupted nuchal band is lacking (Manthey and Grossmann, 1997; Chan-ard et al., 1999). However, a distinct difference can be observed in the flank pattern: whereas the flanks beneath the dorsolateral stripes and/or bands are typically unicoloured and covered with light blotches in *C. quadrivirgatus*, *C. pseudoquadri-*

virgatus sp. nov. typically bears distinct dark stripes or a longitudinal series of blotches on a light ground colouration.

Etymology.– The name refers to *Cyrtodactylus quadrivirgatus*, with which the new species may be easily confused with due to the striking similarities in external morphology, including scalation, colouration and pattern; the prefix pseudo derives from the Greek pseudes = false, pretended.

Distribution.– Currently, the species is known only from Vietnam. *Cyrtodactylus pseudoquadrivirgatus* sp. nov. is known to occur in the central Vietnamese provinces of Quang Tri, Thua Thien-Hue, Da Nang and Kon Tum (from north to south, see Fig. 5).

Natural history.– The holotype of *Cyrtodactylus pseudoquadrivirgatus* sp. nov. was found in the primary forest of A Luoi, near the Lao border, in Thua Thien-Hue Province, at 800 m asl. Two specimens were discovered at 2300 h, ca. 2 m above ground on the surface of a large rock near a stream, but only the smaller one could be collected. The adult female, which was collected in the summer, contained one large (10.4 x 8.0 mm) egg; the intestine contained remains of a labidognath spider.

The paratypes were discovered at night, at altitudes of ca. 400–1,100 m asl. Most of these from A Luoi, Huong Hoa and Kon Plong were collected from the vicinity of slow-running forest streams in the summer (Fig. 6). Specimens were usually found on leaves at heights of ca. 1 m above ground. The paratypes from Ba Na Nature Reserve were collected from granitic outcrops in secondary evergreen forest, close to small stream banks of the upper part of the Thac Mo Waterfall.

KEY TO *CYRTODACTYLUS* SPECIES OF VIETNAM

1 Subcaudals not transversely enlarged . .2

1′ Subcaudals transversely enlarged 4

2 Enlarged femoral scales absent 3

2′ 7–8 enlarged femoral scales, 5–7 precloacal pores, 41–46 scales across belly, nuchal band medially undivided, dorsum with irregular large blotches that are located close together and have light edges . . . . *irregularis*

3 5–9 precloacal pores, 41–58 scales across belly, nuchal band medially divided, dorsum with irregular blotches, serrated bands or stripes . . . . *pseudoquadrivirgatus* sp. nov.

3′ 9–11 precloacal pores, 47–50 scales across belly, nuchal band medially undivided, dorsum with 3–5 wide bands with pale seams, separated by large intervals . . . . *cryptus*

4 34 or fewer scales across belly. 5

4′ 40 or more scales across belly 6

5 25–28 scales across belly, without precloacal pores, dorsum with four bands that are uninterrupted in vertebral region . . . . *badenensis*

5′ 30–34 scales across belly, 0–4 precloacal pores with enlarged femoral scales, dorsum with seven bands that are interrupted in vertebral region . . . . *paradoxus*

6 10 or fewer precloacal pores 7

6′ 32–42 preanofemoral pores, 32–42 scales across belly, dorsum with four wide, serrated bands with light seams . . . . *phongnhakebangensis*

7 Femoral scales enlarged. 8

7′ Enlarged femoral scales lacking, 0–2 (if at all) hardly visible precloacal pores, 42–49 scales across belly, dorsum (if at all) with four barely visible, interrupted bands . . . . *nigriocularis*

8 6–10 enlarged femoral scales, 8–10 precloacal pores, 40–50 scales across belly, dorsum with four wide, unserrated bands with light edges . . . . *intermedius*

8′ A series of enlarged femoral scales, 4–7 precloacal pores, 35–40 scales across belly, dorsum with irregular blotches . . . . *condorensis*

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NOTE ADDED IN PROOF

While the present paper was in press, four new *Cyrtodactylus* have been described from Vietnam: *C. caovansungi* Orlov, Nguyen, Nazarov, Ananjeva & Nguyen, 2007, *C. chauquangensis* Hoang, Orlov, Ananjeva, Johns, Hoang & Dau, 2007, C. huynhi Ngo & Bauer, 2008, and *C. takouensis* Ngo & Bauer, 2008:

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ON THE TAXONOMIC STATUS OF *UROPELTIS BICATENATA* (GÜNTHER) (REPTILIA: SERPENTES: UROPELTIDAE)

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(with six text-figures)

ABSTRACT.– The Indian uropeltid snake *Uropeltis bicatenata* (Günther, 1864) has been considered a junior synonym of *Uropeltis ceylanica* Cuvier, 1829, implicitly or explicitly, since Beddome (1886). Re-examination of the holotype and historical and newly collected material of *U. bicatenata* confirms Günther's (1864) assessment that this form represents a distinct species of *Uropeltis*. We resurrect *U. bicatenata* from the synonymy of *Uropeltis ceylanica*, provide a new diagnosis of the species, redescribe the holotype, document variation among all known material, and discuss aspects of the state of the taxonomy of *Uropeltis*.

KEY WORDS.– India, shieldtail, snakes, systematics, taxonomy, Western Ghats.

INTRODUCTION

Uropeltidae (*sensu* McDiarmid et al., 1999) is a family of charismatic, burrowing alethinophidian snakes endemic to peninsular India and Sri Lanka (Gans, 1973, 1976, 1979; Cadle et al., 1990; Bossuyt et al., 2004). At first glance, the taxonomy of Uropeltidae appears stable, the vast majority of taxonomic actions having been executed in the 1800s. For example, only seven of the 47 currently recognised species were described after 1896 (McDiarmid et al., 1999), and only one of these in the last 50 years (Deraniyagala, 1975). However, this lack of recent taxonomic activity creates the false impression of a well-established systematic framework. In reality, most species are poorly characterised on the basis of few character systems for which variation has been studied across only small samples. In addition, much of the type and important historical material has poor locality data, and is housed in London and Paris, with limited accessibility to modern Indian and Sri Lankan workers. The robustness of the current taxonomy is uneven across the family, and it is our impression that the most unsatisfactory situation relates to the most speciose (c. 23 species) of the currently recognised genera, *Uropeltis* Cuvier, 1829. In the 1800s, a flurry of taxonomic action saw several genera (*Siluboura* Gray, 1845; *Coloburus* Duméril in Duméril and Duméril, 1851; *Crealia* Gray, 1858) erected and subsequently relegated to the junior synonymy of *Uropeltis*, and many species synonymised within the genus, but little of this has been reassessed in any detail in the intervening period. This early work was often conducted in a more casual framework than would occur today, where type specimens were not designated and synonymies often listed without any discussion. This has resulted in an intricate and often confusing taxonomic history (see Gans, 1966; McDiarmid et al., 1999). This is exemplified by the type species of *Uropeltis*, *U. ceylanica* Cuvier, 1829, for which McDiarmid et al. (1999) list many unjustified emendations, junior synonyms and varieties, as well as documenting that the type locality "Ceylan" is both imprecise and presumably incorrect.

During examination of new *Uropeltis* material from the Western Ghats of Maharashtra, India, we recognised an apparently distinct form that keys out (using the most recent keys of Smith, 1943; Rajendran, 1985; Sharma, 2003) as *U. ceylanica* but which has a distinctive colour pattern and differs in other characters from the lectotype of *U. ceylanica* and many other specimens previously referred to that species. Furthermore, the new material closely resembles two historical specimens in separate collections—the type and previously only reported specimen of *U. bicatenata* (Günther, 1864) in the Natural History Museum, London, UK (BMNH), and a specimen wrongly identified by M. A. Smith (Ali, 1949) as *U. rubrolineatus* (Günther) in the collections of the Bombay Natural History Society, Mumbai, India (BNHS). *Uropeltis bicatenata* was described by Günther (1864) but has been subsequently considered a junior synonym of *U. ceylanica* (see below). Here we reassess *U. bicatenata*, resurrect it from the synonymy of *U. ceylanica*, rediagnose the species (based on historical and new material), and redescribe and figure the holotype. The Muséum National d'Histoire Naturelle, Paris, France is abbreviated as MNHN.

TAXONOMIC HISTORY

Günther (1863: 350) included "Silybura bicatenata. Dekkan. East India Company." in a brief report listing new species to be described in a subsequent monograph. The latter work (Günther, 1864) presented a formal description of *S. bicatenata* (p. 191), a figure of the whole body (plate XVII H) and a line drawing of head scalation in dorsal view (plate XVII H'). These are reproduced here, below and in Fig. 1.

> "SILYBURA BICATENATA. (Plate XVII. Figs. H, H'.)
>
> Snout obtusely conical; rostral rounded, very short, shorter than the nasals; vertical square, its front part, which extends between the frontals being as large as its hind part; it is rectangular anteriorly and posteriorly. Fourth upper labial as high as long. Caudal disk flat, well defined, not much shorter than tail, terminating in a broad, horny, bicuspid scale which is slightly turned upwards; each scale composing the caudal disc is provided with one or two or three keels. The body is surrounded by seventeen series of scales on the neck as well as in its middle; ventral shields 135; twelve pairs of subcaudals. The circumference of the thickest (anterior) part of the body is one-eleventh of the total length. Black above and below, each scale on the back with a yellowish margin. A yellow band runs along each side of the body; it corresponds to the joining edges of the fourth and fifth outer series of scales; anteriorly it is broken up into a series of large spots, posteriorly it flanks the lower part of the tail. Lower parts entirely black.
>
> A single example of this beautiful species, 9½ inches long, was brought by Colonel Sykes from the Deccan. The specimen is a male, with the tail 8 lines long; it is figured on Plate XVII. Of its natural size; figure H' represents the upper side of the head."

Eleven years later, Günther (1875) still recognised *S. bicatenata* as a distinct species (with no indication that any more specimens had been found), and included it in a key to the species of *Silybura*. Theobald (1868, 1876) also listed *bicatenata* as a valid species. Beddome (1886) and Boulenger (1890, 1893) listed, without discussion, *Silybura bicatenata* under the synonymy of their preferred names for *S. ceylanica*, namely S. *nilgherriensis* Beddome, 1863 and *S. brevis*

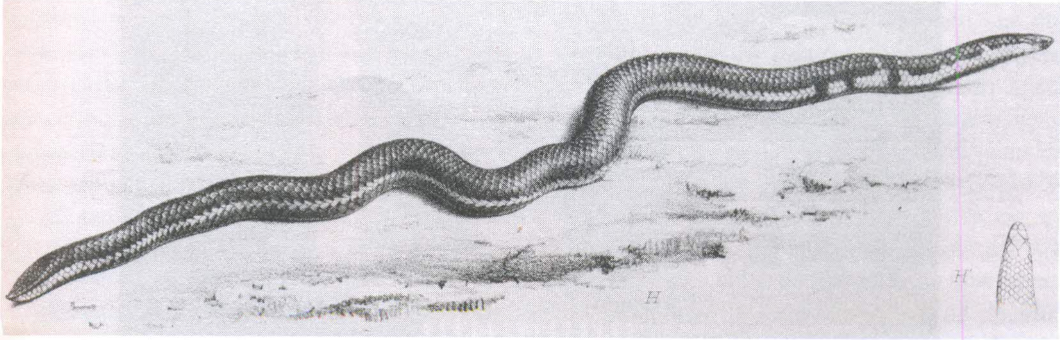

Figure 1. Reproduction of Günther's (1864: plate XVII. figs. H, H') original figures of *Uropeltis bicatenata* (Günther).

Figure 2. Holotype (BMNH 1946.1.16.8) of *Uropeltis bicatenata* (Günther). Scale in millimetres.

Günther, 1862, respectively. *Silybura* Peters, 1861 is an unjustified emendation of *Siluboura* Gray, 1845 which is a junior synonym of *Uropeltis* Cuvier, and treatment of *U. bicatenata* as a junior synonym of *U. ceylanica* has been followed, without further comment, by all four of the main subsequent comprehensive taxonomic treatments of Uropeltidae: Smith (1943: 80), Gans (1966: 18—the type locality of *Silybura bicatenata* is incorrectly given as "Wynad, Malabar, 3500 feet elevation"), Mahendra (1984: 85–86) and McDiarmid et al. (1999). This taxonomy has also been followed implicitly or explicitly by authors of post-Smith (1943) faunal lists (e.g., Das, 1997, 2003; Murthy, 1982, 1990; Sharma, 2003; Whitaker, 1978). Despite interpreting *U. bicatenata* as a junior synonym of *U. ceylanica*, several authors continued to list "*bicatenata*" as a colour variant of the senior synonym. This appears to have been initiated by Smith's (1943: 80) diagnosis of *U. ceylanica,* which includes: "with a lateral yellow stripe (*bicatenata*)". Rajendran (1985: 65) imprecisely quoted Smith by reporting a "bicarinate" variant of *U. ceylanica*. Murthy (1990: 15) upgraded Smith's variant to *U. ceylanicus bicatenata* but confused things further by attributing various ventral colour patterns to the form that are not present in Günther's material, and which were not ascribed by Smith to any particular one of his listed varieties.

Ali (1949) reported a uropeltid specimen from Bhimashankar, Maharashtra, India, that M. A. Smith had identified for him as *Uropeltis rubrolineatus* (Günther, 1875). We refer this specimen (BNHS S225) to *U. bicatenata*, which we consider a valid species. We follow the taxonomic nomenclature of McDiarmid et al. (1999).

TAXONOMY

Uropeltis bicatenata (Günther, 1864)

(Figs. 1–6, Table 1)

Silybura bicatenata Günther, 1863: *Nomen nudum*. Günther (1863: 350)

Silybura bicatenata Günther 1864: Günther (1864: 191, Pl. XVII H, H"; 1875: 229); Theobald (1868: 43; 1876: 134); Gans (1966: 18)

Silybura nilgherriensis Beddome, 1863: Beddome (1886: 15)

Silybura brevis Günther, 1862: Boulenger (1890: 269; 1893: 158)

Uropeltis ceylanicus Cuvier, 1829: Smith (1943: 80)

Uropeltis rubrolineatus (Günther, 1875): Ali (1949: 376)

Uropeltis (Siluboura) ceylanicus Cuvier, 1829: Mahendra (1984: 85–86)

U[ropeltis]. ceylanicus bicatenata (Günther, 1864): Murthy (1990: 15)

Uropeltis ceylanica Cuvier, 1829: McDiarmid et al. (1999: 144)

Holotype.– BMNH 1946.1.16.8 (formerly BMNH 60.3.19.1277), male, from "Dekkan" or "the Deccan" according to Günther (1863) and Günther (1864) respectively. The BMNH catalogue and the jar label gives "Deccan (?)", which McDiarmid et al. (1999: 144) interpret as a questioning of the locality. Other than that the specimen was presented by Colonel Sykes, there are no further collection data, although the first part of the original BMNH specimen number indicates that the specimen was catalogued in 1860. The BMNH accessions register entry for 60.3.19.1277 states only "*Typhlops*", presented by East India House.

Referred material.– BNHS S225 (female, collected by S. Ali, September 1948), Bhimashankar, Pune District, Maharashtra, India; BNHS 3251 and 3252 (male and female respectively, I. Agarwal and S. Kehimkar, 2004), close to Bhimashankar Wildlife Sanctuary, Pune District, Maharashtra, India; BNHS 3265 (male), 3266 (male) and 3267 (female) Fangul Gawhan, Pune District, Maharashtra, India (all three collected by S. Thakur, October 2003). See Table 1 for details and morphometric and meristic data, and Fig. 6 for distribution of localities.

Diagnosis.– A *Uropeltis* with 17 dorsal scale rows at midbody and a notably flat-to-mildly-concave tail shield (distinctly not convex). Ranges of variation of seven known specimens: total length 155–264 mm; ventral scales 130–141; subcaudal scales 8–9 (three females) or 10–12 (four males); tail shield with 34–43 keeled scales; typically 7 (uniquely 6, on one side only) maxillary and dentary teeth per row. *Uropeltis bicatenata* differs from type specimens of all other similarly scaled and shielded, nominate species of the genus, namely Smith's (1943: 74) group IIA and IIB species (see Table

2) in the following ways: *Uropeltis arcticeps* (Günther, 1875) has fewer teeth (4–5 per row), a shorter ocular and proportionately smaller eye, and fewer ventrals (< 130). *Uropeltis ceylanica* has fewer teeth (4 maxillary, 5 dentary), a proportionately larger 3rd supralabial, a longer midline suture between prefrontals than nasals, a rostral that extends posterior to the nares, fewer subcaudals (6), a proportionately broader tail shield with fewer keeled scales (28), smaller ocular and eye, narrower frontal, shorter parietal, and narrower ventrals. *Uropeltis rubrolineata* (Günther, 1875) has more ventrals (>164), fewer subcaudals (6–7 female, 9 male), fewer maxillary teeth (typically 5 per row), fewer keeled shield scales (27–30), a proportionately shorter tail, and smaller eye relative to ocular scale. *Uropeltis rubromaculata* (Beddome, 1867) has fewer maxillary teeth (5 per row), a longer head relative to snout-vent length, and more keeled scales on the tail shield (45–52). *Uropeltis myhendrae* (Beddome, 1886) and *Uropeltis phipsonii* (Mason, 1888) have more dentary teeth (typically 9 per row), and proportionately longer rostrals—so that the portion visible from above is clearly longer than its distance from the frontal. *Uropeltis myhendrae* has more keeled scales on the tail shield (47). *Uropeltis phipsonii* has more ventrals (>143) and more supralabials (5; one type has 4 on one side), although four BNHS non-type specimens (BNHS S231–234) that we are confident can be referred to *Uropeltis phipsonii* all have 4 (AC, pers. obs).

Remarks.– We consider many if not most species of *Uropeltis* to be poorly characterised, and have therefore restricted ourselves here to comparisons of all (*arcticeps, ceylanica, phipsonii, rubrolineata, rubromaculata*) or all BMNH-housed (*myhendrae*—one, possibly two MNHN types not examined, see McDiarmid et al., 1999) type material of Smith's Group IIA and IIB (Table 2). Although we are confident that *U. bicatenata* is a distinct, clearly diagnosable, valid species, we anticipate that the ranges of variation of individual characters will increase when larger samples are considered. That the material newly referred to *U. bicatenata* encompasses the size range of at least one of the types of each of the other species (compare Tables 1 and 2) lends some confidence to distinguishing the species based on small samples.

In addition to the combinations of characters listed above, *U. bicatenata* has a distinctive colour pattern that serves to separate it from all similarly scaled species. For example, *U. rubrolineata* and *U. rubromaculata* have vivid red (in life) and not yellowish markings, and the lateral stripes in the types of *U. rubrolineata* are broader, occupying dorsal scale rows 1–3 or 1–4 (versus rows 4–5 in *U. bicatenata*). Unlike the unblemished belly of all known *U. bicatenata*, the ventrals of the type specimens of *U. ceylanica, U. arcticeps, U. myhendrae, U. rubrolineata* and *U. rubromaculata* have pale specks, blotches and/or bands. The types of *U. ceylanica, U. phipsonii,* and *U. rubrolineata* also differ from all known material of *U. bicatenata* in having a broad transverse ventral band in the region of the anus, linking the left and right lateral stripes on the tail (although this character is known to vary in some other *Uropeltis*, e.g., *U. macrolepis macrolepis*, AC, pers. obs.). Finally, although varying in their clarity, the speckled yellow chevron markings on the dorsum of *U. bicatenata* are not seen in the other species. Günther's (1875) key separated *bicatenata* from other *Uropeltis* species having 17 scale rows, <160 ventrals, flat tail shield, and lacking a sharply pointed snout, on the basis of its regular, narrow, lateral yellow stripes, and this serves still to identify all the known material of this species except for one heavily blotched individual (see below).

Uropeltis bicatenata is distinct also (DJG, pers. obs.) in colour pattern and meristic and morphometric characters from all types of all other species (*brevis* Günther, 1862; *shorttii* Beddome, 1863; *nilgherriensis* Beddome, 1863; *annulata* Beddome, 1886) recognised as junior synonyms of *U. ceylanica* in the most recent comprehensive treatments (Smith, 1943; Gans, 1966; McDiarmid et al., 1999). Detailed data for these types are not presented here because a much-needed, full re-evaluation of the taxonomy of *U. ceylanica* is beyond the scope of the present study. Some of our new observations lie outside Smith's (1943: 61) diagnosis of Uropeltidae—the five (versus a constant four) supralabials in at least some *U. phipsonii*, and the several instances of tooth counts beyond the reported range of 6–8 per maxilla and 8–10 per mandible (Tables 1, 2).

Redescription of holotype.– Some morphometric and meristic data are given in Table 1. New photographs and drawings of the holotype are presented in Fig. 2 and 3, respectively. The specimen is an adult male in fair condition, preserved in a single loose, flat coil. Some parts of the body are soft, especially in the anterior half of the specimen. In particular, the head is soft, and here the outermost layer of keratin of the scales has been lost so that determining exact squamation patterns is difficult in some places. The colour is somewhat faded, with the black and yellow described by Günther (1864) now dark brown and pale, golden yellow. There are no incisions into the specimen, its sex has been inferred here from the relatively long tail and high number of subcaudal scales via comparison with the dissected, referred, sexually dimorphic BNHS material. It is unclear how Günther (1864) sexed the holotype as a male.

Snout tip a little squashed, but capped by short, rounded (dorsal and lateral views) rostral shorter (dorsal view) than gap between it and anterior tip of frontal scale (= "vertical" of Günther, 1864). Rostral extends back dorsally no further than level of nares. Ventral surface of rostral gently notched at margin of mouth. Unpaired hexagonal frontal distinctively shaped, being marginally longer than broad, with short lateral (ocular) margins that are not parallel (divergent anteriorly), and slightly concave posterolateral margins. Anterolateral margins also slightly concave posteriorly, and subequal in length to posterolateral margins. Paired nasals (there are no separate internasals) not greatly outsized by prefrontals (= "frontals" of Günther, 1864), with subequal midline contacts between two pairs both being asymmetric. Small (c. 0.3 mm diameter) subcircular external naris slightly countersunk within small depression, lying in anteroventral corner of undivided nasal. Four supralabials: first smallest, making shortest contribution to margin of mouth. Second a little longer, much larger. Third (low posteriorly) and especially fourth much the largest. Nasal contacts supralabials 1 and 2; ocular contacts supralabials 3 and 4. Ocular large, conspicuous (but slightly less than half ocular length), circular eye in anteroventral corner. Eye bulges in dorsal view, shrivelled pupil appears subcircular. Pre-, supra- and postoculars absent. Paired parietals not notably longer than frontal, with broadly rounded posterior margins. Two small scales in temporal region between and in contact with fourth supralabial and posterior of parietal. Three elongate infralabials: second and third subequal in length, notably longer than first. First infralabials make minimal midline contact immediately behind small, slightly protuberant mental. Beyond first infralabials, single pair of scales (left substantially overlapping right, anteriorly) lies between mental and first single midventral scale (latter = first ventral *sensu* Gower and Ablett, 2006). First ventral longer than wide, these proportions reversed by third ventral.

Inside of mouth pale, without notable pigmentation. Tongue deeply forked, dorsal surfaces of pointed tips with some midline pigmentation. Seven teeth in each maxillary row and seven (left) and eight (right) in dentary rows. No signs of palatal teeth. All teeth simple, pointed, backward pointing, rather straight. Spacing of teeth even in all rows. No great variation in tooth size, but largest maxillary teeth towards middle of row, anterior teeth largest in dentary row. Dentary teeth hidden deeper in gingivae and less prominent than maxillary rows. Anteriormost maxillary teeth approximately aligned with suture between first and second supralabials, posteriormost tooth just behind posterior margin of third supralabial. Dentary row of similar length and alignment.

Body subcylindrical to slightly dorsoventrally compressed. All head and body scales lack keels, macroscopically smooth, with iridescent outer keratin layer. Dorsal body scales evenly sized around and along body. Midline ventral scales between mental and anal 134 (*versus* Günther's count of 135), generally evenly sized except for gradually narrowing anterior- and posteriormost members. At midbody, ventrals approximately 1.5 times as broad as exposed part of adjacent, first row of dorsals. At level of fifth ventral, 19 dorsal scale rows, reducing to 17 rows soon thereafter, maintained until at least up to tenth ventral anterior to anals. At one ventral anterior to anals, 15 dorsal scale rows. Immediately anterior to tail shield, 12 dorsal scale rows. Paired anal scales (right overlying left) considerably larger than posteriormost ventrals and all subcaudals. Distal margin of each anal overlaps two other scales in addition to anteri-

Table 1. Meristic and morphometric (mm) data for the holotype (*) and referred specimens of *Uropeltis bicatenata* (Günther). Tail shield is here defined by region covered by those keeled scales that are matt over at least half their surface. Measurements to 0.1 mm taken with dial callipers, those to 1 mm with ruler; circumferences measured with string and ruler. Abbreviations: C = circumference; D = distance; f = female; l = left; L = length; m = male; r = right; SVL = snout-vent length; W = width.

1	Specimen	BMNH 1946.1.16.8*	BNHS S225	BNHS 3251	BNHS 3252	BNHS 3265	BNHS 3266	BNHS 3267
2	Locality	"Deccan"	Bhimashankar	Bhimashankar	Bhimashankar	Fangul Gawhan	Fangul Gawhan	Fangul Gawhan
3	Sex	m	f	m	f	m	m	f
4	Total L (TL)	248	264	155	165	204	192	239
5	Tail L (tl)	16.5	12	8.4	7.4	12.9	13.6	10.7
6	TL/tl	15	22	18.5	22.3	15.8	14.1	22.3
7	tl as % of TL	6.7	4.5	5.4	4.5	6.3	7.1	4.5
8	Midbody W	7.3	8.7	5	4.8	7.1	7	7.8
9	TL/W	34	30	31	34	29	27	31
10	Midbody C	26	27	16	18	22	21	25
11	W at anus	6	7.4	4.2	4.3	6	5.4	6.1
12	C at anus	22	25	14	16	20	18	20
13	Shield W	4.9	6.9	3.9	3.5	5.3	4.6	6.3
14	Shield L	10.7	10	7.1	7	10.5	10.1	11
15	Min. no. scales across shield W	6	6	7	6	6	6.5	6
16	Max. no. scales across shield L	9	7	8.5	7.5	9	9	9
17	No. keeled scales on shield	41	34	41	38	43	41	42
18	Maximum L of parietal scale	3	3.2	2.2	2.3	2.6	2.3	2.8
19	D between rostral and posterior of midline suture between parietals	6.1	6.1	3.9	4.9	5.4	5.3	5.9
20	D between snout tip and posterior of midline suture between parietals	6.7	6.9	5.2	5.3	5.7	5.7	6
21	Midline D between rostral and frontal scales	1.7	1.6	1.2	1.1	1.3	1.1	1.2
22	D between snout tip and posterior of last supralabial scale (= HL)	7.5	7.9	6	5.9	7.2	6.8	7.3
23	SVL/HL	31	32	24	27	27	26	31
24	L frontal scale	3.1	3.4	2.5	2.9	2.9	3.1	3.2

25	W frontal scale	2.8	3	2.1	2.2	2.5	2.5	2.8
26	Max. L prefrontal	2.2	1.7	1.4	1.5	1.9	1.8	1.8
27	Max L ocular scale (LO)	2.3	2.5	1.9	1.8	2.2	2.2	2.5
28	Eye diameter (ED)	1.1	1.1	0.9	0.9	1.1	1.1	1.2
29	LO/ED	2.09	2.27	2.11	2	2	2	2.08
30	D between nares	1.8	1.9	1.5	1.6	1.9	1.6	1.7
31	D between eyes	3.5	3.7	2.6	2.7	3.2	3.1	3.2
32	D between eye and naris	2.3	2.3	1.7	1.7	1.9	1.9	2.1
33	D between snout tip and eye	3.4	3.4	2.7	2.7	3.3	3.1	3.3
34	Head W at corner of mouth	4.8	4.9	3.7	3.8	4.2	4	4.5
35	Max. W of ventral scales at midbody (WV)	3.5	4	2.2	2.5	3.4	2.8	3.6
36	Max. W of 1st dorsal scale row at midbody (WD)	2.3	2.6	1.4	1.6	2.3	2	2.2
37	WV/WD	1.52	1.54	1.57	1.56	1.48	1.4	1.64
38	Maxillary teeth (left, right)	7,7	7,7	7,7	7,6	7,7	7,7	7,7
39	Dentary teeth (left, right)	7,8	7,7	7,6	7,7	7,7	7,7	7,7
40	Supralabials (left, right)	4,4	4,4	4,4	4,4	4,4	4,4	4,4
41	Infralabials (left, right)	3,3	3,3	3,3	3,3	3,3	3,4	3,4
42	No. dorsal scale rows at level of 5th ventral	19	19	19	19	19	19	19
43	No. dorsal scale rows at level of 10th ventral	17	18	19	17	18	18	17
44	No. dorsal scale rows at midbody	17	17	17	17	17	17	17
45	No. dorsal scale rows at level of ten ventral scales anterior to anal scale	17	17	17	15	16	17	17
46	No. dorsal scale rows at level of one ventral scale anterior to anal scale	15	15	15	15	15	15	15
47	Ventral scales	134	135	135	141	130	131	137
48	Anal scales and nature of overlap	2 r/l	2 r/l	2 r/l	2 r/l	2 r/l	2 r/l	2 r/l
49	Subcaudals (left, right)	12, 12	8, 8	11, 11	9, 8	12, 10	12, 12	8, 8

Table 2. Meristic and morphometric (mm) data for all types (except *U. myhendrae*, for which MNHN type material was not examined) of species of *Uropeltis* in Smith's (1942) Group IIA and IIB. † specimen badly shrivelled, so measurements and some counts not taken. ‡ two untagged specimens in same jar. Methods and abbreviations as for Table 1.

		U. ceylanica	***U. myhendrae***	***U. arcticeps***	***U. arcticeps***	***U. rubrolineata***	***U. rubrolineata***	***U. rubrolineata***
1	Specimen	MNHN 39	BMNH 1946.1.16.9	BMNH 1946.1.16.12	BMNH 1946.1.16.11	BMNH 1946.1.15.63	BMNH 1946.1.16.26†	BMNH 1946.1.15.53
4	Total L (TL)	161	334	194	148	177		398
5	Tail L (tl)	6.8	13.7	11.1	8.6	6.4		12.9
6	TL/tl	23.7	24.4	17.5	17.2	27.7		30.9
7	tl as % of TL	4.2	4.1	5.7	5.8	3.6		3.2
8	Midbody W	5.7	11.7	6.4	5.3	5.4		10.7
9	TL/W	28	29	30	28	33		37
11	W at anus	5.1	9.8	5.3	4.6	4.6		8.7
13	Shield W	4.8	9.4	5.2	4.4	4.2		7.2
14	Shield L	7.3	14	9.5	7.4	6.8		12.7
15	Min. no. scales across shield W	7	8	6	6	6	6	5
16	Max. no. scales across shield L	6.5	7.5	8	8	7.5	7.5	7.5
17	No. keeled scales on shield	28	47	32	34	29	30	27
18	Maximum L of parietal scale	1.9	4.7	2.7	1.9	2.6		5.3
19	D between rostral and posterior of midline suture between parietals	4.2	7.4	4.9	3.8	4.5		8.6
20	D between snout tip and posterior of midline suture between parietals	4.9	9.5	5.4	4.4	5.5		10.9
21	Midline D between rostral and frontal scales	1.3	1.8	1.4	1.2	1		2.2
22	D between snout tip and posterior of last supralabial scale (= HL)	5.3	11	6	4.7	6.3		13.2
23	SVL/HL	29	29	30	30	27		29
24	L frontal scale	2.4	3.7	2.9	2.4	2.5		4.2
25	W frontal scale	1.7	3.3	1.9	1.5	2		3.6
26	Max. L prefrontal	1.6	2.3	1.8	1.3	1.5		2.7
27	Max L ocular scale (LO)	1.5	2.3	1.7	1.4	1.6		3.6
28	Eye diameter (ED)	0.7	1	0.6	0.6	0.6		1.3
29	LO/ED	2.14	2.3	2.67	2.33	2.67		2.77

30	D between nares	1.1	2.7	1.3	1.1	1.6		2.9
31	D between eyes	2.3	4.5	2.6	2.1	2.7		4.8
32	D between eye and naris	1.8	3.1	2.2	1.6	1.8		3.4
33	D between snout tip and eye	2.5	5.4	3.1	2.4	3		5.7
34	Head W at corner of mouth	3.4	7	3.9	3.2	4.1		8.7
35	Max. W of ventral scales at midbody (WV)	2.1	5.5	2.7	2.1	2.3		5.7
36	Max. W of 1st dorsal scale row at midbody (WD)	1.6	3.3	1.9	1.4	1.5		3.4
37	WV/WD	1.31	1.67	1.42	1.5	1.53		1.68
38	Maxillary teeth (left, right)	4, 4	7, 8	4, 4	5, 4	5, 5	5, 5	6, 5
39	Dentary teeth (left, right)	5, 5	9, 8	4, 5	5, 5	7, 8	8, 8	9, 9
40	Supralabials (left, right)	4, 4	4, 4	4, 4	4, 4	4, 4	4, 4	4, 4
41	Infralabials (left, right)	3, 3	3, 3	3, 3	3, 3	3, 3	3, 3	3, 3
44	Dorsal scale rows at midbody	17	17	17	17	17		17
47	Ventral scales	130	140	127	128	167		165
48	Anal scales and nature of overlap	2r/l	2r/l	2r/l	2r/l	2r/l	2	2r/l
49	Subcaudal scales (left, right)	6, 6	7, 8	8, 8	9, 9	7, 6	9, 9	6, 6

ormost subcaudals. Twelve pairs of macroscopically smooth subcaudal scales between anus and single terminal tail scute.

Tail shield (= "caudal disk" of Günther, 1864) conspicuous, well defined. Flat to gently concave, oval, longer than head. Shield scales matt, minutely pitted. Some dorsal body scales anterior and anterolateral to shield (as defined here) bear low carinae but distinct from shield scales by being mostly or entirely shiny. There are 41 matt, keeled scales lying entirely or mostly within the shield. Transversely, shield is maximally six keeled scales wide; longitudinally minimally nine keeled scales long (excluding terminal scute). Anteriormost shield scale bears four subparallel, low carinae or keels, all other shield scales bear one, two (mostly) or three, generally more prominent carinae. Shield carinae straight, longitudinal, hardened keels, with perpendicular to mildly concave posterior margin, so that hardened posterodorsal tips are square to posterodorsally-pointed in lateral view. Terminal scute mildly transversely convex, dorsally and ventrally. Terminally it bears pair of paramedian, posteriorly directed short spines. Upper surface of terminal scute bears few irregularly scattered, small, hardened pointed tubercles.

Background colour an even chocolate-brown across dorsal and ventral surfaces of body, head and tail. Body scales slightly paler distally, with yellowish halo immediately inside transparent outer rim. Some notable pale golden-yellow markings stand out against background. Lateral stripe begins narrowly on margin of mouth, on second supra- and infralabials. Stripe remains narrow on upper jaw until broadening behind eye, passes over most of large fourth supralabial; broadens at posterior of third infralabial. Behind corner of mouth, lateral stripe two to three scales wide. Stripe becomes broken on right (level with ninth ventral) and left (20th ventral) to form three blotches on right and two on left. Four dorsal crossbars (widely incomplete middorsally) arise from blotched region, anteriormost lies anterior to first lateral blotch. Backwards from level of 32nd ventral lateral stripe again complete along most of body as regular, narrow, zigzag line (with rounded edges). Zigzag formed by yellowish markings on posterodorsal edge of each scale in fourth dorsal row and posteroventral edge of each fifth

Table 2. contd.

		U. phipsonii	*U. phipsonii*	*U. rubromaculata*	*U. rubromaculata*	*U. rubromaculata*	*U. rubromaculata*	*U. rubromaculata*
1	Specimen	BMNH 1946.1.16.33-34‡	BMNH 1946.1.16.33-34‡	BMNH 1946.1.15.82	BMNH 1946.1.15.83	BMNH 1946.1.15.84	BMNH 1946.1.15.51	BMNH 1946.1.15.52
4	Total L (TL)	277	218	343	349	256	365	368
5	Tail L (tl)	14.9	12.3	14.6	18.7	15	15.2	16.5
6	TL/tl	18.6	17.7	23.5	18.7	17.1	24	22.3
7	tl as % of TL	5.4	5.6	4.3	5.4	5.9	4.2	4.5
8	Midbody W	8.5	8.3	9.9	10.8	8.6	11.4	10.2
9	TL/W	33	26	35	32	30	32	36
11	W at anus	7.1	6.8	9	9.3	7.7	10.8	9.9
13	Shield W	6.3	4.8	8.6	8.1	7.2	9.8	9.2
14	Shield L	12.3	10.7	15.1	17.5	14.2	16.9	17.1
15	Min. no. scales across shield W	5.5	5	6	6	6.5	7	6.5
16	Max. no. scales across shield L	8	8.5	9	9.5	10	8.5	9
17	No. keeled scales on shield	34	30	45	50	52	52	49
18	Maximum L of parietal scale	2.8	2.4	5	5.3	4.1	5.8	5.4
19	D between rostral and posterior of midline suture between parietals	5.3	4.6	8.1	8.2	6.5	8.4	8.2
20	D between snout tip and posterior of midline suture between parietals	6	5	9.7	9.9	7.7	10.5	10.1
21	Midline D between rostral and frontal scales	1.3	0.9	2	2.2	1.8	2.3	2.2
22	D between snout tip and posterior of last supralabial scale (= HL)	8.5	6.8	12	12.2	9.4	13	13
23	SVL/HL	31	30	27	27	26	27	27
24	L frontal scale	3.5	2.9	4.7	4.2	3.5	4.7	4.9
25	W frontal scale	2.7	2.2	3.6	3.8	3	3.8	4.2
26	Max. L prefrontal	1.7	1.2	2.9	3.1	2.3	3	3.3
27	Max L ocular scale (LO)	2.2	1.9	3.3	3.3	2.8	3.3	3.4
28	Eye diameter (ED)	1	0.8	1.5	1.5	1.3	1.5	1.5
29	LO/ED	2.2	2.38	2.2	2.2	2.2	2.2	2.3
30	D between nares	1.7	1.5	2.7	2.7	2.3	3.1	2.9
31	D between eyes	3.3	2.9	4.6	4.9	3.8	5.1	5.2

32	D between eye and naris	2.3	2.1	3	3.1	2.4	3.3	3.3
33	D between snout tip and eye	3.6	3	5	5.1	4	5.7	5.5
34	Head W at corner of mouth	5.2	5	7.3	7.6	6	9.4	8.2
35	Max. W of ventral scales at midbody (WV)	4.1	3.6	5	5.2	3.9	5.7	5.6
36	Max. W of 1st dorsal scale row at midbody (WD)	2.7	2.5	3.4	3.1	2.7	3.4	3.6
37	WV/WD	1.52	1.44	1.47	1.68	1.44	1.68	1.56
38	Maxillary teeth (left, right)	8, 8	7, 7	5, 5	5, 5	5, 5	5, 5	5, 5
39	Dentary teeth (left, right)	9, 9	9, 9	7, 7	7, 7	6, 7	6, 6	7, 7
40	Supralabials (left, right)	5, 5	5, 4	4, 4	4, 4	4, 4	4, 4	4, 4
41	Infralabials (left, right)	4, 4	3, 3	3, 3	3, 3	3, 3	3, 3	3, 3
44	Dorsal scale rows at midbody	17	17	17	17	17	17	17
47	Ventral scales	147	144	133	131	127	135	133
48	Anal scales and nature of overlap	2 r/l	2 r/l	2 r/l	2 r/l	2 r/l	2 r/l	2 r/l
49	Subcaudal scales (left, right)	11, 11	11, 12	9, 8	10, 9	10, 10	9, 8	8, 8

row scale. Lateral stripes again broken briefly about ten ventral scales in front of anus. Stripes remain narrow zigzags until three ventrals in front of anus, here extending onto tail as broad continuous stripes (about two scales wide). Left and right stripes converge a little toward end of slightly tapered tail, barely crossing lateralmost margins of penultimate subcaudal scales where stripes terminate one scale prior to terminal scute. Anal scales with off-white posterior margin, just inside transparent outer edge. No transverse bands extending onto ventral surface of tail from lateral stripes.

Posterior to irregular and incomplete anterior cross-bars, majority of dorsal surface of body marked with delicate, largely regular pattern of forward-pointing V-shapes (chevrons) spaced one dorsal scale row apart. Each V formed by yellowish blotches on distal tips of midline (ninth) dorsal scale row and posteromedial margin of next two (seventh and eight) scale rows, although even here, scales have transparent distalmost edge. Dorsal V pattern continues up to level of anus with varying completeness. Between anus and tail shield dorsal surface unpatterned, uniform brown. Dorsal pattern Vs often incompletely formed, in particular the pale spot on distal tip of scale row nine not always contacting the generally more continuous patches on rows seven and eight, particularly further posteriorly, so that pattern (\ /) can also be described as herringbone- or tyre-tread-like. Tail-shield scales uniform pale brown except for translucent tips of carinae. Terminal scute with midline whitish stripe on posterior half, two pointed tips also pale.

Additional information from referred specimens.– Some meristic and morphometric data are presented in Table 1. Line drawings of head scalation and photographs of some of the referred material are shown in Fig. 4 and 5, respectively. The referred material comprises six additional specimens (three males, three females) ranging from 155 to 264 mm total length (TL), thus encompassing the holotype (male, 248 mm). Sexual dimorphism in tail length (4.5% of TL in females, 5.4–7.1% in males) and number of subcaudal scales (females 8–9, males 10–12) is pronounced and non-overlapping. No other notable dimorphism was observed.

Head scalation patterns in referred material generally match holotype. Portion of rostral visible dorsally always shorter than its distance from frontal, only in BNHS 3251 does it extend as far back as level with posterior margin of nares (Fig. 4B). Frontal generally with concave antero- and posterolateral margins, but extent varies—anterolateral margins strongly concave in BNHS 3265 and 3267, posterolateral margins straight to mildly convex in smallest specimen (BNHS 3251). Midline nasal and prefrontal sutures straight only in BNHS 3251 and 3267. Supra- and infralabials constant in number and relative sizes. Under front of lower jaw, first pair of infralabials make broad midline contact behind mental only in BNHS 3267. Only in BNHS 3251 do first pair of chin scales behind first infralabials not make broad, overlapping (some left over right, some *vice versa*) contact, so that first ventral contacts mental (Fig. 4C). Ocular and eye consistently large and maintain fairly constant relative proportions. Parietals generally short, rounded, longest in BNHS 3267. BNHS 3251 has asymmetric pair of small scales immediately between back of irregularly sutured parietals. Left side of BNHS S225 has three (not two) small scales between and contacting fourth supralabial and parietal (Fig. 4A). Teeth almost constant in number. Pupil in preserved specimens generally an irregular blob, most circular in BNHS 3267. Anal scales always paired, right overlying left. Subcaudals always macroscopically smooth. Tail shield similarly proportioned in all specimens, with 34 to 43 keeled, matt scales, most of which are bicarinate, a few unicarinate, fewer tricarinate, and none tetracarinate. A single tetracarinate, glossy scale lies just anterior to shield of BNHS 3251. Largest keels resemble closely those of holotype in being sharply pointed with perpendicular to concave posterior margins, so that shield as a whole is rough. Terminal scute of BNHS S225 broken; that of 3251 lacks right posterior spine. Length of spines varies (long in e.g., BNHS 3265, 3266). Most specimens have small additional, less acutely pointed lateral and/or posteromedial spines. Terminal scute spines of BNHS 3265 have small additional lateral cusps, BNHS 3265 has a small posteromedial cusp.

Background body colour not chocolate brown in any referred specimen. Grey-brown in BNHS S225, but black (as originally described for holotype by Günther, 1864) to dark blue-black in all more recently preserved specimens. Paler markings always shades of yellow (never red), more lemon-yellow anteriorly and more orange-yellow posteriorly in larger Fangul Gawhan individuals. Body scales resemble those of holotype in consistently having transparent distal margins lying beyond thin, translucent, yellowish halo. Apart from translucent distal margins, ventrals uniformly darkly coloured in all specimens. Scales under lower jaw uniform in all specimens except BNHS 3265 and 3266, which have small, pale-yellowish spots on each of paramedian scales contacting first and second ventrals. BNHS 3265 has an additional small spot nearby on second ventral.

Lateral body stripes and dorsal chevron markings constant and distinctive in all referred specimens except for notable variant BNHS 3267 (Fig. 5e, f), which has extensive lateral blotches and faint dorsal speckles only occasionally coming close to forming Vs. BNHS 3267 is interpreted as a rare exception—it is the only unusually marked individual seen among tens of uncollected live animals at Bhimishankar (AC, SST, pers. obs.) and c. 10 animals seen at Fangul Gawhan (SST, pers. obs.). Indeed, it was collected especially because of its unusual colour pattern.

Dorsal chevrons vary in completeness, best defined in holotype, in referred specimens spots on distal ends of midline (ninth) dorsal scale row small or absent, so that pattern is more herringbone (\ /) or tyre-tread than chevron-like, and arms of Vs or /s are sometimes incomplete. Midline dorsal scales often with yellow marks on posterolateral margins instead of posterior tip, so that V or \ / pattern is more U-U like. Dorsal markings extend onto tail but fade before shield, this varying from two (BNHS 3265) to seven (BNHS 3266) scales anterior to first shield scale. Lateral stripe extends forwards generally onto second supralabial and posterior of third infralabial, but may continue further forwards as a thin line on lips, most notably in BNHS 3252 where it extends onto first supra- and infralabials. First break in stripes behind head ranges from level with ninth (BNHS 3267) to fifteenth (BNHS 3266) ventral, though in BNHS 3251 it remains complete. Anteriorly, stripe nar-

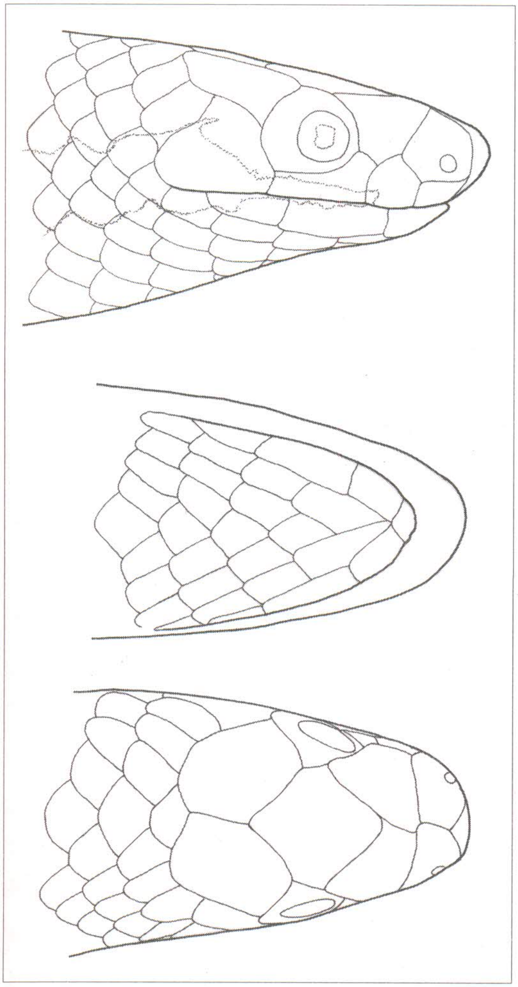

Figure 3. Outline scale drawings of head of holotype (BMNH 1946.1.16.8) of *Uropeltis bicatenata* (Günther) in lateral, ventral and dorsal views. For scale see Fig. 2.

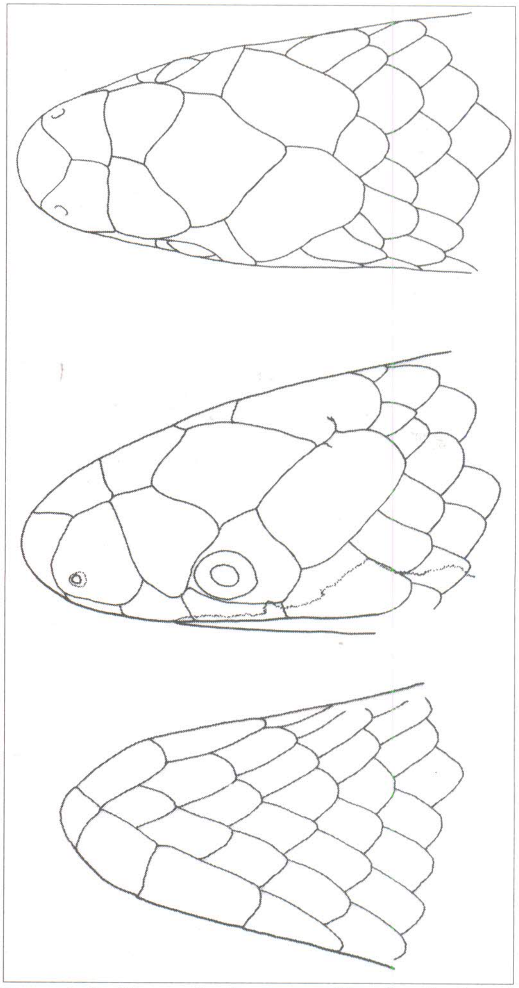

Figure 4. Outline scale drawings of heads of referred specimens of *Uropeltis bicatenata* (Günther). Upper figure: dorsal view of BNHS S255 (female, TL = 264); Middle, lower figures: anterodorsolateral view of head and ventral view of lower jaw of BNHS 3251 (male, TL = 155 mm).

rows after final main break between points level with ventrals 29 to 39. Anterior to anus, stripe broadens at a point between one and four ventral scales further forwards than in holotype (i.e., three to six scales anterior to anal). Stripe on tail generally two scales wide, three in BNHS 3265 and BNHS 3267, never encroaching onto subcaudals. In all referred specimens except BNHS 3267, lateral stripes generally thin, complete, regular, and zigzagged. Except in BNHS 3267, posteriorly the stripes are never broken for the entire length of one scale, in BNHS 3252 they are unbroken.

Whitish line toward distal margins of anal scales of holotype is yellow in referred specimens, varying from faint and diffuse (BNHS 3251, BNHS 3252) in the smallest specimens to a thin faint arc (BNHS 3267) or clearer but still narrow (BNHS 3265) band in larger animals. As in the holotype, hardened spines on distal edge of terminal scute, and short midline stripe are yellow (larger animals) to off-white in all referred specimens. In life, the recently collected referred specimens were blackish with vibrant golden/orange yellow markings. From photographs taken in life, the pupil is circular.

Distribution, ecology and conservation.– *Uropeltis bicatenata* is known with certainty from only two localities, Bhimashankar and Fangul Gawhan (locally known as Fangli) both in Pune District,

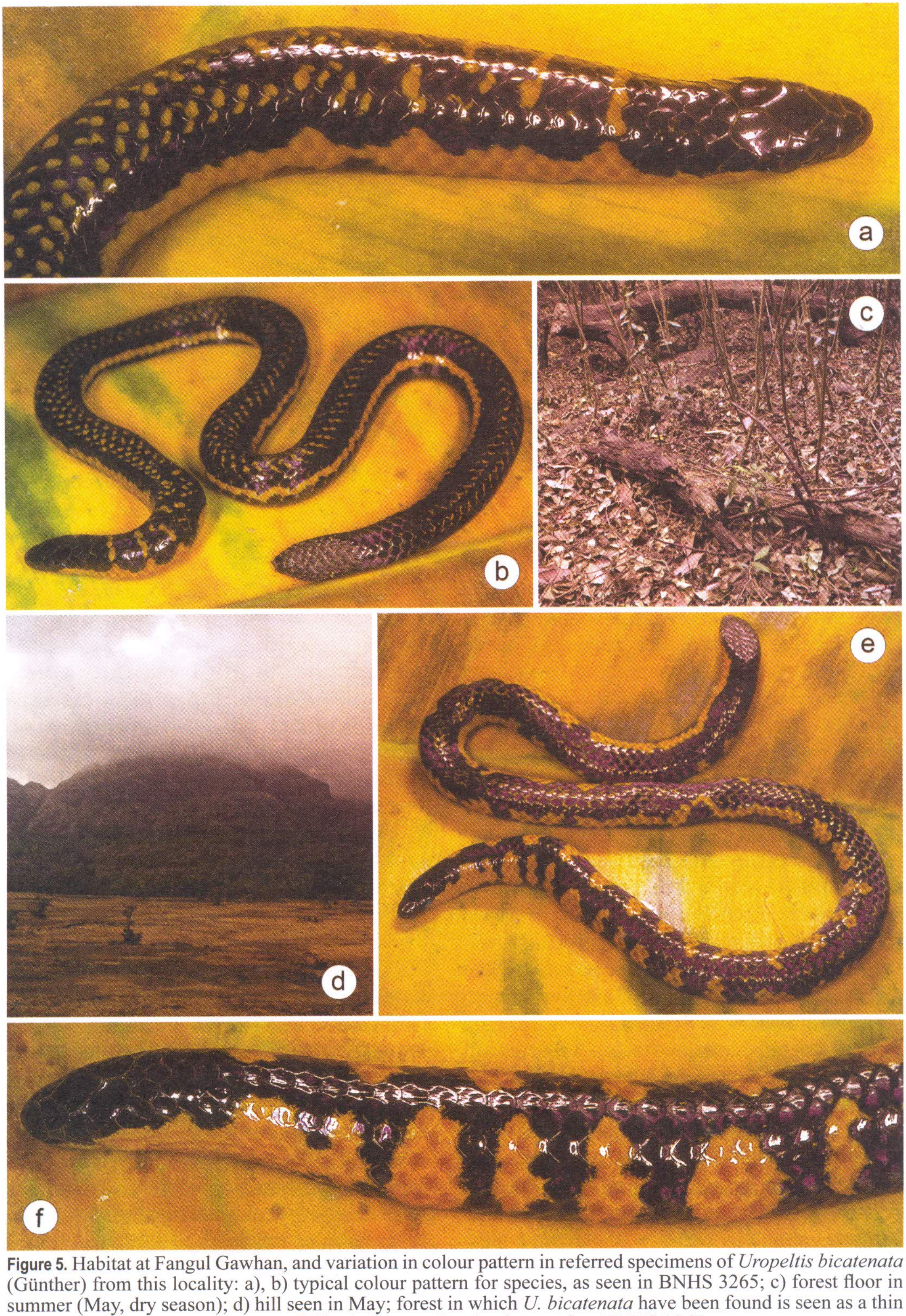

Figure 5. Habitat at Fangul Gawhan, and variation in colour pattern in referred specimens of *Uropeltis bicatenata* (Günther) from this locality: a), b) typical colour pattern for species, as seen in BNHS 3265; c) forest floor in summer (May, dry season); d) hill seen in May; forest in which *U. bicatenata* have been found is seen as a thin green horizon towards lower part of hill; e), f) exceptional colour variant BNHS 3267.

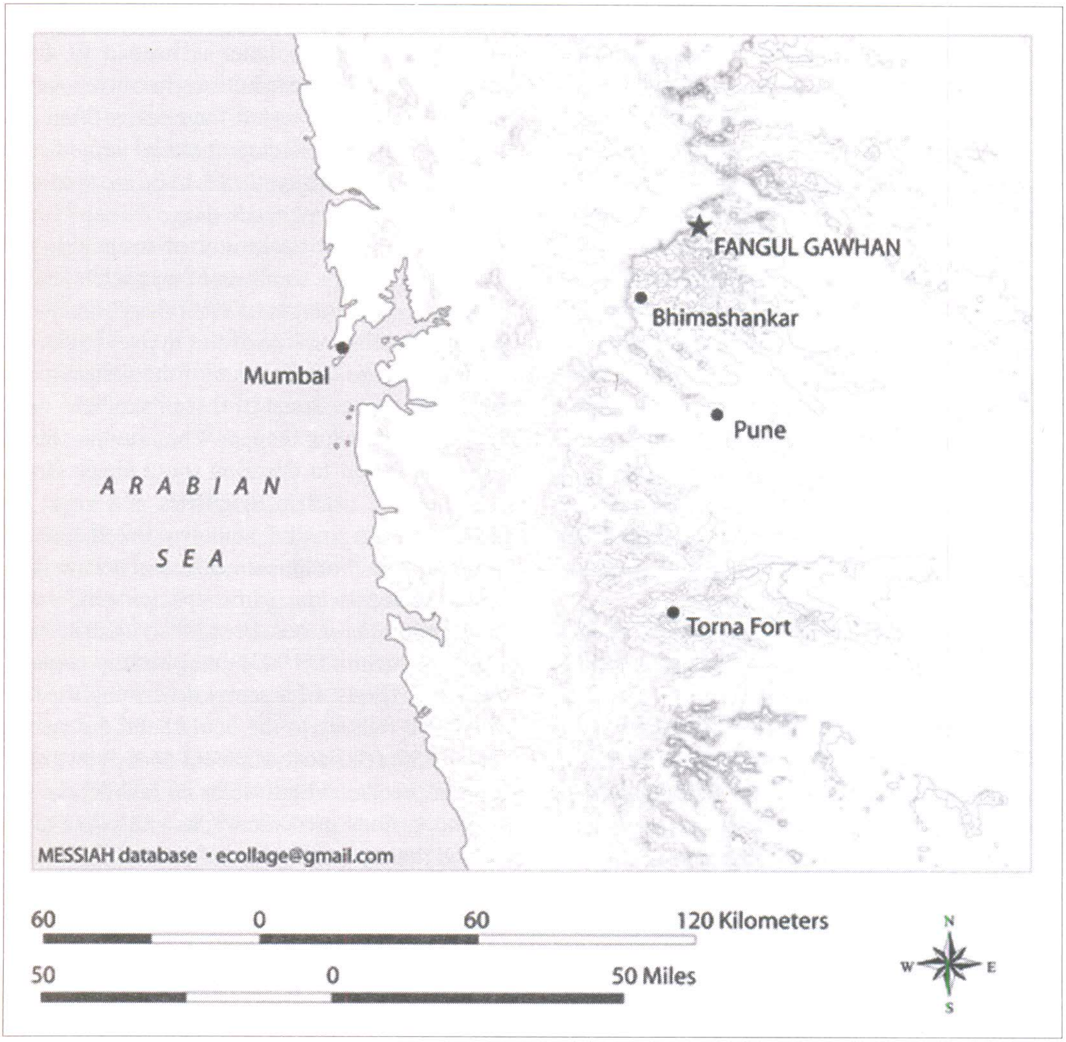

Figure 6. Map showing known (Bhimashankar, Fangul Gawhan) and possible (Torna Fort) localities for *Uropeltis bicatenata* (Günther).

Maharashtra (Fig. 6), separated by c. 30 km. Further fieldwork is required to ascertain whether the species occurs at intervening and surrounding localities, and at other altitudes and habitats. The type locality of "Deccan" is imprecise but can be considered to include the two known localities, which lie in the higher altitudes of the Ghats at this part of their range, at the western edge of the Deccan plateau. In addition to the two known localities, a superficially similar (in colour and pholidosis), potentially conspecific form has been seen (but not collected) at the more southerly locality of Torna (c. 40 km south-west of Pune), Pune District, Maharashtra (Fig. 6).

The specimens from Fangul Gawhan (Fig. 5c, d) were found under a log in secondary semi-evergreen forest: 10–15 m tall with 70% canopy (19°15'11"N, 73°42'27"E, 803 m asl), a short distance from the village (19°15'55"N, 73°43'02"E, 740 m asl). Vegetation in the immediate vicinity of the collection site included *Mallotus philippensis*, *Albizia amara*, *Ficus racemosa*, *Atalantia racemosa*, *Carvia callosa*, *Olea dioica*, *Mangifera indica*, *Pittosporum dasycaulon*; *Piper* sp. and *Memycylon umbellatum*.

In addition to the recently collected material, several other sightings of *Uropeltis bicatenata* have been made inside the protected area (130 km^2) of Bhimashankar Wildlife Sanctuary (centrally 19°14'N, 73°35'E; 650–1,140 m asl) (AC, SST, pers. obs.; I. Agarwal, S. Kehimkar, pers.

comm.). The species can be seen occasionally on roads (including roadkills), and in and near waste heaps, but little is known about tolerance to habitat disturbance. The site at Fangul Gawhan is not officially protected, but the Forest Department has attempted to get local people to prevent further degradation of the forest. Although there is no indication that the species is currently threatened, we suggest that it is recognised as data deficient based on IUCN criteria pending further, especially distributional data.

Uropeltis bicatenata is closer in appearance and ground colour to *U. m. macrolepis*, which has 15 midbody scale rows, than it is to *U. phipsonii*, which like *U. bicatenata*, has 17 scale rows. All three species as (as presently understood) are found in the Bombay Ghats/ Hills. More work is required to determine if any of these species are sympatric.

Suggested common name.– We prefer "Bicatenate *Uropeltis*" or "Two-chained *Uropeltis*". We assume *bicatenata* to stem from the Latin *catena*, meaning chain—this perhaps in reference to the superficially chain-link-like lateral stripes that are formed by rounded-zigzag lines, or alternatively to the arms of the Vs on the dorsal surface of the body, although this seems less likely given that these markings are more complete Vs and less herringbone (\ /) like in the only specimen available to Günther. *Uropeltis* translates as shield-tail, from the Greek and Latin *pelte* for small shield, and the Greek *oura* for tail. However, "shieldtail" is widely used to refer to uropeltids as a whole, rather than *Uropeltis* (e.g., Whitaker and Captain, 2004; Das and de Silva, 2005), and we suggest it is best avoided as a common name for members of the genus.

DISCUSSION

Uropeltis bicatenata is a valid species. That it remained hidden in the synonymy of *U. ceylanica* for more than 100 years, with the second known specimen being referred to a third species (*U. rubrolineata*) by one of the foremost workers in the field (M. A. Smith) illustrates the inadequate state of the taxonomy of uropeltids, especially *Uropeltis*. It is our belief that *Uropeltis* is taxonomically extremely poorly understood, and in need of substantial revision. This should ideally be based on investigation of a wider range of characters for type, historical, and newly collected material. The latter is needed in many cases to establish distributions because locality data of type and referred material is often imprecise. Newly collected material would also enable taxonomic hypotheses to be more readily tested with DNA sequence data.

Previously, the taxonomy of uropeltids has been founded on a small set of characters, mostly colour, size, number of ventral and subcaudal scales, the relative size of the eye and ventrals, the form of the tail tip, size of the rostral scale, and snout shape. Some of these have been dealt with in a confusing manner. For example, terms previously used to describe snout shape (some of which are used in diagnoses and keys) include obtusely pointed, acutely pointed, pointed and rounded. Sometimes different terms have been applied to the same species—the snout of *U. macrolepis* has been described as both "rounded" (Smith, 1943) and obtusely conical" (Günther, 1864). Characters describing the size of the eye relative to the ocular, and the ventral scale width relative to adjacent dorsal rows have been imprecise, with little or no raw data or exact proportions presented. Our study has highlighted the potential utility of several previously un- or underexploited character systems for *Uropeltis* systematics. Although further work is required to further test this potential, these characters include tooth counts, the number of keeled shield scales, and morphometrics (Tables 1, 2). Investigating new characters as part of future work will be an important component of the much needed revision of uropeltid taxonomy.

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NEW COUNTRY RECORDS AND RANGE EXTENSIONS FOR MYANMAR AMPHIBIANS AND REPTILES

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(with one text-figure)

ABSTRACT.– **Myanmar lies at a biogeographic crossroads where the faunas of China, Indochina, India, Himalaya, and the Malay Peninsula converge. Since 1999, the Myanmar Herpetological Survey, a collaborative effort the California Academy of Sciences, the National Museum of Natural History, Smithsonian Institution, and the Forest Department, Ministry of Forestry, Myanmar, has surveyed the amphibians and reptiles throughout the country. Our surveys in Myanmar have added many additions to the country's fauna, and species ranges within Myanmar have been extended. These general biotic surveys represent the only new information for much of Myanmar's herpetofauna for over a half-century. We present 18 new country records and 45 range extensions and state records in this paper.**

KEY WORDS.– **Myanmar, amphibians, reptiles, geographic distribution.**

INTRODUCTION

The herpetofauna of Myanmar is poorly known. Early collections by Leonard Fea followed by collections by the British set the groundwork for our understanding of the biodiversity within Myanmar. Although many species were described from Myanmar primarily by British naturalists George Boulenger, Malcolm Smith and Frank Wall, during the late 19th and early 20th centuries, comprehensive surveys of the country's herpetofauna have not been conducted until initiated by the National Museum of Natural History, Smithsonian Institution, and the California Academy of Sciences. The Myanmar Herpetological Survey, a collaborative effort among the California Academy of Sciences (CAS), National Museum of Natural History, Smithsonian Institution (USNM) and the Nature and Wildlife Conservation Division, Forest Department, Ministry of Forestry, Myanmar, has surveyed throughout the country from 1999 to present, and as such has discovered new species (18 of which have been recently described in Slowinski and Wüster, 2000; Slowinski et al., 2001; Bauer, 2002, 2003; Schulte et al., 2004; Vindum et al., 2003; Wilkinson et al., 2003, Wilkinson et al., 2005; Wogan et al., 2003; Zug et al., 2006), rediscovered some rare species (Wilkinson and Rao, 2004; Gonzalez et al., 2005), as well as new country division/state records (Leviton et al., 2003; Gonzalez and Vindum, 2005), and range extensions.

The importance of documenting the composition of the herpetofauna within Myanmar has been pointed out in several region wide assessments (Inger, 1999; Bhupathy, 2000; Das, 2000). Because of the biogeographic position of Myanmar, and because so many type localities lie within Myanmar's borders, an understanding of the patterns of distribution, and the evolutionary histories of Asia's amphibian and reptile species can not be fully understood until data from Myanmar can be incorporated into comprehensive regional assessments.

At present, there are 82 amphibian and 289 reptile taxa (Zug et al., 2003) documented in Myanmar. The authors anticipate that the number of species confirmed from Myanmar will continue to grow as survey efforts in border regions with Bangladesh, India, China, Laos and Thailand, are carried out and research progresses. The first part of this paper details species that are documented for the first time in Myanmar bringing the known number of amphibian species up to 94 and known reptile species to 295. The second portion outlines division/state records and range extensions. Within each section, records are organized alphabetically by family and then by genus and species. Distribution data for snakes belonging to the families Elapidae and Viperidae are further detailed in Leviton et al. (2003). Distributions for species belonging to the genus *Hemidactylus* within Myanmar are depicted in Zug et al. (2007). Amphibian taxonomy follows AmphibiaWeb (2007).

METHODS

Animals were collected by hand by the authors. Latitude and longitude were recorded using a Garmin 12 XL GPS (datum WGS 84). Animals were euthanized and then fixed in 10% buffered formalin before being transferred to 70% ethanol. Specimens are deposited in the California Academy of Sciences (CAS).

Identifications were made by Htun Win, J. B. Slowinski, J. V. Vindum, and G. O. U. Wogan in the field, and confirmed against museum specimens and literature by J. A. Wilkinson (Rhacophoridae), J. V. Vindum and M. S. Koo (Sauria), J. B. Slowinski *(Amphiesma, Rhabdophis)* and G. O. U. Wogan (remaining taxa). Records reported by Shreve (1940) were confirmed by Wogan. Museum symbolic codes follow Leviton et al. (1985). For commonly encountered species, not all individuals are included, no more than 20 unique localities are included to cover the distribution within the country. Detailed locality descriptions can be obtained from the Department of Herpetology's website (http://www.calacademy.org/research/herpetology/catalog/). Unless otherwise noted, catalogue numbers refer to CAS specimens. Museum numbers following the detailed distribution data refer to specimens examined, museum numbers not appearing in this section, but otherwise mentioned are taken from the literature. Unless otherwise mentioned, identifications of materials cited from the literature, have not been confirmed by the authors. Figure 1 shows geopolitical boundaries of Myanmar and the region.

RESULTS

New Country Records

Megophryidae

Xenophrys longipes (Boulenger, 1886)

This species is widespread in southern Thailand and the Malay Peninsula (Chan-ard et al., 1999). We discovered a single individual of this species at night in evergreen hardwood forest in southern peninsular Myanmar, Tanintharyi Division.

Tanintharyi Division: 235843.

Xenophrys glandulosa (Fei et al., 1991)

Described from Yunnan, this species has also been documented in Nagaland, India (Ao et al., 2003), and is now reported from northern Kachin State, Myanmar.

Kachin State: 221363, 221395, 221442, 221484, 221567–68.

Microhylidae

Microhyla rubra (Jerdon, 1854)

Originally described from the Carnatic region, this species was previously known only from India (including Assam) and Sri Lanka (Frost, 2007). Dutta (1997) mentions a record of this species from the Moulmein (Mon State) area, but the source of this record has not been confirmed. The discovery of this species in Myanmar is, in addition to being a new country record, the easternmost record of its distribution. Representatives of this species have thus far been documented only from Magwe Division. Individuals were found at night during the monsoon season. Sympatric congeners include

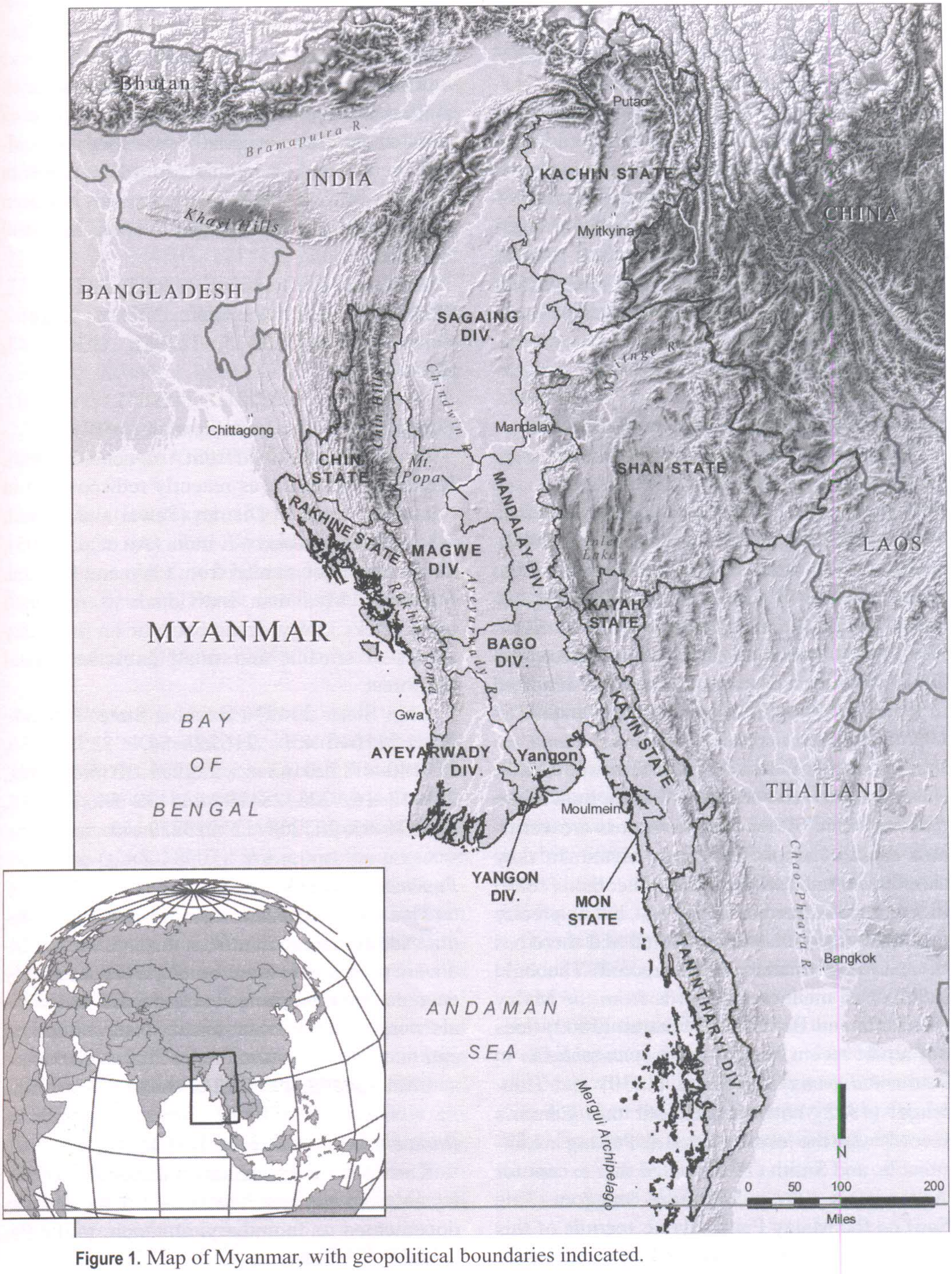

Figure 1. Map of Myanmar, with geopolitical boundaries indicated.

M. berdmorei, *M. ornata*, and an undescribed species.

Magwe Division: 213799, 215851–90.

Ranidae

Amolops viridimaculatus (Jiang, 1983)

One representative of this species was found in Kachin State, northern Myanmar. In addition to China (Jiang, 1983), recent records have also emerged from two states in north-east India; Nagaland (Ao et al., 2003) and Arunachal Pradesh (*A.* cf. *viridimaculatus*) (Pawar and Birand, 2001) and northern Vietnam (Ohler et al., 2000). The lone individual was found in bamboo canopy (Wogan et al., 2004).

Kachin State: 224378.

Euphlyctis cyanophlyctis (Schneider, 1799)

The species has been reported from areas as far west as Afghanistan (Frost, 2007), and throughout India, including Nagaland (Ao et al., 2003), and Kamrup (Choudhury et al., 2002). Sclater (1892) reported this species from Jergo Island, Arakan (Rakhine State; ZSI 9349–formerly 12632–3), and Moulmein (Mon State; ZSI 10960), however, of the above specimens ZSI 12633 was destroyed, 12632 is reported in the ZSI catalogue simply as "frog", and ZSI 10960, although identified as *Rana cyanophlyctis,* lacks locality data beyond "Austin?" (M. S. Ravichandran pers. comm. 2004). In light of the fact that none of the former records are verifiable as *E. cyanophylctis* from Myanmar, they should be treated with caution. Theobald (1882) mentioned this species from Pegu, but no precise catalogue numbers were reported and there has been no confirmation of this record. Theobald (1882) also mentioned records from the Malay Peninsula and Bengal. Sukumaran (2002) does not report recent records of *E. cyanophlyctis* in Peninsular Malaysia. Smith (1930) and Boulenger (1912) both pointed out that Cantor's records with the locality listed as Penang are unreliable, and Smith (1930) stated that except for Annandale's 1917 record from Singgora (Talé Sap) on the Malay Peninsula no records of this species are reported from Indo-China. Taylor (1962) further suggested that this record may be the result of an introduction. We have found *E. cyanophlyctis* in northern Rakhine State close to the Bangladesh border. Individuals were found at night in water.

Rakhine State: 222035–37, 221088, 221118, 222075.

Fejervarya cancrivora (Gravenhorst, 1829)

This species has been found throughout coastal SE Asia (excluding Myanmar) and Indonesia from where it was originally described. Individuals were found on mudflats in tidal streams in mangrove forest. Thus far, this species has been documented in Ayeyarwady Division, Mon and Rakhine States.

Ayeyarwady Division: 222697, 222736–37, 222756, 222800; Mon State: 222621; Rakhine State: 222964, 222978, 222982, 223080–83, 223336–37.

Occidozyga borealis (Annandale, 1912)

Originally described from Arunachal Pradesh, India, this species was recently rediscovered in Arunachal Pradesh District (Pawar and Birand, 2001), and Nagaland NE India (Ao et al., 2003), and is now documented from Chin and Rakhine States. In Myanmar, individuals were found under rocks in dry streambeds, or on the rocky shores of streams and small pools in coastal rainforest.

Chin State: 234936 Rakhine State: 205064–92, 211640–45, 216553–54, 220134–36, 220140–47, 220162–65, 222995–3036, 223091, 223112–16, 223128–29, 223139–54, 223178, 223194–95, 223208–12, 223237–40.

Pterorana khare Kiyasetuo and Khare, 1986

This species was discovered in Nagaland, India. Additional records from throughout NE India are reviewed in Ao et al. (2006). We recently encountered this species in Chin State. Individuals were found in slow moving water sitting on egg masses.

Chin State: 234933, 234941–42.

Rana chalconota (Schlegel, 1837)

Known from throughout Indonesia, and Malaysia and peninsular Thailand, this species was documented in Tanintharyi Division, in the Pakchan Forest Reserve.

Tanintharyi Division: CAS 229539, 229564, 229610.

Rana chloronota (Günther, 1875)

Originally described from northern India, this species has been historically confused with *Rana livida* (see Bain et al., 2003 for discussion). Most recently, this species has been confirmed from Vietnam (Bain et al., 2003). In Myanmar, *R. chloronota* has been found in lowlying montane forests in Kachin, Rakhine, and Shan States as well as Bago, Sagaing and Tanintharyi Divisions.

Bago Division: 211671, 211719, 221850; Kachin State: 221261, 221315–56, 221321, 221393–94, 224702, 221534, 224702, 224748, 225153, 225211, 225540, 232920, 233101, 233112; Rakhine State: 216574, 220186–88, 220260–61, 220271–76, 220341, 220347–48, 220367, 220466, 220612, 222907; Sagaing Division: 210224, 210230–31, 210233–35, 221776; Shan State: 210642, 221771–72; Tanintharyi Division: 229539, 229564, 22601.

Rana hosii (Boulenger, 1891)

A single specimen referable to *R. hosii* has been documented in southern Myanmar in the Pakchan Reserve Forest in Tanintharyi Division.

Tanintharyi Division: 229627.

Rana taipehensis Van Denburgh, 1909

Smith (1940) tentatively identified one specimen from N'Chang Yang, Kachin State, to this taxon, however, he remarked on the lack of an outer metatarsal tubercle, which is present on the holotype (CAS 18007). We report the presence of *R. taipehensis* from low elevations throughout Myanmar. All observed *R. taipehensis* from Myanmar possess a distinct outer metatarsal tubercle, and despite extensive surveys in Kachin State, *R. taipehensis* has not been documented in the region, indicating that Smith's specimen is perhaps not *R. taipehensis*. Assigning Smith's specimen a specific name requires additional evaluation. Records for this species now exist for Rakhine and Mon States, Ayeyarwady, Bago, Mandalay, and Yangon Divisions. Individuals have been found in flooded fields and along forest streams.

Ayeyarwady Division: MCZ A–132432, 132460–61, 132462–65, CAS 212433, 220609, 222717–20; Bago Division: 210743, 222095; Mandalay Division: 208473; Mon State: 222524, 222572; Rakhine State: 205298, 220148–50, 220161, 221082–3, 221085, 221093, 221098–100, 221104–06, 221111–13, 221130–33, 221952, 221977, 222015, 222032, 222050–52, 222054–55, 222057, 222987, 222994, 223108; Yangon Division: 210805, 213434.

Colubridae

Amphiesma xenura (Wall, 1907)

Previously reported from both the Khasi Hills (Smith, 1943) and Naga Hills (Romer, 1945) in Assam, India. Recent surveys have also found this species in the Palak Lake area, Mizoram Assam (Pawar and Birand, 2001). In Myanmar, this species has been encountered in northwest Sagaing and throughout the Rakhine Hills, Rakhine State.

Rakhine State: 220256, 220332, 220368–71, 220378, 222969; Sagaing Division: 232203.

Lycodon jara Russell, 1796

Known from NE India and Nepal (Das, 2002), this species was encountered in northern Kachin State, making it the first record for SE Asia. One of the individuals was found moving in open grass, the other was found in an agricultural area.

Kachin State: CAS 235387–88.

Lycodon subcinctus Boie, 1827

Documented from countries bordering Myanmar, two individuals were encountered in Kachin State and Tanintharyi Division. Both individuals were found at night in a disturbed habitat.

Kachin State: CAS 235846; Tanintharyi Division: 229726.

Pareas monticola (Cantor, 1839)

This species was originally described from the Naga Hills in NE India. A single specimen was found in the Chin State in the Mindat district. Co-occurring congeners include *P. macularius*.

Chin State: 235254.

Sinonatrix yunnanensis Rao and Yang, 1998

This species was previously reported only from Yunnan Province, China. Records from

Kachin State represent the first records of the species outside of China.

Kachin State: 221518, 221544, 224440, 224485, 224730.

Scincidae

Tropidophorus robinsoni Smith, 1919

This lizard was previously known only from Thailand. We have documented one specimen from the Tanintharyi Division of Myanmar in the Dawei Region (formerly Tavoy).

Tanintharyi Division: 228558.

New State Records and Geographic Range Extensions

Bufonidae

Bufo asper (Gravenhorst, 1829)

This species is known from peninsular Thailand and peninsular Malaysia (Taylor, 1962; Frost, 2007). Taylor (1962) reported the species occurring as far north as Chumphon, Thailand. Fea collected a specimen (ZMH A04113) from Mount Karen, Kayah State (Hallerman et al., 2002) and a second specimen from Thagata Juwa (Kayin State; Boulenger, 1887). Other historical records for Myanmar are primarily from the Myeik Archipelago in Tanintharyi Division, collected during the Mergui Expedition by Anderson in 1882 (deposited at the ZSI). A recent record from Kyaik Kti Yo Wildlife Sanctuary represents the first documentation of this species in Mon State.

Mon State: 222196.

Bufo macrotis Boulenger,1887

This species was originally described from Teinzo and Kakhein Hills (Kachin State). Boulenger (1892–3) further reported it from Palon (Yangon Division). Outside of Myanmar, it is known from Thailand (Taylor, 1962). Recent surveys have encountered this species in northwest Sagaing Division near the Indian border.

Sagaing Division: 232191, 232195.

Microhylidae

Glyphoglossus molossus Günther, 1869

The type locality is in Bago Division (Frost, 2007). Although Boulenger (1890) reported the species as occurring in the Irrawaddy Delta (Ayeyarwady Division) and Pegu (Bago Division), he mentioned that he only had one specimen (the type), thus there is some confusion concerning the location of the type locality. Theobald (1882) provides additional details concerning the discovery of the type specimen mentioning that it was discovered in the "tidal portion of the Irrawaddy Delta". The species has been reported from east-central Sagaing Division by Zug et al. (1998) and from Prome (Bago Division) by Shreve (1940). We have recorded the species from Mandalay Division and south-western Sagaing Division.

Mandalay Division: 216094–95, 221608–09; Sagaing Division: 210056, 210117.

Microhyla berdmorei (Blyth, 1856)

Records are available for Bago (reported as Pegu) and a general locality of Burma (Boulenger, 1882). Bourret (1942) reported the species from Pegou (Bago Division) and Karin Biapo (Kayah State), and Shreve (1940) reported a single specimen (MCZ A–23433) from the Chin Hills, Chin State, however, the collection locality is actually in Magwe Division (Ainggyi, Pakokku Hills), thus this species is not presently known to occur in Chin State. Choudhury et al. (2002) recently reported this species from northern India. Our surveys have found this species in Rakhine and Shan States, and Magwe, Sagaing, Tanintharyi and Yangon Divisions.

Magwe Division: 219884–85; Rakhine State: 205029–48, 205199, 216534–39, 220410–11, 221150, 222908–15, 222971–72, 223045–46, 223048–51, 223054–56, 223105, 223135–37, 223166, 223169–71; Sagaing Division: 204875–80, 205191–98, 215686–87; Shan State: 210637; Tanintharyi Division: 229765 Yangon Division: 213242–43, 213415–16, 213432–33, 213488–89.

Microhyla butleri Boulenger, 1900

Bourret (1942) reported this species from He-Ho Plaines of southern Shan State, this record confirmed by ZSI 19324. Hallermann et al. (2002) recorded this species from Kayah State (ZMH A04074). We obtained representatives of this species from Yangon Division, making it the western-most records of this species.

Yangon Division: 210750–60, 210822–27.

Microhyla heymonsi Vogt, 1911

Bourret (1942) records this species from He Ho Valley (southern Shan State), and Hallermann et al. (2002) recorded it from Kayah State (ZMH A04068–72). In addition to records from Shan State, we have also located this species in Kachin State and Tanintharyi and Yangon Divisions. Thus far, the distribution does not extend into or west of the central dry zone of Myanmar.

Kachin State: 232718; Tanintharyi Division: 229637, 229830; Yangon Division: 210748–49, 210785, 210789.

Ranidae

Ingerana tenasserimensis (Sclater, 1892)

Historical records from Myanmar are from Tanintharyi and the Karen Hills, Kayah State (Bourret 1942), our surveys have found this species throughout Mon State.

Mon State: 210557–58, 222205–08, 222217, 222245–60, 222269–74, 222443–57, 222461–68, 222474–89, 222535–69, 222579–80, 222596–600, 222609–10, 222663–64.

Limnonectes limborgi (Sclater, 1892)

Known from the type locality of Meetan, Tennasserim (Tanintharyi Division; Sclater, 1892) and Karen Bia-po, Yado and Thao (Kayah State; Boulenger, 1888). This species has been documented in Mon State.

Mon State: 210559–62.

Rana cubitalis (Smith, 1917)

This species is reported from the Karen Hills (Kayah State) by Smith (1930). Shreve (1940), with uncertainty, referred specimens (MCZ–A23425–9) from Maymyo (Mandalay Division) to this species. We obtained a specimen referable to this species from Mandalay Division.

Mandalay Division: 216286.

Rana lateralis Boulenger, 1887

The type locality of the species is from the Moulmein area in Mon State (Boulenger, 1887). Boulenger (1888) recorded additional specimens from Palon and Rangoon (Yangon Division) and Pegu (Bago Division); Shreve (1940) recorded specimens from Hmawbi (Yangon Division) and Chin State, Zug et al. (1998) from Sagaing Division and Hallermann et al. (2002) from Yangon Division (ZMH A 04120). We recorded the species from Magwe Division and Kachin State.

Kachin State: 232504; Magwe Division: MCZ A–23415; Yangon Division: 210791, 210797, 210806, 220527, MCZ A–23390–91.

Rana macrodactyla (Günther, 1858)

Rana macrodactyla has been reported from Bhamo (Kachin State; Bourret, 1942) and from Palon (Yangon Division; Bourret, 1942; Hallermann et al. 2002; ZMH A04119). The range is now extended east to Mon State.

Mon State: 222492, 222644.

Sphaerotheca breviceps (Schneider, 1799)

The first record of this species in Myanmar was from the Chattin Wildlife Sanctuary, Sagaing Division (Zug et al., 1998). The distribution now includes Mandalay, Magwe, Yangon Divisions and Shan State.

Magwe Division: 210701, 213872–73; Mandalay Division: 210659, 210666, 216097–104, 216126, 216263, 221636–43, 221833–35; Shan State: 221635; Yangon Division: 213294.

Rhacophoridae

Chirixalus doriae Boulenger, 1893

The type locality of this species is the Karin Bia-po District (Kayin State). Hallermann et al. (2002) recorded the species from Kayah State (ZMH A03144, A031445), and Shreve (1940) reported this species from "30 km north of Prome" (Bago Division; MCZ A–23402–9+4 uncat.) Our survey has revealed the distribution to include Yangon, Mandalay and Sagaing Divisions, Rakhine and Kachin States.

Kachin State: 232962, 232979–81, 233052–54, 233072–73; Mandalay Division: 216079, 216116–17; Rakhine State: 221134–35; Sagaing

Division: 210078–94, 210247–48, 215527–30, 215628–30; Yangon Division: 210782.

Chirixalus nongkhorensis (Cochran, 1927)

Ahl (1930) reported the species (listed as *Rhacophorus* (*Chirixalus*) *striatus*) from Carin-Berge (Kayah State) and Zug et al. (1998) has recorded the species from the Chatthin Wildlife Sanctuary, Sagaing Division. Additional specimens have now been recorded from Mandalay Division and Rakhine State.

Mandalay Division: 215915; Rakhine State: 221564.

Chirixalus vittatus (Boulenger, 1887)

Originally described from Kachin State (Bhamo), and reported from Palon (Yangon Division) by Fea (1897), this species was found throughout Kachin State, as well as Bago Division and Rakhine State.

Bago Division: 215824; Kachin State: 232963–65, 232974–78, 233060–71, 233082; Rakhine State: 221114–15.

Rhacophorus bipunctatus Ahl, 1927

Known from collections made by Fea in 1887 from the Karen Hills (Kayah State) as *Rhacophorus bimaculatus* (Boulenger, 1892–3), this species has recently been encountered in Shan and Kachin States. Recent work has suggested that smaller brown species with black spots on the sides typically considered *R. bipunctatus* from throughout SE Asia are actually *R. rhodopus*, while larger green species with black spots on the sides recently described as *R. htunwini* (Wilkinson et al., 2005) are *R. bipunctatus* (Bordoloi et al., 2007), further examination of the Myanmar populations are required.

Kachin State: 221344–45, 221492, 224676–77, 224690, 224734–35, 224755, 225127, 225150–52, 229886–87, 229891–92, 229894–95, 229897; Shan State: 229898-99, 229900–12, 229914–15.

Colubridae

Ahaetulla fronticincta (Günther, 1858)

Ahaetulla fronticincta was reported from Rangoon (Yangon) and Pegu (Bago) regions by Smith (1943) and from Rakhine State by Theobald (1882). Our surveys have found this species in mangrove habitat as far south as Mudon Township in southern Mon State, throughout the Yangon area, and as far east as Myaung Mya Township, Ayeyarwady Division.

Ayeyarwady Division: 204966, 212237, 219789, 222797; Mon State: 222584–90, 222594, 222612–13, 222617, 222619–20, 222634–39.

Calamaria pavimentata Duméril, Bibron and Duméril, 1854

Smith (1943) reported a general locality of west to the Chin Hills (Chin State) for the Myanmar distribution. We obtained individuals of this species in northern Kachin State.

Kachin State: 224575, 224647, 230226.

Coelognathus radiatus (Boie, 1827)

Wall (1926) recorded this species from Shan and Kachin States, Schulz (1996) from Rakhine, Kachin, and Kayin States, Mandalay, Mon, Bago and Yangon Divisions, Zug et al. (1998) from Sagaing and Hallermann et al. (2002) from Palon (Yangon Division; ZMH R06248), and Malewoon (Tanintharyi Division; ZMH R06254). Additional records are for Bago, Mandalay, Sagaing and Tanintharyi Divisions, and the first record of this species has been documented for Magwe Division.

Magwe Division: 210719, 213632, 213660, 213893.

Orthriophis taeniurus Cope, 1861

Schulz (1996) mentions an unnamed *E. taeniura* subspecies with which two of our specimens agree in scale counts and pattern. Two individuals referable to this subspecies were found in limestone caves in Shan State.

Shan State: 235825.

Dinodon septentrionale (Günther, 1875)

Smith (1943) recorded this species as far south as Chaing Mai Thailand and from throughout Myanmar, and both Boulenger (1892–3) and Hallermann et al. (2002) reported it from Kayin State (ZMH R05369). Wall (1908) reported this species from Mogok region (southern Kachin State). We obtained this species in northern Kachin State and northern Mon State.

Kachin State: 221512, 221527; Mon State: 222234.

Psammophis condanarus (Merrem, 1820)

Smith (1943) reported this species as occurring south of 21°N latitude, and stated that "no specimens have been obtained from "upper Burma". We obtained specimens from Sagaing, Mandalay and Magwe Divisions that extend the distribution record north ca. 134 km.

Magwe Division: 210700, 215896, 215902; Mandalay Division: 215952, 215956, 215983–84, 216015, 216018, 216024, 216027–28, 216113, 216121; Sagaing Division: 215375, 215815.

Oligodon cinereus (Günther, 1864)

The Myanmar distribution is reported from Tanintharyi Division, Shan State (as far north as Taunggyi) and between the latitudes of 20° to 26° N (Smith 1943). This species was found in Kachin and Rakhine States and Sagaing and Yangon Divisions.

Kachin State: 221529; Rakhine State: 205028, 221933; Sagaing Division: 215597, 215605; Yangon Division: 213379, 213423–24.

Oligodon dorsalis (Gray, 1834)

This species is known from throughout NE India (Das, 2002) and has been reported from the Mansi Katha District of Chin Hills (Chin State; Smith, 1943), as well as N'Changyang (Kachin State; Smith, 1940). We have encountered additional individuals within both of these states that extend the distribution. In Chin State, individuals were encountered in the Mindat District (SE Chin State). In Kachin State, a single individual was found in Hukaung Valley on the border with India.

Chin State: 233295, 235310, 235362–63, 235365; Kachin State: 230264.

Oligodon mcdougalli Wall, 1905

Known only from the type specimen from Sandoway (Thandawe, Rakhine State), we extend the distribution south to the Gwa region of Rakhine State.

Rakhine State: 221086, 221969.

Oligodon planiceps (Boulenger, 1888)

Previously known from four specimens from Yangon and Bago Divisions (Tharrawaddy District) (Smith, 1943), records now exist for Magwe Division.

Magwe Division: 210842, 213822.

Oligodon quadrilineatus (Jan, 1866)

Smith (1943) recorded this species from Thailand, Cambodia and Vietnam, and Zug et al. (1998) from Sagaing Division. It was recently encountered in Shan State.

Shan State: CAS 236093.

Oligodon torquatus (Boulenger, 1888)

Smith (1943) reported this species from between Mytkyina and Bhamo in Kachin State, and Hallermann et al. (2002) recorded a specimen (ZMH R06249) from Kachin State. In addition, it was documented in Magwe and Mandalay Divisions.

Magwe Division: 210692–93, 210695; Mandalay Division: 215290, 215976.

Pareas macularius Theobald, 1868

Formerly documented from Yangon Division (Rangun [sic], Pegu) (Theobald, 1876), and Kachin (Htingnan, Mogok), Shan (Kalaw) and Tanintharyi (Martaban) States in Myanmar (Smith, 1943), this species was also encountered in Chin State and Bago Division.

Bago Division: 206620; Chin State: 233330, 235218, 235359.

Rhabdophis himalayanus (Günther, 1864)

Venning (1910, 1911) and Shreve (1940) reported this species from Chin State, and Smith (1943) from latitudes higher than 22°N. Specimens were obtained from Rakhine State, extending the range 485 km to the south.

Rakhine State: 220255, 220350, 220372–73, 220380–81, 222906, 224420, 224425, 224438, 224705.

Rhabdophis nigrocinctus (Blyth, 1856)

Smith (1943) reported this species from Tenaserim (Tanintharyi) and as far north as Toungoo (Bago Division), two specimens (ZMH R05448–9) were also recorded from Kayah State (Hallermann et al., 2002). This species was documented in Shan State, near Kalaw, extending the distribution 185 km north within Myanmar.

Shan State: 215280.

Sibynophis bistrigatus (Günther, 1868)

This rare snake is known only from Prome and Pegu (Bago) in Bago Division (Smith, 1943). The range is extended northward to include Mandalay Division.

Mandalay Division: 214081

Xenochrophis trianguligerus Boie, 1827

The species, previously known in Myanmar from the Mergui Archipelago (Anderson, 1889; Smith, 1943) was recorded from the Dawei region of northern Tanintharyi Division.

Tanintharyi Division: 229658, 229784.

Gekkonidae

Cyrtodactylus annandalei Bauer, 2003

Originally described from a single locality in Sagaing Division, a single individual was documented in Magwe Division. The individual was found at night crossing the road in a deciduous hardwood forest.

Magwe Division: 234785.

Cyrtodactylus slowinskii Bauer, 2002

Previously known from a single protected area (Alaungdaw Kathapa National Park) in Sagaing Division, this species was recently encountered in southern Chin State. Individuals were found in evergreen forest.

Chin State: 234847, 234945, 235347.

Gehyra mutilata (Weigmann, 1834)

Reported from southern Burma by Smith (1935b), and from Burma without precise locality data by Rendahl (1937). We have records of this species from Ayeyarwady Division.

Ayeyarwady Division: 206567, 212899.

Agamidae

Acanthosaura lepidogaster (Cuvier, 1829)

Previously reported from Bago Divison (ZMH R04615–16) and Kayah State (ZMH R04572–73, R04575–77) (Smith, 1935a; Hallermann et al., 2002). New records extend the distribution west to southern Rakhine State.

Rakhine State: 216422, 216598, 220137–38, 220258, 220334–35, 220337, 220345–46, 220374–76, 220383, 220430–31, 221937, 221983, 221991, 222010.

Draco blanfordii Boulenger, 1885

Myanmar populations of *Draco blanfordii* were previously reported from throughout Tenasserim with a northern distribution limit in the Dawna Hills (Kayah State). We confirm new records of this species from Tanintharyi Division, with additional records from Bago and Sagaing Divisions, and Shan and Kachin States.

Bago Division: 221153–54; Kachin State: 228480; Shan State: 228465; Sagaing Division: 228466.

Draco taeniopterus Günther, 1861

The Myanmar distribution previously included Tenasserim and Mergui Archipelago (Tanintharyi Division; Smith, 1935b). New records for Tanintharyi exist for the Dawei region, and the range is extended significantly farther north to Shan State.

Mon State: 222231–32, 222237, 222278–80, 222284; Shan State: 228464; Tanintharyi Division: 228468–69, 228471, 228477.

Japalura planidorsata Jerdon, 1870

Smith (1935b) reported this species from northern Chin Hills (Chin State). Recent collections of the species have been made in the Mount Victoria area of southern Chin State and from the Haka and Falam regions of northern Chin State.

Chin State: 219935, 220131–32, 233211, 233296.

Leiolepis belliana (Hardwicke and Gray, 1827).

Reported previously as having a northern limit of 18°N in Myanmar (Smith, 1935b), and near Moulmein (Mon State) by Hallermann et al. (2002; ZMH R06563–5). Recent northern records include Sagaing, Magwe and Mandalay Divisions and Chin and Shan States extend this range ca. 552 km to the north.

Chin State: 234701; Magwe Division: 210720–30, 213769, 213814, 213842, 213886; Mandalay Division: 214080, 214153, 214170, 215319–20, 215927, 215931, 215979, 215991, 216037, 216054, 216169, 216170, 216232; Sagaing Division: 210246, 210326, 215455, 215543–44, 215648, 215650–52, 215708; Shan State: 230478, 230586.

Scincidae

Eutropis novemcarinata (Anderson, 1871)

Smith (1935b) listed this species as occurring in Mandalay, Yangon, and Minhla (Magwe). The distribution now extends to include Sagaing Division and Chin State.

Chin State: 221878; Saging Division: 215359, 215377, 215414, 215459, 215714, 215744, 215758, 215761, 215772, 215779–80, 215783–84, 215790, 215792–93 215799, 215804–09, 215812.

Eutropis quadricarinata (Anderson, 1871)

Previously known from Bhamo (Kachin State; Smith, 1935b) and Chattin (Sagaing Division; Zug et al., 1998). Records now exist from Mandalay Division.

Mandalay Division: 213984, 216233.

Scincella reevesi (Gray, 1838)

Smith (1935b) reports this species from Bhamo (Kachin State), Bago Division, and from the Dawna Hills (Kayin State). It has additionally been documented from Tanintharyi Division (Theobald, 1868), as well as from Mount Popa in the Mandalay Division (Shreve, 1940). We add records from Ayeyarwady and Yangon Divisions and Shan and Mon States.

Ayeyarwady Division: 213094; Mon State: 222283; Shan State: 216298, 216331, 216342, 230709, 230731; Yangon Division: 204984, 213286, 213293, 213301, 213330–31, 213335.

Tropidophorus berdmorei (Blyth, 1853)

Records for this species within Myanmar are confined to the Mergui Archipelago and Tennasserim (Tanintharyi Division), Pegu (Bago Division) and Bhamo (Kachin State; Smith 1935a). Recent records expand the known range to Sagaing Division and Shan State.

Sagaing Division: 204900–07, 210182, 210236–38; Shan State: 210639.

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NEW COUNTRY RECORDS AND RANGE EXTENSIONS FOR MYANMAR AMPHIBIANS AND REPTILES

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(with one text-figure)

ABSTRACT.– **Myanmar lies at a biogeographic crossroads where the faunas of China, Indochina, India, Himalaya, and the Malay Peninsula converge. Since 1999, the Myanmar Herpetological Survey, a collaborative effort the California Academy of Sciences, the National Museum of Natural History, Smithsonian Institution, and the Forest Department, Ministry of Forestry, Myanmar, has surveyed the amphibians and reptiles throughout the country. Our surveys in Myanmar have added many additions to the country's fauna, and species ranges within Myanmar have been extended. These general biotic surveys represent the only new information for much of Myanmar's herpetofauna for over a half-century. We present 18 new country records and 45 range extensions and state records in this paper.**

KEY WORDS.– **Myanmar, amphibians, reptiles, geographic distribution.**

INTRODUCTION

The herpetofauna of Myanmar is poorly known. Early collections by Leonard Fea followed by collections by the British set the groundwork for our understanding of the biodiversity within Myanmar. Although many species were described from Myanmar primarily by British naturalists George Boulenger, Malcolm Smith and Frank Wall, during the late 19th and early 20th centuries, comprehensive surveys of the country's herpetofauna have not been conducted until initiated by the National Museum of Natural History, Smithsonian Institution, and the California Academy of Sciences. The Myanmar Herpetological Survey, a collaborative effort among the California Academy of Sciences (CAS), National Museum of Natural History, Smithsonian Institution (USNM) and the Nature and Wildlife Conservation Division, Forest Department, Ministry of Forestry, Myanmar, has surveyed throughout the country from 1999 to present, and as such has discovered new species (18 of which have been recently described in Slowinski and Wüster, 2000; Slowinski et al., 2001; Bauer, 2002, 2003; Schulte et al., 2004; Vindum et al., 2003; Wilkinson et al., 2003, Wilkinson et al., 2005; Wogan et al., 2003; Zug et al., 2006), rediscovered some rare species (Wilkinson and Rao, 2004; Gonzalez et al., 2005), as well as new country division/state records (Leviton et al., 2003; Gonzalez and Vindum, 2005), and range extensions.

The importance of documenting the composition of the herpetofauna within Myanmar has been pointed out in several region wide assessments (Inger, 1999; Bhupathy, 2000; Das, 2000). Because of the biogeographic position of Myanmar, and because so many type localities lie within Myanmar's borders, an understanding of the patterns of distribution, and the evolutionary histories of Asia's amphibian and reptile species can not be fully understood until data from Myanmar can be incorporated into comprehensive regional assessments.

At present, there are 82 amphibian and 289 reptile taxa (Zug et al., 2003) documented in Myanmar. The authors anticipate that the number of species confirmed from Myanmar will continue to grow as survey efforts in border regions with Bangladesh, India, China, Laos and Thailand, are carried out and research progresses. The first part of this paper details species that are documented for the first time in Myanmar bringing the known number of amphibian species up to 94 and known reptile species to 295. The second portion outlines division/state records and range extensions. Within each section, records are organized alphabetically by family and then by genus and species. Distribution data for snakes belonging to the families Elapidae and Viperidae are further detailed in Leviton et al. (2003). Distributions for species belonging to the genus *Hemidactylus* within Myanmar are depicted in Zug et al. (2007). Amphibian taxonomy follows AmphibiaWeb (2007).

METHODS

Animals were collected by hand by the authors. Latitude and longitude were recorded using a Garmin 12 XL GPS (datum WGS 84). Animals were euthanized and then fixed in 10% buffered formalin before being transferred to 70% ethanol. Specimens are deposited in the California Academy of Sciences (CAS).

Identifications were made by Htun Win, J. B. Slowinski, J. V. Vindum, and G. O. U. Wogan in the field, and confirmed against museum specimens and literature by J. A. Wilkinson (Rhacophoridae), J. V. Vindum and M. S. Koo (Sauria), J. B. Slowinski *(Amphiesma, Rhabdophis)* and G. O. U. Wogan (remaining taxa). Records reported by Shreve (1940) were confirmed by Wogan. Museum symbolic codes follow Leviton et al. (1985). For commonly encountered species, not all individuals are included, no more than 20 unique localities are included to cover the distribution within the country. Detailed locality descriptions can be obtained from the Department of Herpetology's website (http://www.calacademy.org/research/herpetology/catalog/). Unless otherwise noted, catalogue numbers refer to CAS specimens. Museum numbers following the detailed distribution data refer to specimens examined, museum numbers not appearing in this section, but otherwise mentioned are taken from the literature. Unless otherwise mentioned, identifications of materials cited from the literature, have not been confirmed by the authors. Figure 1 shows geopolitical boundaries of Myanmar and the region.

RESULTS

New Country Records

Megophryidae

Xenophrys longipes (Boulenger, 1886)

This species is widespread in southern Thailand and the Malay Peninsula (Chan-ard et al., 1999). We discovered a single individual of this species at night in evergreen hardwood forest in southern peninsular Myanmar, Tanintharyi Division.

Tanintharyi Division: 235843.

Xenophrys glandulosa (Fei et al., 1991)

Described from Yunnan, this species has also been documented in Nagaland, India (Ao et al., 2003), and is now reported from northern Kachin State, Myanmar.

Kachin State: 221363, 221395, 221442, 221484, 221567–68.

Microhylidae

Microhyla rubra (Jerdon, 1854)

Originally described from the Carnatic region, this species was previously known only from India (including Assam) and Sri Lanka (Frost, 2007). Dutta (1997) mentions a record of this species from the Moulmein (Mon State) area, but the source of this record has not been confirmed. The discovery of this species in Myanmar is, in addition to being a new country record, the easternmost record of its distribution. Representatives of this species have thus far been documented only from Magwe Division. Individuals were found at night during the monsoon season. Sympatric congeners include

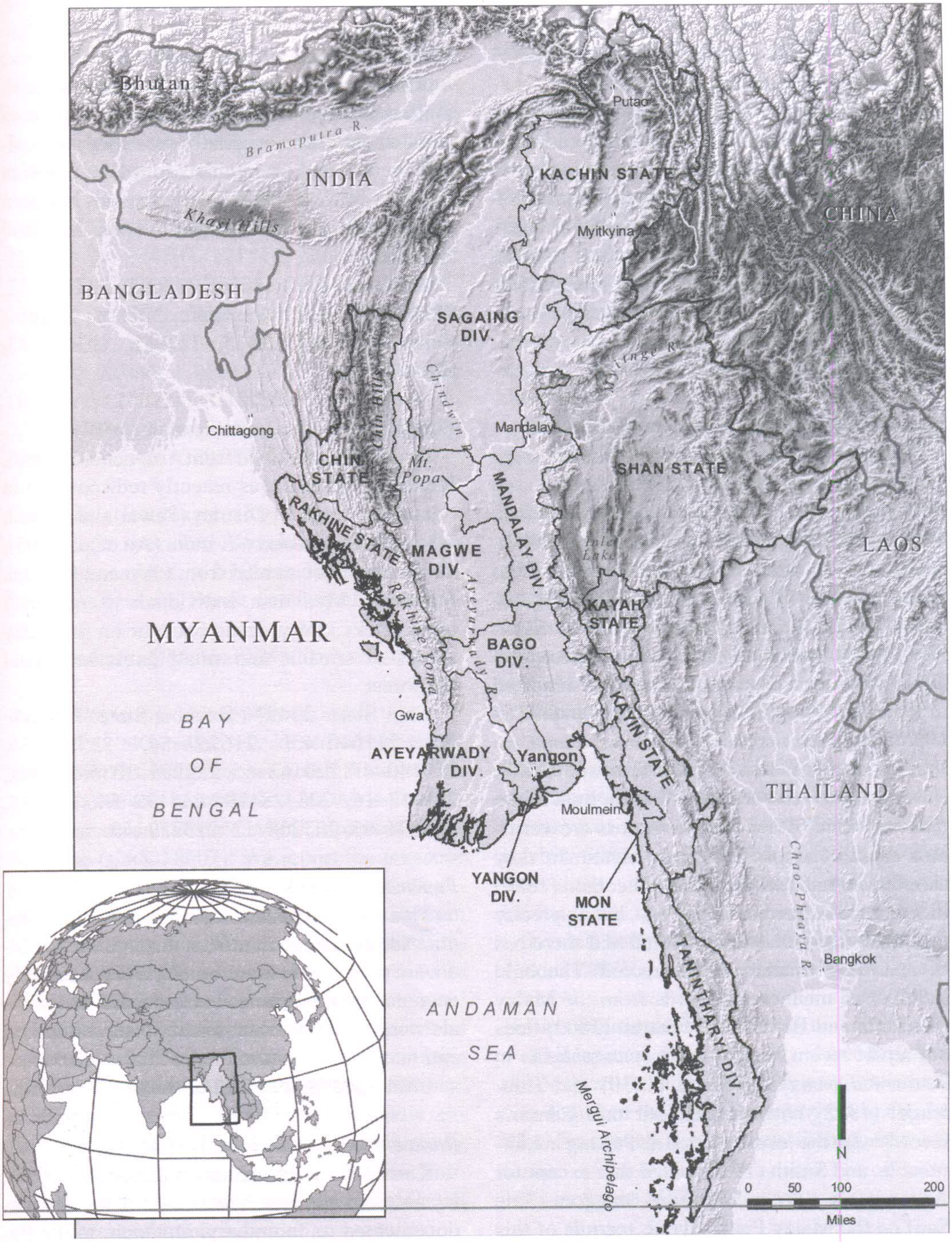

Figure 1. Map of Myanmar, with geopolitical boundaries indicated.

M. berdmorei, M. ornata, and an undescribed species.

Magwe Division: 213799, 215851–90.

Ranidae

Amolops viridimaculatus (Jiang, 1983)

One representative of this species was found in Kachin State, northern Myanmar. In addition to China (Jiang, 1983), recent records have also emerged from two states in north-east India; Nagaland (Ao et al., 2003) and Arunachal Pradesh (*A.* cf. *viridimaculatus*) (Pawar and Birand, 2001) and northern Vietnam (Ohler et al., 2000). The lone individual was found in bamboo canopy (Wogan et al., 2004).

Kachin State: 224378.

Euphlyctis cyanophlyctis (Schneider, 1799)

The species has been reported from areas as far west as Afghanistan (Frost, 2007), and throughout India, including Nagaland (Ao et al., 2003), and Kamrup (Choudhury et al., 2002). Sclater (1892) reported this species from Jergo Island, Arakan (Rakhine State; ZSI 9349–formerly 12632–3), and Moulmein (Mon State; ZSI 10960), however, of the above specimens ZSI 12633 was destroyed, 12632 is reported in the ZSI catalogue simply as "frog", and ZSI 10960, although identified as *Rana cyanophlyctis,* lacks locality data beyond "Austin?" (M. S. Ravichandran pers. comm. 2004). In light of the fact that none of the former records are verifiable as *E. cyanophylctis* from Myanmar, they should be treated with caution. Theobald (1882) mentioned this species from Pegu, but no precise catalogue numbers were reported and there has been no confirmation of this record. Theobald (1882) also mentioned records from the Malay Peninsula and Bengal. Sukumaran (2002) does not report recent records of *E. cyanophlyctis* in Peninsular Malaysia. Smith (1930) and Boulenger (1912) both pointed out that Cantor's records with the locality listed as Penang are unreliable, and Smith (1930) stated that except for Annandale's 1917 record from Singgora (Talé Sap) on the Malay Peninsula no records of this species are reported from Indo-China. Taylor (1962) further suggested that this record may be the result of an introduction. We have found *E. cyanophlyctis* in northern Rakhine State close to the Bangladesh border. Individuals were found at night in water.

Rakhine State: 222035–37, 221088, 221118, 222075.

Fejervarya cancrivora (Gravenhorst, 1829)

This species has been found throughout coastal SE Asia (excluding Myanmar) and Indonesia from where it was originally described. Individuals were found on mudflats in tidal streams in mangrove forest. Thus far, this species has been documented in Ayeyarwady Division, Mon and Rakhine States.

Ayeyarwady Division: 222697, 222736–37, 222756, 222800; Mon State: 222621; Rakhine State: 222964, 222978, 222982, 223080–83, 223336–37.

Occidozyga borealis (Annandale, 1912)

Originally described from Arunachal Pradesh, India, this species was recently rediscovered in Arunachal Pradesh District (Pawar and Birand, 2001), and Nagaland NE India (Ao et al., 2003), and is now documented from Chin and Rakhine States. In Myanmar, individuals were found under rocks in dry streambeds, or on the rocky shores of streams and small pools in coastal rainforest.

Chin State: 234936 Rakhine State: 205064–92, 211640–45, 216553–54, 220134–36, 220140–47, 220162–65, 222995–3036, 223091, 223112–16, 223128–29, 223139–54, 223178, 223194–95, 223208–12, 223237–40.

Pterorana khare Kiyasetuo and Khare, 1986

This species was discovered in Nagaland, India. Additional records from throughout NE India are reviewed in Ao et al. (2006). We recently encountered this species in Chin State. Individuals were found in slow moving water sitting on egg masses.

Chin State: 234933, 234941–42.

Rana chalconota (Schlegel, 1837)

Known from throughout Indonesia, and Malaysia and peninsular Thailand, this species was documented in Tanintharyi Division, in the Pakchan Forest Reserve.

Tanintharyi Division: CAS 229539, 229564, 229610.

Rana chloronota (Günther, 1875)

Originally described from northern India, this species has been historically confused with *Rana livida* (see Bain et al., 2003 for discussion). Most recently, this species has been confirmed from Vietnam (Bain et al., 2003). In Myanmar, *R. chloronota* has been found in low-lying montane forests in Kachin, Rakhine, and Shan States as well as Bago, Sagaing and Tanintharyi Divisions.

Bago Division: 211671, 211719, 221850; Kachin State: 221261, 221315–56, 221321, 221393–94, 224702, 221534, 224702, 224748, 225153, 225211, 225540, 232920, 233101, 233112; Rakhine State: 216574, 220186–88, 220260–61, 220271–76, 220341, 220347–48, 220367, 220466, 220612, 222907; Sagaing Division: 210224, 210230–31, 210233–35, 221776; Shan State: 210642, 221771–72; Tanintharyi Division: 229539, 229564, 22601.

Rana hosii (Boulenger, 1891)

A single specimen referable to *R. hosii* has been documented in southern Myanmar in the Pakchan Reserve Forest in Tanintharyi Division.

Tanintharyi Division: 229627.

Rana taipehensis Van Denburgh, 1909

Smith (1940) tentatively identified one specimen from N'Chang Yang, Kachin State, to this taxon, however, he remarked on the lack of an outer metatarsal tubercle, which is present on the holotype (CAS 18007). We report the presence of *R. taipehensis* from low elevations throughout Myanmar. All observed *R. taipehensis* from Myanmar possess a distinct outer metatarsal tubercle, and despite extensive surveys in Kachin State, *R. taipehensis* has not been documented in the region, indicating that Smith's specimen is perhaps not *R. taipehensis*. Assigning Smith's specimen a specific name requires additional evaluation. Records for this species now exist for Rakhine and Mon States, Ayeyarwady, Bago, Mandalay, and Yangon Divisions. Individuals have been found in flooded fields and along forest streams.

Ayeyarwady Division: MCZ A–132432, 132460–61, 132462–65, CAS 212433, 220609, 222717–20; Bago Division: 210743, 222095; Mandalay Division: 208473; Mon State: 222524, 222572; Rakhine State: 205298, 220148–50, 220161, 221082–3, 221085, 221093, 221098–100, 221104–06, 221111–13, 221130–33, 221952, 221977, 222015, 222032, 222050–52, 222054–55, 222057, 222987, 222994, 223108; Yangon Division: 210805, 213434.

Colubridae

Amphiesma xenura (Wall, 1907)

Previously reported from both the Khasi Hills (Smith, 1943) and Naga Hills (Romer, 1945) in Assam, India. Recent surveys have also found this species in the Palak Lake area, Mizoram Assam (Pawar and Birand, 2001). In Myanmar, this species has been encountered in northwest Sagaing and throughout the Rakhine Hills, Rakhine State.

Rakhine State: 220256, 220332, 220368–71, 220378, 222969; Sagaing Division: 232203.

Lycodon jara Russell, 1796

Known from NE India and Nepal (Das, 2002), this species was encountered in northern Kachin State, making it the first record for SE Asia. One of the individuals was found moving in open grass, the other was found in an agricultural area.

Kachin State: CAS 235387–88.

Lycodon subcinctus Boie, 1827

Documented from countries bordering Myanmar, two individuals were encountered in Kachin State and Tanintharyi Division. Both individuals were found at night in a disturbed habitat.

Kachin State: CAS 235846; Tanintharyi Division: 229726.

Pareas monticola (Cantor, 1839)

This species was originally described from the Naga Hills in NE India. A single specimen was found in the Chin State in the Mindat district. Co-occurring congeners include *P. macularius.*

Chin State: 235254.

Sinonatrix yunnanensis Rao and Yang, 1998

This species was previously reported only from Yunnan Province, China. Records from

Kachin State represent the first records of the species outside of China.

Kachin State: 221518, 221544, 224440, 224485, 224730.

Scincidae

Tropidophorus robinsoni Smith, 1919

This lizard was previously known only from Thailand. We have documented one specimen from the Tanintharyi Division of Myanmar in the Dawei Region (formerly Tavoy).

Tanintharyi Division: 228558.

New State Records and Geographic Range Extensions

Bufonidae

Bufo asper (Gravenhorst, 1829)

*This species is known from peninsular Thai*land and peninsular Malaysia (Taylor, 1962; Frost, 2007). Taylor (1962) reported the species occurring as far north as Chumphon, Thailand. Fea collected a specimen (ZMH A04113) from Mount Karen, Kayah State (Hallerman et al., 2002) and a second specimen from Thagata Juwa (Kayin State; Boulenger, 1887). Other historical records for Myanmar are primarily from the Myeik Archipelago in Tanintharyi Division, collected during the Mergui Expedition by Anderson in 1882 (deposited at the ZSI). A recent record from Kyaik Kti Yo Wildlife Sanctuary represents the first documentation of this species in Mon State.

Mon State: 222196.

Bufo macrotis Boulenger,1887

This species was originally described from Teinzo and Kakhein Hills (Kachin State). Boulenger (1892–3) further reported it from Palon (Yangon Division). Outside of Myanmar, it is known from Thailand (Taylor, 1962). Recent surveys have encountered this species in northwest Sagaing Division near the Indian border.

Sagaing Division: 232191, 232195.

Microhylidae

Glyphoglossus molossus Günther, 1869

The type locality is in Bago Division (Frost, 2007). Although Boulenger (1890) reported the species as occurring in the Irrawaddy Delta (Ayeyarwady Division) and Pegu (Bago Division), he mentioned that he only had one specimen (the type), thus there is some confusion concerning the location of the type locality. Theobald (1882) provides additional details concerning the discovery of the type specimen mentioning that it was discovered in the "tidal portion of the Irrawaddy Delta". The species has been reported from east-central Sagaing Division by Zug et al. (1998) and from Prome (Bago Division) by Shreve (1940). We have recorded the species from Mandalay Division and south-western Sagaing Division.

Mandalay Division: 216094–95, 221608–09; Sagaing Division: 210056, 210117.

Microhyla berdmorei (Blyth, 1856)

Records are available for Bago (reported as Pegu) and a general locality of Burma (Boulenger, 1882). Bourret (1942) reported the species from Pegou (Bago Division) and Karin Biapo (Kayah State), and Shreve (1940) reported a single specimen (MCZ A–23433) from the Chin Hills, Chin State, however, the collection locality is actually in Magwe Division (Ainggyi, Pakokku Hills), thus this species is not presently known to occur in Chin State. Choudhury et al. (2002) recently reported this species from northern India. Our surveys have found this species in Rakhine and Shan States, and Magwe, Sagaing, Tanintharyi and Yangon Divisions.

Magwe Division: 219884–85; Rakhine State: 205029–48, 205199, 216534–39, 220410–11, 221150, 222908–15, 222971–72, 223045–46, 223048–51, 223054–56, 223105, 223135–37, 223166, 223169–71; Sagaing Division: 204875–80, 205191–98, 215686–87; Shan State: 210637; Tanintharyi Division: 229765 Yangon Division: 213242–43, 213415–16, 213432–33, 213488–89.

Microhyla butleri Boulenger, 1900

Bourret (1942) reported this species from He-Ho Plaines of southern Shan State, this record confirmed by ZSI 19324. Hallermann et al. (2002) recorded this species from Kayah State (ZMH A04074). We obtained representatives of this species from Yangon Division, making it the western-most records of this species.

Yangon Division: 210750–60, 210822–27.

Microhyla heymonsi Vogt, 1911

Bourret (1942) records this species from He Ho Valley (southern Shan State), and Hallermann et al. (2002) recorded it from Kayah State (ZMH A04068–72). In addition to records from Shan State, we have also located this species in Kachin State and Tanintharyi and Yangon Divisions. Thus far, the distribution does not extend into or west of the central dry zone of Myanmar.

Kachin State: 232718; Tanintharyi Division: 229637, 229830; Yangon Division: 210748–49, 210785, 210789.

Ranidae

Ingerana tenasserimensis (Sclater, 1892)

Historical records from Myanmar are from Tanintharyi and the Karen Hills, Kayah State (Bourret 1942), our surveys have found this species throughout Mon State.

Mon State: 210557–58, 222205–08, 222217, 222245–60, 222269–74, 222443–57, 222461–68, 222474–89, 222535–69, 222579–80, 222596–600, 222609–10, 222663–64.

Limnonectes limborgi (Sclater, 1892)

Known from the type locality of Meetan, Tennasserim (Tanintharyi Division; Sclater, 1892) and Karen Bia-po, Yado and Thao (Kayah State; Boulenger, 1888). This species has been documented in Mon State.

Mon State: 210559–62.

Rana cubitalis (Smith, 1917)

This species is reported from the Karen Hills (Kayah State) by Smith (1930). Shreve (1940), with uncertainty, referred specimens (MCZ–A23425–9) from Maymyo (Mandalay Division) to this species. We obtained a specimen referable to this species from Mandalay Division.

Mandalay Division: 216286.

Rana lateralis Boulenger, 1887

The type locality of the species is from the Moulmein area in Mon State (Boulenger, 1887). Boulenger (1888) recorded additional specimens from Palon and Rangoon (Yangon Division) and Pegu (Bago Division); Shreve (1940) recorded specimens from Hmawbi (Yangon Division) and Chin State, Zug et al. (1998) from Sagaing Division and Hallermann et al. (2002) from Yangon Division (ZMH A 04120). We recorded the species from Magwe Division and Kachin State.

Kachin State: 232504; Magwe Division: MCZ A–23415; Yangon Division: 210791, 210797, 210806, 220527, MCZ A–23390–91.

Rana macrodactyla (Günther, 1858)

Rana macrodactyla has been reported from Bhamo (Kachin State; Bourret, 1942) and from Palon (Yangon Division; Bourret, 1942; Hallermann et al. 2002; ZMH A04119). The range is now extended east to Mon State.

Mon State: 222492, 222644.

Sphaerotheca breviceps (Schneider, 1799)

The first record of this species in Myanmar was from the Chattin Wildlife Sanctuary, Sagaing Division (Zug et al., 1998). The distribution now includes Mandalay, Magwe, Yangon Divisions and Shan State.

Magwe Division: 210701, 213872–73; Mandalay Division: 210659, 210666, 216097–104, 216126, 216263, 221636–43, 221833–35; Shan State: 221635; Yangon Division: 213294.

Rhacophoridae

Chirixalus doriae Boulenger, 1893

The type locality of this species is the Karin Bia-po District (Kayin State). Hallermann et al. (2002) recorded the species from Kayah State (ZMH A03144, A031445), and Shreve (1940) reported this species from "30 km north of Prome" (Bago Division; MCZ A–23402–9+4 uncat.) Our survey has revealed the distribution to include Yangon, Mandalay and Sagaing Divisions, Rakhine and Kachin States.

Kachin State: 232962, 232979–81, 233052–54, 233072–73; Mandalay Division: 216079, 216116–17; Rakhine State: 221134–35; Sagaing

Division: 210078–94, 210247–48, 215527–30, 215628–30; Yangon Division: 210782.

Chirixalus nongkhorensis (Cochran, 1927)

Ahl (1930) reported the species (listed as *Rhacophorus* (*Chirixalus*) *striatus*) from Carin-Berge (Kayah State) and Zug et al. (1998) has recorded the species from the Chatthin Wildlife Sanctuary, Sagaing Division. Additional specimens have now been recorded from Mandalay Division and Rakhine State.

Mandalay Division: 215915; Rakhine State: 221564.

Chirixalus vittatus (Boulenger, 1887)

Originally described from Kachin State (Bhamo), and reported from Palon (Yangon Division) by Fea (1897), this species was found throughout Kachin State, as well as Bago Division and Rakhine State.

Bago Division: 215824; Kachin State: 232963–65, 232974–78, 233060–71, 233082; Rakhine State: 221114–15.

Rhacophorus bipunctatus Ahl, 1927

Known from collections made by Fea in 1887 from the Karen Hills (Kayah State) as *Rhacophorus bimaculatus* (Boulenger, 1892–3), this species has recently been encountered in Shan and Kachin States. Recent work has suggested that smaller brown species with black spots on the sides typically considered *R. bipunctatus* from throughout SE Asia are actually *R. rhodopus*, while larger green species with black spots on the sides recently described as *R. htunwini* (Wilkinson et al., 2005) are *R. bipunctatus* (Bordoloi et al., 2007), further examination of the Myanmar populations are required.

Kachin State: 221344–45, 221492, 224676–77, 224690, 224734–35, 224755, 225127, 225150–52, 229886–87, 229891–92, 229894–95, 229897; Shan State: 229898-99, 229900–12, 229914–15.

Colubridae

Ahaetulla fronticincta (Günther, 1858)

Ahaetulla fronticincta was reported from Rangoon (Yangon) and Pegu (Bago) regions by Smith (1943) and from Rakhine State by Theobald (1882). Our surveys have found this species in mangrove habitat as far south as Mudon Township in southern Mon State, throughout the Yangon area, and as far east as Myaung Mya Township, Ayeyarwady Division.

Ayeyarwady Division: 204966, 212237, 219789, 222797; Mon State: 222584–90, 222594, 222612–13, 222617, 222619–20, 222634–39.

Calamaria pavimentata Duméril, Bibron and Duméril, 1854

Smith (1943) reported a general locality of west to the Chin Hills (Chin State) for the Myanmar distribution. We obtained individuals of this species in northern Kachin State.

Kachin State: 224575, 224647, 230226.

Coelognathus radiatus (Boie, 1827)

Wall (1926) recorded this species from Shan and Kachin States, Schulz (1996) from Rakhine, Kachin, and Kayin States, Mandalay, Mon, Bago and Yangon Divisions, Zug et al. (1998) from Sagaing and Hallermann et al. (2002) from Palon (Yangon Division; ZMH R06248), and Malewoon (Tanintharyi Division; ZMH R06254). Additional records are for Bago, Mandalay, Sagaing and Tanintharyi Divisions, and the first record of this species has been documented for Magwe Division.

Magwe Division: 210719, 213632, 213660, 213893.

Orthriophis taeniurus Cope, 1861

Schulz (1996) mentions an unnamed *E. taeniura* subspecies with which two of our specimens agree in scale counts and pattern. Two individuals referable to this subspecies were found in limestone caves in Shan State.

Shan State: 235825.

Dinodon septentrionale (Günther, 1875)

Smith (1943) recorded this species as far south as Chaing Mai Thailand and from throughout Myanmar, and both Boulenger (1892–3) and Hallermann et al. (2002) reported it from Kayin State (ZMH R05369). Wall (1908) reported this species from Mogok region (southern Kachin State). We obtained this species in northern Kachin State and northern Mon State.

Kachin State: 221512, 221527; Mon State: 222234.

Psammophis condanarus (Merrem, 1820)

Smith (1943) reported this species as occurring south of 21°N latitude, and stated that "no specimens have been obtained from "upper Burma". We obtained specimens from Sagaing, Mandalay and Magwe Divisions that extend the distribution record north ca. 134 km.

Magwe Division: 210700, 215896, 215902; Mandalay Division: 215952, 215956, 215983–84, 216015, 216018, 216024, 216027–28, 216113, 216121; Sagaing Division: 215375, 215815.

Oligodon cinereus (Günther, 1864)

The Myanmar distribution is reported from Tanintharyi Division, Shan State (as far north as Taunggyi) and between the latitudes of 20° to 26° N (Smith 1943). This species was found in Kachin and Rakhine States and Sagaing and Yangon Divisions.

Kachin State: 221529; Rakhine State: 205028, 221933; Sagaing Division: 215597, 215605; Yangon Division: 213379, 213423–24.

Oligodon dorsalis (Gray, 1834)

This species is known from throughout NE India (Das, 2002) and has been reported from the Mansi Katha District of Chin Hills (Chin State; Smith, 1943), as well as N'Changyang (Kachin State; Smith, 1940). We have encountered additional individuals within both of these states that extend the distribution. In Chin State, individuals were encountered in the Mindat District (SE Chin State). In Kachin State, a single individual was found in Hukaung Valley on the border with India.

Chin State: 233295, 235310, 235362–63, 235365; Kachin State: 230264.

Oligodon mcdougalli Wall, 1905

Known only from the type specimen from Sandoway (Thandawe, Rakhine State), we extend the distribution south to the Gwa region of Rakhine State.

Rakhine State: 221086, 221969.

Oligodon planiceps (Boulenger, 1888)

Previously known from four specimens from Yangon and Bago Divisions (Tharrawaddy District) (Smith, 1943), records now exist for Magwe Division.

Magwe Division: 210842, 213822.

Oligodon quadrilineatus (Jan, 1866)

Smith (1943) recorded this species from Thailand, Cambodia and Vietnam, and Zug et al. (1998) from Sagaing Division. It was recently encountered in Shan State.

Shan State: CAS 236093.

Oligodon torquatus (Boulenger, 1888)

Smith (1943) reported this species from between Mytkyina and Bhamo in Kachin State, and Hallermann et al. (2002) recorded a specimen (ZMH R06249) from Kachin State. In addition, it was documented in Magwe and Mandalay Divisions.

Magwe Division: 210692–93, 210695; Mandalay Division: 215290, 215976.

Pareas macularius Theobald, 1868

Formerly documented from Yangon Division (Rangun [sic], Pegu) (Theobald, 1876), and Kachin (Htingnan, Mogok), Shan (Kalaw) and Tanintharyi (Martaban) States in Myanmar (Smith, 1943), this species was also encountered in Chin State and Bago Division.

Bago Division: 206620; Chin State: 233330, 235218, 235359.

Rhabdophis himalayanus (Günther, 1864)

Venning (1910, 1911) and Shreve (1940) reported this species from Chin State, and Smith (1943) from latitudes higher than 22°N. Specimens were obtained from Rakhine State, extending the range 485 km to the south.

Rakhine State: 220255, 220350, 220372–73, 220380–81, 222906, 224420, 224425, 224438, 224705.

Rhabdophis nigrocinctus (Blyth, 1856)

Smith (1943) reported this species from Tenaserim (Tanintharyi) and as far north as Toungoo (Bago Division), two specimens (ZMH R05448–9) were also recorded from Kayah State (Hallermann et al., 2002). This species was documented in Shan State, near Kalaw, extending the distribution 185 km north within Myanmar.

Shan State: 215280.

Sibynophis bistrigatus (Günther, 1868)

This rare snake is known only from Prome and Pegu (Bago) in Bago Division (Smith, 1943). The range is extended northward to include Mandalay Division.

Mandalay Division: 214081

Xenochrophis trianguligerus Boie, 1827

The species, previously known in Myanmar from the Mergui Archipelago (Anderson, 1889; Smith, 1943) was recorded from the Dawei region of northern Tanintharyi Division.

Tanintharyi Division: 229658, 229784.

Gekkonidae

Cyrtodactylus annandalei Bauer, 2003

Originally described from a single locality in Sagaing Division, a single individual was documented in Magwe Division. The individual was found at night crossing the road in a deciduous hardwood forest.

Magwe Division: 234785.

Cyrtodactylus slowinskii Bauer, 2002

Previously known from a single protected area (Alaungdaw Kathapa National Park) in Sagaing Division, this species was recently encountered in southern Chin State. Individuals were found in evergreen forest.

Chin State: 234847, 234945, 235347.

Gehyra mutilata (Weigmann, 1834)

Reported from southern Burma by Smith (1935b), and from Burma without precise locality data by Rendahl (1937). We have records of this species from Ayeyarwady Division.

Ayeyarwady Division: 206567, 212899.

Agamidae

Acanthosaura lepidogaster (Cuvier, 1829)

Previously reported from Bago Divison (ZMH R04615–16) and Kayah State (ZMH R04572–73, R04575–77) (Smith, 1935a; Hallermann et al., 2002). New records extend the distribution west to southern Rakhine State.

Rakhine State: 216422, 216598, 220137–38, 220258, 220334–35, 220337, 220345–46, 220374–76, 220383, 220430–31, 221937, 221983, 221991, 222010.

Draco blanfordii Boulenger, 1885

Myanmar populations of *Draco blanfordii* were previously reported from throughout Tenasserim with a northern distribution limit in the Dawna Hills (Kayah State). We confirm new records of this species from Tanintharyi Division, with additional records from Bago and Sagaing Divisions, and Shan and Kachin States.

Bago Division: 221153–54; Kachin State: 228480; Shan State: 228465; Sagaing Division: 228466.

Draco taeniopterus Günther, 1861

The Myanmar distribution previously included Tenasserim and Mergui Archipelago (Tanintharyi Division; Smith, 1935b). New records for Tanintharyi exist for the Dawei region, and the range is extended significantly farther north to Shan State.

Mon State: 222231–32, 222237, 222278–80, 222284; Shan State: 228464; Tanintharyi Division: 228468–69, 228471, 228477.

Japalura planidorsata Jerdon, 1870

Smith (1935b) reported this species from northern Chin Hills (Chin State). Recent collections of the species have been made in the Mount Victoria area of southern Chin State and from the Haka and Falam regions of northern Chin State.

Chin State: 219935, 220131–32, 233211, 233296.

Leiolepis belliana (Hardwicke and Gray, 1827).

Reported previously as having a northern limit of 18°N in Myanmar (Smith, 1935b), and near Moulmein (Mon State) by Hallermann et al. (2002; ZMH R06563–5). Recent northern records include Sagaing, Magwe and Mandalay Divisions and Chin and Shan States extend this range ca. 552 km to the north.

Chin State: 234701; Magwe Division: 210720–30, 213769, 213814, 213842, 213886; Mandalay Division: 214080, 214153, 214170, 215319–20, 215927, 215931, 215979, 215991, 216037, 216054, 216169, 216170, 216232; Sagaing Division: 210246, 210326, 215455, 215543–44, 215648, 215650–52, 215708; Shan State: 230478, 230586.

Scincidae

Eutropis novemcarinata (Anderson, 1871)

Smith (1935b) listed this species as occurring in Mandalay, Yangon, and Minhla (Magwe). The distribution now extends to include Sagaing Division and Chin State.

Chin State: 221878; Saging Division: 215359, 215377, 215414, 215459, 215714, 215744, 215758, 215761, 215772, 215779–80, 215783–84, 215790, 215792–93 215799, 215804–09, 215812.

Eutropis quadricarinata (Anderson, 1871)

Previously known from Bhamo (Kachin State; Smith, 1935b) and Chattin (Sagaing Division; Zug et al., 1998). Records now exist from Mandalay Division.

Mandalay Division: 213984, 216233.

Scincella reevesi (Gray, 1838)

Smith (1935b) reports this species from Bhamo (Kachin State), Bago Division, and from the Dawna Hills (Kayin State). It has additionally been documented from Tanintharyi Division (Theobald, 1868), as well as from Mount Popa in the Mandalay Division (Shreve, 1940). We add records from Ayeyarwady and Yangon Divisions and Shan and Mon States.

Ayeyarwady Division: 213094; Mon State: 222283; Shan State: 216298, 216331, 216342, 230709, 230731; Yangon Division: 204984, 213286, 213293, 213301, 213330–31, 213335.

Tropidophorus berdmorei (Blyth, 1853)

Records for this species within Myanmar are confined to the Mergui Archipelago and Tennasserim (Tanintharyi Division), Pegu (Bago Division) and Bhamo (Kachin State; Smith 1935a). Recent records expand the known range to Sagaing Division and Shan State.

Sagaing Division: 204900–07, 210182, 210236–38; Shan State: 210639.

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COUNTRY RECORDS OF SNAKES FROM LAOS

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(with 24 text-figures)

ABSTRACT.– **The known snake fauna of Laos continues to increase with improved sampling. We report 13 country records of colubrid and viperid snakes from Laos, based on vouchered museum specimens that were obtained during herpetological surveys over the past decade. Species included in this report are: *Amphiesma leucomystax* David, Bain, Nguyen, Orlov, Vogel, Vu & Ziegler, *Calamaria yunnanensis* Chernov, *Elaphe prasina* (Blyth), *Fimbrios klossi* Smith, *Liopeltis stoliczkae* (Sclater), *Psammophis condanarus* (Merrem), *Pseudoxenodon bambusicola* Vogt, *Pseudoxenodon macrops* (Blyth), *Rhabdophis nigrocinctus* (Blyth), *Sinonatrix aequifasciata* (Barbour), *Sinonatrix percarinata* (Boulenger), *Ovophis monticola* (Günther) and *Protobothrops mucrosquamatus* (Cantor).**

KEYWORDS.– **Laos, Serpentes, geographic distributions, Colubridae, Viperidae.**

INTRODUCTION

Largely owing to a monograph by Deuve (1970), snakes are the best-known component of the herpetofauna of Laos (Lao People's Democratic Republic). Nevertheless, much remains to be learned and a number of additions to the snake fauna have been made since Deuve's monograph. Stuart (1999) provided a list of snakes and the general regions and habitats in which they are known to occur in Laos. Hermann et al. (2002) and Stuart (2006) provided country records, expanded descriptions, and natural history data for two poorly known species of snakes, *Triceratolepidophis sieversorum* and *Parahelicops annamensis*. Malhotra and Thorpe (2004) and Malhotra et al. (2004) gave records of *Trimeresurus* from Laos. Teynié et al. (2004) and Teynié and David (2007) reported on recent collections of snakes, primarily from Champasak Province in southern Laos, and Bain et al. (2007a, b) provided historical records of two species (*Calloselasma rhodostoma* and *Lycodon laoensis*) from near the capital city of Vientiane.

Herein, we report country records of 13 species of colubrid and viperid snakes from Laos. These records are based on vouchered specimens that were collected by us during our fieldwork, or by colleagues who made them available to us for the purposes of this work. These species were not reported from Laos by Bourret (1936), Smith (1943), or the authors cited above; an exception is that Stuart (1999) listed some of these records but did not provide voucher numbers, detailed locality information, or justification for the identifications. The present paper provides that information.

MATERIALS AND METHODS

Specimens were caught in the field by hand, preserved in 10% buffered formalin, and later transferred to 70% ethanol. Tissue samples were taken by preserving pieces of liver in 95% ethanol before the specimen was fixed in formalin.

Specimens were deposited at the Field Museum of Natural History (FMNH). Measurements of preserved specimens were made with dial calipers or a soft measuring tape. Ventral scales were counted following the method of Dowling (1951). Coordinates in parentheses are estimates.

SPECIES ACCOUNTS

Family Colubridae

Amphiesma leucomystax David, Bain, Nguyen, Orlov, Vogel, Vu & Ziegler (Figs. 1–2)

FMNH 255236, Laos, Khammouan Province, Nakai District, Phou Hin Poun National Biodiversity Conservation Area, 17°53'N, 104°55' E, 570 m elev., on sandy bank of stream in dry evergreen mixed with dipterocarp and pine forest, coll. Bryan L. Stuart and Tanya Chan-ard, 23 March 1998. FMNH 258667, Laos, Xe Kong Province, Kaleum District, Xe Sap National Biodiversity Conservation Area, along Houay Alung Stream, 16°00'32"N, 106°55'31"E, 920–1,000 m elev., on dirt bank 1.5 m above a small stream pool in evergreen forest, coll. Bryan L. Stuart, 30 June 1999.

Two females fully agree with David et al.'s (2007) original description and with two paratypes (FMNH 252118–19) from Vietnam, which we have examined. The Laos specimens have a single anterior temporal; 19 mid-body dorsal scale rows; 158–161 ventrals; a broad, white stripe extending below the eye from the snout tip to the neck; and a dorsolateral series of transverse spots.

Figure 1. *Amphiesma leucomystax* from Laos.

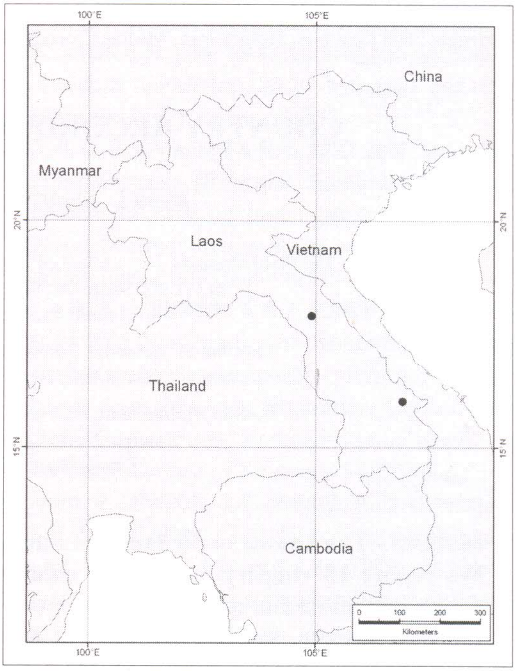

Figure 2. *Amphiesma leucomystax* localities in Laos.

Calamaria yunnanensis Chernov (Fig. 3)

FMNH 258666, Laos, Phongsaly Province, Phongsaly District (21º29'N, 102º12'E), dead on the mountainous road to Udomxai about 25 km from Phongsaly city, coll. Bounthavy Phommachanh, 6 October 1999.

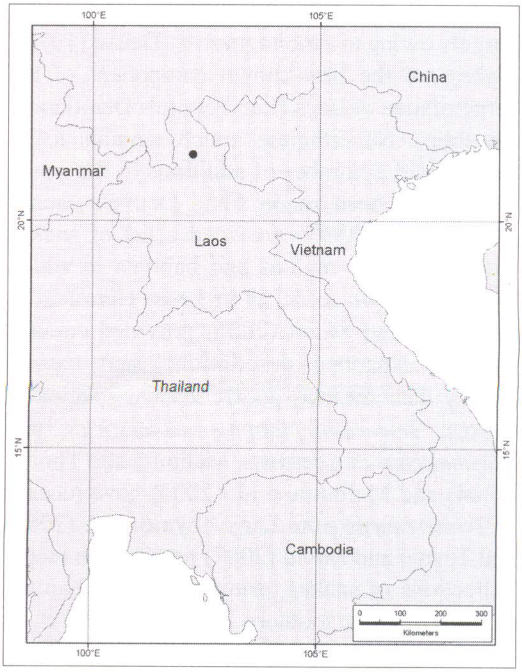

Figure 3. *Calamaria yunnanensis* locality in Laos.

A single female closely agrees with Chernov's (1962) original description of the species based on a single male from Jingdong County, Yunnan Province, China. Inger and Marx (1965) treated *C. yunnanensis* as a "doubtful form" because they were not able to examine the type and deficiencies in the original description cast doubt on its distinctiveness from two species known to occur in China, *C. septentrionalis* Boulenger and *C. pavimentata* Duméril & Bibron. Zhao and Adler (1993) listed *C. yunnanensis* as a valid species. The Laos specimen differs from *C. pavimentata* and *C. septentrionalis* by the absence of a preocular, higher number of ventrals, dorsals reducing only to six rows on the tail, in colouration, and further from *pavimentata*, by having a thick, non-tapering tail. No records of *C. yunnanensis* have been reported since Chernov (1962), and so the Laos specimen is described in detail, as follows.

Rostral wider (2.4 mm) than high (1.9 mm), portion visible from above (1.0 mm) shorter than prefrontal suture (1.7 mm). Prefrontal (2.3 mm) shorter than frontral (2.7 mm), touching first two supralabials, broadly entering orbit. Frontal hexagonal, almost twice length of supraocular (1.4 mm), about two-thirds length of parietal (4.0 mm). Parietal about 1.7 times length of prefrontal. Paraparietal surrounded by six shields and scales. Nasal smaller than postocular. No preocular. Single postocular, higher than wide, not as high (0.9 mm) as eye diameter (1.2 mm). Eye diameter about equal to eye-mouth distance (1.1 mm). Distance from anterior margin of eye to nostril 1.9 mm, to tip of snout 3.0 mm. Four supralabials, second and third entering orbit, fourth (2.6 mm) longest, third (1.1 mm) about two-thirds length of second (1.7 mm), first (1.3 mm) slightly longer than third and about three-fourths length of second. Mental triangular, not touching anterior chin shields. Five infralabials, three touching anterior chin shield. Anterior pair of chin shields meeting in midline, posterior pair diverging and only in contact anteriorly. Three gulars in midline between posterior pair of chin shields and first ventral. Maxillary teeth modified *sensu* Inger & Marx (1965). All scales smooth, 13 dorsal rows at mid-body, 179 ventrals, 22 divided subcaudals. Dorsal scales reduced to six rows on tail opposite 12th subcaudal posterior to cloaca. Snout-vent length ca. 330 mm, tail length ca. 32 mm. Mid-body diameter ca. 7 mm, base of tail diameter ca. 6 mm. Tail thick, not tapered, tip rounded with conical terminal scale. Tail/total length ratio 0.088. Colouration in ethanol bluish-brown above with five weakly-visible dark longitudinal stripes (under epidermis, brown with five dark brown longitudinal stripes) from behind eye to tip of tail, outermost stripe strongly demarcating dark dorsal colouration from yellowish ventral colouration; lower three-fourths of supralabials, side of head, lower half of third dorsal scale row anteriorly, shifting ventrally to lower half of second dorsal scale row about two head-lengths behind head, first dorsal scale row, ventrals, and subcaudals uniformly yellowish.

Elaphe prasina (Blyth) (Figs. 4–5)

FMNH 258760, Laos, Champasak Province, Pakxong District, Dong Hua Sao National Biodiversity Conservation Area, Bolaven Plateau, near 15°05'N, 106°10'E, 1,000 m elev., on trail in disturbed, wet evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 20 September 1999.

A single male has snout length twice the eye diameter; loreal scale present; 10 supralabials, the fourth, fifth and sixth touching the eye; 20: 19: 15 dorsal scale rows, first and second rows smooth, remaining rows weakly keeled; 195 ventrals, with lateral keel; 106 paired subcaudals; single anal plate; and uniform green colouration above.

Fimbrios klossi Smith (Figs. 6–7)

FMNH 258639, Laos, Champasak Province, Pakxong District, Dong Hua Sao National Bio-

Figure 4. *Elaphe prasina* from Laos.

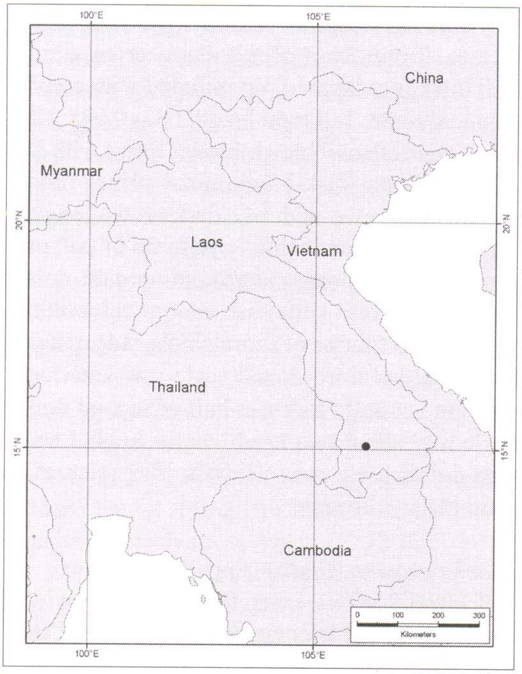

Figure 5. *Elaphe prasina* locality in Laos.

diversity Conservation Area, Bolaven Plateau, near 15°04'37"N, 106°08'15"E, 1,000 m elev., swimming in emergent grass in slow-moving muddy stream in wet evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 10 September 1999. FMNH 258640–41, Laos, Champasak Province, Pakxong District, Dong Hua Sao National Biodiversity Conservation Area, Bolaven Plateau, near 15°03'55"N, 106°13'03"E, 1,200 m elev., under leaf litter in wet evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 22 September 1999.

A male and two females fully agree with Smith's (1921) original description by having the rostral separated from the internasals by a horizontal ridge of tissue; the nostril in the anterior part of a large, concave nasal; rostral, nasal, and labials with strongly raised edges; a single, large pair of chin shields; and keeled body scales with visible interstitial skin.

Figure 6. *Fimbrios klossi* from Laos.

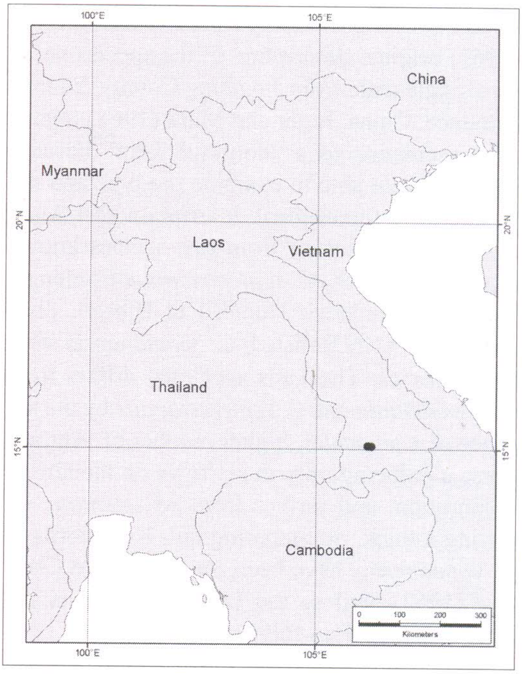

Figure 7. *Fimbrios klossi* localities in Laos.

Liopeltis stoliczkae (Sclater) (Fig. 8)

FMNH 254780, Laos, Bolikhamxay Province, Khamkeut District, Lac Xao (18°11'N, 104°58'E), dead on road, coll. David Davenport, August 1996.

A single male has the head distinct from neck; snout length twice the eye diameter; a small nostril in a long, undivided nasal; a square loreal; eight supralabials, fourth and fifth entering orbit; 150 ventrals; 128 subcaudals; brown dorsum with a broad black stripe on the side of head that extends onto the anterior part of body before gradually disappearing; and a grey stripe on the outer margins of the ventrals.

Psammophis condanarus (Merrem) (Figs. 9–10)

FMNH 255234, Laos, Champasak Province, Mounlapamok District, Dong Khanthung National Biodiversity Conservation Area, 14°09'N, 105°39'E, 100 m elev., in tree 1.5 m above the ground in a rice paddy adjacent to a grassland

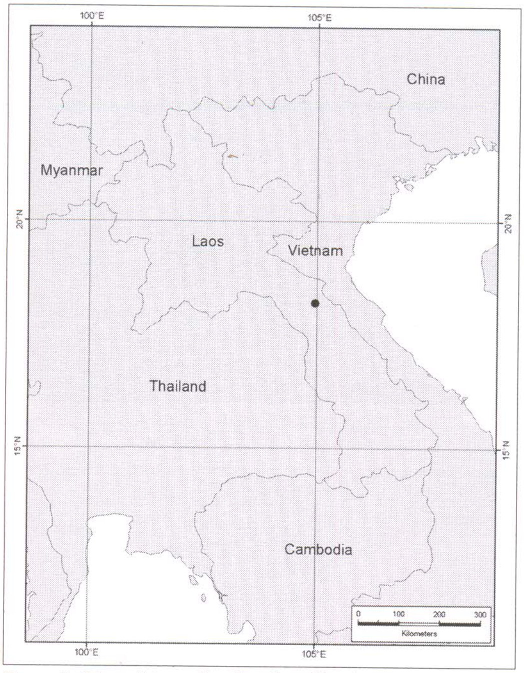

Figure 8. *Liopeltis stoliczkae* locality in Laos.

with dry dipterocarp forest, coll. Bryan L. Stuart, 9 July 1998.

A single male has the nasal incompletely divided; frontal longer than its distance from the tip of the snout, anterior end less than twice as broad as the middle; divided anal plate; and four dark brown longitudinal stripes edged with black, continuing onto the head as longitudinal markings.

Pseudoxenodon bambusicola Vogt (Figs. 11–12)

FMNH 256423, Laos, Khammouan Province, Nakai District, Nakai-Nam Theun National Biodiversity Conservation Area, along Houay Dreng Stream, 17°50'N, 105°35'E, 600 m elev., on leaf litter 30 m from a stream in wet evergreen forest, coll. Bryan L. Stuart, 3 December 1998.

A single male has a large nostril between two nasals; large eye with round pupil; one preocular; three postoculars; eight supralabials, fourth and fifth entering orbit; 19: 17: 15 dorsal scale rows; 136 ventrals; 59 subcaudals; a dark bar across the prefrontals, continuing as dark stripe through the eye to corner of jaw; approximately 20 brown bands across the body, the first connected to the neck by a narrow black dorsolateral stripe on each side; and anterior part of venter with large quadrangular dark spots.

Figure 9. *Psammophis condanarus* from Laos.

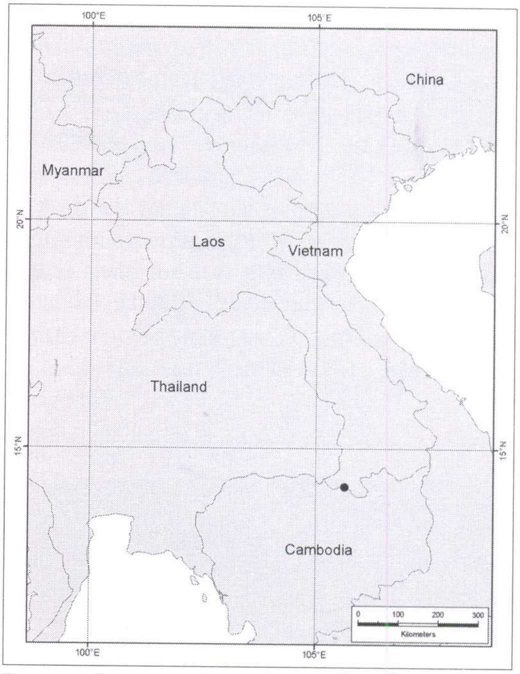

Figure 10. *Psammophis condanarus* locality in Laos.

Figure 11. *Pseudoxenodon bambusicola* from Laos.

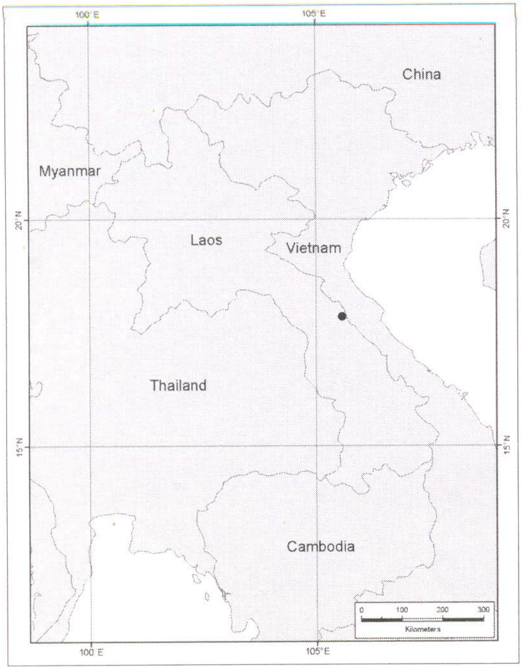

Figure 12. *Pseudoxenodon bambusicola* locality in Laos.

Pseudoxenodon macrops (Blyth) (Figs. 13–14)

FMNH 258649, Laos, Champasak Province, Pakxong District, Dong Hua Sao National Biodiversity Conservation Area, Bolaven Plateau, near 15°03’55”N, 106°13’03”E, 1,200 m elev., on leaf litter in wet evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 21 September 1999. FMNH 258762, Laos, Khammouan Province, Nakai District, Nakai-Nam Theun National Biodiversity Conservation Area, Navang (17°50’N, 105°35’E), coll. David Davenport, 2 March 1997.

A male and female have a large nostril between two nasals; large eye with round pupil; one preocular; three postoculars; eight supralabials, fourth and fifth entering orbit; 19: 17: 15 dorsal scale rows; 155–160 ventrals; 62–63 subcaudals; dark bar from behind eye to corner of jaw; vertebral series of dark-edged spots; and anterior part of venter with large quadrangular dark spots, sometimes united to form crossbars.

Figure 13. *Pseudoxenodon macrops* from Laos.

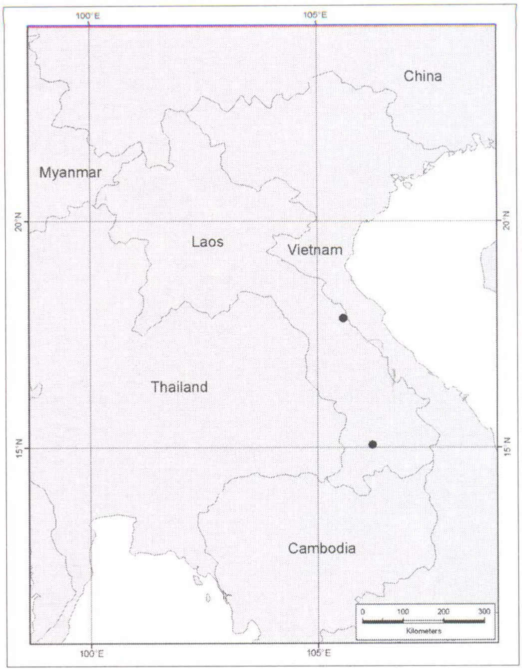

Figure 14. *Pseudoxenodon macrops* localities in Laos.

Rhabdophis nigrocinctus (Blyth) (Figs. 15–16)

FMNH 255237, Laos, Khammouan Province, Boualapha District, Hin Namno National Biodiversity Conservation Area, Phou Khaonok Mountain, 17°23’N, 105°45’E, 545 m elev., on rocks 2 m from a stream in evergreen forest, coll. Bryan L. Stuart, 19 February 1998. FMNH 258646, Laos, Phongsaly Province, Phongsaly District, Phou Dendin National Biodiversity Conservation Area, near confluence of Nam Ou and Nam Sa Rivers, near 22°05’31”N, 102°06’19”E, 600 m elev., swimming at night across 3 m wide stream in hill evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 20 October 1999.

Two males have the nostril lateral; single preocular; 2+2 temporals; nine supralabials, fourth, fifth and sixth entering orbit; 17 or 19 dorsal scale rows at mid-body; olive-green above, becoming browner posteriorly, with narrow, black crossbars; two black oblique stripes on the side

Figure 15. *Rhabdophis nigrocinctus* from Laos.

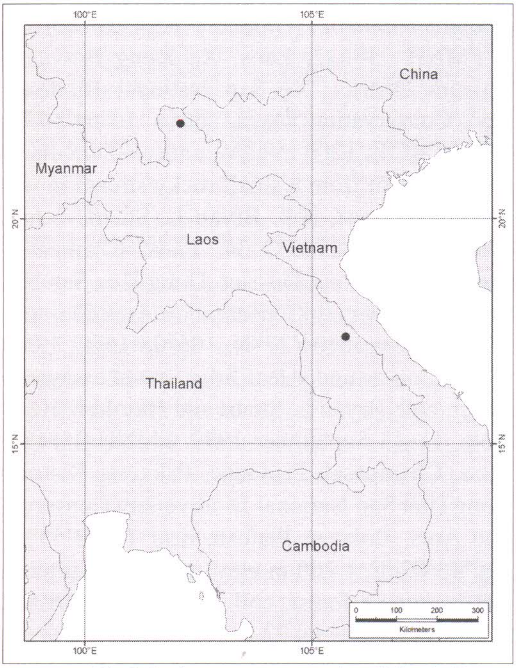

Figure 16. *Rhabdophis nigrocinctus* localities in Laos.

of head, one below eye, the other from rear of the eye to corner of jaw; and black chevron on neck.

Sinonatrix aequifasciata (Barbour) (Figs. 17–18)

FMNH 256420, Laos, Khammouan Province, Nakai District, Nakai-Nam Theun National Biodiversity Conservation Area, 17°57'N, 105°34'E, along Houay Duen Stream, 700 m elev., swimming in shallow water of a rocky stream in evergreen forest, coll. Bryan L. Stuart, 11 November 1998. FMNH 256421, Laos, Khammouan Province, Nakai District, Nakai-Nam Theun National Biodiversity Conservation Area, 17°58'N, 105°34'E, along Houay Ting Tou Stream, 700 m elev., on rocky bank 4 m from a stream, coll. Bryan L. Stuart, 6 November 1998. FMNH 258670, Laos, Bolikhamxay Province, Khamkeut District, Nape (18°15'N, 105°07'E), wet evergreen forest, coll. David Davenport, 16 March 1997.

An adult female and two juveniles have nine supralabials, none or only one entering orbit; 19 dorsal scale rows at mid-body; 147–153 ventrals; 18–21 dark bands encircling the body, constricted on sides, those in the adult double on back and belly; and 8–9 dark bands encircling tail.

Figure 17. *Sinonatrix aequifasciata* from Laos.

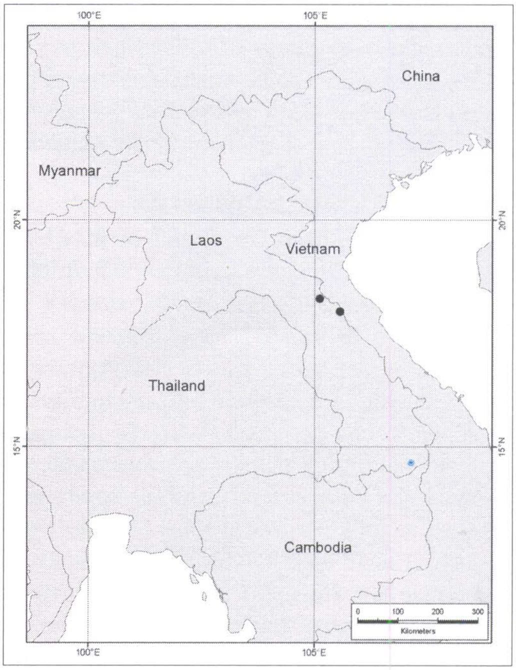

Figure 18. *Sinonatrix aequifasciata* localities in Laos.

Sinonatrix percarinata (Boulenger) (Figs. 19–20)

FMNH 255239–40, Laos, Huaphahn Province, Vieng Tong District, Phou Louey National Biodiversity Conservation Area, near Nam Poung River, 20°14'N, 103°16'E, 985 m elev., under submerged rock or log in a stream in hill evergreen forest, coll. Bryan L. Stuart, 27 April 1998. FMNH 258671, 258763–66, Laos, Bolikhamxay Province, Khamkeut District, Nape (18º15'N, 105º07'E), wet evergreen forest, coll. David Davenport, 15–20 March 1997. FMNH 258680, Laos, Phongsaly Province, Phongsaly District, Phou Dendin National Biodiversity Conservation Area, near Nam Ou River, near 22°05'38"N, 102°12'50"E, 600 m elev., being eaten by a *Bungarus fasciatus* (FMNH 258654) on a stream bank in hill evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 11 October 1999.

Figure 19. *Sinonatrix percarinata* from Laos.

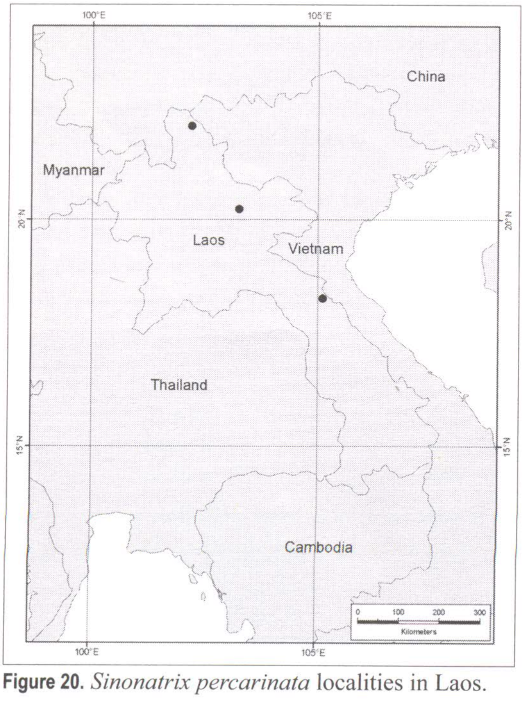

Figure 20. *Sinonatrix percarinata* localities in Laos.

These have nine supralabials, two entering orbit, without black sutures; 19 dorsal scale rows at mid-body; 28–36 dark bands on body, broad dorsally, becoming narrow laterally, distinct in juveniles, indistinct or absent in larger specimens; bands on lateral and ventral surfaces of tail, distinct in juveniles, indistinct or absent in larger specimens.

Family Viperidae

Ovophis monticola (Günther) (Figs. 21–22)

FMNH 258632, Laos, Xe Kong Province, Kaleum District, Xe Sap National Biodiversity Conservation Area, near 16°04'10"N, 106°58'45"E, 1200 m elev., under 40 cm diameter rock 1 m from a small rocky stream in wet evergreen forest, coll. Bryan L. Stuart, 7 July 1999. FMNH 258633–34, Laos, Champasak Province, Pakxong District, Dong Hua Sao National Biodiversity Conservation Area, Bolaven Plateau, near 15°04'37"N, 106°08'15"E, 1,000 m elev., on or under leaf litter in wet evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 11–13 September 1999. FMNH 258635, Laos, Champasak Province, Pakxong District, Dong Hua Sao National Biodiversity Conservation Area, Bolaven Plateau, near 15°03'55"N, 106°13'03"E, 1,200 m elev., under leaf litter in wet evergreen forest, coll. Bryan L. Stuart and Harold F. Heatwole, 22 September 1999.

An adult male, adult female, and two juveniles have the first labial separated from the nasal; large internasals separated by a single scale; large, non-erect supraoculars separated by 6–7

Figure 21. *Ovophis monticola* from Laos.

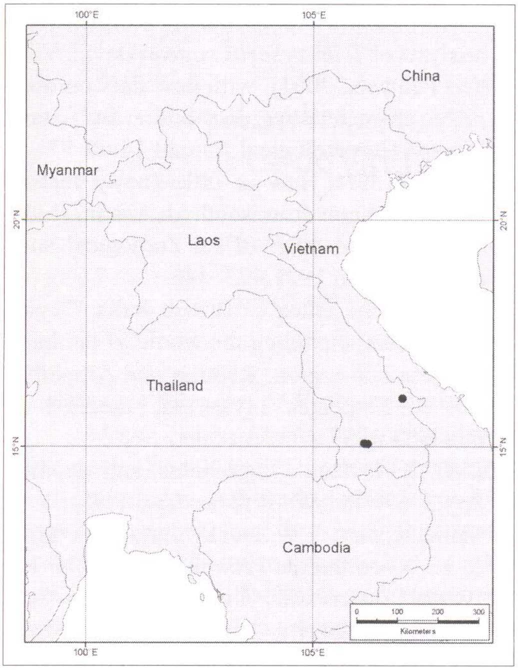

Figure 22. *Ovophis monticola* localities in Laos.

scales; subocular broken up into smaller scales; 23–25 dorsal scale rows at mid-body; 132–142 ventrals; 36–47 subcaudals; brown colouration above with dorsal series of squarish, dark brown spots and lateral series of smaller, dark brown spots; and venter heavily powdered with brown.

Protobothrops mucrosquamatus (Cantor) (Figs. 23–24)

FMNH 256418, Laos, Khammouan Province, Nakai District, Nakai-Nam Theun National Biodiversity Conservation Area, 17°56'N, 105°34'E, along Houay Balong Stream, 600 m elev., on pebble substrate of intermittent stream bed 3 m from a stream pool in evergreen forest, coll. Bryan L. Stuart, 16 November 1998.

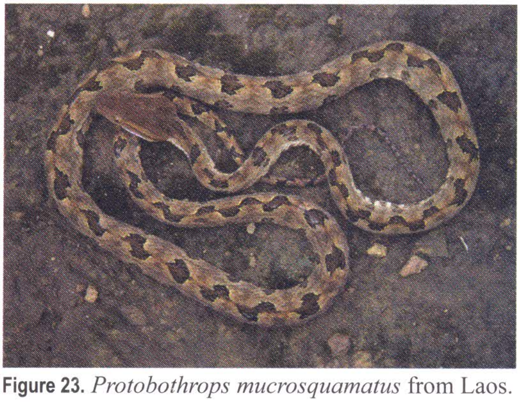

Figure 23. *Protobothrops mucrosquamatus* from Laos.

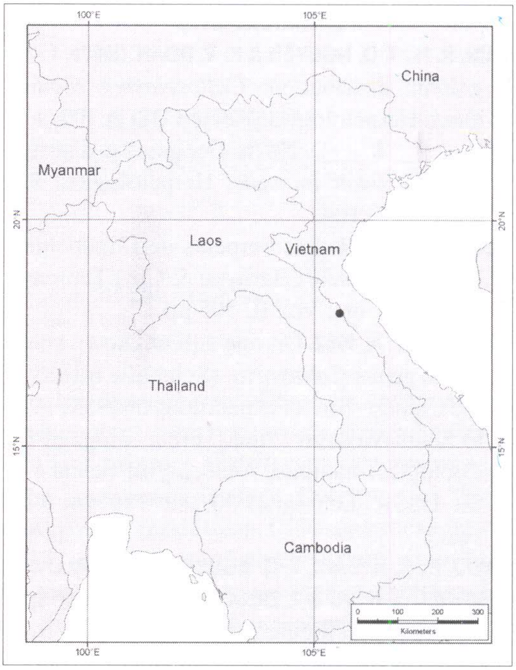

Figure 24. *Protobothrops mucrosquamatus* locality in Laos.

A single male has the first labial separated from the nasal; small internasals separated by 4–6 small scales; long, narrow, non-erect supraoculars separated by 15–17 scales; 25 dorsal scale rows at mid-body; 213 ventrals; 96 subcaudals; and brown colouration above with dorsal series of irregular, dark brown spots and lateral series of smaller, dark brown spots.

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FOOD HABITS OF ANURAN LARVAE FROM BARAK VALLEY, NORTH-EASTERN INDIA

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(with three text-figures)

ABSTRACT.– Tadpoles of *Bufo melanostictus, Fejervarya limnocharis, Microhyla ornata* and *Euphlyctis cyanophlyctis* were collected from permanent and temporary water bodies from the Barak Valley in north-eastern India. Water samples of different systems were also analyzed. All the tadpoles were found to be continuous feeders. Detritus was the most important food item in all four species. Among algal food items, Chlorophyceae was dominant in *B. melanostictus, F. limnocharis* and *M. ornata* but relatively unimportant in *E. cyanophlyctis.* Tadpoles of *F. limnocharis* fed more on filamentous algae as compared to *M. ornata*, and *E. cyanophlyctis* fed more on detritus than *F. limnocharis* when they coexisted in two systems. Larger tadpoles of *F. limnocharis* fed more on filamentous algae than smaller individuals, which ate non-filamentous algae. Feeding behaviour in general showed spatial habitat separation, and a degree of selective feeding on different algal genera was also observed, although there was dietary overlap.

KEY WORDS.– Food habits, anuran larvae, *Bufo melanostictus, Fejervarya limnocharis, Microhyla ornata, Euphlyctis cyanophlyctis*, niche overlap.

INTRODUCTION

Tadpoles are in general herbivorous (Kupferberg et al., 1994) and consume many different taxa of algae including filamentous green algae (Jenssen, 1967), epiphytic and epibenthic algae (Dickman, 1968; Calef, 1973), planktonic diatoms and unicellular chlorophytes and cyanobacteria (Hendricks, 1973; Seale and Beckvar, 1980; Johnson, 1991), as well as algae in the tadpole faecal pellets (Steinwascher, 1978). Detritus derived from dissolved organic matter has long been recognized as a potential source of food for aquatic organisms (Baylor and Sutcliffe, 1963; Gordon, 1970; Lush and Hynes, 1973; Riley, 1963) but tadpoles fed on amorphous detritus do not grow well even though they showed low mortality rate (Ahlgren and Bowen, 1991).Tadpoles are known to filter feed but do not assimilate equally from all food items they ingest (Altig and McDearman, 1975)

In India, dietary habits of tadpoles have received relatively little attention. Kamat (1962) observed that tadpoles do not feed on all algae. The feeding habits of the tadpoles of *Euphlyctis hexadactylus, E. cyanophlyctis, Polypedates maculatus, Bufo melanostictus, Rhacophorus malabricus, Ramanella monatana, Hoplobatrachus tigerinus, Fejervarya limnocharis* and *Sphaerotheca breviceps* were studied by several workers (Sabnis and Kolhatkar, 1977, 1978; Das, 1979; Sabnis and Kuthe, 1980, Dutta Munshi et al., 1986; Sekar, 1990, 1992; Mallick, 1998), although some of these studies were conducted under laboratory conditions. Only a few studies have been conducted on tadpoles from northeastern India (Chanda, 1993, Bordoloi and Kalita, 1998) but anurans from the Barak Valley have remained unexplored. The present study determines the feeding habits of four anuran tadpoles from this region.

STUDY SITE

The present study was carried out in the Barak Valley, southern Assam between November 1996 and December 2000. The Barak Valley comprises the districts of Cachar, Karimganj and

Hailakandi and is situated between 24° 8'N–25° 8'N and 92°15'E–93°15'E. The valley, drained by the Barak River and its tributaries, is bounded by the North Cachar Hills District of Assam and the Jaintia Hills District of Meghalaya in the north, Mizoram in the south, Manipur to the east and the state of Tripura and Sylhet districts of Bangladesh on the west. This region abounds in wetlands in the floodplains of the Barak River and its tributaries, tanks and ponds of various sizes, streams, pools, marshes and others wetlands. Tadpoles of *Bufo melanostictus, Euphlyctis cyanophlyctis, Fejervarya limnocharis* and *Microhyla ornata* were collected from a number of different ecosystems that included permanent ponds, slow flowing streams, ephemeral rain water pools, ditches and holes made at construction sites. Most of these sites were located in urban and rural areas while a few were inside forests. The dominant marginal vegetation included *Cynodon dactylon, Commelina benghalensis, Cyperus* sp., *Linderina crustacea* and *Enhydra fluctuans*. The major forest tree was *Artocarpus chaplasha.*

MATERIALS AND METHODS

Tadpoles of *Bufo melanostictus*, *Fejervarya limnocharis, Euphlyctis cyanophlyctis* and *Microhyla ornata* collected with a dip net were fixed immediately in 10% formalin. The gut of each individual was dissected, the contents transferred to a watch glass and mixed with 0.5 ml of water. One drop of this sample was placed on a glass slide, covered by a cover slip and examined with a microscope fitted with a Whipple grid. Three to eight such subsamples were examined for each specimen. The number of diatoms, desmids, flagellates, blue-green algae, spores and other organisms in each subsample as well as the number of squares in the grid occupied by detritus were counted. The length and width of each food item was measured and represented in terms of grid area occupied in order to assess the relative importance of detritus and other food items. All food items were expressed in terms of percentage abundance, percent grid area occupied and percent frequency of occurrence. This method was a modification of similar earlier methods used for aquatic insects (Brown, 1961; Hall and Pritchard, 1975; Shapas and Hilsenhoff, 1976; Gupta et al., 1994). Filamentous algae were counted as 10 μm units, as individual cells were often indistinguishable (Trivedy and Goel, 1986).

The degree of dominance of food items in stomach samples of tadpoles was calculated by the Berger-Parker Diversity Index as follows:

$$D = Nmax/N$$

where, N is the total number of individuals and Nmax, the number of individuals in the most abundant resources. The reciprocal form of the measure was used so that the index increases with increasing food diversity (Das, 1996).

The diversity of food items was estimated using the Brillouin Index:

$$HB = \frac{\ln N! - \Sigma \ln ni!}{N}$$

where, n*i* represents the number of individuals in each food resource state; N, the total number of individuals in all resource states and ! represents a factorial. To calculate factorials for N > 10, Sterling's slacker approximation (*In N!~ninN-N*) was used (Das, 1996).

Niche breadths of different species were estimated using the Shannon-Weiner Index of Diversity

$$H^{/} = -\sum pi \log pi$$

where, p*i* represents the proportional abundance of the i^{th} resource state (Brower and Zar, 1977; Das, 1996).

Niche overlaps (*Ojk*) between species were calculated as

$$Ojk = \frac{\sum_{i=1}^{n} pij\ pik}{\sqrt{\sum_{i=1}^{n} pij^2 \sum_{i=1}^{n} pik^2}}$$

where, p*i* is the proportion of resource *i* in the diets of species *j* and *k*, respectively (Pianka, 1973; Toft, 1982; Dudgeon, 1989).

Niche overlaps in tadpoles were calculated including both detritus and algae as well as including only algae.

Water samples collected from different systems by plankton net were fixed in 10% formalin. The samples were centrifuged and the condensed material was examined with a compound microscope by placing one drop on a glass slide (5–8 subsamples/systems). The number of diatoms, desmids, flagellates, blue-green algae, zooplankton, spores and other organisms was expressed as percent abundance.

Identification of organisms found in the tadpoles and water samples was based on Edmondson (1959) and Battish (1992). Food items were identified to the level of genus.

RESULTS

The intestinal tract of all the tadpoles contained food. Detritus was present in the guts of all the four species. A total of 26 genera of desmids, diatoms, euglenophyceae, filamentous chlorophyceae and cyanophyceae were identified in the tadpole guts. The most frequent and abundant green algae were *Cloesterium, Cosmarium, Penium, Volvox, Netrium* and *Staurastrum*. Among the diatoms *Navicula, Gomphonema* and *Synedra* were most frequent whereas *Anabeana* was the most common blue-green algae (Table 1). Algal diversity in the gut of *E. cyanophlyctis* was poor in comparison to the other species.

The relative percent abundances of the major classes of food items are represented in Fig.1. Detritus was present in the guts of all the species and was significantly more than all other food items as revealed by one-way Anova and Tukey test (Table 2). The importance of detritus as food was most evident in *E. cyanophlyctis*. Chlorophyceae was an important algal food in all the species, although cyanophyceae was nearly equally important in *B. melanostictus* (Fig.1). Euglenophyceae and Cyanophyceae were not represented in the guts of *E. cyanophlyctis* tadpoles.

The detrital particles occupied more area than the other food items in all the four species (Fig.2). The tadpoles of *E. cyanophlyctis* have a strong preference for detrital material. No significant difference could be detected in percent area occupied between the other food items (i.e., Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae and spores in all the species).

The percent frequency of occurrences of different food items (Fig.3) also shows detritus to be the most frequent food item in all the species except *F. limnocharis,* where Chlorophyceae and to some extent Bacillariophyceae were also frequent (Table 2).

Table 3 represents the percent abundance of food items in two systems where *M. ornata* and *F. limnocharis* and *F. limnocharis* and *E. cyanophlyctis* coexisted, respectively. In System I, *M. ornata* and *F. limnocharis* had common food items although the latter fed much more on *Zygnema*. System II had a poor algal diversity. Nevertheless, *F. limnocharis* exploited the algal food items more compared to *E. cyanophlyctis*.

Table 4 depicts the percent abundance of food items in the guts of different size classes of *B. melanostictus* tadpoles collected simultaneously from the same fresh water system. It is evident that detritus was an important food in all the size classes. The smallest size class fed almost exclusively on *Volvox*, the next size class fed on several other algae with *Volvox* still remaining the dominant food item and the largest size class fed more on *Zygnema* with *Volvox* being an insignificant food item.

The Berger-Parker Diversity Index ($^1/_d$ = reciprocal form) showed that diversity of food items was highest in *B. melanostictus*, followed by *M. ornata, F. limnocharis* and *E. cyanophlyctis*. Both the Brillouin Index and Niche breadth Index indicated high diversity of prey and niche breadth in *M. ornata* followed by *B. melanostictus*, *F. limnocharis* and *E. cyanophlyctis* (Table 5).

Niche overlap (Ojk) calculations considering the proportional abundance of food items (without detritus and with detritus) showed when detritus was not considered, niche overlap was highest between *B. melanostictus* and *E. cyanophlyctis*, followed by *M. ornata* and *E. cyanophlyctis*. Overlaps were least between *B. melanostictus* and *F. limnocharis* and between *F. limnocharis* and *E. cyanophylctis* (Table 6).

The niche overlap between the four tadpoles, when detritus was taken into consideration, was much higher than that calculated for only algal food items (Table 7).

Table 8 presents the niche overlap value between the tadpoles of *M. ornata* and *F. limnocharis* and between *F. limnocharis* and *E. cyanophlyctis* in System I and II where they occurred together. Niche overlap was higher between *M. ornata* and *F. limnocharis* than between *F. limnocharis* and *E. cyanophlyctis*.

Table 1. Percent abundance of food items in the guts of tadpoles of different anuran species collected from Barak Valley, southern Assam, between November 1996–December 2000.

Food items	*Bufo melanostictus*	*Fejervarya limnocharis*	*Euphlyctis cyanophlyctis*	*Microhyla ornata*
Chlorophyceae:				
Zygnema	3.25	19.51	-	2.45
Chlorella	-	-	5.37	7.46
Eudorina	-	-	-	0.79
Chlamydomonas	4.98	0.12	-	0.67
Volvox	8.22	-	-	0.44
Penium	0.10	0.19	-	1.68
Closteridium	-	-	-	0.51
Closterium	0.03	2.77	-	0.75
Netrium	0.05	-	-	1.03
Staurastrum	0.03	0.78	-	0.74
Cosmerium	0.02	2.10	-	1.45
Euastrum	-	0.63	-	0.76
Desmidium	-	0.27	-	0.83
Scenedesmus	0.04	-	-	0.04
Pediastrum	0.1	1.73	-	-
Other desmids	1.54	0.22	-	1.04
Bacillariophyceae:				
Synedra	0.17	-	-	1.85
Gomphonema	0.65	10.63	0.64	2.61
Navicula	0.96	4.14	3.05	3.29
Fragilaria	-	-	-	0.12
Other diatoms	4.75	-	-	1.35
Cyanophyceae				
Rivularia	-	-	-	0.02
Anabaena	11.85	2.86	-	8.75
Microcystis	3.75	-	-	0.56
Coccochloris	-	-	-	0.44
Gleocaspa	0.10	-	-	-
Synchocystis	-	-	-	0.22
Other blue-green algae	2.48	-	-	-
Euglena	1.68	2.52	-	4.47
Detritus	53.48	51.24	87.12	53.43
Spores	1.45	0.29	3.82	1.38
Vascular plant tissue, plant debris etc.	0.32	-	-	0.89

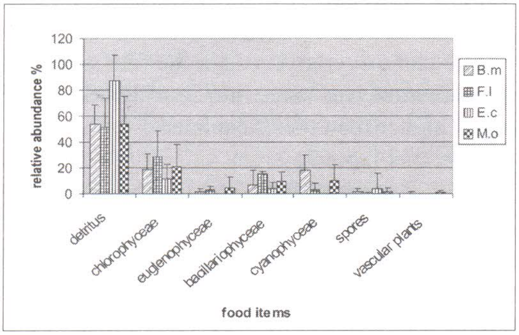

Figure 1. Percent relative abundance (mean ±SD) of food items in the guts of four anuran species tadpoles.

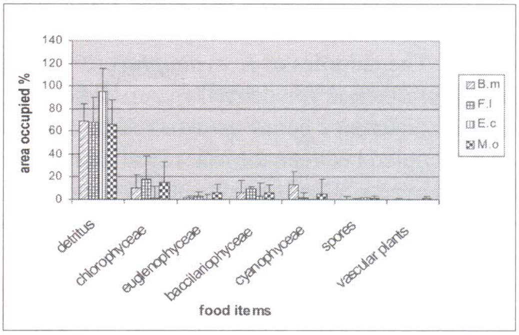

Figure 2. Percent area occupied (mean ±SD) by food items in the guts of four anuran species tadpoles.

Table 2. Significance of differences in percent abundance, percent area, percent frequency of occurrence among different food items in four anuran species, as revealed by one-way Anova and Tukey Test (p = 0.05).

Species	Parameters	'F' value	
Bufo melanostictus	% Abundance	$25.78_{5,60}$	Detritus > all groups Chlorophyceae > spores, Euglenophyceae
	% Area	$73.74_{5,60}$	Detritus > all groups
	% Frequency of occurrence	$21.49_{5,60}$	Detritus > all groups Chlorophyceae > all groups (except detritus)
Microhyla ornata	% Abundance	$24.03_{5,42}$	Detritus > all groups Chlorophyceae > Euglenophyceae, spores
	% Area	$35.86_{5,42}$	Detritus > all groups
	% Frequency of occurrence	$16.38_{5,42}$	Detritus > all groups (except Chlorophyceae) Chlorophyceae > Euglenophyceae, Cyanophyceae, spores Bacillariophyceae > spores
Fejervarya limnocharis	% Abundance	$12.37_{5,48}$	Detritus > all groups Chlorophyceae > Euglenophyceae, spores
	% Area	$40.79_{5,48}$	Detritus > all groups
	% Frequency of occurrence	$15.78_{5,48}$	Detritus > Euglenophyceae, spores, Cyanophyceae Chlorophyceae > Euglenophyceae, spores, Cyanophyceae Bacillariophyceae > Euglonophyceae, spores, Cyanophyceae
Euphlyctis cyanophlyctis	% Abundance	$136.44_{3,20}$	Detritus > all groups
	% Area	$1077.57_{3,20}$	Detritus > all groups
	% Frequency of occurrence	$10.58_{3,20}$	Detritus > all groups

Table 9 presents the niche overlap values between the four tadpoles based on the frequency of occurrence of food items calculated without considering the detrital material. The highest niche overlap was between *B. melanostictus* and *E. cyanophlyctis* and least between *B. melanostictus* and *F. limnocharis*.

Water samples from a few systems where tadpoles were collected for gut content analysis contained a variety of algal and non-algal forms (Table 10). The non-algal forms included rotifers, crustaceans, spores and some nematodes.

DISCUSSIONS

The guts of all four tadpoles were filled with ingested material, indicating that they were continuous feeders, as also shown in several studies on other species (Savage, 1951, 1961; Jenssen, 1967; Warkentin, 1992). The guts of all tadpoles contained a variety of food items. Detritus was the most important food item in terms of percent abundance, percent frequency of occurrence and percent area occupied (Fig.1–3). Detritus has been recognized as a potentially important food resource for a wide variety of aquatic organisms (Baylor and Sutcliff, 1963; Gordon, 1970; Lush & Haynes, 1973; Riley 1963; Ahlgren, 1990b, Ahlgren and Bowen, 1991; Gupta et al., 1994) and is selected intentionally and not ingested incidentally in fish (Ahlgren, 1990a). Quammen & Durtsche (2003) have also reported the predominance of detritus as food in three anuran

Table 3. Percent abundance of food items in coexisting species of anurans.

Food items	**Percent abundance of food items**			
	System I		**System II**	
	Microhyla ornata	***Fejervarya limnocharis***	***Fejervarya limnocharis***	***Euphlyctis cyanophlyctis***
Zygnema	5.08	26.7	-	-
Chlorella	-	-	-	5.37
Penium	0.21	0.56	-	-
Closterium	2.83	7.44	-	-
Staurastrum	2.37	1.78	0.55	-
Cosmerium	0.78	3.44	2.85	-
Euastrum	0.33	0.21	1.67	-
Desmidium	2.51	0.80	-	-
Scenedesmus	0.22	-	-	-
Volvox	2.63	-	-	-
Other desmids	5.39	0.66	-	-
Synedra	1.25	-		
Gomphonema	0.52	15.57	12.89	0.64
Navicula	3.77	0.61	3.22	3.05
Fragilaria	0.13	-		
Other diatoms	8.11	-		
Anabaena	11.81	8.58	-	-
Euglena	0.39	-	1.77	-
Detritus	49.96	32.80	77.05	87.12
Spores	1.71	0.85	-	3.82

Table 4. Percent abundance (mean ± SD.) of food items in different size classes of *Bufo melanostictus* tadpoles.

Algal genera	**SVL = 4–5 mm**	**SVL = 5–6 mm**	**SVL = 7–8 mm**
Zygnema	-	3.08 ± 16.85	15.50 ± 32.84
Volvox	23.87 ± 20.97	29.46 ± 31.23	4.19 ± 16.88
Penium	-	0.69 ± 2.70	-
Closterium	-	-	0.21 ± 1.26
Cosmerium	-	-	0.13 ± 0.80
Pediastrum	-	0.67+3.65	-
Other desmids	-	1.17+4.62	3.16+7.35
Other Chlorophyceae	-	-	1.04+3.76
Synedra			
Navicula	-	0.89+2.90	0.28+1.73
Other diatoms	-	1.38+3.38	0.27+1.47
Anabaena	-	-	1.04+4.93
Euglena	-	2.86+15.66	-
Detritus	1.79+5.24	0.16+0.87	0.24+1.46
Spores	72.29+23.57	55.91+35.73	67.56+32.92
Vascular plant material	2.05+4.62	3.40+9.22	4.42+7.76
plant debris etc.	-	0.33+1.83	1.96+12.09

Table 5. Estimates of Berger-Parker Diversity Index ($^1/_d$=reciprocal form), Brillouin Index (HB), and Niche Breadth (Shannon-Weiner Diversity Index H') in the tadpoles of four anuran species.

Species	$^1/_d$	**HB**	H'
Microhyla ornata	2.513	0.820	0.828
Bufo melanostictus	2.611	0.786	0.791
Fejervarya limnocharis	2.155	0.648	0.657
Euphlyctis cyanophlyctis	1.147	0.225	0.234

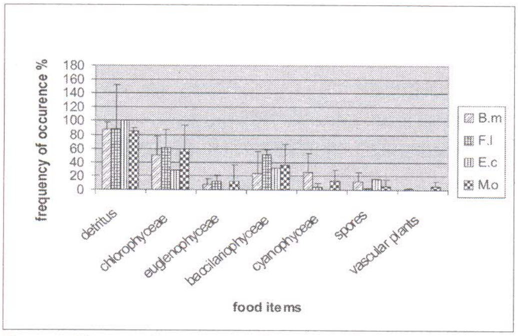

Figure 3. Percent frequency of occurrence (mean ±SD) of food items in the guts of four anuran species tadpoles.

tadpoles, in addition to periphyton (aüfwichs or algal material). However, Jenssen (1967) found *Rana clamitans* was predominantly an algal feeder. In the present study *E. cyanophlyctis* was mostly dependent on detritus for its nutrition. Khan and Mufti (1995) also observed that *E. cyanophlyctis* tadpoles largely fed on detritus presumably because they lived in the bottom of the water bodies.

The four species showed some differences in the relative abundance of different algal groups, with Chlorophyceae and Cyanophyceae more dominant in *B. melanostictus*, Chlorophyceae and Bacillariophyceae in *F. limnocharis,* and Chlorophyceae in *M. ornata*. In contrast, algae comprised a relatively unimportant food item in *E. cyanophlyctis*. Some preference for certain food items were shown, albeit with a fair degree of dietary overlap. Although Euglenophyceae was one of the dominant algal groups in most of the study sites they were not proportionately represented in the guts of tadpoles. Preference for certain food items by the different species cannot be ruled out, although most studies have revealed tadpoles to be indiscriminate feeders (Farlowe, 1928; Jenssen, 1967; Heyer, 1972; 1973; Wassersug, 1972, 1975; Seale and Beckvar, 1980). However, Kamat (1962) also observed the absence of certain algal forms in the guts of anuran tadpoles although they were found in the water.

When feeding propensities of coexisting species in two systems were compared, some preference in choice of food was evident with *F. limnocharis* feeding more on filamentous algae as compared to *M. ornata*, while *E. cy-*

Table 6. Niche overlap (*Ojk* for proportionate abundance of food items without detritus) among the tadpoles of four anuran species.

	B. melanostictus	**F. limnocharis**	**E. cyanophlyctis**
Microhyla ornata	0.721	0.500	0.902
Bufo melanostictus		0.361	0.969
Fejervarya limnocharis		-	0.365

Table 7. Niche overlap (*Ojk* for proportionate abundance of food items with detritus) among the tadpoles of four anuran species.

	Bufo melanostictus	**Fejervarya limnocharis**	**Euphlyctis cyanophlyctis**
Microhyla ornata	0.978	0.934	0.996
Bufo melanostictus		0.919	0.999
Fejervarya limnocharis		-	0.979

Table 8. Niche overlap (*Ojk* for proportionate abundance of food items without detritus) among the tadpoles coexisting in the same freshwater system. *Microhyla ornata* and *Fejervarya limnocharis* and *Fejervarya limnocharis* and *Euphlyctis cyanophlyctis* were found to coexist in two different freshwater systems, respectively.

	Fejervarya limnocharis	**Euphlyctis cyanophlyctis**
Microhyla ornata	0.518	-
Fejervarya limnocharis	-	0.436

Table 9. Niche overlap (*Ojk* for frequency of occurrence of food items without detritus) among the tadpoles of four anuran species.

	Bufo melanostictus	**Fejervarya limnocharis**	**Euphlyctis cyanophlyctis**
Microhyla ornata	0.496	0.731	0.942
Bufo melanostictus		0.400	0.972
Fejervarya limnocharis		-	0.439

Table 10. Percent composition of organisms found in water of five different freshwater systems. Sites 1-4 are permanent ponds, while Site 5 is a temporary pool.

Organisms	Percent abundance of organisms				
	1	2	3	4	5
Chlamydomonas	6.61	-	-	-	2.90
Chlorella	0.88	11.76	6.73	1.09	-
Volvox	3.96	-	4.48	3.26	17.39
Eudorina	-	-	1.49	1.09	-
Pandorina	1.32	-	-	-	-
Chaelopaltis	-	-	-	1.09	-
Spirogyra	-	-	-	-	-
Zygnema	1.76	1.96	-	-	2.87
Closterium	-	29.41	60.44	66.30	60.87
Coelastrum	1.76	-	-	-	-
Penium	-	-	-	1.09	-
Netrium	-	1.96	0.75	-	1.45
Pediastrum	-	1.96	-	-	-
Scenedesmus	0.44	3.92	-	-	-
Gomphonema	-	5.88	-	1.09	1.45
Gomphoneis	-	1.96	-	-	2.90
Nitzia	-	1.96	-	-	-
Fragilaria	0.44	7.84	1.49	2.17	1.47
Navicula	-	3.92	-	-	-
Synchococcus	0.44	-	-	-	-
Gleomonas	-	-	0.75	-	-
Euglena	61.67	11.76	20.9	17.39	2.90
Crustacea	1.76	-	0.75	5.43	5.80
Rotifera	1.76	1.96	1.49	-	-
Nematoda	-	-	0.75	-	-
Spore	17.20	13.75	-	-	-

anophlyctis depended more on detritus than *F. limnocharis*. Khan (1998) also showed *F. limnocharis* to be a macrophagus rasper as well as a microphagus plankton feeder. Evidence for food selectivity among the different size classes of tadpoles of the same species is also apparent from the fact that while the larger *B. melanostictus* tadpoles fed more on filamentous algae, the smaller tadpoles fed more on nonfilamentous forms, like volvox, albeit with some degree of overlap (Table 4).

The feeding behaviour of the four species also ensured some spatial habitat separation. While *B. melanostictus* tadpoles preferred to graze on the roots of aquatic plants, rocks and weeds at the peripheral area of the ponds, the tadpoles of *M. ornata* and *F. limnocharis* remained scattered, floating and suspended in clear water. The tadpoles of *E. cyanophlyctis* were typically bottom dwelling (Khan and Mufti, 1995).

Estimates of food diversity based on the reciprocal form of the Berger-Parker Diversity Index as well as Brillouin Index reveal that food diversity was relativity high in *M. ornata* and *B. melanostictus* tadpoles, while it was lowest in E. cyanophlyctis. The number of algal genera ingested was also the highest in *M. ornata* followed by *B. melanostictus*. *E. cyanophlyctis* ingested few algae. The niche breadth of *M. ornata* was greater than that of *B. melanostictus* in a study conducted in Thailand (Sakaerat Experiment Station). However, niche breadth values for these two species recorded in the present study were higher than those recorded in the Thailand study (Heyer, 1974). Inger et al. (1986) studied the niche breadths of a tadpole assemblage in Borneo and recorded a niche breadth range of 1.0–4.67. After converting the $\log_{10}$ values used while calculating Shannon-Weiner Index in the present study to natural logarithm, the values ranged from 0.539–1.91, thereby indicating that the tadpoles had a much narrower niche breadth when compared to those recorded in Borneo. The much greater microhabitat availability in the rainforest streams of Borneo as compared to that in Barak Valley was probably responsible for the observed difference. The niche overlap estimates revealed some interesting differences when detritus was included or excluded. The preponderance of detritus in the food of all the species resulted in high overlaps among them (Table 7). In contrast when only algal genera and spores were taken into account, the overlap values were considerably low between *B. melanostictus* and *F. limnocharis*, *F. limnocharis* and *E. cyanophlyctis* and *M. ornata* and *F. limnocharis*. Thus, detritus being an abundant resource could probably be exploited by all the species without any need for trophic niche separation. In contrast, some degree of niche separation in terms of algal feeding was exhibited (Table 6). This contention is further supported by low overlaps between *M. ornata* and *F. limnocharis,* and *F. limnocharis* and *E. cyanophlyctis* when niche overlaps excluding detritus were estimated in coexisting tadpoles of these species (Table 7). When niche overlaps based on frequency of occurrence were computed, somewhat similar results were obtained with low overlap between *F. limnocharis* and *E. cyanophlyctis* tadpoles which were found to coexist in the present study.

Zooplankton and microcrustaceans were not detected in tadpole gut. Several workers have reported the presence of these organisms in the guts of anuran tadpoles (Jenssen, 1967; Khan and Mufti, 1994; Khan, 1996, 1998). In the present study rotifers, crustaceans and nematodes were found to be present in the water samples, but were not fed upon by the tadpoles.

The present study shows that these tadpoles are herbivore-detritivores with a fair degree of dependence on detrital food and some degree of interspecific differences in choice of food items. They also exhibited spatial habitat separation, due to choice of different microhabitat. A certain degree of selective feeding on different algal genera was also observed with low dietary overlaps between certain species. Hence, the contention that anuran tadpoles are nonselective algal feeders (Jenssen, 1967; Heyer, 1972, 1973; Wassersug, 1972, 1975; Seale and Beckvar, 1980) needs to be reviewed in the light of the present study, which indicates that tadpoles may exhibit some selectivity in algal feeding. The energy obtained from detritus also needs to be analysed.

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PRELIMINARY SURVEY OF *INDOTESTUDO TRAVANCORICA* (TESTUDINIDAE) AT THE INDIRA GANDHI WILDLIFE SANCTUARY, SOUTHERN INDIA

(with two text-figures)

The Travancore tortoise, *Indotestudo travancorica* is endemic to the Western Ghats of India (Boulenger, 1907; Groombridge et al., 1983; Frazier, 1989; Das, 1991). Earlier synonymised with the Sulawesi tortoise *Indotestudo forstenii* by Hoogmoed and Crumly (1984), *I. travancorica* was resurrected as a separate species (Pritchard, 2000; Iverson et al., 2001). Though considered 'Vulnerable' (IUCN, 2004), information on its distribution and natural history is scanty (Groombridge et al., 1983; Frazier, 1989; Bhupathy and Choudhury, 1995; Molur and Walker, 1998). Literature available states that it is found in rocky biotopes, close to streams in the tropical moist deciduous, semi-evergreen and wet evergreen forests of the Western Ghats up to ca. 650 msl. It is crepuscular, and inactive animals use leaf litter, tree buttresses and rock clefts for shelter (Vijaya, 1983; Das, 1991; Bhupathy and Choudhury, 1995). Earlier reports mention the presence of this species within the Indira Gandhi Wildlife Sanctuary (Vijaya, unpubl.; editor's note in Frazier, 1989; Das, 1991), and the largest number of *I. travancorica* sightings (n = 7; Moll, 1989) was reported from the Annamalai Hills where the Sanctuary is located. However, no wild tortoises were sighted during a subsequent survey in the same area (Bhupathy and Choudhury, 1995).

This note describes a preliminary survey conducted in the Indira Gandhi Wildlife Sanctuary (IGWLS) in the southern Western Ghats which resulted in the largest number of *I. travancorica* sightings till date (n = 27). The aim of the survey was to confirm the presence of this species in the sanctuary and gather baseline data that would facilitate a detailed study.

First, forest-dwelling people from the Kadar, Malasar and Pulayar tribes were interviewed to identify locations of sightings. Based on this information, the area between Topslip (10°28'N, 76°49E, 750 msl) and Varagaliar (10°25'N; 76°51'E, 600 msl) was surveyed (Fig 1). The survey consisted of unconstrained active searches by 2–7 persons along seasonal streams and marshes (known as *vayals)*, between 1000–1900 h, from 1 May to 24 June 2002. Visual cues such as trails (narrow, well-worn paths) or footprints (in marshy areas) and bitten leaves were also used to locate individuals. All individuals captured were temporarily marked with cosmetic nail varnish (Sutherland, 2000) on the underside of the supracaudal scute and on a claw each of the forelimb and hindlimb. Data collected included

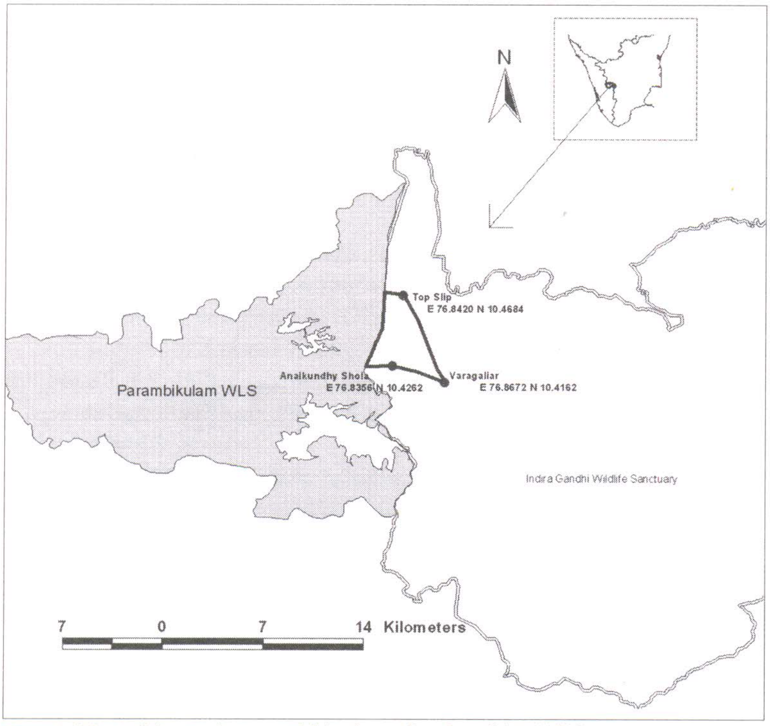

Figure 1. Map of the study area within the Indira Gandhi Wildlife Sanctuary, India.

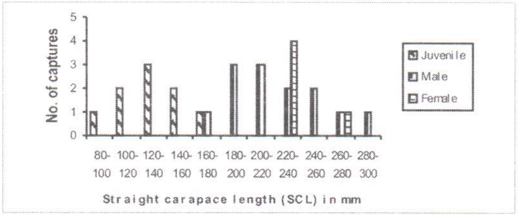

Figure 2. Straight carapace length (SCL) in mm, *Indotestudo travancorica* from IGWLS, May– June 2002.

time of encounter, microhabitat descriptions, activity and morphometrics for all individuals. Male tortoises were identified by their concave plastrons and prominent, hooked tail claws (Auffenberg, 1964; Vijaya, 1983; Das, 1991).

A total of 27 tortoises were captured, with no recaptures, during this survey (Table 1). All tortoises were seen singly – a majority (70%, n = 23) were found between 1700–1830 h and were active (sitting with head out, moving or feeding) at the time of capture (83%, n = 24). Some were found near thickets of *Lantana camara* and *Cromolarium glandulosum* (40%, n = 22), and most (77%, n = 22) were found near vegetation, not rocks. Further, many *I. travancorica* (63%, n = 27) were found at higher altitudes (Karian Shola in Topslip is ca. 750 msl) than previously reported. Tortoises took shelter under thick vegetation or leaf litter during rains, none vocalized (see Auffenberg in Campbell and Evans, 1967).

Table 1. Sightings of *Indotestudo travancorica* from IGWLS, India, May – June 2002.

Locality	Vegetation type	N tortoises
Karian Shola	wet evergreen	17
Anaikundhy	wet evergreen	5
Kozhikamuthy & Sichali	moist deciduous/ teak / vayal	3
Varagaliar	teak / vayal	2

Nine individuals were smaller, lighter, with soft carapaces and transparent edges to the marginal scutes– these were classified as juveniles (Fig 2). Among the adults, 13 were males and five females. The largest male measured 280 mm (SCL) and weighed 3.2 kg, while the largest female measured 264 mm (SCL) and weighed 2 kg (Table 2). The smallest identifiable male (with concave plastron, hooked tail claw) was 160 mm (SCL) and weighed 0.9 kg – this is of interest because the age or size at which sexual dimorphism first develops is unknown and juvenile males may be mistakenly classified as females. All tortoises (n = 27) sighted during this study lacked a nuchal scute and this is a key feature used to distinguish *Indotestudo travancorica* from *I. forstenii* (Pritchard, 2000).

From this survey, it is clear that certain localities in the IGWLS continue to harbour this species. The search techniques using focussed effort on suitable microhabitats and using visual cues to locate tortoises, seem effective. Trails were the most useful cue as they were clearly visible even in dense thickets of *Lantana camara*; these are different from the furrows made by animals burrowing under leaf litter for shelter (Vijaya, 1983; Das, 1991). However, the cues cannot be used to estimate abundance because they could be indicative of any chelonian, and the Indian Black Turtle (*Melanochelys trijuga)* also occurs in the sanctuary. Further, evening searches would boost efficiency since most active tortoises were sighted then and given their cryptic colouration, active individuals can be located easier than inactive ones. Finally, the noise made by many searchers moving around made *I. travancorica* hide or move away– therefore reducing the number of searchers might

Table 2. Morphometric data (in mm and kg) of *Indotestudo travancorica* from IGWLS, India, May – June 2002. *n = 7.

	Males (n = 13)		Females (n = 5)		Juveniles (n = 9)	
	mean ± 1 SD	range	mean ±1 SD	range	mean ± 1 SD	range
Straight carapace length	217.9 ± 33.7	(160–280)	237.4 ± 15.7	(225–264)	129.4 ± 25.3	(98–178)
Straight carapace width	131.5 ± 17.7	(102–166)	136.4 ± 19.1	(106–158)	92.7 ± 10.3	(79–108)
Plastron length	166 ± 20.6	(136–200)	183.5 ± 47.9	(134–260)	104.2 ± 17.7	(79–136)
Plastron width	135.1 ± 21.1	(110–180)	137.8 ± 27.8	(98–175)	84.5 ± 11.94	(69–106)
Shell height	80.5 ± 10.1	(62–98)	85.2 ± 5.6	(76–90)	57.5 ± 5.8	(52–66)
Anal fork	53.5 ± 9.4	(41–72.3)	48.3 ± 8.3	(36.3–56.5)	29.5 ± 8.2	(19.9–40)
Anal notch	43.3 ± 8.2	(30–57.2)	49.2 ± 11.6	(29–57.5)	21.4 ± 8.5	(10–33.8)
Weight	1.9 ± 0.7	(0.9–3.18)	1.9 ± 0.5	(2.04–2.27)	0.75 ± 0.21 *	(0.45–1.14)*

improve efficiency, and reduce inter-observer biases (Freilich and LaRue, 1998).

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ON THE OCCURRENCE OF THE ASIATIC SOFTSHELL TURTLE, *AMYDA CARTILAGINEA* (BODDAERT, 1770), ON SULAWESI, INDONESIA

(with four text-figures)

Sulawesi, in central Indonesia, is home to three species of indigenous, non-marine turtles (Iskandar and Tjan, 1996; Platt, 2006; Vetter and van Dijk, 2006): the widespread Southeast Asian box turtle, *Cuora amboinensis*, the Sulawesi tortoise, *Indotestudo forstenii* and the Sulawesi forest turtle, *Leucocephalon yuwonoi*; the last two endemic to the island. According to Rummler and Fritz (1991), the Sulawesi box turtle population belongs to the nominotypic subspecies *Cuora a. amboinensis* which is abundant throughout the island (Iskandar and Tjan, 1996; A. Koch and E. Arida, pers. obs.). In contrast, the documented ranges of *L. yuwonoi* and *I. forstenii* are restricted to the northern peninsula and parts of central Sulawesi (Iskandar and Tjan, 1996; Iskandar, 2000; Riyanto, 2006; Vetter and van Dijk, 2006). In addition, the red-eared slider, *Trachemys scripta elegans*, an invasive species introduced by pet trade to fresh water bodies nearly all over the world has recently been listed for Sulawesi (Samedi and Iskandar, 2000).

The Asiatic softshell turtle, *Amyda cartilaginea* (Boddaert, 1770) is currently the only recognized species of the genus *Amyda* Geoffroy Saint-Hillaire, 1809 (Iverson, 1992; Fritz and Havaš, 2006; Vetter and van Dijk, 2006). It was removed from the genus *Trionyx* Geoffroy Saint-Hillaire, 1809 by Meylan (1987), who at the same time classified *Trionyx nakornsrithammarajensis* Wirot, 1979 from Thailand as a synonym of *A. cartilaginea*.

The Asiatic softshell turtle shows a typical oriental distribution ranging from extreme eastern India, through Myanmar, Vietnam, Laos, Cambodia, Thailand and the Malay Peninsula, to the Sunda shelf islands of Borneo, Sumatra, Bangka, Belitung, Java, and Bali (Iverson, 1992; Choudhury et al., 2000; Iskandar, 2000; Pawar and Choudhury, 2000; Kuchling et al., 2004; Vetter and van Dijk, 2006). Records from Bangladesh, however, are non existent. Farkas and Ziegler (2002) reviewed the distribution of the species in Vietnam. They confirmed the northernmost-known genuine locality for *A. cartilaginea* as being the Sé Bang Hien (Mekong side) and Kon Tum (coastal Annamite side) records (Fig. 1). The occurrence of the Asiatic softshell turtle in Maluku (Ambon/Ceram) as originally reported by Gray (1855) and subsequently adopted by later authors (e.g., Boulenger, 1889; de Rooij, 1915) remains unconfirmed (CITES, 2004). The record of a specimen from Lombok (NHMB 10626) as illustrated by Iverson (1992) is most probably incorrect. In 1931, the partly albinotic specimen was donated to the Basel collection by Dr. P. Wirz. In the catalogue entry, the locality, Lombok, is followed by a question mark and thus, is doubtful (R. Winkler, pers. comm.). Consequently, in the absence of genuine, recent records from eastern Indonesia, there is no proof that *A. cartilaginea* succeeded in crossing the boundary of the Sunda Shelf, better known as Wallace's Line. However, Iskandar (2000) and Samedi and Iskandar (2000) suggested the occurrence of *A. cartilaginea* on Sulawesi. As this was hitherto unconfirmed, we report here on *A. cartilaginea* for the first time from the Indonesian island of Sulawesi, representing the apparently easternmost locality for this species and the fourth (respectively fifth) non-marine Sulawesi turtle species.

During field expeditions in 2001, early 2005 and summer 2006, several live specimens and some skeletal remains of *A. cartilaginea* were found at a local reptile trader in Palu, the capital of the province Sulawesi Tengah and in the village of Palolo, Kabupaten Donggala, near the northern border of the Lore Lindu National Park (Fig. 1). A photograph taken in 2003 by local inhabitants near the village Palolo confirms our observations (Fig. 2). A nearly adult specimen with a carapace length of ca. 50 cm and a weight of ca. 10 kg was discovered at a reptile trader in Palu in July 2006 (Fig. 3). At the same time, numerous adult and subadult specimens of *I. forstenii* and *L. yuwonoi* were awaiting their shipment for the international pet trade. According to the trader's statement, the specimen of *A. cartilaginea* was not from outside Sulawesi but originated from a lake in Central Sulawesi. However, he could not specify the exact local-

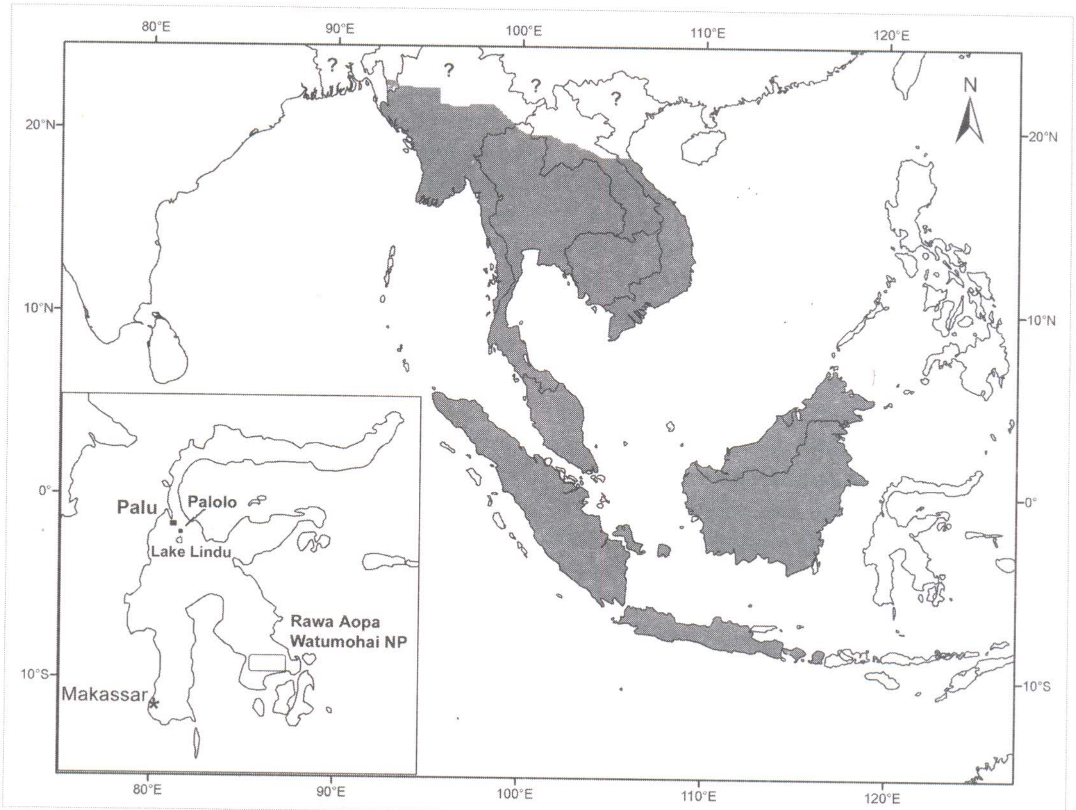

Figure 1. Map of south-east Asia, showing the distribution of *Amyda cartilaginea* (shaded areas) according to Iverson (1992), Choudhury et al. (2000), and Vetter and van Dijk (2006). Insert, map of Sulawesi, showing known localities of *A. cartilaginea* in central Sulawesi Province near Palu. Asterisk indicates the specimen of *Pelochelys* sp. found at a market in Makassar (Ujung Pandang) as reported by A. Rhodin in Webb (2002). Rectangle, south-eastern peninsula, indicates Rawa Aopa Watumohai NP a possible habitat of *A. cartilaginea* as suggested by Wibowo (1999) and Samedi and Iskandar (2000).

ity. Due to its large size and weight, it was not possible to preserve this specimen as a voucher. Digital photographs are deposited in the private collection of the authors and the Zoologisches Forschungsmuseum A. Koenig Bonn, Germany. Nevertheless, there exist two voucher specimens of *A. cartilaginea* originating from Sulawesi in the herpetological collections of the Museum Zoologicum Bogoriense (MZB) and the Louisiana Museum of Natural History (LSUMZ). Specimen MZB Test 257, a juvenile, was collected in Sulawesi Tengah by a trader 20 September 2001. Its carapace is 137.53 mm long and 115.3 mm wide.

Amyda cartilaginea shows great ecological plasticity and inhabits a variety of permanent freshwater bodies. Thus, it is found in lowland rivers, ponds, canals, peat swamps, hill streams, and lakes up to 900 m altitude (Iskandar, 2000; CITES, 2004). The largest lake in the vicinity of Palu and a possible habitat for *A. cartilaginea* is Danau (= Lake) Lindu, located in the Lore Lindu National Park, which is ca. 50 km south-east of Palu. Another permanent freshwater habitat may be Danau Poso, the largest lake of Central Sulawesi. In their listing of Indonesian wetland sites, Samedi and Iskandar (2000) further predict ("not reported but surely present") the occurrence of *A. cartilaginea* for Rawa Aopa Watumohai National Park at the tip of the south-eastern peninsula of Sulawesi (Fig. 1).

Within its entire range, three different phenotypes of *Amyda cartilaginea* are recognized according to van Dijk (1992) and Vetter and van Dijk (2006). These are the "Mainland form" from continental south-east Asia, the "Borneo-Sumatra form" from both these islands (see also Auliya, 2000), and the "Javanese form" from Java. Due to the loss of characteristic features in colouration with increased body size, the

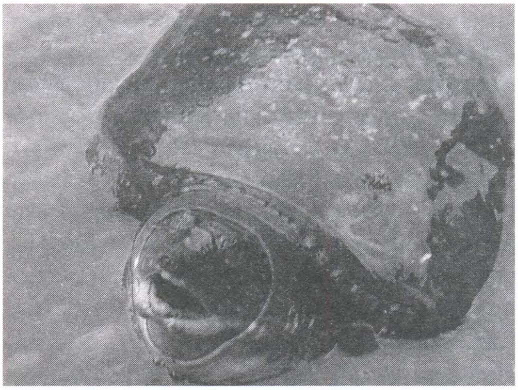

Figure 2. A specimen of *Amyda cartilaginea* taken at a pond near the village Palolo, south-east of Palu, central Sulawesi. Local people regularly trap softshell turtles at this site for food supply.

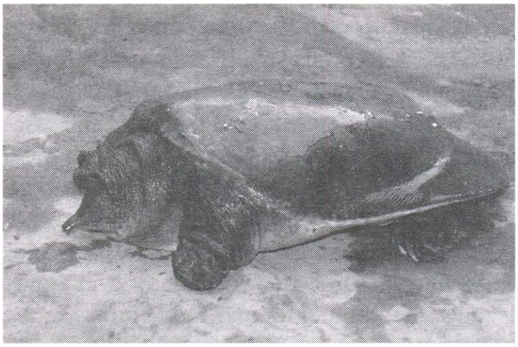

Figure 3. A specimen of *Amyda cartilaginea* at a local reptile trader in Palu. According to the trader, the specimen originated from a lake in Central Sulawesi, possibly Lake Lindu, ca. 50 km south-east of Palu.

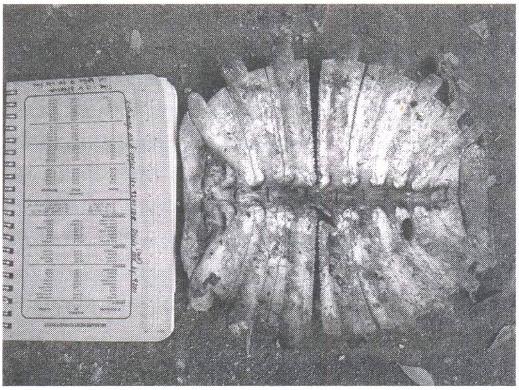

Figure 4. Vertebral column of a subadult softshell turtle (carapace width ca. 20 cm), probably *Amyda cartilaginea*, found in the yard of a house of a Chinese family in the village of Palolo, Kabupaten Donggala, central Sulawesi. The family frequently prepares dishes made from softshell turtle meat.

Sulawesi specimen from 2006 (Fig. 3) can not be assigned to any of the three known phenotypes of *A. cartilaginea* (P. P. van Dijk, pers. comm.). The oval carapace was olive to greenish brown with fading dark streaks. The distal end of the soft carapace displayed a deep cut but the wound had already healed. Yellow dots and longitudinal rows of small tubercles typical for juvenile specimens were lacking. The head was brownish with little dark and yellowish spots. Neck and limbs were unicoloured greyish without any pattern of light dots. Laterally, the neck became orange green to the ventral side which was whitish-grey to flesh-coloured. The plastral colouration in combination with the tail extending beyond the carapace margin and bulging well before the cloaca suggests that the specimen was probably a male (P. P. van Dijk, pers. comm.). In contrast, several adult specimens examined at the trader in Palu in 2001 matched the Bornean form (D. T. Iskandar, pers. obs.). The specimens had the distinct butterfly marking on the first half of the carapace as mentioned by Auliya (2000) or figured in de Rooij (1915:329). In contrast to the aforementioned specimen from 2006, the plastron in these specimens was uniform dark grey or blackish, possibly the only distinguishing character compared to most other populations of *A. cartilaginea* outside Sulawesi.

When visiting Palolo village, south-east of Palu in February 2005, remains of softshell turtles were found in the yard of a Chinese family home (Fig. 4). The family reported that they prepared dishes made from turtle meat, either from *I. forstenii* or softshell turtles, once a week (Ives, 2006). The family's oldest son would trap softshell turtles in a nearby pond for the family's consumption and for sale to other local Chinese cooks. Escorted by the Chinese locals to a nearby pond, a specimen of the Asiatic softshell turtle was observed (I. Ives, pers. obs.). Photographic evidence confirms the existence of *A. cartilaginea* in ponds around the village since at least 2003.

It seems reasonable to suggest that *A. cartilaginea* was introduced to central Sulawesi by human transportation, possibly from the nearest natural occurrence of the species along the east coast of Kalimantan. Public ferries and trading vessels regularly cross the 300 km wide Makassar Strait between Borneo and Sulawesi but even more important is the ship trade with Java or Bali. Therefore, it is more likely that the introduced *Amyda* would have the Javanese characteristics and not the Kalimantan phenotype.

The Makassar Strait, with its deep ocean trench, served as natural barrier for the migration of many Asiatic fauna for at least the last 40 My (Hall, 1998; Moss and Wilson, 1998). This period of long geological isolation resulted in the evolution of a high percentage of endemism on Sulawesi, such as the endemic Geoemydid turtle genus *Leucocephalon*. Although the herpetofauna of Sulawesi is still far from being completely inventoried (Iskandar and Tjan, 1996; Gillespie et al., 2005; J. McGuire, pers. comm.; A. Koch and E. Arida, unpubl. data), the natural occurrence of a large-sized softshell turtle such as *A. cartilaginea* would not have been unnoticed by herpetologists since the exploration of the herpetofauna of Sulawesi started 150 years ago (Bleeker, 1857). However, the discovery of *L. yuwonoi* in the US pet trade as recently as 1986 (described by McCord et al., 1995) proves that even large turtles may be overlooked by scientists (Fritz and Obst, 1999).

Alternatively to a human mediated transportation, it may be worth considering that specimens of *A. cartilaginea* from Kalimantan were flushed out from Mahakam or Kutai rivers which flow into the Macassar Strait opposite Palu bay. After heavy rainfall such large streams transport huge amounts of fresh water, trees and other vegetation onto the open sea (D. T. Iskandar, pers. obs.). Together with the strong, temporary west-east current, these floating islands may serve as natural rafts that facilitated the crossing of Wallace's line and thus the colonization of Sulawesi by Oriental faunal elements in the past (Inger and Voris, 2001; Whitten at al., 2002). With reference to the amphibians and reptiles of Sulawesi, Boulenger (1897) already recognized that there is "… a greater agreement with the Western than with the Eastern islands of the [Indo-Australian] Archipelago, as already pointed out by Peters and Doria [1878]". Moreover, it is known that softshell turtles are tolerant to salt water as most large species occur in estuaries (Iskandar, 2000). Consequently, their successful oversea dispersal does not even depend on natural rafts.

Due to the lack of substantiated evidence for a natural trans-oceanic dispersal over Macassar Strait (but see Gerlach et al., 2006), our observations suggest that specimens of *A. cartilaginea* were introduced to Sulawesi for food supply mainly for the Chinese population who frequently eat softshell turtles and *I. forstenii* (I. Ives, pers. obs.). However, if *A. cartilaginea* was introduced to Sulawesi, one might expect to find the species primarily around Macassar and Manado, the two main ports of Sulawesi. This assumption is substantiated by the occurrence of many introduced species near both these cities (see Iskandar and Tjan, 1996).

At any rate, the assertions of the reptile trader at Palu and the local Chinese people as well as the juvenile voucher specimen suggest that, at least in central Sulawesi, *A. cartilaginea* has established reproducing populations.

The first record of a live softshell turtle in Sulawesi refers to a short communication of A. Rhodin in Webb (2002), who found a specimen of *Pelochelys* sp. in a market in Makassar (Ujung Pandang), the capital of South Sulawesi Province on the south-western peninsula (Fig. 1). This finding of *Pelochelys* in Sulawesi closes the gap of the disjunct distribution of the genus in continental south-east Asia, the Greater Sunda Islands, the Philippines and New Guinea in the east of the Indo-Australian Archipelago (Iverson, 1992). Samedi and Iskandar (2000) had already suggested the occurrence of *P. cantorii* on Sulawesi. Fossil, presumed late Pliocene, trionychid material from Cabenge, Soppeng District, Southwest Sulawesi, ca. 115 km northeast of Makassar had been reported by Hooijer (1954, 1958), which was cited by Whitten et al. (2002) as "*Chitra ?indica*". According to Webb and van Dijk (2004), however, these fossil remains are consistent with *Pelochelys* although an exact determination is impossible. Recent *Pelochelys* records from the Moluccas or the Lesser Sunda Islands are lacking, but may follow in the future.

All these evidences discussed above provide strong evidence for the existence of a second and probably genuine species of softshell turtle on Sulawesi. Nevertheless, transportation by human activities cannot be excluded. Therefore, further fieldwork and morphological as well as molecular studies are required to clarify the origin and taxonomic status of *A. cartilaginea* and possibly other softshell turtles in Sulawesi.

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REJECTION OF AN AUSTRALIAN DISTRIBUTION OF THE SOLOMON ISLANDS AGAMID LIZARD *HYPSILURUS LONGII* (MACLEAY, 1877)

Manthey and Denzer (2006) recently revised the agamid lizard genus *Hypsilurus*, and divided *Hypsilurus godeffroyi* (Peters, 1867) into four species. They restricted *Hypsilurus godeffroyi* to a population purportedly from Micronesia that may be extinct, and resurrected from synonymy the names *Hypsilurus longii* (Macleay, 1877), *Hypsilurus macrolepis* (Peters, 1872) and *Hypsilurus schoedei* (Vogt, 1932) for populations that had been assigned to *H. godeffroyi* by previous authors. The latter three species were considered to have non-overlapping distributions: *H. macrolepis* in the eastern part of the Solomon Islands, *H. schoedei* in the Admiralty Islands, and *H. longii* in the Bismark Archipelago and Bougainville, possibly extending east as far as the Shortland and Treasury Islands.

They included north Queensland in the distribution of *H. longii* on the basis of two specimens: the holotype of *Tiaris longii* Macleay, stated to have been presented to Macleay's collection by "Mr Mark H. Long, of William-street [presumably William Street, Sydney], and ... taken in some part of Northern Queensland" (Macleay, 1877), and a second specimen, newly reported by Manthey and Denzer (2006), in the collection of the Zoologisches Museum, Museum für Naturkunde, Berlin (ZMB 19898, from "Queensland", though stated by Manthey and Denzer, 2006: 16 as "North Queensland").

The provenance of the holotype of *Tiaris longii* has long been doubted (McCoy, 1978; Cogger, 1979; Cogger et al., 1983; Covacevich et al., 1982), as it is geographically highly disjunct from the rest of the distribution of *H. godeffroyi* auctorum. Manthey and Denzer (2006) considered that the ZMB specimen confirmed the occurrence of *H. longii* (and hence the *H. godeffroyi* complex in general) in Australia.

In contrast, I do not accept the accuracy of this second record, and believe it is no more reliable than the nominal type locality.

The ZMB record has no precise locality other than Queensland. It is part of a small collection received from the natural history dealer W. Schlueter, who was based in Halle an der Saale in Germany (R. Günther, pers. comm., 28.iii.2007). On the basis of its registration between entries from 1900 (ZMB 14714, the gap between this register entry and preceding reading "Etatsjahr 1899–1900") and a collection from the Hamburg South-West Australian Expedition of 1905 (ZMB 21299–210307, 21426–21467), described by Werner (1910), I infer that it was registered into the ZMB collection between 1900 and 1910.

I can find no evidence that Schlueter ever visited Australia, and presumably he received the specimen from another source. It is possible that Schlueter was trading in the residue of, or with material previously sold to private German collecters by, the Godeffroy Museum, a company dealing in natural history specimens that operated between 1860 and 1879, and which received collections from both Queensland (collected by Amalie Dietrich from Brisbane, Bowen, Mackay, Rockhampton and Lake Elphinstone between 1863 and 1872, and Eduard Dämel from Port Curtis, Port Denison, Rockhampton, Cape York, Peak Downs and Gayndah between 1860 and 1874) and the Bismark Archipelago (Duke of York Island, New Ireland and New Britain, collected by Franz Hübner and Johann Theodor Kleinschmidt between 1875 and 1881) (Musgrave, 1932; Panning, 1956; Spoehr, 1963; Sumner, 1993). The last of its collections were dispersed between 1884 and 1886 (Panning, 1956).

Hypsilurus species are inhabitants of wet forests, and two species do occur in Queensland: *H. boydii* (Macleay, 1884) from north-east Queensland and *H. spinipes* (Duméril, in Duméril and Duméril, 1851) from south-east Queensland (Covacevich and McDonald, 1993). Both species are well represented in Australian museum collections, and moderately easily located in the field. However, despite extensive herpetological collecting over the past century in Queensland rainforests, no records of any *Hypsilurus* species other than *H. boydii* and *H. spinipes* are to be found in Australian museum collections.

In the absence of any records from reliable collectors with specific localities, the poor collecting data for ZMB 19898, the potential for an erroneous locality to have become associated with this specimen via an intermediary distributor, and the existence of earlier German commercial collections that contained material from both Queensland and the Bismark Archipelago and that could have served as a source of a misapplication of localities, I regard the Queensland locality for ZMB 19898 to be spurious, and continue to exclude Australia from the distribution of *Hypsilurus longii*.

I thank the University of Sydney for providing funds to visit the Zoologisches Museum, Berlin and study its Australian herpetological collections, and Rainer Günther for subsequently providing information on the Berlin specimen and its source.

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REVIEWERS FOR *HAMADRYAD* VOL. 32 & VOL. 33.

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R. Altig, R. Bain, A. M. Bauer, S. Bhupathy, A. C. Captain, P. David, A. de Silva, S. K. Dutta, J. G. Frazier, V. Giri, L. L. Grismer, A. Haas, R. F. Inger, D. T. Iskandar, J. B. Iverson, K. Jackson, A. Leaché, T. M. Leong, B. L. Lim, S. Mahony, U. Manthey, H. Ota, B. Stuart, P. P. van Dijk, V. Wallach, D. Warrell, G. Wogan, A. Wynn and G. R. Zug.

VENOMOUS SNAKES OF ASIA. GIFTSCHLANGEN ASIENS

By Gernot Vogel.
2006. Terralog, Volume 14.
Edition Chimaira, Frankfurt am Main (www.chimaira.de).
148 pp. + 1 folding table.
Hardbound. ISBN 3-89973-364-9. Price: 44.80 €.

This attractive book is an atlas illustrating the terrestrial and freshwater elapids, viperines and crotalines of eastern, southern and south-eastern Asia. It includes a summary and list of taxa (pp:3–6), a short introduction, mainly expressing the taxonomic views of the author on the taxa presented (pp:7–13), and a short list of references (pp:14–16), followed by the main part of the book: a taxonomically/alphabetically-arranged succession of colour pictures of all taxa and respective colour distribution maps (pp:18–148). At the end a folder are captions of symbols associated with the pictures, mainly concerning ecology, and also brief indications for captive care. The book has been printed on solid glossy paper, with good quality hardbound. The main text is presented both in English and German; picture and map captions are given in English only. Common names in these two languages are given for each taxon.

Taxonomic opinions of the author are conservative, and may be unacceptable for some readers concerning the non-recognition of the splitting of the genus *Trimeresurus* as recently proposed by Malhotra and Thorpe (2004), while it is true that this latter arrangement needs refinement. The author, though, follows the synonymization of various taxa under *Calliophis maculiceps* by Cox (2000); fortunately, several colour morphs are presented, stressing the surprising heterogeneity for a single taxon and will hopefully encourage some authors to investigate further.

Each of the 168 presented taxa is illustrated by one or more high-quality colour pictures – there are in total 532! Only 11 taxa (ca. 7%) could not be illustrated in life (*Bungarus lividus*, *Calliophis beddomei*, *C. bibroni*, *C. b. bivirgatus*, *C. gracilis*, *C. intestinalis philippinus* and *C. i. suluensis*, *Ceratrimeresurus shenlii*, *Ovophis monticola zhaokentangi*, *Tropidolaemus huttoni* and *Vipera renardi tienshanica*), but they are shown through pictures of preserved museum specimens. And among these, *Ceratrimeresurus shenlii* is, as stressed by the author, most probably synonymous with *Protobothrops cornutus*, a species abundantly illustrated alive in the book. Many picture captions give detailed and interesting localities. An excellent point for the book is that for many of the species a typical biotope picture is provided.

Maps give sometimes approximative but mostly accurate ranges. No map was unfortunately provided for *Sinomicrurus kelloggi*, *Trimeresurus* "sp. A", nor for *Macrovipera lebetina cernovi*. The case of *Ovophis monticola orientalis* is more unfortunate: although the range of this taxon indeed appears in green on the map of page 70, its name does not appear in the caption of the map. The distributions of *Naja sputatrix* and *N. sumatrana* are shown on the same map (p. 47), but the caption is mixed up: the distribution indicated as that of *N. sputatrix* is the one of *N. sumatrana* and vice and versa. The caption for the distributions of *Protobothrops elegans* and *P. flavoviridis*, shown together on the same map on p. 76, is incomplete: the red colour refers to the first and the yellow to the latter. The distribution range of *Sinomicrurus m. macclellandi* should be corrected according to the data provided by Nabhitabhata et al. ("2000" 2004); more recently the species was even found as far southwest as Phetchaburi Province in the Thai Peninsula (Pauwels and Chan-ard, 2006). Since the book was printed, a record of *Popeia fucata* from Phetchaburi Province was published (Pauwels and Chan-ard, 2006), extending its range northwards. The locality indicated in the caption of the first picture of *Echis carinatus multisquamatus* (p. 144), "Southeast Turkmenia", is largely outside the range shown for this taxon on the map p:143. The presentation of several species ranges on a single map makes that the map and the picture of a given species are sometimes far from each other, and there is no reference to the pages were they are shown. The *Ophiophagus hannah* depicted on p:50 (photo RS00901-4), indicated as originating from Thailand, is more precisely a captive-born issued from parents caught in Phetchabun Province in central Thailand (Chanhome, pers. comm.).

I could detect only one misidentification. A "*Trimeresurus kanburiensis*" illustrated on p:98 (photo. RS02572-4) presents all characters typical of *T. venustus* (internasals in contact, 12 cephalic scales, unkeeled occipitals, bottle-green colour with reddish-brown crossbands, etc.) and out of the known variation range for *kanburiensis*. Both species were erroneously regarded as synonyms by many authors for a number of years, although well distinct. Vogel (pers. comm.) indicated us that the picture is older than the clarification of the characters separating *venustus* from *kanburiensis* published by David et al. (2004), and that the locality "Kanchanaburi Province", still the only locality known for *kanburiensis*, might have been automatically added to the picture that was still labeled under *kanburiensis*. This individual actually most probably originates from southern Thailand.

Only two references mentioned in the text are not listed in the literature cited: Lenk et al. (2001) and Liang and Liu (2003); the first is listed here below. The second, referring to the authorship of *Ceratrimeresurus shenlii*, is actually included in Liang (2003). The complete authorship for the latter species is thus "Liang & Liu *in* Liang, 2003". The gender of the genus *Calliophis* being masculine, the epithets "*bivirgata*", "*tetrataenia*", "*bilineata*", "*lineata*", "*philippina*" should be accorded and thus end with "*-us*". At the contrary, *Calliophis* "*melanurus*" should be corrected to *Calliophis melanura*, the latter word being a noun in apposition meaning "black tail". The nominal form of the Russell's Viper is written *Daboia russellii russelii*, thus alternating spellings with one or two "*l*". The current agreement is however to spell it *russelii* (Adler et al., 2000). The caption folder gives the caption but not its symbol for the protected species; this symbol, a stop sign, is however put at the right place under the pictures of these species (*Naja* spp. and *Ophiophagus hannah*).

Most interestingly, several species undescribed when the book was printed are illustrated. Among them a colourful *Calliophis* cf. *intestinalis* from the Cameron Highlands and "*Trimeresurus* sp. A", "sp. B" and "sp. C". *Trimeresurus* "sp. C" from Pulau Tioman in West Malaysia was since described under *Popeia buniana* (Grismer et al., 2006). The *Calliophis*, the *Trimeresurus* sp. A (probably a *Cryptelytrops*) and *Trimeresurus* sp. B (also more recently illustrated by David et al., 2006, with scalation details; a member of the genus *Parias*), are still undescribed to date.

The few mistakes noted above, as well as a few minor misspellings, are only little criticisms. The opus is indeed highly valuable for all herpetologists and nature lovers who want to have an excellent idea of the diversity of this fascinating group of animals. Such a high quality book was in fact expectable from an author who recently contributed other remarkable books on southeast Asian snakes, and who is actively involved in the research on the systematics and biology of Asian snakes; he indeed (co-)described not less than five of the species presented in the book. I strongly recommend the purchase of this book for all herpetological and natural history libraries.

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