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Front cover: Stout sand snake (*Psammophis longifrons*). New Panvel,Maharashtra State, India. Malcolm Smith says "of considerably stouter build than the other Indian members of this genus". Definitely so. Brown above, scales of the vertebral region edged with black; top of head uniform brown; white underside. Tongue brown. A quick, alert snake- upon release went under leaf litter. Gentle, made no attempt to bite while we were photographing it. Photo and text: Ashok Captain/Indian Herpetological Society (Fuji Velvia 50 ASA, pushed to 40); Nikon F5 with a 60 mm, 2.8 AFD Macro-Nikkor and SB-21B flash unit).

Back cover: Doria's angle-headed lizard (*Gonocephalus doriae*). Gunung Gading National Park, Sarawak, Malaysia (Borneo). Found on a liana, within a lowland dipterocarp forest in the granitic massif of Gunung Gading, in western Sarawak, this is an endemic of Borneo. Generally slow-moving, arboreal and insectivorous. Dorsum emerald green, changeable to brown when stressed. Photo and text: Indraneil Das (Fuji Velvia 50 ASA); Nikon F5 with a 105 mm, 2.8 AFD Macro-Nikkor and SB-29 flash unit).

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THE AMPHIBIAN FAUNA OF A FORESTED AREA IN TEMENGOR, PERAK, MALAYSIA, WITH THE FIRST RECORD OF *PHILAUTUS PARVULUS* (BOULENGER, 1893) IN THE MALAY PENINSULA

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ABSTRACT.– **An amphibian survey was carried out in a logging concession in Temengor Forest Reserve, Hulu Perak, Perak Darul Ridzwan, Peninsular Malaysia, documenting 26 species of frogs in five families. Among the species identified in the concession was *Philautus parvulus*. This species was previously known only from Myanmar, Vietnam and Thailand, with Chiang Mai Province, Thailand, being its southernmost locality. Thus, this is the first record of this species, not only in Peninsular Malaysia, but in the Tenasserim-Malay Peninsula biogeographical region. Other species of herpetofauna documented include an adult *Gonocephalus abbotti* and anecdotal evidence of *Tomistoma schlegelii*. This paper discusses briefly some of the threats faced by the amphibian fauna in the area, especially the widespread and uncontrolled harvesting of *Limnonectes blythii* (Boulenger, 1920). Also included in this paper are some Jahai (Orang Asli or aboriginal) names for some of frog species encountered, to aid future fieldwork in this area.**

KEYWORDS.– **Amphibians, *Philautus parvulus*, trade, harvesting, *Tomistoma schlegelii*.**

INTRODUCTION

The Perak Integrated Timber Complex (PITC) logging concession is located in Hulu Perak, Perak Darul Ridzwan, northern Peninsular Malaysia. Logging in the concession began in 2001, and currently the concessionaire is attempting to attain Forest Stewardship Council certification. As part of this process, PITC commissioned a study of the concession's biodiversity, to inventory species in the area and to formulate management and operational recommendations for the logging company that will minimize the impact timber extraction on biodiversity and maintain the integrity of as much as possible of the area as viable habitat for a broad range of flora and fauna. This paper is a report of the findings of the herpetological (amphibian) component of the study. No herpetological studies have been previously carried out in the immediate area of the concession. However, two inventories have been carried out in the greater Belum-Temengor forest area, one in Belum (Kiew et al., 1995) and one in Temengor (Norsham, et al. 2000).

LOCATION

The PITC concession is located between 05º 24' 40" to 05º 34' 15" N and 101º 33' 00" to 101º 39' 30" E. This 9,765 hectare area is part of the larger Temengor forest, which lies south of the proposed Belum Protected Area. The concession comprises mostly primary lower and upper hill mixed dipterocarp forest, though there are areas dominated by bamboo.

The survey focussed on the northern part of the concession, a 1,500 ha. area, where logging operations have recently begun. The major river draining this area is Sungei Jelud, which flows in a generally east-west direction, just on the northern border of the concession. Numerous small streams from the surrounding hills feed into this river. Both the larger rivers as well as the smaller streams, their associated floodplains, and the hill slopes and ridges formed the core habitats surveyed.

Elevation in the concession ranges from 500 m to over 1,000 m, but most of the surveying was confined to areas between 500 m and 800 m.

TIME AND SEASON

The survey was conducted during two periods, 11-17 December 2001, and 26 January to 1 February 2002. The first period coincided with the beginning of the rainy season, i.e. the Northeast Monsoon, which arrived late during the year, and, as such, continuous, heavy rain was experienced throughout most of this time. The second period coincided with the tail end of the monsoon, and was mostly dry, though small, scattered showers were experienced.

METHODOLOGY

The surveys were carried out with the primary purpose of producing a qualitative (presence/absence) species inventory. Walking surveys were conducted at night, using both headlamps and hand-held flashlights, during both survey periods, in a range of habitat types (see below). Field assistance was provided by Orang Asli (aborigines) of the Jahai group, who along with the Temiah group, are native to the area.

Habitats were classified into four broad types:

(a) Small streams and creeks.- These were streams smaller than 5 m in width. Usually they were fast-running, located on steep hill slopes leading into larger river valleys. The bottom were mixtures of sandy gravel and boulders.

(b) Larger streams and rivers.- These were much bigger rivers (approaching 10 m) - Sungei Jelud and Sungei Mangga. They were fast-running, with many large boulders, and a substrate consisting of small rocks and sand.

(c) Floodplains.- These were located around the two large rivers mentioned above, consisting of flat areas with a closed forest canopy and typical floodplain vegetation understorey. There were many signs of ephemeral streams (i.e., stream tracks) on the ground.

(d) Hill slope and dry land forests.- These were hill slopes leading down to the larger stream valleys, quite a distance away from any significant water body.

Due to the lack of adequate pre-operation habitat documentation and analysis, and lack of background information that would allow such an analysis to be carried out, a finer-grained mapping of habitats was not possible. Given this, it was decided that the primary aim of the survey methodology was to produce a comprehensive *in-situ* inventory of the amphibians in the concession area, as opposed to a more rigorous survey involving equal search-effort in representative sample habitat types in both logged and unlogged areas with the aim of producing a valid amphibian *alpha*- and *beta*-diversity analysis.

Amphibians were located both visually and acoustically, and were identified on the basis of both their calls and morphological features. In most cases, recognition by call provided the easiest and most accurate identification, since calls always present an unambiguous identification of the species if the observer is familiar with them, and can be recorded at a distance. Identification by morphological characters requires, of course, visual inspection, and this was done by tracking down animals based on their eye shine or their calls, if they were calling. Wherever possible, individuals of each species encountered for the first time were collected for close inspection, and identities were confirmed using standard references applicable to the region (e.g. Boulenger, 1912; Smith, 1930; Berry, 1975; Taylor, 1962; Inger, 1966).

Taxonomic arrangement and nomenclature generally follows Frost (2000), with two exceptions:

- *Megophrys nasuta* (Schlegel, 1837): Frost considers *Megophrys nasuta* (Schlegel, 1837), a subspecies of *Megophrys montana* Kuhl and Van Hasselt, 1822. Here, however, following Taylor (1962), it is treated as a full species.
- *Rana chalconota raniceps* (Peters, 1871): Frost considers *Rana chalconota raniceps* (Peters, 1871) a full species, *Rana raniceps* (Peters, 1871). Here I consider it a subspecies, *Rana chalconota raniceps* (Peters, 1871), following Inger (1966).

Physical voucher specimens were only collected for one species (*Philautus parvulus*), and arrangements are being made to deposit these at the Field Museum of Natural History, Chicago. In all other cases, where possible, photographic and audio-recording vouchers were made. Some of these will be made publicly available through the internet (http://frogweb.org/).

TABLE 1: Amphibian species identified at the PITC Concession, Temengor Forest, Perak, West Malaysia. [1]Habitats: SS = Small Streams; LS = Large Streams; FP = Floodplains; HS = Hill Slopes; O = Other (see text for details); [2]Identification: V = Visual inspection; A = Acoustic recognition (i.e. through vocalization); [3]Verification: P = Photographic voucher; A = Audio recording; S = Specimen collected; *Range extension of this species. See text for details.

Species	Habitats[1]	Identification[2]	Verification[3]
Bufonidae			
1. *Bufo asper* Gravenhorst, 1829	SS, LS, FP, O	A, V	P
2. *Bufo parvus* Boulenger, 1887	SS, FP	A	A
3. *Leptophryne borbonica* (Tschudi, 1838)	SS, LS	A, V	P
4. *Pedostibes hosii* (Boulenger, 1892)	LS	A, V	A, P
Megophryidae			
5. *Leptolalax heteropus* (Boulenger, 1900)	SS, LS, FP	A, V	A, P
6. *Megophrys nasuta* (Schlegel, 1837)	SS, FP, HS	A, V	A, P
7. *Xenophrys aceras* (Boulenger, 1903)	O	V	P
Microhylidae			
8. *Microhyla butleri* Boulenger, 1900	O	V	-
9. *Microhyla heymonsi* Vogt, 1991	O	A, V	A
Ranidae			
10. *Amolops larutensis* (Boulenger, 1899)	LS	A, V	P
11. *Fejervarya limnocharis* (Boie, 1835)	HS, O	V	-
12. *Limnonectes blythii* (Boulenger, 1920)	SS, LS	A, V	P
13. *Limnonectes kuhlii* (Tschudi, 1838)	SS	V	P
14. *Limnonectes laticeps* (Boulenger, 1882)	SS	A, V	P
15. *Limnonectes plicatellus* (Stoliczka, 1873)	SS, HS	A	A
16. *Rana* cf. *baramica* Boettger, 1903	FP	A	A
17. *Rana glandulosa* Boulenger, 1882	FP, O	A, V	P
18. *Rana hosii* Boulenger, 1891	LS	A, V	P
19. *Rana nigrovittata* (Blyth, 1856 “1855”)	SS, FP, HS, O	A, V	P
20. *Rana chalconota raniceps* (Peters, 1871)	SS, LS, O	A, V	-
21. *Rana signata* (Günther, 1872)	SS	A, V	P
Rhacophoridae			
22. *Nyctixalus pictus* (Peters, 1871)	FP	A	-
23. *Philautus parvulus* (Boulenger, 1893)*	HS	A, V	A, P, S
24. *Polypedates leucomystax* (Gravenhorst, 1829)	O	A, V	-
25. *Rhacophorus nigropalmatus* Boulenger, 1895	O	V	P
26. *Rhacophorus prominanus* Smith, 1924	O	V	P

RESULTS

During the field surveys, 26 species of amphibians in 14 genera and five families were documented. The results are presented below, in Table 1, along with indications of the habitat types in which they where encountered, as well as basis for identification and types of documentary verification.

Bufonidae

Bufo asper Gravenhorst, 1829

This species was found in large numbers along the major streams and rivers, and were calling throughout both survey periods. A few individuals were also encountered in the floodplains of the larger rivers, and, sometimes a stray young male would be found on the logging road. The

Jahai call this frog "rengkong", probably an onomatopoeic term based on its call.

Bufo parvus Boulenger, 1887

This species was very vocal during the first survey, i.e., during the rains. During the second survey, very little sign of them was evident, except in the evenings after or during a shower. The Jahai call this frog "behuh".

Leptophryne borbonica (Tschudi, 1838)

These were found along the banks of both the smaller and larger streams, and were especially abundant in places where the bank was relatively flat and sandy. They were very vocal during the drier survey period, and were markedly less so during the wetter period.

Pedostibes hosii (Boulenger, 1892)Numerous individuals were found on branches of trees overhanging or next to the larger rivers (e.g. Sungei Jelud). There appeared to be more in evidence during the second, drier, survey period than the first. The Jahai call this frog "berngok".

Megophryidae

Leptolalax heteropus (Boulenger, 1900)

These small megophryids were quite abundant during the second survey period, and were encountered advertising from the leaves and branches of vegetation along many of the streams and rivers. They were found as low as 500 m above sea-level in elevation, thus confirming the findings of Dring (1979) and Kiew et al. (1995) that this species is not limited to higher altitudes.

Megophrys nasuta (Schlegel, 1837)

The distinctive calls of this species – loud, explosive 'henks' or 'honks', were documented throughout both survey periods, with a conspicuous increase in calls noted whenever it rained. A classic species of the forest-floor leaf litter, numerous individuals were located in many different parts of the concession. The Jahai call this frog "kengkang", definitely an onomatopoeic term based on its call.

Xenophrys aceras (Boulenger, 1903)

Two individuals of this species were documented, one each during each study period. Both were observed at the side of the main logging road, one at about 550 m, while the other was found at about 800 m. The Jahai call this frog "wugwak" if it is reddish, though this might possibly be a reference to *Xenophrys leptopus* (Boulenger, 1886 "1885") if at higher altitudes; otherwise, they call it "kaltup", apparently considering it a different species.

Microhylidae

Microhyla butleri Boulenger, 1900

Tadpoles of this species were collected from a large pool of collected rainwater off the side of the main logging road during the second survey. The tadpoles were of the mid-water type (deep-bodied), with a broad head, widely-spaced eyes, and dorsally-placed nostrils. The tails had high upper and lower crests, that tapered sharply at the end to a slender, narrow tip. Bodies were translucent with fine speckles, with a reddish coloration on the tail crests. Identification was with reference to Smith (1930), with the assistance of Dr. Peter Paul van Dijk.

No adults were documented during either survey.

Microhyla heymonsi Vogt, 1991

Choruses of these were regularly heard around the base camp area during both surveys, and several were located visually after searches.

Ranidae

Amolops larutensis (Boulenger, 1899)

The bigger rivers had many individuals of this species, characteristically clinging on to rocks in the middle of the torrent. The Jahai call this frog "kashing".

Fejervarya limnocharis (Boie, 1835)

Encountered in small numbers along the main logging road and around the logging camp.

Limnonectes blythii (Boulenger, 1920)

Relatively fewer individuals of this species were encountered, though these few were generally of tremendous size. At least four individuals measuring from 230 to 255 mm were observed along one of the larger rivers (Sungei Jelud) in one night. During the second survey period, two pairs were observed in courtship. The Jahai call this frog "segnuk", and it is heavily harvested by them, and others, for sale for consumption.

Limnonectes kuhlii (Tschudi, 1838)

This species was encountered in pools of small, clear streams with sandy or gravel bottoms. It was very difficult to approach them, as they would dive into the water and swim off with the slightest provocation, usually burying and hiding themselves in the gravel. However, as with most frogs, if left for a while, they would soon return to their station in the middle of the pool. The Jahai call this frog "peht".

Limnonectes laticeps (Boulenger, 1882)

This species was common along streams flowing down many of the steeper slopes in the area. Their distinctive calls, likened to a bottle being filled, were heard during both survey periods. The Jahai call this frog "kahweh".

Limnonectes plicatellus (Stoliczka, 1873)

The distinctive calls of this species were recorded at one location – a waterlogged gully beside a stream off the main logging road near the camp – and only during the first survey. Despite targeted searches in the area during the second survey, no sign of them was found.

Rana cf. *baramica* Boettger, 1903

The high-pitched "yip-yip-yip-yip" calls of this species were noted during both surveys, mostly in the floodplain of Sungei Jelud.

Rana chalconota raniceps (Peters, 1871)

This species was found on vegetation by both the smaller and larger rivers. The Jahai call this frog "charai", though the term seems to be applied equally to any green riverine frog (e.g., *Rana hosii* Boulenger).

Rana glandulosa Boulenger, 1882

The resonant "wahk-wahk-wahk-wahk" calls of this species were noted during both surveys in the patch of waterlogged area near the bridge over Sungei Jelud. During the first survey, a non-advertising individual was collected from behind the base camp. The Jahai call this frog "beruong".

Rana hosii Boulenger, 1891

This species, along with *Bufo asper*, was probably the most commonly encountered species in and along the larger rivers (e.g., Sungei Jelud). Males were advertising during both survey periods.

Rana nigrovittata (Blyth, 1856 "1855")

This species was observed in various places – in silt traps, in the logging camp latrines, in the waterlogged area near the Sungei Jelud bridge, etc. Interestingly, they were also observed calling from ditches in the town of Grik, though they are not normally considered a commensal species. They were heard advertising during both survey periods, but there were considerably more apparent during the second period. The Jahai call this frog "pohahk".

Rana signata (Günther, 1872)

This species was observed along the smaller streams, but was absent from the larger rivers. They were observed calling during both survey periods.

Rhacophoridae

Nyctixalus pictus (Peters, 1871)

The single-note, monotone whistle call of this species was noted twice, from two different locations in the Sungei Jelud floodplain, during the first survey.

Philautus parvulus (Boulenger, 1893)

As both Taylor (1962) and Dring (1979) noted, there is a possibility- and there have been instances- of confusing *Philautus parvulus* (Boulenger, 1893) with *Philautus petersi* (Boulenger, 1900). Taylor (1962) provided a comparison of the two species, and noted several characters that distinguish *Philautus parvulus* from *Philautus petersi*. Dring (1979) engaged in a similar exercise using material collected by Smith in Thailand and Cambodia, and suggested that the Thai and Cambodian specimens which Smith identified as *Philautus petersi* may actually be *Philautus parvulus*.

The most important of the characters that distinguish the two species are summarized below, in table 3, and characters from the specimens collected from Temengor during the surveys are compared against them. As can be seen, the characters of the specimens from Temengor agree with those given for *Philautus parvulus* rather than *Philautus petersi*.

More significantly, apart from the morphological evidence, the calls of the frogs collected in Temengor differ from that of *Philautus* *petersi*, as observed and recorded at Genting Highlands (Sukumaran, unpubl. obs. 2001-2002). The Temengor specimens, all of which were tracked down while vocalizing, had a high-pitched staccato 'pik-pik-pik' call, with distinct periods between each note. *Philautus petersi*, on the other hand, has a raspy, insect-like trill.

Given the difference in the calls, and given that the Temengor frogs conform in all respects to the descriptions of *Philautus parvulus* as given in Taylor (1962), rather than *Philautus petersi*, then the *Philautus* frogs from Temengor may confidently be assigned to *Philautus parvulus*.

With a type locality in the "District of the Karin Bia-po", Myanmar, this species is also known to occur in Vietnam (Inger, et al. 1999), and Thailand (Taylor 1962). The species also occurs in Cambodia, recorded in the Cardomom mountains by the FFI (Flora and Fauna International) Expedition of 2001-2002 and in Bokor by Bryan Stuart, though there are no published records (van Dijk, pers. comm.).

In Thailand, it is known from Chiang Mai province (Taylor, 1962) and the Phu Lang and Khao Yai provinces (P. P. van Dijk, pers. comm.). The identification of this species in Perak, Peninsular Malaysia, thus represents a range extension of over a 1,000 kilometres southwards, and places this species in a new biogeographical region, the Tenasserim-Malay Peninsula, as defined by Inger (1999) as well as a new political unit (Peninsular Malaysia).

The observation of this species here represents a major range extension. It was evident in abundance during the first survey, where its single-note, staccato calls, "pik-pik-pik-pik", often with long periods between each note, could be heard from vegetation along the logging roads, and bamboo clusters and shrubs in the hills and floodplains. During the second survey period, it was much less evident, and, except for the times when it rained, no calls were heard. Three calling individuals were tracked down and collected, two from a bamboo cluster in the floodplain of Sungei Jelud, at about 550 m, and another one from a clump of bamboo up a skid trail, quite a distance from any river, at about 700 m. The Jahai call this frog "tektek", probably an onomatopoeic term based on its call.

Arrangements are being made for the specimens collected from Temengor to be deposited at the Chicago Field Museum of Natural History.

Polypedates leucomystax (Gravenhorst, 1829)

This ubiquitous commensal was, along with *Microhyla heymonsi*, abundant in the logging camp. It was also observed around the silt traps along the logging road.

Rhacophorus nigropalmatus Boulenger, 1895

This impressive frog, the original "Wallace's Flying Frog" (Taylor, 1962), was encountered in abundance during the rainy season, i.e. the first survey, forming large breeding aggregations in and around pools in the logging camp and on logging roads for several days. Their large, sticky foam nests were also observed hanging on branches over the muddy pools in this period, and, in addition, one of the females spawned while isolated in a collecting bag. They were not encountered during the second survey, despite revisiting the areas of previous observation.

Rhacophorus prominanus Smith, 1924

A few males and a single female were observed near the pools of water around the logging camp during the first survey, among the *Rhacophorus nigropalmatus* breeding aggregations.

Other amphibians.- A tiny frog was observed on a bamboo-forested hill slope during the second survey, and was tentatively assigned to *Taylorana hascheana* (Stoliczka, 1870), based mostly on body shape and the presence of a pale patch on the snout. However, the individual escaped before a close inspection could confirm the identification. As the harsh, crow-like calls of *T. hascheana* usually can be heard night or day, regardless of season, if they are present in an area, and no such calls were observed during either survey, it was felt that this identification was too dubious to be included in the species inventory.

The Orang Asli (aboriginals) also reported a frog that sits in water-filled bamboo stumps and calls, which could apply to either *Kalophrynus* spp. or *Metaphrynella pollicaris*.. However, neither of these were observed during this survey.

Reptiles.- No systematic effort at sampling reptiles was made. However, during the course of the surveys, several juvenile agamids, *Gonocephalus grandis,* were observed perched characteristically on vegetation overhanging the larger rivers. A single adult *G. abbotti* was collected from a sapling growing in the Sungei Jelud floodplain, at about 550 m, which is a significant find as this species is rarely encountered (Cox et al., 1998; Taylor, 1963). Only one gecko was observed, *Cyrtodactylus quadrivirgatus*. Numerous *Draco* spp. were documented during daylight observations, including *Draco sumatranus, Draco melanopogon*, etc. Some of these were collected from their tree perches with the assistance of the Orang Asli guides, who stunned them using mud-pellets fired from blowpipes, and this material has yet to be examined. Only two snakes were documented, the Blunt-headed Slug Snake, *Aplopeltura boa*, and a large (over 1.5 m) Wagler's Pit-viper, *Tropidolaemus wagleri*.

The Orang Asli guides also reported the False Gharial, *Tomistoma schlegelii*, from Sungei Jelud. The Orang Asli descriptions, unprompted, of a crocodilian with a long and very narrow snout, encountered swimming in mats of floating vegetation in the slow-moving parts of the larger rivers (hence, called "buaya sampah" by them), are accurate enough, but nonetheless it is difficult to confidently assert the presence of this species based on such anecdotal evidence. However, given the global importance of this species (it is classified in the IUCN Red List as EN C1 "Endangered", with an estimated 2,500 animals remaining in the wild) and its near-complete extirpation from Peninsular Malaysia, it is imperative that further investigations be undertaken.

DISCUSSION

The amphibian diversity of the PITC area.- The amphibian assemblage documented at the PITC concession during the course of these surveys reflects in many ways the full richness of a primary rainforest amphibian fauna, with species richness approaching that documented in other primary forest areas nearby (see below), and with sensitive species such as *Rhacophorus nigropalmatus* present. With the exception of *Polypedates leucomystax*, there is a significant absence of many commensal species such as *Bufo melanostictus* or *Kaloula pulchra* even in areas highly impacted by logging. Conversely, we found primary rainforest frogs present at these sites (e.g., *R. nigropalmatus* found in breeding pools at the logging camp, or along the logging roads). This is probably due to the relative recency of the disturbances, giving insufficient time for the commensals and edge species to invade. It is probably impossible to prevent the invasion of these commensals in the more severely disturbed areas, such as the logging camp, over the long term. But, unless stringent management measures are adopted to protect other areas, such as the pockets of unlogged forest in buffer zones, etc., there is the likelihood that many of these invasives will colonize these areas as well, and consequently exclude or extirpate the more sensitive species from there.

Comparison with other areas in the Belum-Temengor forest. - There have been two previous studies carried out in the larger Belum-Temengor area. A direct, quantitative, comparison is difficult to make, given differences in time (season), study period and search effort. As such, only a qualitative comparison is made here, noting the differences in the species assemblages recorded in each of these surveys (see table 2), but caution should be exercised drawing conclusions about the relative richness of the different areas studied based on this.

The first (Kiew et al., 1995), carried out in the Belum Forest Reserve, documented 24 or 25 species of frogs in five families, depending on the taxonomic arrangement used. The study cited treated *Polypedates macrotis* Boulenger and *Polypedates linki* Taylor as separate species, and thus reports 25 species; the taxonomical arrangement I use here, that of Frost (2000), treats the latter name as a junior synonym of the former, based on Inger (1966) and thus counts only 24 species. This study, too, noted the absence of many commensals. Species recorded in this area

TABLE 2 : Comparison of amphibian diversity documented in the PITC concession with other areas of the Belum-Temengor Forest Complex.

Species	This Study	Kiew et al. 1995 (Belum Forest Reserve)	Norsham et al. 2000 (Temengor Forest Reserve)
Bufonidae			
1. *Bufo asper* Gravenhorst, 1829	X	X	X
2. *Bufo parvus* Boulenger, 1887	X	X	X
3. *Leptophryne borbonica* (Tschudi, 1838)	X		
4. *Pedostibes hosii* (Boulenger, 1892)	X		X
Megophryidae			
5. *Leptobrachium hendricksoni* Taylor, 1962		X	
6. *Leptolalax heteropus* (Boulenger, 1900)	X	X	
7. *Megophrys nasuta* (Schlegel, 1837)	X	X	
8. *Xenophrys aceras* (Boulenger, 1903)	X		
Microhylidae			
9. *Kalophrynus pleurostigma* Tschudi, 1838		X	
10. *Microhyla butleri* Boulenger, 1900	X		
11. *Microhyla heymonsi* Vogt, 1911	X	X	
Ranidae			
12. *Amolops larutensis* (Boulenger, 1899)	X	X	X
13. *Fejervarya limnocharis* (Boie, 1835)	X	X	X
14. *Limnonectes blythii* (Boulenger, 1920)	X	X	X
15. *Limnonectes kuhlii* (Tschudi, 1838)	X	X	
16. *Limnonectes laticeps* (Boulenger, 1882)	X	X	
17. *Limnonectes paramacrodon* (Inger, 1966)			X
18. *Limnonectes plicatellus* (Smith, 1935)	X		
19. *Occidozyga laevis* (Günther, 1859 “1858")		X	
20. *Rana cf. baramica* Boettger, 1903	X		
21. *Rana chalconota raniceps* (Peters, 1871)	X	X	
22. *Rana erythraea* (Schlegel, 1837)		X	X
23. *Rana glandulosa* Boulenger, 1882	X	X	
24. *Rana hosii* Boulenger, 1891	X	X	X
25. *Rana nigrovittata* (Blyth, 1856 ”1855")	X	X	
26. *Rana signata* (Günther, 1872)	X	X	
Rhacophoridae			
27. *Nyctixalus pictus* (Peters, 1871)	X		
28. *Philautus parvulus* (Boulenger, 1893)	X		
29. *Philautus petersi* (Boulenger, 1900)		X	
30. *Polypedates leucomystax* (Gravenhorst, 1829)	X		
31. *Polypedates macrotis* (Boulenger, 1891)		X	
32. *Rhacophorus nigropalmatus* Boulenger, 1895	X		
33. *Rhacophorus prominanus* Smith, 1924	X	X	

TABLE 3: Characters of specimens collected from Temengor compared with characters that distinguish *Philautus parvulus* (Boulenger, 1895) from *Philautus petersi* (Boulenger, 1900). [1]Taylor (1962). *Philautus parvulus* (Boulenger, 1893) characters from specimen collected at "Mai Salat, stream, 4000 ft. elev. headwaters Muang Khawng, Ampur, Me Pang, Chiang Mai). Characters of *Philautus petersi* (Boulenger, 1900), which Taylor refers to as *Philautus larutensis*, based on specimen collected from Fraser's Hill; [2]Dring (1979); [3]Inger (1966); [4]Grandison (1972).

Character	Specimens collected from Temengor	*Philautus parvulus* (Boulenger, 1893)	*Philautus petersi* (Boulenger, 1900)
Size	Snout-vent length 19.5 mm, head width 7 mm and head length 6.5 mm.	Relatively smaller, males with snout-vent length 18 – 19.6 mm, head width 6.5 – 7 mm, and head length 6.7 – 7.1 mm[1].	Relatively larger, males with snout-vent length 23 mm, head width 10.6 mm and head length 10.5 mm[1].
Vocal sacs	Large vocal sacs on chin clearly visible, with heavy skin folds.	Large vocal sacs on chin[1]. Gular skin folded to accommodate large vocal sacs[1,2].	No evidence of large external vocal sacs[1]. Gular skin moderately folded[2].
Vocal sac slits	Elongate, extending from jaw commissure to about halfway down mandibles.	Elongate, reaching forward to middle of mandibles[1,2].	Small, rounded or oval[3], located near jaw commissure[2].
Crenulated fringe on feet	No fringe.	No fringe noted[1]	Outer edge of fifth metatarsal and fifth toe bear a crenulated fringe[4].

that were not documented at the PITC site during these surveys include *Leptobrachium hendricksoni*, *Rana erythraea*, *Occidozyga laevis*, *Philautus petersi*, *Polypedates macrotis*, and *Kalophrynus pleurostigma*. Given the findings of the present paper, it would be interesting to re-examine the *Philautus* spp. material from the Kiew et al. (1995) study, to confirm the identity of the species assigned to *Philautus petersi*.

The second study (Norsham et al., 2000), carried out in the Temengor Forest Reserve, documented nine species of frogs in two families. This study reported one species, *Limnonectes paramacrodon*, that was not documented in the PITC site.

Threats and conservation.- Logging. Obviously, the direct and indirect impacts of timber extraction represents the most significant threat to the amphibian biodiversity. Perhaps most important of these are changes in microclimate parameters and water quality. Microclimatic changes, especially of humidity and temperature, will restrict movements and other behaviour of some sensitive species (Johns, 1997). Perhaps more significantly for the overall diversity of an area are changes in water quality (due to sedimentation, etc.), that will, through changes in larval habitat availability and suitability, effect changes in the species compositions of the amphibian assemblage (Johns, 1997). Harvesting.- During the course of the surveys, it was observed that harvesting of *Limnonectes blythii* for sale for consumption was widespread and intensive in the area, and is carried out by a wide range of parties, from the Orang Asli to the loggers to locals to illegal Thai *gaharu* (a fungus that invades species of *Agar* trees, and a source of expensive incense) collectors. It was not possible to infer, even approximately, the actual volume of the harvesting., though one of the survey team members observed the transport of four gunny sacks full of frogs, the results of two days of collection by eight people, to the nearby town of Grik, for sale. Neither is it possible at this stage to make any statement regarding the impact of this harvesting on the wild populations. Undoubtedly, however, unmonitored and unregulated as the trade is, and yet so lucrative (a single large frog can fetch up to RM 20 in Grik, according to interviews with the Orang Asli), there is little doubt that if the trade is allowed to continue without controls, as it is now, populations of the species will be significantly affected.

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LITERATURE CITED

BERRY, P. Y. 1975. The amphibian fauna of Peninsular Malaysia. Tropical Press, Kuala Lumpur. x + 90 pp.

BOULENGER, G. A. 1893. Concluding report on the reptiles and batrachians obtained in Burma by Signor L. Fea, dealing with the collection made in Pegu and the Karin Hills in 1887-1888. *Ann. Mus. Civ. Stor. Nat., Genova* 2(13): 304-307.

________. 1900. Descriptions of new batrachians in the collection of the British Museum (Natural History). *Ann. & Mag. nat. Hist.* 6(16): 169-171.

________. 1912. A vertebrate fauna of the Malay Peninsula from the Isthmus of Kra to Singapore including adjacent islands: Reptilia and Batrachia. Taylor and Francis, London. xiii + 294 pp.

COX, M. J., P. P. VAN DIJK, J. NABITABHATA & K. THIRAKHUPT. A photographic guide to snakes and other reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publishers, London. 144 pp.

DRING, J. C. M. 1979. Amphibians and reptiles from northern Trengganu, Malaysia, with descriptions of two new geckos, *Cnemaspis* and *Cyrtodactylus*. *Bull. British Mus. (nat. Hist.)* 34: 181-240.

FROST, D. R. 2000. Amphibian species of the world: an online reference. (Http://research.amnh.org/herpetology/amphibia/index.html).

GRANDISON, A. G. C. 1972. The Gunong Benom expedition: 5. Reptiles and amphibians of Gunong Benom with a description of a new species of *Macrocalamus*. *Bull. British Mus. (nat. Hist.)* 23: 45-101.

INGER, R. F. 1966. The systematics and zoogeography of the Amphibia of Borneo. *Fieldiana: Zool.* 52: 5-402.

________. 1999. Distribution patterns of amphibians in Southern Asia and adjacent islands. In: Patterns of Distribution of Amphibians: A Global Perspective. pp. 445-482. W. E. Duellman (Ed). John Hopkins University Press, Baltimore and London.

________, N. ORLOV, & I. DAREVSKY. 1999. Frogs of Vietnam: a report on new collections. *Fieldiana Zool. n.s.* 92: i-iv + 1-46.

JOHNS, A. G. 1997. Timber production and biodiversity conservation in tropical rainforests. Cambridge University Press, Cambridge. 225 pp.

KIEW, B.H., C.H. DIONG & B.L. LIM. 1995. An annotated checklist of the amphibian fauna in the Temengor Forest Reserve, Hulu Perak, Malaysia. *Malayan nat. J.* 48: 347-351.

NORSHAM, Y., H. BERNARD, K.-L. CHEW, H.-S. YONG, M.-N. YAP & B.-L. LIM. 2000. An annotated checklist of herpetofauna in the northern part of Belum Forest Reserve, Perak, Peninsular Malaysia. *Malayan nat. J.* 54: 245-253.

SMITH, M. A. 1930. The Reptilia and Amphibia of the Malay Peninsula. *Bull. Raffles Mus.* 3: 1-149.

TAYLOR, E. H. 1962. The amphibian fauna of Thailand. *Univ. Kansas Sci. Bull.* 43: 265-599.

________. 1963. The lizards of Thailand. *Univ. Kansas Sci. Bull.* 44: 687-1077.

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A REVIEW OF THE SOFTSHELL TURTLES OF THE GENUS *CHITRA*, WITH THE DESCRIPTION OF NEW TAXA FROM MYANMAR AND INDONESIA (JAVA)

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ABSTRACT.– **Taxonomic, distribution and morphological data are presented for the trionychid turtle genus *Chitra* (Testudines: Trionychidae). Many confusing taxonomic details are clarified. Types and type localities are described for both previously named *Chitra* species. Details of forelimb scalation, chromatic and pattern characteristics, original head drawings accentuating phenotypic characters, shell morphology, general skeletal details, and mitochondrial and nuclear gene sequencing results are presented. The overall range of the genus *Chitra* is discussed, with details of field collections confirming previously undescribed Indonesian populations. A new species of narrow-headed softshell, *Chitra vandijki* sp. nov. is described from the Ayeyarwaddy River drainage, Myanmar, distinguished from its congeners by its distribution, a unique combination of carapace, head and neck patterns, and genetic sequence divergence of a level corresponding to full species recognition. A new subspecies of narrow-headed softshell turtle, *Chitra chitra javanensis* ssp. nov., is described from eastern Java, Indonesia, distinguished from the nominate subspecies by its distribution, by details of carapace, dorsal head and chin patterns, and by a genetic sequence divergence level appropriate to subspecies status. Lastly, a first-use chresonymy is presented for the genus *Chitra* and included species.**

KEYWORDS.– **Testudines, taxonomy, systematics, Trionychidae, *Chitra*, Ganges, Ayeyarwady, Mae Klong, Pasuruan.**

INTRODUCTION *Chitra indica*

During much of the 19th century, the spoils, trophies, and curiosities of the British Empire flowed from the far corners of the globe into London, the hub of the entire colonial enterprise. Among these items, little noticed at the time, were both some original paintings and a preserved specimen (having died *en voyage*) of a truly extraordinary turtle from India. These miscellanea gave tangible evidence of the existence of a giant Asiatic softshell turtle with a remarkably small, narrow head, and eyes so small and far forward that many biologists, seeing a skull, are inclined to mistake the orbits for the nostrils.

The evidence for this strangely proportioned creature's existence specifically included a pair of water-colours painted for Major-General Thomas Hardwicke (1755-1835), who employed both Indian and British artists (Archer, 1962; Wheeler, 1998). These were completed while Hardwicke was in the service of the East India Company, commanding the Bengal Artillery. They were brought to England when Hardwicke retired in 1823, and he bequeathed them, along with various other turtle paintings, and several hundred drawings of other Indian reptiles and amphibians, to the British Museum of Natural History (= BMNH) upon his death in 1835 (Dawson, 1946). Another Englishman in service in India was Dr. Francis Buchanan-Hamilton (1762-1829), who at different times, was supervisor of both the "Calcutta Garden" (now the Alipore Zoological Gardens, Kolkata) and the "Institute for Promotions of the Natural History of India" ("The Barrackpore Menagerie") where actual specimens were documented by "careful drawings" (Archer, 1962). Basically, the two men worked in a cooperative spirit, sometimes having their staff copy paintings in each other's collections. Today, these originals of Hardwicke's "coloured drawings" reside in bound volumes in the Zoological Library of the BMNH in London, and those of Buchanan-Hamilton in the India Office Library, also in London (Webb, 1980; Wheeler, 1998). Other artistic works from Hardwicke and Buchanan-Hamilton are thought to have been deposited with the East India Company, or with the Library of the Asiatic Society of Bengal, but cannot now be traced (S. Biswas, pers. comm. to Webb, 1980).

Hardwicke's surviving turtle drawings, thirteen in number, bear BMNH identification numbers 28 to 40. The illustrations of the new, giant softshell turtle, numbers 31 (dorsal) and 40 (ventral), bear the handwritten inscription "Sewteree – Country Name Found in the Ganges – grows to the size of 240 lbs. Futtehghur May". The illustrations themselves are well done and clearly show the four plastral callosities; the small, very narrow head with short nasal tube; the extraordinarily small, anteriorly located eyes; the longitudinal lines on the neck; the paramedian neck lines forming a "V"; the complex, vermiform marbling of the leathery shell; and the concave posterior border of the bony carapace that together characterize the genus *Chitra*.

Hardwicke also collected specimens, but all three collections that he shipped to London were lost by shipwreck (Gray, 1872). Nevertheless, it appears that one narrow-headed softshell specimen, reportedly from the East Indies, did reach London safely, although it cannot be located today (Farkas, 1994: 117). This was received in a fluid-preserved state by the Royal College of Surgeons (= RCS), where in 1817 (Farkas, 1994: 118) it was listed in the "Rough Minute Book" of the College as "No. 903 [= ledger or entry #]. Mr. Henderson. East Indies. Sept. 4th 1818. A specimen of the soft shell'd tortoise, called 'mud-tortoise.' (Brought by the General Kyd Indiaman, and died on its passage.) *Testudo membranacea*. Nat. Hist. [specimen] No. 1238.B."

The name *Testudo membranacea* was first used by Blumenbach (1779) with the clearly erroneous type locality "Guiana" (living trionychids are unknown in South America), and was considered (e.g., by Wermuth and Mertens, 1961, 1977) to be a questionable synonym of *Testudo cartilaginea* Boddaert (1770), which was the first trionychid turtle to be described. Both names describe general qualities of all trionychids, i.e. the seemingly non-bony, cartilaginous or membrane-like shell. It is uncertain what actual species was represented by the name *T. membranacea.* No type was designated. Gray (1831b) did not clarify the matter when he placed it (with question) in the synonymy of the African *Trionyx Niloticus*, which in itself was an unjustified replacement name for the older name *Testudo triunguis* Forskål (1775). We hereby declare the name *Testudo membranacea* a *nomen dubium* for the reasons stated above (see also chresonymy).

A later entry, by Richard Owen in an 1859:104 RCS catalogue, reads: "No. 685 [ledger #]. The Indian Mud-Tortoise (*Trionyx indicus*, Gray; *Testudo membranacea*, Henderson). Fig. Gray, Illust. Ind. Zool. vol. i. p. 80. Cat. of Tortoises in Brit. Mus. p. 49. Hab. Penang. [= same basic locality as RCS "Nat. Hist. No. 1238.B" (= RCS 1238.B)] Presented by Dr. Henderson." (Farkas, 1994: 117). This specimen is also presently unaccounted for and is likely the same (RCS 1238.B) specimen as is mentioned in the 1817 Royal College of Surgeons ledger "No. 903".

J. E. Gray (1800-1875), the prolific chelonian (among other topics) specialist at the British Museum (BMNH) for much of the 19th century, reproduced some of Hardwicke's and Buchanan-Hamilton's paintings (see Archer, 1962) in his oversized folio "*Illustrations of Indian Zoology*," a two volume work, comprised of 202 colored plates, originally produced as 16 issues in 20 parts (Wheeler, 1998) between 1830 and 1835. Although Hardwicke provided most of the illustrations and financed the work, Gray edited and described the new species illustrated [with a few exceptions credited to Bell (1829-1842) by Bourret (1941: 158) and Wheeler (1998: 349), plus see "T. Bell" in Iverson (1992: 166), but we agree with Boulenger (1889), Wermuth and Mertens (1961) and Iverson (1992), crediting the contested species to Gray (1831b: 20, 21, 23) being first published], so this work is attributed solely to Gray (Wheeler, 1998: 348). The accompanying text, the "*Prodromus Faunae Indicae*" was never published, as explained by Dawson (1946: 63). Plate 80 (Fig. 1), copied as a composite of Hardwicke's paintings (BMNH 31 and 40) of the narrow-headed softshell species, is thought to have been published in October of 1831 (Kinnear, 1925; Sawyer, 1971; Webb, 1980; Wheeler,1998), and is identified in the second of two unnumbered introductory pages as "Egyptian Trionyx. *Trionyx AEgyptiacus*, var. Indica" (see *Trionyx AEgyptianns* [sic] in Appendix). The actual caption to the plate itself is slightly different: "TRIONYX AEGYPTIACUS. Var. Indica. n. EGYPTIAN TRIONYX. Indian. Var. Ganges, called Sewteree, sometimes grows to 240 lbs." The contemporary Hindi and Bengali vernacular words for the species today are both "Chitra", not "sewteree," although the latter name lives on in the label of a small stuffed ("young") specimen (see Boulenger, 1889: 265, specimen "b", Capt. Boyes) of this species from "India" in the BMNH 48.2.1.39 (see also Boulenger, 1889: 265 [BMNH 48.8.14.11], "Hgr." [half grown] specimen "a"). It should be noted that, in pre-Partition days (i.e., pre-1947), the term "India" was an inclusive one, including present day Bangladesh, Pakistan, sometimes Burma (Myanmar), as well as the present Republic of India.

Gray had described the narrow-headed softshell more formally in two prior publications (Gray, 1831a, 1831b). The first of these descriptions makes no mention of an actual specimen, although it does refer to the author's *Illustrations of Indian Zoology*, without mention of Hardwicke. However, the second description specifically associates Hardwicke, and thus his two paintings (BMNH 31 & 40), with the author's *Illustrations of Indian Zoology* and clearly refers (although without quoting catalogue number) to an actual specimen deposited in the RCS collection. This would be the Henderson specimen (RCS 1238.B) alluded to above, which is presumed destroyed by wartime bombing in 1941 (E. Allen, pers. comm. to Farkas, 1994).

The actual wording of Gray's two brief descriptions is as follows:

Gray 1831a, p. 18: "*Indian Trionyx. Trionyx Indicus*, Gray, Illust. Ind. Zool. t. Olive green, with black-edged, irregular pale tortuous and forked streaks; sternal callosities four, the hinder ones rounded triangular. India."

Gray 1831b, p. 47: "*Trionyx Indicus*, (*Indian Trionyx*.) – Testa supra subconvexa olivaceo viridi, lineis irregularibus tortuosis vel furcatis nigro marginatis ornata, sterno 4-calloso, callis lateralibus quadrangularibus, posticis longe triangularibus, cauda brevi.

Trionyx Egyptiacus, Var. [sic] *Indicus*. Hard. Illust. Ind. Zool. T. *Testudo Chitra*, Hamilton, Icon. Ined. (v. Icon. Mus. Ind.)

Habitat. In India, fl. Ganges, Penang, *Dr. Henderson*, (v. Mus. Col. Surg.)

Sometimes weighing 240 pounds. The lateral callosities are four-angular, and of nearly equal width at each end; their inner extremity is obliquely truncated in front; the hinder callosities are parallel, long triangular, with the outer side slightly rounded."

As explained by Webb (1980: 70), Gray (1831a) appears to have been published before Gray (1831b). Most authors (see Farkas 1994) over the last century have considered the more detailed Gray (1831b) to be the source of the new name *Trionyx indicus* [now *Chitra indica*] with its declared type specimen and explicit citation of the Hardwicke drawings (Plate 80) in Gray's *Illustrations of Indian Zoology*. For reasons of precedence and taxonomic stability we hereby clarify that Gray (1831a) is the original description of *Chitra indica*.

As stated, Hardwicke retired and returned to England in 1823 at the age of 67, after which he spent time at the BMNH and exchanged notes with Gray in the ensuing years (including the unpublished "*Prodromus Faunae Indicae*"), so that

Gray would have had access to the Indian softshell paintings before they were bequeathed to the British Museum of Natural History in July of 1835 (Dawson, 1946: 60), allowing him to publish copies of them in 1831.

Gray explicitly indicates that he had access both to Hardwicke's paintings and to the Henderson specimen in the RCS when he wrote his 1831b expanded description. He also had obviously seen the unpublished painting ("Icon. Ined.") of Buchanan-Hamilton's *Testudo Chitra*, which he at that time correctly associated with the Hardwicke and Henderson material. An actual cited specimen co-existing with cited illustrations in an original description would have precedence over the illustrations when it comes to the designation of type material. We will not disagree with Farkas (1994: 117) that if Gray (1831b) was the original description, the RCS (#1238.B i.e., Henderson's) specimen "could" be considered a syntype of *C. indica,* but since it was not cited in the accepted original (Gray, 1831a) description, it is not designated or indicated as type material here. To clarify the taxonomic status of *Chitra indica*, the specimen illustrated on Gray's plate 80 in the *Illustrations of Indian Zoology* (1830-35), upon which Gray's (1831a) original description of *C. indica* is based, should itself be the holotype (by monotypy; absence of reference in the original description to any other specimens or illustrated specimens having been examined at the time of description). In agreement with Webb (1980: 64), we hereby recognize the specimen illustrated on Plate 80 (a composite of Farkas's 1994 icontypes, BMNH 31 and 40) of Gray's *Illustrations of Indian Zoology* (1830-35, Vol. I, part 8) to be the holotype ("type") of *Trionyx indicus* Gray (1831a: 18) [= *Chitra indica*]. Although not perfect, Plate 80 displays diagnostic characters of *Chitra indica* such as its head, neck and carapacial markings, and the presence of four lamellae and three pseudodigits on the forelimb (see Figure 1, Table 1).

The current version of the Code of Zoological Nomenclature (ICZN, 1999) specifically permits the use of an illustrated individual as a type specimen: Article 73.1.4: "designation of an illustration of a single specimen as a holotype is to be treated as designation of the specimen illustrated; the fact that the specimen no longer exists or cannot be traced does not of itself invalidate the designation."

The above historical points have interesting implications, one being that the suggested type locality of *C. indica* has varied from "Found in the Ganges… Futtehghur, May" as inscribed on Hardwicke's BMNH 31 and 40 illustrations, to "East Indies" for Hardwicke/ Henderson's RCS specimen #1238.B, to "India" (Gray, 1831a), "In India, fl. Ganges, Penang" (Gray, 1831b), "Ganges" as given on Gray's (1831) Plate 80, or "Fatehgarh, Ganges" by Smith (1931). [Not restricted to "Barrackpore" India as stated by King and Burke (1989: 110, see Webb, 1980: 61; Archer, 1962: 39; Iverson, 1992: 310.)] If one were to focus on Gray (1831b), historically although incorrectly often cited as the original description (see above), and assign the Penang locality to Dr. Henderson's "v. Mus. Col. Surg." (RCS #1238.B) specimen, this might suggest Penang (Malaysia) as the type locality of the only actual specimen upon which *C. indica* was described. However, accepting Gray (1831a) as the original description removes this confusion, since that reference cites "India" for the locality. In addition, the specimen illustrated on Plate 80, the holotype, records "Ganges" as the locality. Various authors cast doubt upon the "Penang" possibility, including Farkas (1994), who observed that the species "is not known to occur at Penang (Malaysia)," and Smith (1931) who doubted the validity of some of T. E. Cantor's Penang, Malaysia collection data. Nevertheless, this paper will later demonstrate that a Penang, Malaysia locality is not impossible for this genus.

Smith (1931: 162) selected "Fatehgarh [a modern transliteration of the word Futtehguhr, a Hindi town name taken from the actual locality written in Hardwicke's paintings], Ganges" as the type locality, on the grounds that Hardwicke conducted at least some of his documented collecting activities there. This is in agreement with the locality "India" given in Gray (1831a), the original description, and "Ganges" given for both Hardwicke's paintings and the specimen illustrated on Plate 80, the holotype of *C. indica.* Unfortunately, after Hardwicke died, legal problems arose concerning the text and money that he had set aside to allow Gray's ongoing *Illustrations of Indian Zoology* project to include his (Hardwicke's) personal data as the "*Prodromus Faunae Indicae*." While some of Hardwicke's notes were "placed in chancery" (i.e., confiscated by the court), where they remained a century later (Smith, 1931), the manuscript of the "*Prodromus Faunae Indicae*" remained in Gray's possession until 1873, when he apparently burned it (Dawson, 1946: 63). We hereby agree with Smith (1931) as first reviser, and Webb (1980), accepting "Fatehgarh on the river Ganges, India" as the type locality of Gray's (1831a: 18) *Trionyx Indicus* [= *Chitra indica*].

There is also the question of Buchanan-Hamilton's *Testudo Chitra*, a taxon based upon painting #522 of the India Office Library and Records Department, London (see Webb, 1980: 67). The species name was based upon the widespread Hindi vernacular name for the species, which in turn derives from the Bengali word for "picture," an allusion to the distinctive carapace design. This combination was never actually published as a valid name, having been merely a handwritten caption on an unpublished artistic rendering until Gray (1831b) placed it into synonymy with *Trionyx Egyptiacus*, *Var*.[sic] *Indicus*. Further, Wermuth and Mertens (1961, 1977) declared *Testudo chitra* to be a *nomen nudum.* Nutaphand (1986, 1990) chose this same specific epithet for a valid new species of narrow-headed softshell from Thailand (i.e., *Chitra chitra*), and may therefore have revalidated it (see below).

Subsequent manipulations of the nomenclature involving *Chitra indica* (commonly called the "Narrow-headed" or "Giant" Indian Softshell) include the division by Duméril and Bibron (1835) of the trionychids into those with fleshy valves or flaps under which the posterior limbs could retract (Cryptopodes), and those in which these valves are absent (Gymnopodes). This was a justified division, and corresponds to the modern subfamilies Cyclanorbinae and Trionychinae (e.g., Meylan, 1987). In Duméril and Bibron's system, this giant Indian species fell into the second category, and was named *Gymnopus lineatus*, based upon a specimen in the Museum national d'Histoire Naturelle, Paris (= MNHN) collection from the Ganges and presented by Dussumier de Fombrune. This new specific epithet, only conditionally being considered the same as *T. indicus* (see Duméril & Bibron, 1835: 493), with a description based on its own type (MNHN 6968) and locality ("le Gange"), is not a replacement name (*nomen novum*), but a subjective synonym of *T. indicus*, and therefore must be treated as a separate name rather than a *nomen novum* or a *nomen substitutum* for *T. indicus* (see Bour et al., 1995: 82).

Gray elevated *T. indicus* to its own genus, as *Chitra indica*, in his 1844 Catalogue, although his brief and imprecise description, with its mention of "Head very depressed, large, dilated behind. Muzzle very short [and] broad" and "head olive, minutely black-dotted", and above all, the occurrence in the "Philippine Islands", leads to the conclusion that he had before him specimens ("a" and "b") of what was later to be designated as *Pelochelys* (see syntypes of *P. cumingii* in Appendix), and not *Chitra*. But he did equate the species (*Chitra indica*) with his earlier (thus having priority over *Pelochelys*) name *Trionyx indicus* and with Buchanan-Hamilton's *Testudo Chitra*, and it is best to conclude (as did Wermuth and Mertens, 1961) that the generic description was a composite of both *Chitra* and *Pelochelys*. Much later, Gray (1864: 91) downplayed the significant differences between the two genera as follows: "This genus [i.e., *Chitra*] and *Pelochelys* are so similar externally, especially in the dried or stuffed specimens, that the specimens were named alike in the British Museum, and so remained for years, though in the meantime they had been examined by several herpetologists, both English and foreign. It is only by a slight difference in the length of the head, compared with the width and the flatness and slight convexity of the forehead, that they can be distinguished, different as the forms of the skulls are." Boulenger (1889: 263) clarified matters to some degree, redefining Gray's genus *Chitra* and providing excellent engravings of the different skulls of the two genera. However, he too, perpetrated an inconsistency by stating that the range of the genus *Chitra* was "East Indies," whereas that of its only known species, *C. indica*, was given as "Ganges and Irawaddy."

The generic designation *Chitra* Gray (1844) prevails over *Gymnopus* Duméril and Bibron (1835) because *Gymnopus* is a substitute name for *Aspidonectes* Wagler (1830), both having the same type species (i.e., *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809, [= *Trionyx triunguis* (Forskål, 1775)] by subsequent designation of Fitzinger, 1843: 30; see Bour et al., 1995: 79). Moreover, *Gymnopus* Duméril and Bibron (1835) is preoccupied by *Gymnopus* Brookes (1825, Aves), and is thus an invalid junior homonym. For reasons given above, and for taxonomic stability, we accept *Chitra* as the appropriate genus for Hardwicke's, Buchanan-Hamilton's, Henderson's, Duméril and Bibron's, Smith's and Gray's drawings and specimens discussed above, with *Trionyx indicus* Gray, 1831a [= *Chitra indica*] as generotype, and "Fatehgarh on the river Ganges, India" as the type locality for the first described species.

Chitra chitra

A second species of *Chitra* from western Thailand, was first described by Nutaphand in 1986, then redescribed a few years later (Nutaphand, 1990). The original description was published in the Thai language, and translates (partially) as follows:

Manlai
the world's largest Soft-shelled Turtle

"… softshells … Manlai (Kanburian [Kanchanaburi] Giant Soft-shelled Turtle).

"Ta Pab" (Soft-shelled Turtle) … common names; species Manlai. Ta Pab Manlai [Striped Softshell], Griu Lai [Striped Giant softshell] or Grau Daeng [Blotched Giant Softshell], *Chitra chitra*

"Manlai" (*Chitra chitra*) is the largest softshell inhabiting Thailand and is assumed to be the largest softshell in the world.

"Manlai" is found only in the Khwae Noi and Khwae Yai rivers of Kanchanaburi Province and in the Mae Klong river of Ratburi Province.

The genus *Chitra* is the genus of "Manlai"; there are two subspecies, the first one is *Chitra chitra chitra*, the second is *Chitra chitra indica*. …. *C. c. indica* is assumed to inhabit India, its full adult size is smaller than that of "Manlai"; additionally, *C. c. indica* has a brownish green or greyish green colour. The adult size of "Manlai" is much larger, it has a very flat and broad shell, and its colour is brown from young animal to adult size, with very clear stripes. …"

Nutaphand (1986: 66) designates *Chitra chitra* as a full species, but then see Nutaphand (1986: 68) proceed to designate *Chitra indica* and *Chitra chitra* as "two subspecies", further declaring *Chitra chitra chitra* as "the principle species in the genus". We agree with Nutaphand's (1986: 66) specific designation, but must declare the Nutaphand (1986: 68) subspecific designations ("*C. c. chitra*" and "*C. c. indica*") invalid, and state that *Chitra chitra* was (due to precedence) neither a nominate subspecies nor a generotype at that time. Nutaphand (1990) advanced *Chitra* taxonomy by clearly recognizing both *Chitra indica* and *Chitra chitra* as full species.

It is not certain why Nutaphand (1986, 1990) used the specific epithet *chitra* and attributed his species *C. chitra* to Gray. Because Nutaphand has not responded to our inquiries, as next reviewer we offer the following likely explanation. We accept that Nutaphand's first exposure to the name "*chitra*" was in Gray's description of the genus *Chitra* in 1844 (thus the credit), and in that same publication (Gray, 1844: 49) he also saw the *nomen nudum Testudo Chitra* (see below). Without mention of "B. Hamilton" or "*Testudo Chitra*" he apparently decided to resurrect "*chitra*" as a species name for his new form, *Chitra chitra*.

In light of Nutaphand's description, the status of Buchanan-Hamilton's and Gray's (1831b, 1844) *Testudo Chitra* must be discussed further. Wermuth and Mertens (1961, 1977) declared "Hamilton's" *T. chitra* a *nomen nudum*, a posi-

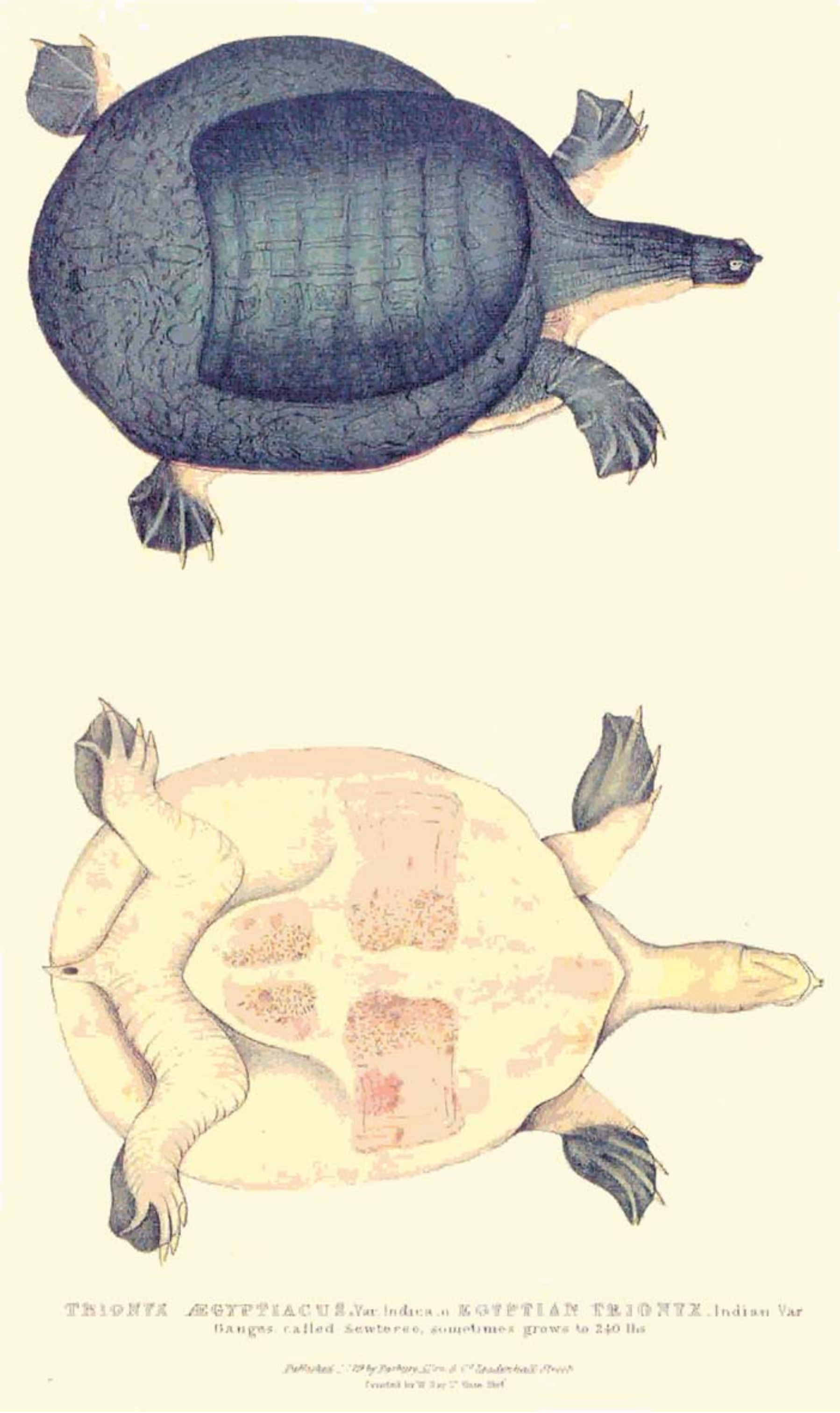

FIGURE 1: Plate 80 in *Illustrations of Indian Zoology* (Gray, 1831 ["1830-35"]).

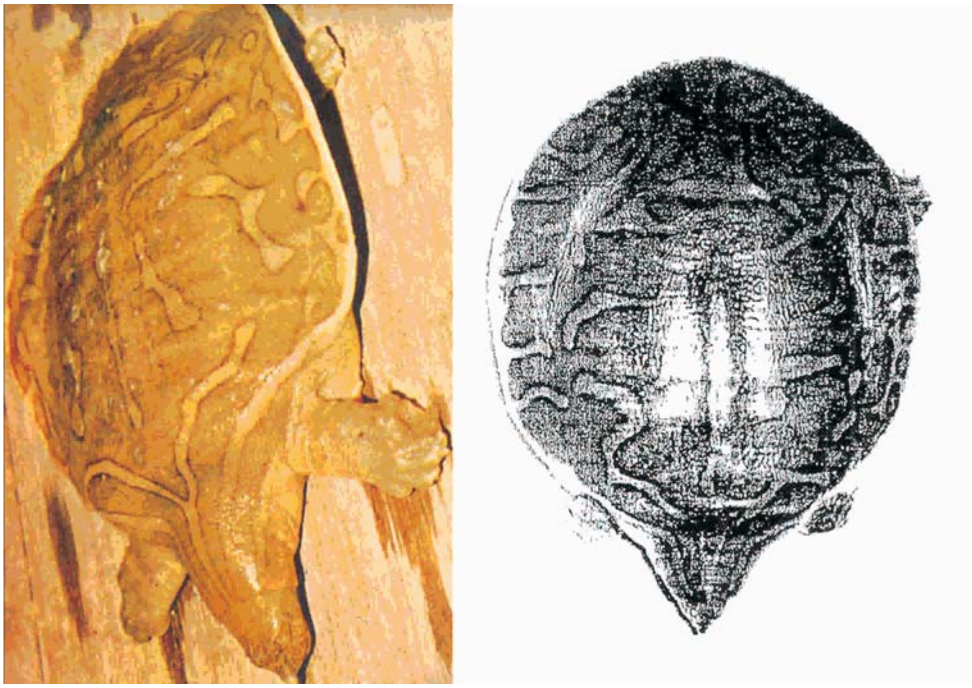

FIGURE 2: Left: Illustration of *Chitra chitra* specimen presented in Nutaphand (1979: 160, 1990: 104). Right: Illustration of *Chitra chitra* specimen presented in Nutaphand (1986: 65).

tion with which we agree. Webb (1980) declared *T. chitra* Gray an unavailable name (unpublished by ICZN Code Standards). We agree with Webb that *T. chitra*, published first in Gray (1831b) only as a synonym, does not qualify as a proper description; however, Nutaphand (1986), has again used the specific epithet "*chitra*" for a new taxon, making it now an available name.

Nutaphand (1986) did not designate an actual specimen in his original description of *C. chitra*, although he did present an illustration. By his (1979, 1986, 1990) descriptions, localities, and exact same Thai and English common names, there is no doubt that Nutaphand's intent was to describe and illustrate the same Thai form in all three works, as distinct from that on the Indian subcontinent. To clarify the taxonomic status of *C. chitra*, we feel it best to now formally designate the indicated holotype (by monotypy; absence of reference in the original description to any other specimens or illustrated specimens having been examined at the time of description) in Nutaphand's original description. We herein designate the specimen illustrated on page 65 of Nutaphand's 1986 original description, as the holotype of the species *Chitra chitra*. Since the better example of *C. chitra* documented by Nutaphand (1979, 1986, 1990) himself is the photo given on page 160 (Fig. 127, labeled *Chitra indica*) in Nutaphand's 1979 book, and again on page 104 of his 1990 *Chitra chitra* redescription, we present it here (with the illustrated holotype), to best demonstrate *C. chitra* (Fig. 2). This illustration best displays diagnostic features herein attributed to Nutaphand's *C. chitra* such as a "simple" carapacial pattern, a continuous pale rim on the carapace, a neck "V" located near the base of the neck, and the presence of a nose/eye "triangle" figure (see description of *C. chitra* below for more detail). Note the *C. chitra* holotype also illustrated in Nutaphand (1979: 160, Fig. 128).

Nutaphand also did not specifically designate a type locality, but he did give three rivers, with Province (see above) where *C. chitra* was to be found. We therefore designate Kanburi (presently Kanchanaburi), where the Khwae Noi and the Khwae Yai rivers join to form the Mae Klong

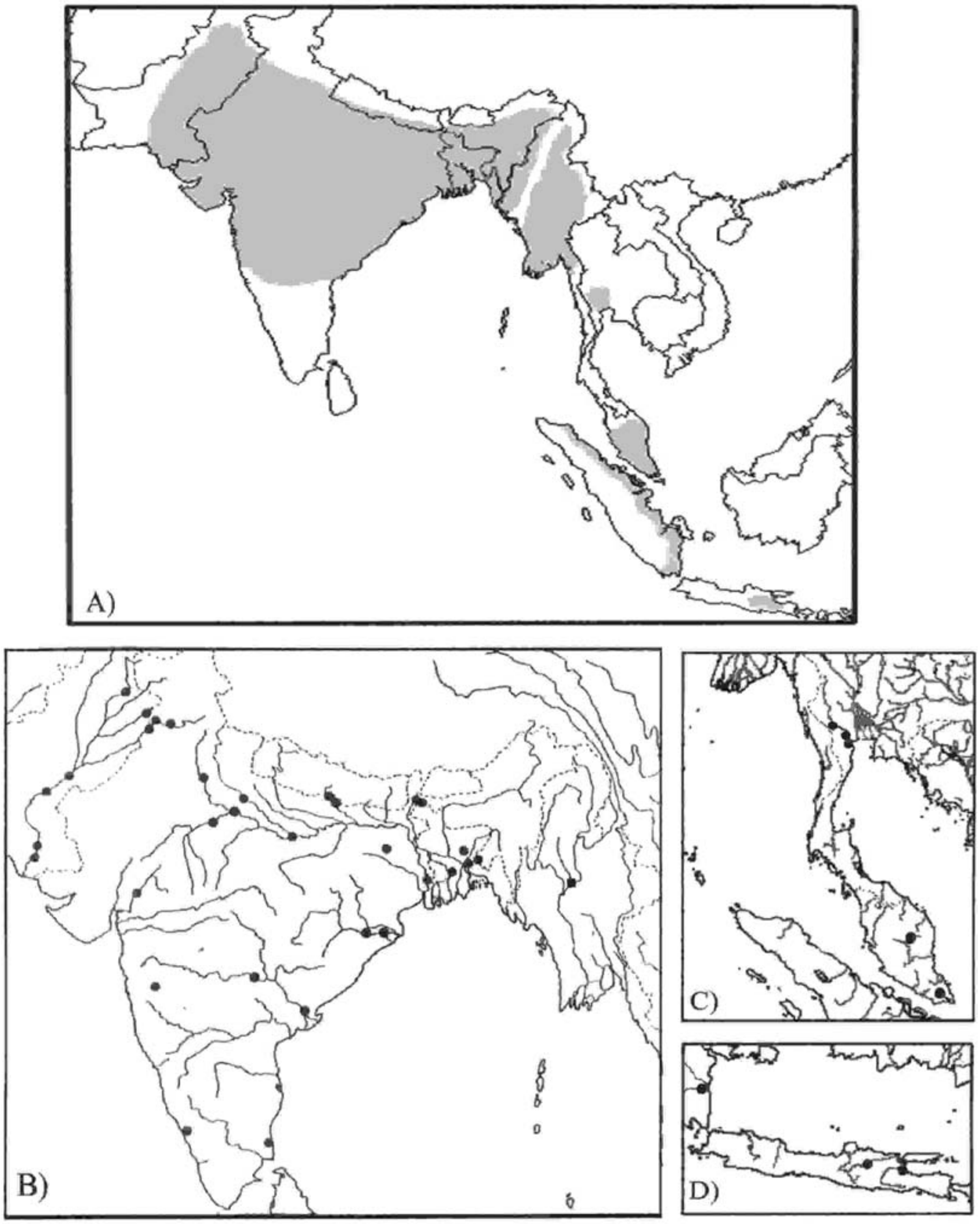

FIGURE 3: Distributions of the species and subspecies in the genus *Chitra*, generally taken from Iverson (1992), but including data from field notes (see text): (A) Overall *Chitra* distribution; (B) *C. indica* (dots) and *C. vandijki* (square); (C) *C. c. chitra*; (D) *C. c. javanensis*.

River in Kanchanaburi Province, Thailand, as the type locality of *Chitra chitra* (see Smith, 1922, 1930, 1931).

GEOGRAPHIC DISTRIBUTION OF THE GENUS *CHITRA* (FIG. 3A)

Much of the turtle literature of both the 19th and 20th centuries has suggested that the distribution of the genus *Chitra* is restricted to the Ganges (today called Ganga) system in northern India (now including Bangladesh) and adjacent Nepal (e.g., Gray, 1864). However, Gray's (1831b) mention of a specimen from "Penang", suggested that the range is much wider than generally thought. Subsequently, Smith (1931) confirmed that the genus occurred in western Thailand; and Webb (1981) documented two specimens (ZSI 21539, n = 2) "from Dhond, (about 190 km ESE Bombay), in the State of Maharashtra", India. Das (1991) recorded *Chitra* from various river systems in peninsular India, including the Mahanadi, Godavari, Krishna, and Cauvari systems. Minton (1966, pl. 11) illustrated a live adult (now AMNH, 85594) from the "Indus River, near Tatta, Tatta District, Pakistan", and noted that, in Pakistan, it appeared to be restricted to sandy sections of the Indus and other large rivers. In 2001, one of us (WPM) received five live specimens, also from Pakistan (see below).

Das (1995) summarized the distribution of *C. indica* in Bangladesh, India, Nepal and Pakistan. Furthermore, Rashid and Khan (2000) reported that *C. indica* is found in all the major rivers of Bangladesh and their major tributaries. They also noted that it has become rare in the north-east, north-west and central regions, and is uncommon in the southern districts. In Nepal, Shrestha (1996a, b) reported populations of *C. indica* in the Patharbhoji section of the Grewa River, and considered it to be one of the most common species in the Karnali area. Overall, the species was described as locally common in suitable habitat in Nepal.

These records indicate a wide distribution of *C. indica* throughout the Ganga and Indus river systems, as well as in various rivers of peninsular India (see Fig. 3B). We have, at present, no indications of significant geographic variation in *Chitra* within the Indus-Ganga-Brahmaputra River systems or the smaller river systems of peninsular India, apart from the casual observation of Rashid and Khan (2000) that, in Bangladesh, individual *C. indica* from the northern and central areas are lighter in colour than those from the south.

Myanmar.-The genus *Chitra* is not included in the recent account by Platt et al. (2000) of tortoise and turtle exploitation in Myanmar. Smith (1931) wrote: "It is said to inhabit the Irawaddy, but I cannot trace any specimen having been obtained there." In 1868 Theobald also did not record *Chitra* in "Birma", but later listed them in 1876, and in 1882, even going as far as calling Burmese *Chitra* "savage and dangerous creatures".

Additional hints of the occurrence of *Chitra* in Myanmar have circulated since the statements of Boulenger (1889), Siebenrock (1909), and Annandale (1912), that *Chitra* was to be found in the "Irrawaddi" or in "Burma", and recent comments by van Dijk (1994) lend substance to this. There is an adult *Chitra* specimen (BMNH 87.3.30.11) bearing the Museum label "Ad. skel. Allahabad. Exch: -w. Theobald Esq. Incomplete" and cited with similar data by Boulenger (1889:265) as specimen "d", that is likely the basis for Boulenger's "Irawaddy" *Chitra* record. There is also a juvenile trionychid, deposited by W. Theobald in the BMNH collection (# 87.3.30.15), labeled "*Pelochelys cantoris*" (see Boulenger (1889:263) specimen "c" from "Burma"; see also Appendix). This specimen is small and consists mostly of the bony carapace (bony disc 7 x 7 cm), and although areas of the leathery carapacial flap are present, they are, at this time, purely black in colour, with no evidence of pattern. The specimen appears, by morphology (see below) to be a *Chitra* rather than a *Pelochelys* (examined by PCHP), but the distinctive markings of the "Burma" form (see below) are no longer in evidence.

Van Dijk (1994) provided the first precise records from Myanmar: a bony trionychid carapace from the Man River, a carapace and plastron from the Mon River, and a partial plastron from the Doke-tha-wady. Careful examination of key characters, including the angled form of the hyo-hypoplastral suture, the relationship between the first and second rib-tips, and the overall form of the rib tips projecting beyond the bony carapace margin, led van Dijk (1994) to the conclusion that the specimens were *Chitra* and not *Pelochelys*.

Subsequently, specimens have been obtained by Yuk Wah (Oscar) Shiu of Hong Kong from the market in Ruili, Yunnan, China, extremely close to the Myanmar border, and the conclusion has been reached (e.g., by Kuchling, 1995, who examined turtles in the same market) that the turtles sold there came from adjacent parts of Myanmar. Four of these specimens have been catalogued into the Chelonian Research Institute (CRI) collection (PCHP 4896, 4897, 5050, 7059).

More recently, a live Myanmar *Chitra* with precise collection data was reported by Platt (2001). This specimen, a subadult with total carapace length (CL) of 40.8 cm and a weight of 5.6 kg, was collected in March 2000, a short distance upstream from Myinthar-Kyarnyut Village at Khayansat Kone village (23°16.30´N; 95°58.99´E), a two day boat ride north of Mandalay (21°58.75´N; 96°03.50´E) on the Ayeyarwady (= Irrawaddy) River (Fig. 3B). The species is said to be locally rare, since fishermen at the village of capture report encountering only about one per year. Other fishermen at Letpangon Village (23°20.16´N; 96°00.55´E) were also familiar with the species but again considered it to be rare.

Thailand.- The first vouchered report of *Chitra* from Thailand probably reflected the specimen (MNHN 8003) received by Bocourt during his 1861-62 sojourn (Bourret, 1939), but upon recent examination by Roger Bour (pers. comm.), this specimen proved to be a misidentified *Pelochelys cantorii*. Later, Smith (1931) documented three Thai *Chitra* specimens, all of which he deposited in the British Museum of Natural History. They were reportedly caught in the upper reaches of the Ratburi River [= Kanchanaburi River; = Mae Klong River, see Thirakhupt and van Dijk, 1994: 210], "where the waters are clear and the banks sandy." In the BMNH catalogue, specimens donated by M. A. Smith include BMNH 1921.4.1.197, identified as "head, limbs, tail in spirit," from Ban Pong, C. Siam; BMNH 1926.12.16.1, a skeleton from the "Ratburi" River, Kanburi, Siam; and BMNH 1931.11.2.1, which is just a humeral gland and duct in spirit. Later, an additional specimen (BMNH 1974.24.5.1), a shell and skeleton also from Ban Pong, were received from the M. A. Smith Collection.

Cox et al. (1998) reported that, in Thailand, the species occurs in the Mae Klong river system, and Thirakhupt and van Dijk (1994), agreeing here with Cox added records for the Srinagarind Reservoir, Kanburi (presently Kanchanaburi) Province (CUMZ (R)1991.08.23.1), and for three specimens captive-hatched from the Khwae Noi River, Kanburi Province (CUMZ (R), unnumbered). The Srinagarind record was based upon an enormous softshell accidentally entangled in a submerged mesh upstream from the hydroelectric dam in 1989 (Amonratanasareegul, pers. comm. to P. P. van Dijk, 1992). Kitimasak and Thirakhupt (2002) discuss new records of *Chitra chitra* specimens found in the Mae Ping River of the Chao Phraya river system of Thailand. With specimens from the Mae Klong and Mae Ping Rivers, a *Chitra chitra* research and breeding program has been run for nine years by the Inland Fisheries Development Center in Kanchanaburi. The goal is to save the species from overcollection, pollution and the detrimental effects of reservoir dams on nesting areas.

There are also three Thai specimens, without detailed collecting data, in the Harvard collection (MCZ 29486-88). Published photographs of Thai specimens include those in Advanced Thailand Geographic Magazine Vol. 36 (July-August, 1999; foldout between pp. 81-87); Lim and Das (1999); Nutaphand (1979, 1986, 1990); Techacharoensukchera (1991); Thirakupt and van Dijk (1994, two separate individuals); Cox et al. (1998); and Fritz and Obst (1999). Available distribution maps (e.g., Nutaphand, 1990; Iverson, 1992) seem to agree that the distribution in Thailand is extremely restricted (see Fig. 3C).

Malaysia.- Well over a century ago, Günther (1864) reported that *C. indica* "is frequent in the estuaries of the Malayan Peninsula." He also published an illustration (Plate VI. fig. c.) labeled "*C. indica*" (see neck "V" and *Chitra* head pattern) that Smith (1931) declared "represents a *P. bibroni* [referring to what is currently *P. cantorii*], but with the markings of a *Chitra indica*". We concur with Smith, supported by Gray (1864: 90), who stated that Günther's "*Chitra indica*" is "not Gray" [meaning here, not *C. indica* (Gray 1831a: 18)], and who also states Günther studied ("soaked") Cantor's (1847) specimen (now known to be *Pelochelys*, see Appendix), and "says he [Günther] observed" a *Chitra* pattern. Günther was therefore erroneously trying to illustrate a *Chitra* pattern for Cantor's specimen (see Gray, 1870: 91), not knowing the sympatric genus *Pelochelys* existed. Günther (1864) added that Mr. Cuming had brought home some "fine examples" of *Chitra*, said to have been procured in the Philippine Islands. Gray (1855), also mentioned the same Philippine specimens. Almost certainly these Philippine records pertain to *Pelochelys cantorii* rather than to *Chitra* (see *P. cummingii* in Appendix), further demonstrating the confusion at that time between the two genera.

Smith (1922) commented (about *Chitra*): "The discovery of this species, one of the largest of the freshwater turtles, in the Malay Peninsula is a fine extension of its known range. It has previously been recorded from the Ganges and Irrawady river systems. This turtle has also been met with in the Ratburi River, western Siam, two adult specimens having been caught near Kanburi. These two examples, which I examined alive, differed from the description of the Indian form in that the disk was marked with numerous, pale broad lines and angular markings". Smith (1930) tells of a *Chitra* specimen from the Tahan River, Pahang, Malaysia (Fig. 3C). Smith (1931) remarked further that Robinson and Kloss obtained a specimen at the foot of Gunong Tahan, in the Malay Peninsula.

Lim and Das (1999) included *Chitra* (a composite account of *C. indica* and *C. chitra*) in their book entitled "Turtles of Borneo and Peninsular Malaysia," and observed that the first West (i.e., mainland) Malaysian specimen was the one caught in Kuala Tahan River, Pahang, in 1922 and cited as obtained by "F. M. S. Museums" by Smith (1930); they commented that there were no recent records. Sharma and Tisen (2000) listed *C. chitra* in the Malaysian fauna, but observed that its current distribution was unknown, the historical records being from Taman Negara. Research and interviews conducted by them along several rivers over the last few years yielded neither specimens nor anecdotal information. They concluded that the species may have been hunted out well before any populations could be verified.

E. O. Moll, an expert on Malaysian freshwater turtles (e.g., Moll, 1980; 1984; 1989), commented (in litt. to P. P. van Dijk): "There is an old record by Smith for the Pahang River and I think I saw one surface in a tributary of that river near the National Park (it could have been a *Pelochelys*). It is the only *Chitra* that I ever saw in Malaysia. They are extremely rare. One of [John M.] Legler's other students bought one in a Chinese shop in Kuala Lumpur but it had no data."

A commercial videotape entitled "Shocking Asia" (Magnum Entertainment, Los Angeles, USA, 1986) includes a sequence showing the capture and butchering of an adult *Chitra* specimen, ostensibly in Malaysia. The dorsal pattern of the specimen, which is very large (ca. 100 cm), includes the markings characteristic of full-size eastern *Chitra* (i.e., bold, imperfectly symmetrical pale yellow streaks without fine structure, and "zig-zag" nuchal markings, on a dark background), and, while the exact locality is unavailable, there is no obvious reason to doubt that the event occurred in Malaysia. Recently, Mr. Keng Liang (Anson) Wong, of Penang, Malaysia, received several live specimens that had been caught "20 miles northeast" of Kota Tinggi, in the Johore River basin, Johor State, southern peninsular Malaysia (Fig. 3C). Mr. Wong also reports knowledge of *Chitra* found in Terengganu State, eastern peninsular Malaysia.

Indonesia.- Probably the first report of Recent *Chitra* from Indonesia was in a generally overlooked paper by Müller (1923). In translation, the section pertaining to *Chitra* reads: "In the year 1908, Dr. Elbert presented to the Bavarian State Museum a series of reptiles consisting for the most part of skeletons of monitors (*Varanus*), crocodiles and turtles. There was only one container with alcoholic specimens, with a collective label indicating that the specimens were from Java, or some possibly from Sumatra. Among the skeletons there was also *C. indica* (Gray, 1831) with the attached tag indicating "Buitenzorg, Java" (now Bogor, Jawa Barat). The species has not previously been reported from the Indo-Australian archipelago. A confirmation of this striking locality record through the procurement of further specimens is therefore of interest."

Two skulls of Indonesian *Chitra* are available in European museums: NMW 162 ("N. Küste Sumatra") and RMNH 7054 ("Java"). Webb (1995) cast doubt upon these recorded localities, but we consider them to be credible. Samedi and Iskandar (2000) reported *C. chitra* to be "rare" in both Sumatra and Java, and Iskandar (2000) gave the Indonesian vernacular name for the species as "labi-labi bintang". His statement of range included southern Thailand, Malaysia, several localities in Sumatra (Aceh, Sumatra Utara, Riau, Jambi), and Java (Karimun Jawa Islands, Ciliwung, Bengawan Solo). In fact, although the presence of this enormous freshwater turtle species in Java is little recognized in the western world, it is already protected by law (as *C. indica*) in Indonesia, (Government Regulation Act. No. 7 and 8 of 1999; Samedi and Iskandar, 2000) based upon the presumed rarity of the species because it has been known from so few specimens. These same authors cite *Chitra* (as *C. indica*) from Karang Gading Wildlife Reserve, South Sumatra; Barbak National Park, Sumatra; and the delta of the Banyuasin-Musi rivers, South Sumatra, as well as Lake Sentarum Wildlife Reserve, West Kalimantan [Borneo], although by the authors' own admission some of these records are questionable, and the possibility exists that some of these reports involved misidentified *Pelochelys.* On habitat likelihood alone (it being observed that *Chitra* requires large, lowland tropical rivers), the Karimun Jawa locality (a group of small, rocky islands between Java and Borneo) is probably in error, even though there is a large specimen in the CRI collection, collected by locals for F. Yuwono, ostensibly from there.

Shepherd (2000) was advised by a major turtle exporter in Medan, Sumatra, that specimens of *C. chitra* were occasionally brought in to his company from various Sumatran localities (excluding the Tembilahan area, where *Amyda* is the only trionychid found). Recently, we have confirmed the presence of *Chitra* on the island of Java, and specimens of *Chitra* said to be from "Lampung", eastern Sumatra have also been obtained (see below, also Fig. 3D).

FIELD NOTES

In Java, most turtles were caught by professional collectors in a tidal creek of the Pasuruan River, near Pasuruan, Probolinggo District, East Java (Fig. 3D). This creek, about 15 m wide and 1-1.5 m deep, had a uniform temperature of 26 C when measured at several points in late July 1997. The location, taken by Global Positioning Satellite System (GPS), was 7°39.83′ S and 112°57.30′ E. Most of the area was utilized for low-intensity agriculture, with some dense vegetation around the creek itself, and scattered homesteads.

A smaller number of turtles were caught in the Solo River (the largest river in Java, Fig. 3D) at a point in East Java Province about 10 km west of the provincial border with Central Java (07° 09.87′S; 111° 38.56′E). At this point the river was wide (at least 100 m), but the season was dry and water levels were low, with extensive sandbanks exposed and water levels shallow (less than 1 m). The area was quite densely populated, with villages just beyond the seasonal sandbanks, much trash in evidence, and numerous locals (especially children) greatly interested in our activities. A local team of turtle hunters was recruited, and, utilizing the "poking" (see below) technique, was able to catch a small *Chitra* (CL 17.8 cm, CW 18.1 cm) within 15 minutes. Later a larger specimen was caught at the same site, and we were given two others. The capture team indicated that, in their experience, *Chitra* was the only trionychid present at this site; there was no evidence of *Amyda*, *Pelochelys* or *Dogania*.

The actual capture technique most used in Java, carried out by local professional turtle hunters under observation by PCHP and F. Yuwono, was for four hunters to walk in water of appropriate depth for wading (up to about 120 cm, sometimes more), constantly poking the bottom substrate with spears fabricated from green bamboo poles, about 2-3 meters long and ca. 4 cm thick, each with a very sharp barbless iron point rigidly attached. The overall objective was to pin down a concealed turtle by perforating it through the leathery carapace flap, and then to bring it to the surface. Smaller turtles are handled by first locating the head, then picking them up by the sides of the carapace with both hands. Others may be enmeshed in a net and brought ashore. Large turtles may be immobilized by impaling the carapace flap in this way by each of two or even more members of the team. One very large adult *Chitra* in the Pasuruan River west of Probolinggo was pinned down by four hunters, but succeeded in swimming with all four in tow for about 100 meters, then turning around and returning upstream, before breaking or extracting all four spears and escaping. Both *Chitra* and *Amyda* are caught in this way; we were advised that *Chitra* are usually lightly buried under a shallow deposit of silt, whereas *Amyda* are generally found deeper.

Another technique employed by some commercial softshell hunters in East Java utilizes a high-ampère battery pack that can be worn as a backpack, attached to two long, pointed electrode shafts with insulated handles. When these electrodes both make contact with a submerged turtle, it is stunned by the electric shock and can be caught by hand.

Interview data with Saiful Anwar in the Pasuruan area indicated that *Chitra* was found in the eastern part of Java, localities personally known to him including Lejoso (between Pasuruan and Lekok), Lumajang (south of Bromo), and Jember (south of Kukusan). *Chitra* was generally sympatric with *Amyda cartilaginea*, and when a turtle was located in the bottom substrate, it was not certain which species it was until it was brought ashore, apart from the fact that *Chitra* reaches a larger size than *Amyda* – weight up to 150 kg. In general, *Amyda* was more abundant than *Chitra*, but both were becoming scarce. The informant had caught softshells for thirty years, but was unfamiliar with *Pelochelys*. He indicated that both sexes of *Amyda* reached a similar size, but that *Chitra*, which he sold alive, could not easily be sexed externally. Both species would sometimes bask on mud flats in the early morning (0600-0900 h) with legs extended, but would quickly return to the water when disturbed. Low tide during the dry season was the best time to catch them; the entire section of the Pasuruan River occupied by *Chitra* (i.e., downstream from the bridge) was strongly tidal.

MATERIALS AND METHODS

Nearly two centuries since the first description, there is still very scant information on geographic variation or speciation within the genus *Chitra*. Even Nutaphand's definition of the second species (*C. chitra*) rests almost solely upon minor comments by Smith (1930). This dilatory scientific advancement stems from several causes, as follows:

Adult turtles of the genus *Chitra* are large and highly sought after as food. They spend most of their time concealed in benthic substrates in large rivers, which makes them inaccessible. By the time the turtles reach scientists they are rarely alive. Most museum specimens are either lacking collection data or with only a general indication of provenance. Most collections only include single range-state specimens making comparisons of species from different range-states difficult. The gross distinguishing features of *Chitra* are skin and shell patterns, yet these characters easily deteriorate upon death. These patterns are subject to marked variation even within a population, and vary with ontogeny. Over-exploitation and habitat destruction have made *Chitra* rare in almost all parts of their range. *Chitra* are difficult to keep alive, both in transit and in captivity.

Our methodology was to compare the phenotypic, morphological, zoogeographic and phylogenetic data obtained from the study of literature, published colour illustrations, and both preserved and live specimens of *Chitra* available to us. Current published live inventories identify only the San Diego and St. Louis Zoos (USA) as each having a pair of live *Chitra*, with two adults and several juveniles in the Khao Kheow Zoo in southern Thailand, and the breeding group mentioned above in Kanchanaburi, Thailand. The Madras Crocodile Bank (Vadanemmeli, Tamil Nadu, India) also has live *Chitra* from time to time. One of the authors (WPM) has series of live subadult animals from Bangladesh, Java, Sumatra, Malaysia, Thailand, Pakistan, and Myanmar, upon which the descriptions below are based. *Chitra indica*, the generotype, is considered to be the "baseline" taxon with which other populations were compared.

We were able to accumulate adequate live samples of *C. indica* from Bangladesh (n= 7) and Pakistan (n= 5). Live Myanmar *Chitra* specimens (n= 8) were obtained from the market in Ruili, Yunnan, along with three preserved Myanmar specimens and a skeleton in the CRI collection (PCHP 4896, 4897, 5050, 7059), plus we saw the coloured photograph in Platt (2001). We also studied a series (n = 18) of Java *Chitra* examined and photographed alive at the time of capture and while in the WPM collection, most since liquid-preserved or prepared as skeletons (PCHP 4629, 4936, 4937, 4965, 4897, 4975, 4988, 4995, 5001, 5002, 5003, 5049, 5052, 5053 and MZB 264, 265, 266, 267), captured for us by supervised professional turtle hunters. While we did not personally supervise the capture of the first two groups, we have confidence that they were local in origin, and we ensured by visual inspection (and later genetic characterization) that they were essentially homogeneous and showed the overall features that we came to recognize in each geographically isolated population. Our series of specimens from Thailand (i.e., topotypic *Chitra chitra*) consisted of a few living Thai specimens seen in collections in Thailand, two living specimens in the collection of WPM, and a skeleton in the PCHP collection (n= 6), and for comparison we had access to an inventory of published illustrations of specimens, nearly all in colour (see references above). We have live specimens from Malaysia (n= 4), that are clearly of the overall *C. chitra* phenotypic "group" (see below).

The following museum acronyms are used herein: AMNH = American Museum of Natural History, New York; AMS = Australian Museum of Science, Sydney; BMNH = British Museum (Natural History), London (officially, but not preferably cited as NHM = The Natural History Museum, London; Colin McCarthy, pers. com.); CRI = Chelonian Research Institute, Oviedo, Florida (houses PCHP = Peter C. H. Pritchard collection); KP(CUMZ(R)) = Chulalongkorn University Museum of Zoology (Reptile), Thailand; MCZ = Museum of Comparative Zoology, Harvard University, Massachusetts; MZB = Museum Zoologicum Bogoriense (Cibinong); MNHN = Muséum National d'Histoire Naturelle, Paris; NMW = Naturhistorisches Museum Wien (Austria); RCS = Royal College of Surgeons (London); RMNH = Rijksmuseum van Natuurlijke Historie, Leiden; ZISP (formerly ZIL) = Zoological Institute, Sankt-Petersburg; ZSI = Zoological Survey of India, Calcutta.

Carapace length (CL) of live and alcohol preserved specimens is herein the straight midline distance from the anterior bony carapace (disc) to the posterior edge of the leathery carapace.

Carapace length (CL) of skeletal specimens is herein the curved midline distance from the anterior bony carapace (disc) to the posterior bony carapace.

Carapace width (CW) of skeletal specimens is herein the curved distance between the widest points of the bony carapace (excluding rib tips).

CHITRA: GENERIC DESCRIPTION

The following combination of characters distinguish *Chitra* from all other genera of softshell turtles: Trionychid turtles characterized by gigantic adult size; a wide flat dorsal disc subject to little if any ontogenetic change in relative size or

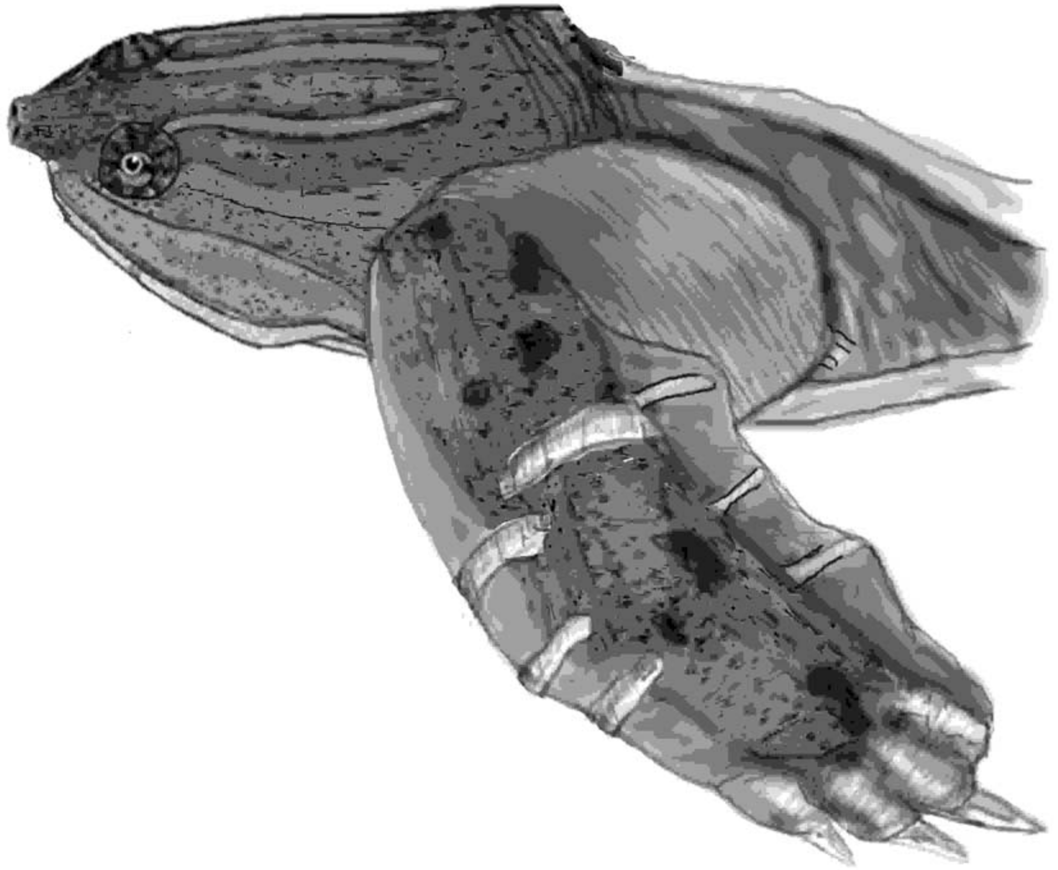

FIGURE 4: Illustration of forelimb lamellae and "pseudodigits" of *Chitra indica*.

shape of either the leathery shell or the bony disc; four plastral callosities that form very early in life, and retain their shape throughout ontogeny; a very specialized head form with extreme anterior displacement of the orbits, overall narrowing, and marked elongation; absence of cutaneous femoral valves under which the hind limbs retract; a unique head, neck and carapacial pattern; and a unique combination of skeletal features (see below).

The forelimbs of *Chitra* bear both sharp-edged anterior scales or lamellae, and elongate, round-edged structures along the distal and lateral aspect of the forelimbs that serve to support and deploy the digital webbing to maximum advantage, for which we use the name "pseudodigits" (Fig. 4). The numbers of these structures are quite variable, and for this reason they were examined and recorded in specimens of each of the populations studied. The samples are too small to merit detailed statistical analysis (Table 1), but it would appear that, in the *C. indica* and Myanmar samples, the lamellae usually number 3 or 4, and in the *C. chitra* samples (Thai, Malaysian and Indonesian) the mean number is 2. The pseudodigits do not appear to show significant geographic differences.

Skeletal features of turtles of the genus *Chitra* may be characterized as follows:

Head: The skull is extraordinarily elongate, streamlined, anteriorly depressed, and narrowed, the widest point being at the lower margin of the quadrate bones, between the tympanic cavity and the jaw articulation (Fig. 5). As an adaptation to accommodation of the extremely long mandible and wide gape, and the associated elongated retractor mandibulae musculature, the supraoccipital process is not only deep (except towards the posterior tip) but very long, and the squamosal bones also show remarkable posterior development. Nasal septal ridges are absent (present in *Pelochelys*). The orbits show extreme anterior displacement, and this is accompanied by a remarkable posterior elongation of the frontals and anterior elongation of the parietals. The vomer-prefrontal struts are absent (present in *Pelochelys*). The postorbital "bar," actually an extensive postorbital area, has a minimum width that is slightly more than twice the horizontal width of the orbit (postorbital bar and orbital diameters about the same in *Pelochelys*). The single premaxilla, although probably always present, is reduced to a minuscule triangular element, dorsal to which the maxillae make contact at the base of the apertura narium. The intermaxillary foramen is almost or completely absent (relatively large in *Pelochelys*). The prootic bone makes up virtually the entire trochlear surface for the sliding movement and redirection of the jaw musculature. The triturating surface has a distinct sharp-edged continuous ridge posteriorly (absent in *Pelochelys*). The inner surface of the dentary has a distinct lingual ridge forming a horizontal shelf, prominent throughout its length except around the mandibular symphysis (absent in *Pelochelys*).

The hyoid structure of *Chitra* is enormous. In fully mature specimens, the corpus hyoideus includes eight ossifications; in younger specimens there are six. The anterior hyoid horns (cornua branchiales I) are each composed of a single ossification, while each posterior horn is composed

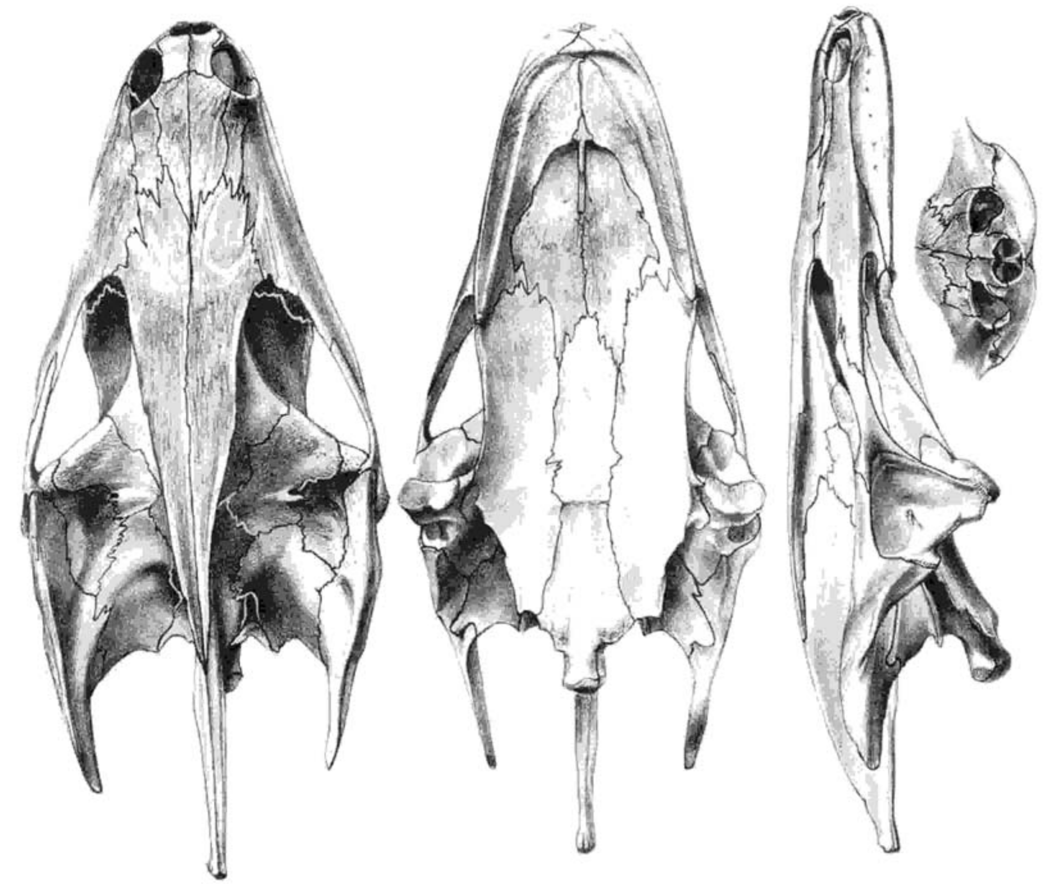

FIGURE 5: *Chitra* skull illustrations (taken from Gray 1855).

of an elongate basal bony element sutured to a short middle component which in turns sutures with a wide, curved posterior element. Such a configuration is shared with *Pelochelys*, but is otherwise unique.

Cervical vertebrae: The eight cervical vertebrae, with the exception of the atlas (a composite of four unfused bones), are all highly elongate, and bear no ventral processes. A dorsal process, for insertion of the musculature that propels the powerful forward thrust of the neck, is present on each of elements IV to VII, the most elevated by far being on cervical VI. Ginglymoidy is present on the articulations of cervicals V-VIII, and the posterior joints of cervicals III and IV are also broadened although not actually doubled.

Carapace: The bony carapace (disc) is very flat and about as wide as long, with an antero-posteriorly foreshortened nuchal bone, and usually eight discrete neural elements, the first four hexagonal with short sides posteriorly, the fifth rectangular, the sixth and seventh hexagonal with short sides anteriorly, and the eighth pentagonal. The first neural element may correspond to neurals I and II (fused) of certain other turtles, including *Aspideretes* and the cyclanorbines (see Meylan, 1987). Occasional variant configurations occur, including asymmetrical realignment of the suture between neurals V and VI, rendering both of these elements pentagonal. The eighth pleurals are wide and well developed, and contact each other along the midline throughout most of their length. The exposed rib-tips are short and stout, and protrude beyond the bony carapace throughout life; the eighth ribs show none of the posterolateral elongation and flexibility typical of many trionychids. The costal bones are fully developed throughout life, and intercostal fontanelles are absent. The costiform processes of the nuchal bone are expanded and grooved, and they curve posterolaterally, often overlapping the first pleural bones. The entire surface of the bony carapace is coarsely cratered and pitted, the concavities sometimes forming vaguely linear or vermiform configurations. The posterior margin of the bony carapace is distinctly and broadly incurved throughout life.

Plastron: The plastron consists of nine bones. The anterior processes of the epiplastra are relatively short, and sinuous in vertical profile. The entoplastron is very large and boomerang-shaped, the slender blades meeting at an angle of approximately 80-85 degrees. Callosities are absent on both entoplastron and epiplastra. On each side, the hyoplastron and hypoplastron are connected by a suture that laterally runs perpendicularly to the midline of the plastron, but towards the midline this suture angles sharply anteriorly. Each hyo-hypoplastral unit is almost completely covered by a superficial callosity that is fully developed even in young specimens. Each xiphiplastron also bears a single callosity that covers almost its entire surface. Along the anterior part of the mesial edge, the xiphiplastra show coarse, angular interdigitation (allowing extensive kinesis), while posteriorly the two bones enclose a permanent fontanelle. The anterior border of each xiphiplastron bears a lateral spur that, together with its smaller neighbor, embraces a corresponding angular spur in the posterior of the hypoplastron, and toward the midline smaller spurs of decreasing size may be present. Permanent entoplastral and mid-plastral fontanelles are present, the former penetrated to some extent by a series of sharp prongs adorning the rounded anteromedial face of each hyoplastron. Each hypoplastron bears an array of stubby protuberances on its posteromesial edge, that juxtapose but do not interdigitate with those of the opposing hypoplastron. There is frequent asymmetry between corresponding plastral elements in terms of the number of spurs, notches, or interdigitations that are present. Anterolaterally each hyoplastron is extended into a bifurcate prong, and the posterolateral corner of each hypoplastron bears two or three prongs. These prongs extend well beyond the lateral limits of the bony carapace.

Limb girdles: The pelvis is very broad and flaring, has a very large, undivided puboischiatic fontanelle (= thyroid fenestra of Romer, 1956 and Meylan, 1987), extremely well-developed pectineal processes, and strong metischial processes. The pectoral girdles are typically trionychid, the acromion process of the scapula,

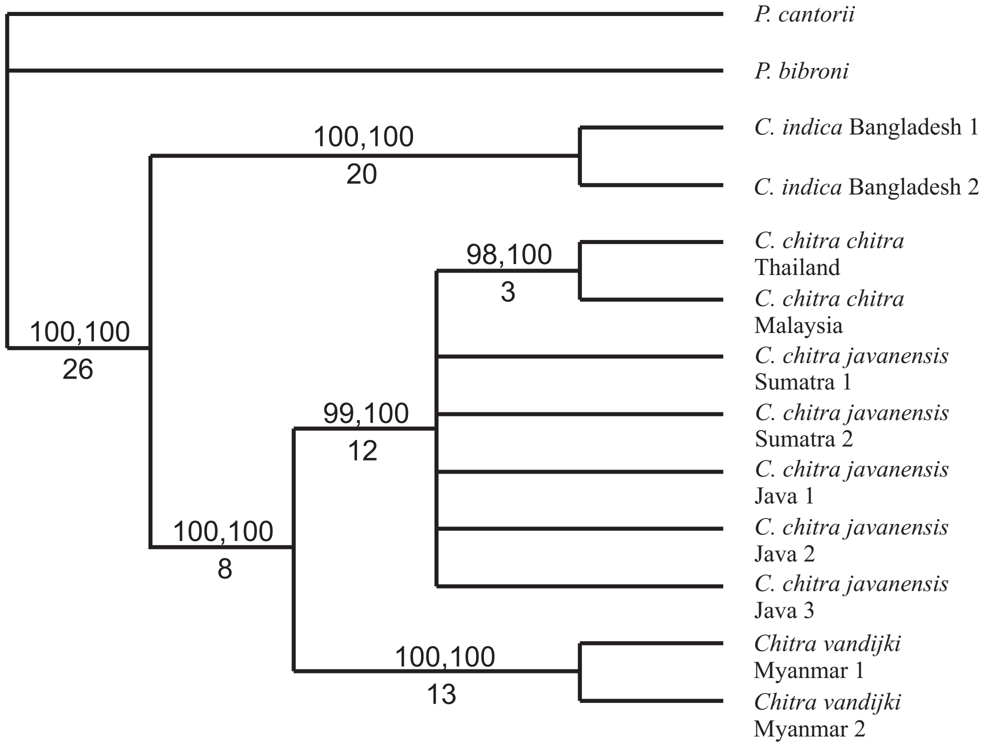

FIGURE 6: Bootstrap consensus phylogeny depicting the relationships within the genus *Chitra* based on likelihood and parsimony analysis (both indicate identical relationships) of the ND4 gene. Numbers above the node represent the bootstrap support for the node in 1000 replicates under likelihood on the left, and under parsimony on the right. Numbers below the node indicate decay index for the node. Redrawn from Engstrom et al. (2002).

the main body of the scapula, and the coracoid radiating in three directions from the glenoid fossa, with the coracoid both the longest and the broadest of the three.

Extremities: The humerus and femur are of very similar length and appearance (although the open entepicondylar groove always distinguishes the former), but the tibia and fibula and the phalanges of the posterior limbs are considerably longer than the corresponding elements of the forelimbs. Each limb bears only three claws (on digits 1-3), and on both fore- and hind limbs the five digits show progressive reduction in robustness from the first to the fifth. Digit 4 of the forelimb may show remarkable elongation and hyperphalangy, with as many as six phalanges.

Skeletal differences between the various populations and taxa of *Chitra* have not been fully documented. Carapacial proportions show some ontogenetic change, but a comparison between Indian (Hindon River) and Burmese (Ayeyarwaddy River) bony shells of virtually identical length is interesting. The Indian shell (CL 36.1 cm; CW 32.7 cm) was narrower than the Myanmar one (CL 36.0 cm; CW 36.8 cm), and had distinctly narrower neural bones. Taking neural I as exemplary, in the Indian specimen the width/length ratio of this bone was 70.6%; in the Burmese one it was 84.2%; and in three Javanese specimens of slightly larger size it was 78.2, 80.2 and 82.8%. The Indian specimens examined also generally had smaller, narrower, and more tapering exposed rib ends, and the edge of the bony carapace was progressively thinned, whereas in the Burmese and Javanese specimens the edge of the bony carapace was thick, and terminated abruptly rather than gradually. In overall contours, the bony carapace of half-grown Javanese specimens was more convex than those of specimens from Myanmar, and there was a tendency toward a slightly bilobed configuration, with a depressed vertebral region, in the former.

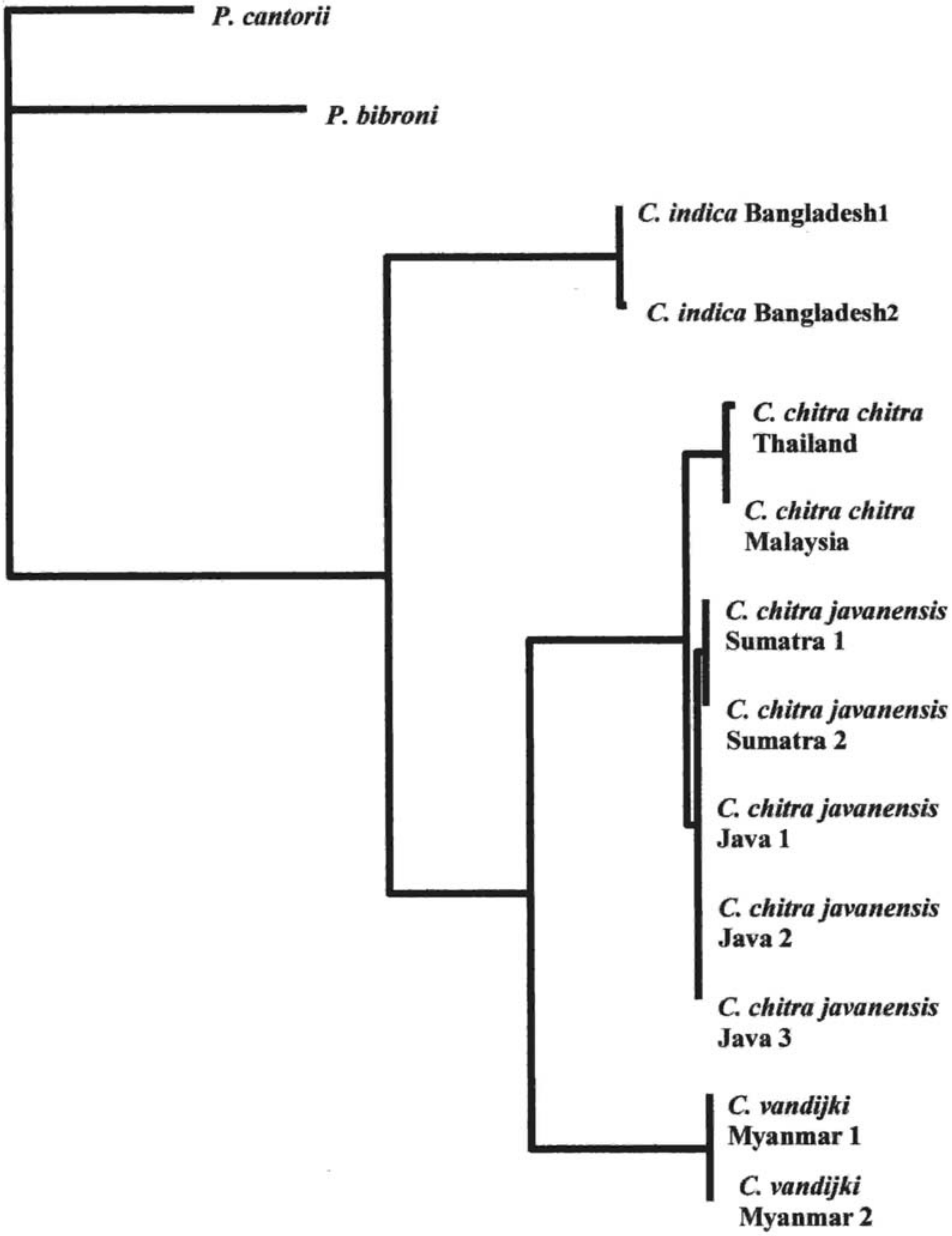

FIGURE 7: The single most likely topology of the phylogenetic relationships within the genus *Chitra* based on likelihood analysis of the ND4 gene. This topology shows the monophyly of the island and mainland clades within *Chitra chitra*. Redrawn from Engstrom et al. (2002).

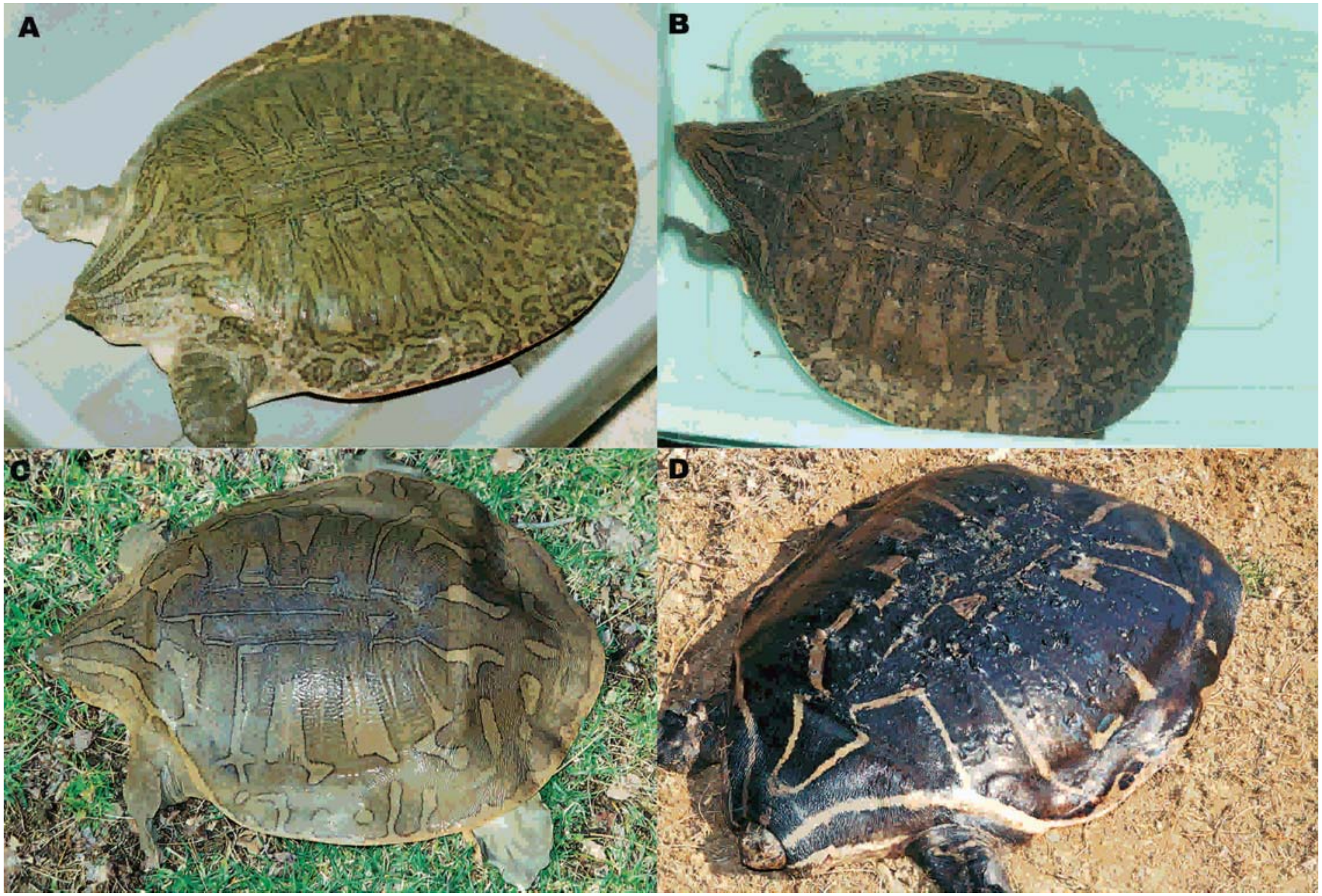

FIGURE 8: Narrow-headed softshells of the genus *Chitra*: (A) *C. indica* (Dhaka market, Bangladesh); (B) *C. vandijki* (Ruili market, Yunnan, China); (C) *C. c. chitra* (vicinity Kota Tinggi, Johor, Malaysia); (D) *C. c. javanensis* (Pasuruan River, Java, Indonesia).

FIGURE 9: Head markings of softshell turtles of the genus *Chitra* (same locality data as Fig. 8): (A) *C. indica*; (B) *C. vandijki*; (C) *C. c. chitra*; (D) *C. c. javanensis*.

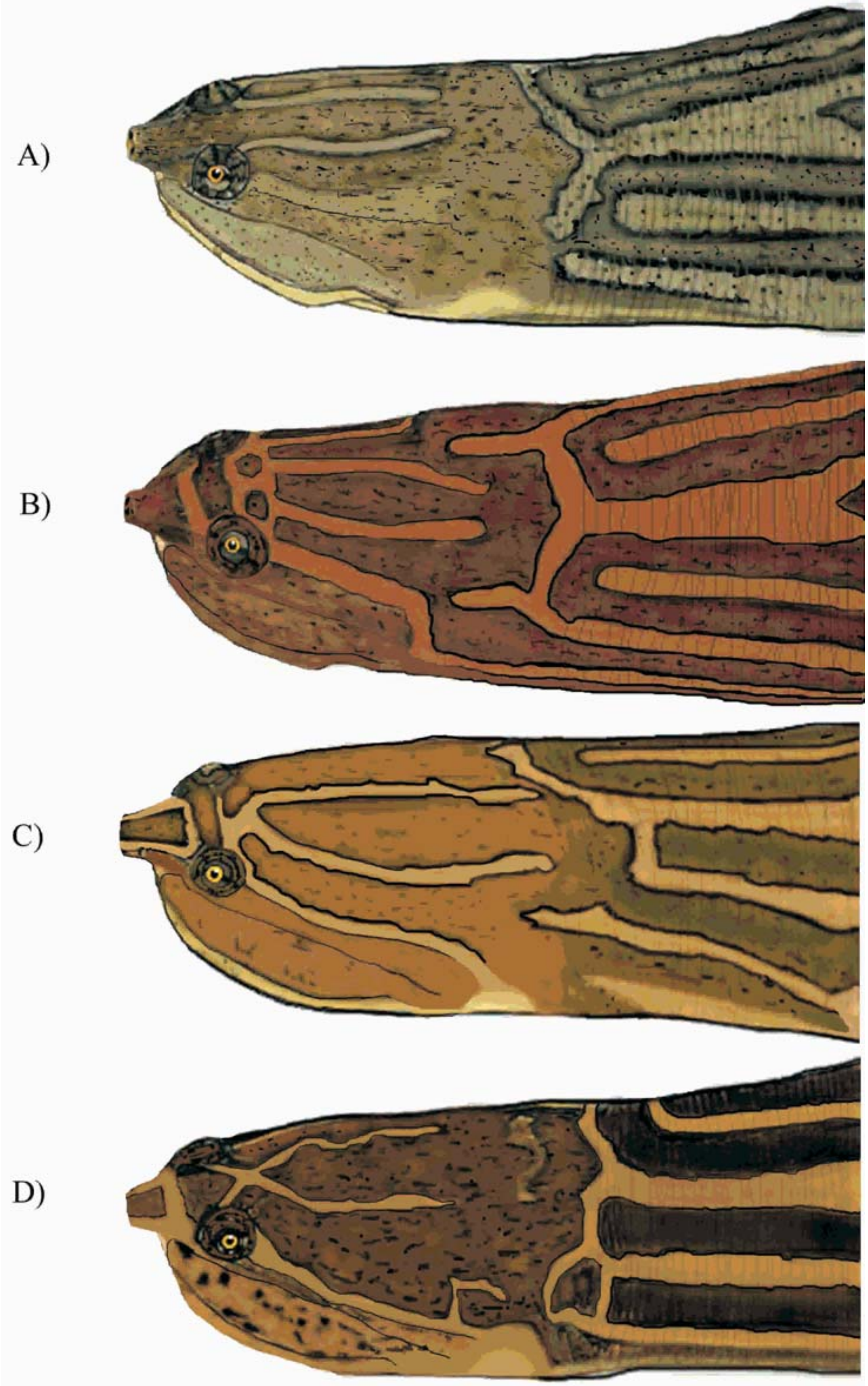

FIGURE 10: Original watercolour illustrations of *Chitra* head and neck patterns. (A) *C. indica*; (B) *C. vandijki*; (C) *C. c. chitra*; (D) *C. c. javanensis*.

FIGURE 11: Holotype of *Chitra vandijki*.

FIGURE 12: Holotype of *Chitra chitra javanensis*.

TABLE 1: Numbers of forelimb lamellae and pseudodigits in several *Chitra* populations.

Specimen	Left lamellae	Right lamellae	Left pseudodigits	Right pseudodigits
Chitra indica (Bangladesh)				
1	2	4	2	2
2	3	4	4	3
3	3	4	2	2
4	3	3	2	2
5	4	4	4	4
6	3	3	2	2
7	4	4	0	0
Chitra vandijki				
1	3	3	1	1
2	4	3	2	2
3	2	2	2	2
4	2	2	2	2
5	3	2	2	3
6	3	3	1	1
7	3	3	2	2
8	3	3	2	2
Chitra chitra (Thai, Malaysian, Indonesian)				
1	2	2	2	2
2	2	2	2	2
3	2	2	1	1
4	1	3	2	2
5	2	2	2	2
6	3	2	2	2

SYSTEMATICS

In striking contrast to its relative *Pelochelys*, which is regularly encountered in estuarine or even marine environments, the ability of *Chitra* to cross oceanic barriers remains undemonstrated. Furthermore, the consistent external differences in *Chitra* (primarily in markings and colour) between the populations in separate mainland river basins (i.e., the Indus/ Ganga/ Brahmaputra systems of Pakistan, India and Bangladesh; the Ayeyarwady system of Myanmar; and the Mae Klong system of Thailand) strongly suggest that genetic isolation is essentially complete. We still lack many details of the distribution in the insular part of the range (Indonesia) as well as on the Malaysian Peninsula. Nevertheless, the ability of the genus to have colonized rivers as far east as central and eastern Java (today separated from the continent of Asia by two marine barriers, the Straits of Malacca and Selat Sunda) may be explained in part by the extremely narrow nature of both of these straits, and in part by the fact that, during Quaternary times when sea levels were lower, the entire range of the genus *Chitra* was connected by land bridges

In parallel with our phenotypic, morphological and zoogeographic studies Engstrom and colleagues have conducted molecular studies of the same *Chitra* populations. Engstrom et al. (2002) found three very well supported deeply divergent evolutionary lineages within the genus *Chitra* (Figs. 6-7). These lineages correspond with the three species recognized here: *Chitra indica* (Gray, 1831a), *Chitra chitra* Nutaphand, 1986, and *Chitra* sp. nov. from Myanmar, described herein. The high level of molecular divergence (Table 2, 8.6%) between *Chitra indica* and the clade containing the *C. chitra* complex and the Myanmar *Chitra* sp. nov. is comparable to divergence levels between other well-recognized species in the family Trionychidae (Weisrock and Janzen, 2000; Engstrom et al., unpublished data) and indicates that these two lineages have a very long history of independent evolution. Similarly the sequence divergence of 5.1%-5.3% between the Myanmar *Chitra* and members of the *C. chitra* complex (Table 2) is higher than comparisons within North American trionychid species (Weisrock and Janzen, 2000) and indicates that these two lineages have also shared a long history of independent evolution. Based on this clear phylogenetic pattern, Engstrom et al. (2002) supports the recognition of three species within the genus *Chitra*.

Engstrom et al. (2002) also observed low levels of geographically structured molecular variation within the *Chitra chitra* complex that are consistent with the subspecies designations presented herein. The two mainland *Chitra chitra* samples differed from each other by a single base pair transition. All seven individuals from Java, of which three were reported by Engstrom et al. (2002), plus four by Engstrom and McCord (2002) had identical DNA sequences. These Java animals differed by a single base pair transition

TABLE 2: Sequence divergence for the outgroup taxa, *Pelochelys cantorii* and *P. bibroni,* and all *Chitra* individuals. The numbers of substitutions are above the diagonal; uncorrected P distances are below it. Reprinted from Engstrom et al. (2002).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1. *Pelochelys cantorii*	-	53	82	83	86	85	80	80	81	81	81	77	77
2. *P. bibroni*	0.072	-	87	88	93	92	87	87	88	88	88	94	94
3. *Chitra indica* Bangladesh	0.112	0.119	-	1	62	61	58	58	57	57	57	58	58
4. *C. indica* Bangladesh 2	0.113	0.120	0.001	-	63	62	59	59	58	58	58	59	59
5. *C. chitra chitra* Thailand	.118	0.127	0.085	0.086	-	1	8	8	7	7	7	39	39
6. *C. chitra chitra* Malaysia	0.116	0.126	0.083	0.085	0.001	-	7	7	6	6	6	38	38
7. *C. chitra javanensis* Sumatra 1	0.109	0.119	0.079	0.081	0.011	0.010	-	0	1	1	1	37	37
8. *C. chitra javanensis* Sumatra 2	0.109	0.119	0.079	0.081	0.011	0.010	0.000	-	1	1	1	37	37
9. *C. chitra javanensis* Java 1	0.111	0.120	0.078	0.079	0.010	0.008	0.001	0.001	-	0	0	38	38
10. *C. chitra javanensis* Java 2	0.111	0.120	0.078	0.079	0.010	0.008	0.001	0.001	0.000	-	0	38	38
11. *C. chitra javanensis* Java 3	0.111	0.120	0.078	0.079	0.010	0.008	0.001	0.001	0.000	0.000	-	38	38
12. *Chitra vandijki* Myanmar 1	0.105	0.128	0.078	0.081	0.053	0.052	0.051	0.052	0.051	0.052	0.052	-	0
13. *Chitra vandijki* Myanmar 2	0.105	0.128	0.078	0.081	0.053	0.052	0.051	0.051	0.052	0.052	0.052	0.000	-

from the two identical sequences from Sumatran specimens. These two island populations differed by 1% from mainland populations. This level of sequence divergence is similar to the level of divergence observed among subspecies of North American softshelled turtles (Weisrock and Janzen, 2000).

In contrast there is almost no molecular variation within *Chitra indica.* The two individuals from Bangladesh sequenced by Engstrom et al. (2002) differed from each other by a single transition. Engstrom and McCord (this volume) have extended this sampling to include another individual from Bangladesh as well as two individuals from Pakistan. In this expanded sampling two individuals from Bangladesh were identical while the third was more closely related to the two from Pakistan. The two individuals from Pakistan differ from one another by a single base pair transition and differ from the third Bangladesh individual by two transitions. This low degree of observed genetic differentiation is consistent with our recognition of *C. indica* as a monotypic species across its range (see Fig. 3B). This apparent genetic uniformity across such a broad geographic area, possibly explained by a highly mobile, riverine species being found in interconnected river systems, is an interesting biogeographic phenomenon, and merits further investigation (Engstrom and McCord, this volume).

We also confirm that for identification purposes, *Chitra* taxa show a fundamental division into two “phenotypic groups”. First is the “*Chitra indica* group” including *C. indica* and Myanmar *Chitra*, defined here as having: a very or relatively complex vertebral and costal pattern; a neck “V” with divergence point located on the anterior half of the extended neck; all neck stripes “blending” posteriorly into the carapacial and

TABLE 3: List of 14 diagnostic characters and their character states for the following species/subspecies of the genus *Chitra*: *C. indica, C. vandijki, C. chitra chitra, C. chitra javanensis*

	C. indica	*C. vandijki*	*C. c. chitra*	*C. c. javanensis*
1. Overall colouration	olive to deep-olive green	chocolate brown	greenish-yellow to olive-green	black
2. Midline (vertebral) carapacial pattern	very complex	moderately complex	simple	simple
3. Midline (vertebral) carapacial stripe	present	absent	usually present	absent
4. Radiating costal stripes	complex	simple	simple	simple
5. Paramedian neck stripes forming a bell-like pattern on anterior carapace	absent	absent	present	present
6. Neck stripes that form a continuous light rim around carapace	no	no	yes	yes
7. Distinct third pair of neck stripes	no	yes	no	no
8. Presence of dark speckling on “light” (head and neck) stripes	yes	no	no	no
9. Neck ‘V’ divergence point on neck	anterior	anterior	posterior	posterior
10. Number of forelimb lamellae	3-4	3-4	2	2
11. Peri-orbital ‘X’ pattern	no	no	no	yes
12. Distinct peri-orbital ocelli	no	yes	no (or partial)	no
13. Distinct naso-orbital triangular “figure”	no	no (or partial)	yes	yes
14. Chin pattern	Few, if any black dots present	black dots present	black dots present	black dots and ocelli present

axillary areas; three to four forelimb lamellae; no continuous light rim on the carapace; no bell-like figure on the carapace; and no distinct naso-orbital triangular figure. The other is the "*Chitra chitra* group" including Thai, Malaysian and Indonesian *Chitra*, having: a very or relatively simple vertebral and costal pattern; a neck "V" with divergence point located at or near the anterior border of the leathery carapace; neck stripes just lateral to the median neck stripe that continue posteriorly to form the continuous light rim present on the carapace; an average of two forelimb lamellae; a bell-like figure on the anterior carapace; and a distinct naso-orbital triangular figure (Table 3).

The molecular results (Figs. 6 - 7) do not parallel the "phenotypic groups" presented above. Genetically, Myanmar *Chitra* are closer to *C. chitra* than *C. indica*. This suggests that the phenotypic similarities between *C. indica* and Myanmar *Chitra* are shared ancestral character states (the "original" *Chitra* phenotype), and that the phenotypic differences in *C. chitra* would then be autapomorphies. At one time a common Myanmar *Chitra* and *C. chitra* ancestor became isolated from their *C. indica* ancestor, only later again to become isolated from each other. This allows *C.indica* and Myanmar *Chitra* to maintain a phenotypic resemblance to their common ancestor and thus each other, while at the same time allowing *C. chitra* to be phenotypically different from Myanmar *Chitra*, even though they share a common ancestor more recently. We must also consider that since DNA analysis only looks at part of the total genome, it is possible there are phenotypic differences for which the genetic basis has not yet been identified.

The various, parallel lines of investigation described in this paper, that include zoogeographic, morphological, chromatic, and genetic approaches, converge upon the conclusion that softshell turtles of the genus *Chitra* from Myanmar constitute an undescribed new species, and that *Chitra chitra* from eastern Java are subspecifically distinct. Descriptions and hypodigm are given in the text below.

Chitra indica (Gray 1831a) Indus, Ganga, Brahmaputra, and several peninsular river systems in India. See Appendix I for chresonymy.

Dorsal pattern (Fig 8A): The overall colour of the dorsal disc (carapace) varies greatly, from pale buff to typically deep olive green, and this variation is evident even among very young specimens. The overall pattern of juveniles is characterized by numerous elongate, irregular, curved light markings. These figures are asymmetrical and dark-bordered; they have a tendency towards longitudinal extension along the vertebral area, and radial deployment along the costals and towards the periphery. Dark spots, small blotches and ocelli may be dispersed among these wandering, vermiform markings. Around the periphery, the light markings may be relatively small and truncated by the edge of the leathery disc. At no stage is there a pale border to the entire outer circumference of the carapace in this species. Anteriorly, the markings become more organized and extend forward into the characteristic longitudinal dorsal neck stripes, the paramedian pair of which meet mesially behind the level of the skull.

With growth, the markings change. In the costal area, the markings radiating towards the periphery may become complex, and give the impression of a palimpsest of bold, dark-bordered vermiform figures superimposed upon a layer of much less defined "shadow" markings. Changes also occur in the vertebral region, where, in turtles of 15-18 cm or greater size, a remarkable, complex design of straight-edged, geometric figures develops. This design includes a pair of distinct, although sometimes interrupted, longitudinal light markings enclosing a series of finely-wrought triangular figures, oblique lines, and very fine longitudinal lines. A fine, sometimes interrupted, distinct midline stripe originating at the anterior rim of the bony carapace is usually present.

In large animals, the markings fade first along the midline, spreading to encompass the area of the bony disc, and ultimately the pattern fades over the entire leathery disc. By contrast, in the related giant softshell *Pelochelys bibroni* from southern New Guinea, which has dorsal markings similar to those of *Chitra* (although lacking the neck "V"), it appears that the pattern is poorly developed in young specimens, but is very bold and striking in large individuals (Webb, 1995).

Ventral coloration: The plastron is unpigmented, white in colour, sometimes with a pink tinge (vascular "blushing") in live individuals. The underside of the limbs and neck usually have a yellowish tinge. The only areas of the ventral aspect that are pigmented are the soles of the feet, which are varying shades of gray. The dorsal surface of the tail is light gray.

Cephalic and neck pattern (Figs. 9A & 10A): The most obvious component of the head and neck pattern is the series of longitudinal stripes, of which there are four on the dorsal surface of the head. The base of the neck has a pair of paramedian stripes that connect into a "V" anteriorly to form a single median stripe. There are two other pairs of stripes on the neck lateral to the paramedian stripes at the base of the neck and to the median stripe on the anterior neck. The most lateral pair blends posteriorly into the axillary region, while the inner pair blends posteriorly into the carapacial pattern (versus continuing intact around the entire rim of the carapace in *C. chitra*). Some individuals display a very indistinct third pair of stripes lateral to all others in the anterior neck. The distinct light stripes are dark bordered, typically with dark speckling within the stripes, and usually heavier dark speckling between them. The paramedian neck stripes extend posteriorly onto the carapace, where they become vaguely incorporated into the carapacial markings. The junction of the paramedian neck stripes (neck "V") occurs far forward on the anterior half of the extended neck, with the distance from the junction of the "V" to the anterior edge of the bony carapace (disc) being approximately 25% of the length of the entire carapace. In rare cases, the paramedian stripes may terminate at a transverse bar before reaching the junction of the "V", or they may become conjoined halfway along the neck, in all cases re-separating transversely near the back of the head. The pattern between the eyes consists of dark speckles only. The irides are golden yellow. The chin bears few, if any black dots. There is no distinguishable naso-orbital stripe pattern.

Chitra vandijki sp. nov.

See Appendix I for chresonymy.

Holotype: PCHP (CRI) 7059, a 22.0 cm (CL) subadult in alcohol, from the Ayeyarwady River system, northeastern Myanmar (Fig. 11). Obtained in the Ruili (Yunnan, China) market by O. Shiu, in 1997.

Paratypes: PCHP (CRI) 4896, a 41.2 cm subadult and PCHP (CRI) 4897, a 23.0 cm subadult, both in alcohol. PCHP (CRI) 5050, a 36.8 cm (bony disc length) subadult skeleton. All have same collection data as holotype.

Vernacular Name: Myanmar Narrow-Headed Softshell Turtle.

Etymology: Named in honor of Peter Paul van Dijk, of the Netherlands, the University of Galway in Ireland, and Chulalongkorn University in Bangkok, in recognition of his noteworthy contributions to the science and conservation of turtles and tortoises, especially the trionychid turtles of Asia.

Type locality: Since the holotype specimen has no specific locality, we hereby designate the type locality as Khayansat Kone Village (23°16.30´N; 95°58.99´E) on the Ayeyarwady River, where the species was first collected with precise field data by Steven Platt, 2001.

Distribution: The Ayeyarwady River basin of Myanmar. Not occurring sympatrically with any other *Chitra*.

Diagnosis and diagnostic comparisons: A large softshell turtle of the genus *Chitra*, in the *Chitra indica* "phenotypic group", distinguished from members of the *Chitra chitra* "phenotypic group" (Thai, Malaysian and Indonesian *Chitra*) by having: a relatively complex vertebral and costal pattern; a neck "V" with divergence point located on the anterior half of the extended neck; paramedian neck stripes blending into the carapacial pattern and not forming a bell-like figure near the front of the carapace; three to four forelimb lamellae; no continuous light rim around the carapace; and no distinct naso-orbital triangular "figure".

Chitra vandijki is distinguished from *C. indica*, the other recognized member of the *Chitra indica* "phenotypic group" by having: a wider bony shell; distinctly wider neural bones (see above); a more abruptly terminating, thicker-edged bony carapace; larger, wider, and less tapered rib tips extending beyond the bony carapace; an overall chocolate brown coloration; no midline carapacial stripe; less overall complexity to the vertebral and costal patterns; a distinct third pair of neck stripes lateral to the median stripe of the neck; distinct ocelli between or behind the eyes; no dark speckling on the light head and neck stripes; and black speckling on the chin.

Description: Dorsal pattern (Fig. 8B): The overall dorsal coloration is considerably darker than that of Indian specimens, with chocolate-brown and yellow-ochre colours predominating. The vertebral markings are relatively simplified, lacking the triangular and oblique elements, and the distinct midline stripe of *C. indica*. The streaks over the costal bones are markedly asymmetrical in most individuals, showing little if any "fine structure" or shadow-markings between the bold streaks. The leathery peripheral area of the dorsal disc is sprinkled predominantly with heavy, generally shapeless light blotches, some subcircular, others less vermiform than in *C. indica*, and with "finer" dark speckling between these light blotches than in *C. indica*. We have not seen very large specimens, and thus cannot comment on ontogenetic changes in pigmentation. Our largest live specimen has a total dorsal disc length of 38.5 cm. Platt (2001) illustrated a 40.8 cm specimen with coloration similar to those in our series.

Ventral coloration: The plastron is white or pinkish. The ventral surface of the limbs and neck have a yellowish tinge. The soles of the feet and dorsal surface of the tail are mid-gray to almost black in colour.

Cephalic and neck pattern (Figs. 9B - 10B): Because of the dark background colour, the dark borders of the four dorsal head stripes and the speckling in between the stripes are less contrasting then in *C. indica*. The speckling is absent within the dark borders of the light stripes of both head and neck. The dorsal neck markings include the standard "V" composed of the convergent paramedian stripes, with the apex of the "V" located on the anterior half of the extended neck at a distance from the anterior of the bony carapace (disc) approximating 20% of the entire carapace length. In this taxon, there are three well-defined, black-bordered stripes on the anterior part of the neck lateral to the median stripe on each side, giving a total of seven distinct stripes at this location on the neck (5 in *C. indica*). As in *C. indica*, the cranial median neck stripe bifurcates transversely near the back of the head. The stripes are often asymmetrical, contorted, or abruptly truncated, and may show asymmetrical lateral cross-connections. The paramedian neck stripes blend posteriorly into the carapacial pattern. The adjacent pair end abruptly on the carapacial rim between the neck and the forelimbs. The most lateral pair of lower (posterior) neck stripes blend into the axillae, while the most lateral (third) pair on the upper (anterior) neck, blend into the ventral mid-neck area. The interorbital pattern is very distinctive, usually including both a transverse light, dark-bordered bar connecting the orbits and one or two pairs of entire or nearly entire light, dark bordered ocelli posterior to the transverse bar between, or behind the eyes. The irides are bright golden-yellow, the chin is speckled with black and a naso-orbital figure is absent or poorly defined.

Chitra chitra chitra Nutaphand, 1986. Thailand (Khwae, Mae Klong and Mae Ping River systems) and Peninsular Malaysia.

See Appendix I for chresonymy.

Dorsal pattern (Fig. 8C): In Thai specimens, the predominant dorsal coloration in younger (up to 40 cm) specimens is varying shades of greenish-yellow. The background coloration darkens to olive green with growth, and large adults may be almost black, although the light markings remain distinct. In young animals, the leathery (dorsal) disc has a rather simple, although usually asymmetrical, pattern, with wandering, sometimes branched, vermiform, light, dark-bordered markings that in general become smaller towards the periphery. There is often a median vertebral stripe originating over the anterior bony carapace, no indistinct "shadow" markings, and the adornments of the vertebral area are not set-off or distinct in any way from those on the costals. Sometimes two distinct discontinuous paramedian vertebral stripes are also present, contrasting with the complex vertebral pattern of *C. indica*. The margin of the carapace is outlined with a light, continuous ring. In some individuals, the bold pale dorsal markings are sharply angular or hatchet-shaped rather than vermiform. The degree to which their form may change with ontogeny is not clear. In our experience the pattern is similar in specimens 30-75 cm in carapace length.

Ventral coloration: The plastron is unpigmented, the undersides of the limbs and neck may have a yellowish tinge, and the soles of feet and dorsal side of the tail are dark.

Cephalic and neck pattern (Figs. 9C - 10C): Four longitudinal head stripes are present. The paramedian neck stripes converge anteriorly to form the neck "V" much more posterior than in Myanmar specimens or in *C. indica*, typically at a point separated from the anterior of the bony carapace (disc) by a distance of only 10-12% of the length of the entire carapace. As paramedian neck stripes continue posteriorly they diverge on the carapace and form laterally-spreading curves or "hooks" that usually extend to reach the carapace margin anterolaterally. They display an angular medial constriction close to the point where they pass over the anterior bony disc, producing an indistinct bell-shaped figure. The pair of neck stripes adjacent to the median neck stripe diverge posterolaterally when reaching the anterior leathery carapace and each becomes continuous with the light border of the entire leathery carapace. The most lateral distinct neck stripes posteriorly blend into the axillary region. The anterior neck displays a third poorly defined pair of lateral neck stripes. The median neck stripe bifurcates transversely behind the head. No dark speckling is present in the light areas within the dark borders of the head and neck stripes. Dorsally, the orbits are connected by one or two transverse bars, sometimes with irregular and incomplete ocelli between or behind the eyes that connect to the anterior paramedian head stripes. When present these partial ocelli are not as distinct as in the Myanmar form. The irides are golden yellow. The chin has black ventral speckling. The naso-orbital pattern is very distinct, composed (in young specimens) of three light, dark-bordered stripes from nostrils to eyes, and from eye to eye, forming an anteriorly pointed triangular pattern. In larger specimens this nose/eye "figure" becomes a solid (anteriorly directed) light triangle.

Chitra chitra javanensis ssp. nov.

See Appendix I for chresonymy.

Holotype: MZB 199, a 57.0 cm (CL), dried specimen, captured July 1997 in a tidal creek of the Pasuruan River, near Pasuruan, East Java, Indonesia by local turtle hunters. Donated by F. Yuwono (Fig. 12).

Paratypes: MZB 264, a 34.2 cm subadult and MZB 265, a 15.5 cm juvenile, both in alcohol; MZB 266 and 267, both subadult skeletons; PCHP (CRI) 4965, a 32.3 cm subadult in alcohol and PCHP (CRI) 4975, an adult skeleton, bony disc length 48.0 cm; RMNH 34920, a 32.5 cm subadult and RMNH 34921, a 35.2 cm subadult, both in alcohol, and donated by H-D Philippen. All have same collection data as holotype.

Vernacular name: Java Narrow-Headed Softshell Turtle.

Etymology: Based upon the locality where the type specimens were collected (see text).

Type locality: Pasuruan River drainage, near Pasuruan, Probolinggo District, East Java, Indonesia.

Distribution: Currently known from the Pasuruan and Solo River drainages of eastern and central Java, Indonesia (see text for additional localities). *Chitra c. javanensis* is not sympatric with any other species or subspecies of *Chitra*.

Diagnosis: A large softshell turtle of the genus *Chitra*, a member of the *Chitra chitra* "phenotypic group", is distinguished from members of the *Chitra indica* "phenotypic group" (*C. indica, C. vandijki*) by having: a reduced, simple vertebral and costal pattern; a neck "V" located at or near the anterior rim of the leathery carapace;

an average of 2 forelimb lamellae; a very distinctive bell-like design on the anterior carapace; a continuous light circumferential rim on the leathery carapace, continuing anteriorly as neck stripes just lateral to the paramedian and median neck stripes; and a distinct triangular naso-orbital "figure".

Chitra c. javanensis is distinguished from the nominate subspecies (*Chitra c. chitra*) and fellow member of the *Chitra chitra* "phenotypic group" by having: darker overall coloration, especially in younger specimens; midline and lateral vertebral carapacial stripes usually lacking; a much more distinctive bell-shaped "figure" on the anterior of the carapace; an "X" shaped figure between the eyes formed by the anterior paramedian head stripes; no partial ocelli between or behind the eyes; bolder black speckling and ocelli on the chin; and narrower, more elongate costal markings.

Description: Dorsal pattern (Fig. 8D): The overall dorsal coloration is dark olive-brown to black, the light markings being light yellow-brown. The pale markings of the carapace, especially peripherally, are fewer in number and of smaller vermiform design, when compared to the more numerous and bolder vermiform markings of Thai and Malaysian specimens, and are often only pale "blotches". A median, and less often lateral, discontinuous vertebral stripes are all infrequently present over the bony carapace. The carapacial margin is outlined with a light, continuous ring. A distinctive bell-like design is seen on the anterior of the leathery carapace. There are no indistinct "shadow" markings, and neither the vertebral nor costal areas have complex designs as in *C. indica*.

Ventral coloration: The plastron is unpigmented; the underside of the limbs and neck are often yellow-tinged; the soles of the feet are dark, as is the dorsal tail.

Cephalic and neck pattern (Figs. 9D & 10D): Four longitudinal head stripes are present. The paramedian head stripes continue anteriorly decussating between or just behind the eyes so as to form an "X" pattern, and terminate at the anteromedial border of the opposite eye. As the median neck stripe posteriorly crosses the anterior leathery carapace it divides to form the neck "V". The point of divergence of the median neck stripe is posteriorly located as in Thai and Malaysian specimens. From this point these light stripes continue caudolaterally, until at the level of the anterior bony disc they briefly angle inward, sometimes almost meeting on the midline over the nuchal bone, before diverging toward the anterolateral rim of the carapace. This pattern usually leaves a distinct bell-like design. The pair of neck stripes adjacent to the paramedian neck stripes posteriorly diverge when reaching the anterior leathery carapace and each becomes continuous with the light border of the entire carapace. The most lateral distinct neck stripes blend into the axillae. The anterior neck displays a third poorly defined pair of lateral neck stripes. The median neck stripe bifurcates transversely behind the head. No dark speckling is present in the light areas within the dark borders of the head and neck stripes. The irides are golden yellow, the ventral chin has both strong black speckling and light centered black ocelli, and the naso-orbital stripe pattern is present, as in Thai and Malaysian forms. With growth the "triangular" figure between the eyes and nose (originally light stripe bordered with a dark center) becomes uniformly light in colour.

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LITERATURE CITED

AGASSIZ, L. 1857. Contributions to the Natural History of the United States of America. Vol. 1, 2. Little, Brown and Co., Boston.

ANNANDALE, N. 1912. The Indian mud-turtles (Trionychidae). *Rec. Indian Mus*. 7 (2): 151-180.

ARCHER, M. 1962: Natural history drawings in the Indian Office Library. Her Majesty's Stationery Office Library, London. ix + 116 pp., 25 pls.

BELL, T. 1829-1842. A monograph of the Testudinata. Parts 1-8, Samuel Highley, London. xiv + 80 pp., 40 pls.

BLUMENBACH, J. F. 1779. Handbuch öer Naturgeschichte. Vol. 1. Göttingen. 74 pp.

BODDAERT, P. 1770. III. Over de Kraakbeenige Schildpad. De Testudine cartilaginea. (Epist. Ad W. Roell, cum tab.) Kornelis van Tongerlo, Amsterdam. 40 pp.

BOETTGER, O. 1886. Aufzählung der von den Philippineine bekannten Reptilien und Batrachier. *Ber. Senckenberg. Naturf. Ges*. 1886: 91-134.

BOULENGER, G. A. 1889. Catalogue of the chelonians, rhynchocephalians and crocodiles in the British Museum (Natural History), Taylor and Francis, London. 311 pp.

________. 1890. Reptilia and Batrachia: in The Fauna of British India including Ceylon and Burma. Taylor and Francis, London. 541 pp.

BOUR, R., A. DUBOIS & R. G. WEBB. 1995. Types of recent trionychid turtles in the Museum national d'Histoire naturalle, Paris. *Dumerilia* 2: 73-92.

BOURRET, R. 1939. Notes herpétologiques sur l'Indochine francaise. XVI. Tortues de la collection du Laboratoire des Sciences naturelles de l'Université. Description d'une espèce nouvelle. *Ann. Bull. Gén. Instruct. Publ., Hanoi* 1938 (6): 5-12.

________. 1941. Les tortues de l'Indochine. Inst. Océanograph. l'Indochine. 235 pp.

BROOKES, J. 1828. Brookesian Museum. The Museum of J. Brookes; a Collection of Anatomical & Zoological Preparations. Privately published, London. (2) 20 pp.

CANTOR, T. E. 1847. Catalogue of reptiles inhabiting the Malayan Peninsula and islands. *J. Asiatic Soc. Bengal* 16: 607-656, 897-952, 1026-1078. Reprinted A. Asher, Amsterdam, 1966.

CARR, A. F. 1938. *Pseudemys nelsoni*, a new turtle from Florida. *Occ. Pap. Boston Soc. Nature. Hist*. 8: 305-310.

COX, M. J., P. P. van DIJK, J. NABHITABHATA & K. THIRAKHUPT. 1998. A photographic guide to snakes and other reptiles of peninsular Malaysia, Singapore and Thailand. New Holland Publishers (UK), Ltd., London. 144 pp.

DAS, I. 1991. Colour guide to the turtles and tortoises of the Indian subcontinent. R & A. Publishing Ltd., Avon. 133 pp.

________. 1995. Turtles and tortoises of India. Oxford University Press, Bombay 179 pp.

DAWSON, W. R. 1946. On the history of Gray and Hardwicke's Illustrations of Indian Zoology, and some biographical notes on General Hardwicke. *J. Soc. Bibl. nat. Hist*. 2 (3): 55-69.

DUBOIS, A. 2000. Synonymies and related lists in zoology: general proposals, with examples in herpetology. *Dumerilia* 4: 33-98.

DUMÉRIL, A.-M.-C. & G. BIBRON. 1835. Erpétologie générale ou histoire naturelle complète des reptiles. Librairie Encyclopedique de Roret (2) Paris. 680 pp.

ENGSTROM, T. N., H. B. SHAFFER & W. P. McCORD. 2002. Phylogenetic diversity of endangered and critically endangered southeast Asian softshell turtles (Trionychidae: *Chitra*). *Biol. Conser*. 104: 173-179.

________& W. P. McCORD. 2002. Molecular support for the taxonomic conclusions of McCord and Pritchard (2002), regarding *Chitra*. *Hamadryad* 27(1): 66-70.

FARKAS, B. 1994. Notes on type and type locality of the narrow-headed softshell turtle, *Chitra indica* (Gray, 1831). (Testudines, Trionychidae). *Misc. Zool. Hungarica* 9: 117-119.

FITZINGER, L. J. F. J. 1843. Systema reptilium. Fasciculus primus. Amblyglossae. Vindobonae, Apud Braumüller & Seidel, Vienna. 106 pp.

FORSKÅL, P. 1775. Descriptiones Animalium, Avium, Amphibiorum, Piscium, Insectorum, Vermium; quae in Itinere orientali observavit Petrus Forskål. Post mortem auctoris edidit Carsten Niebuhr. Hauniae, Copenhagen. 164 pp.

FRITZ, U. & F. J. OBST. 1999. Neue Schildkröten aus Südostasien. Teil. II. Bataguridae (*Cyclemys, Heosemys, Mauremys, Ocadia, Pyxidea, Sacalia*) und Trionychidae. *Sauria* (*Berlin*) 21 (1): 11-26.

GAFFNEY, E. S., M. ARCHER & A. WHITE. 1989. Chelid turtles from the Miocene freshwater limestones of Riversleigh Station, north-western Queensland, Australia. *American Mus. Nov.* 2959: 1-10.

GEOFFROY SAINT- HILAIRE, E. F. 1809. Sur les tortues molles, nouveau genre sous le nom de *Trionyx* et sur la formation des carapaces. *Ann. Mus. Hist. Natur. Paris* 14: 1-20.

GILMORE, C. W. 1922. A New Fossil Turtle, *Kinosternon arizonense*, from Arizona. *Proc. U. S. Nat. Mus.* 62: 1-8.

GRAY, J. E. 1830-35. Illustrations of Indian Zoology; chiefly selected from the collection of Major-General Hardwicke, F.R.S. Vol. 1 (published 1831), Treuttel, Wurtz, Treuttel jun. and Richter, also Parbury Allen and Co., London.

________. 1831a. A synopsis of the species of the Class Reptilia. pp. 1-110 *In*: The Class Reptilia, arranged by the Baron Cuvier, with specific descriptions. E. Griffith & E. Pigeon (Eds). Vol. 9. Whittaker, Treacher & Co., London.

________. 1831b. Synopsis Reptilium, or short descriptions of the species of reptiles. Part 1. Cataphracta, Tortoises, Crocodiles, and Enaliosaurians. Treuttel, Wurtz & Co., London. 84 pp.

________. 1844. Catalogue of the tortoises, crocodiles and amphisbaenians, in the collection of the British Museum. Brit. Mus., London. 80 pp.

________. 1855. Catalogue of the shield reptiles in the collection of the British Museum. Part I. Testudinata (Tortoises). Taylor and Francis, London. 79 pp.

________. 1864. Revision of the species of Trionychidae, found in Asia and Africa, with description of some new species. *Proc. Zool. Soc. London* 1864: 76-98.

________. 1870. Supplement to the catalogue of shield reptiles in the collection of the British Museum. Part 1. Testudinata (Tortoises), Taylor and Francis, London. 120 pp., 40 figs.

________. 1872. On Indian mud-tortoises (*Trionyx*). *Ann. Mag. Nat. Hist.* (4) 10: 326-340.

________. 1873. Notes on mud-tortoises (*Trionyx:* Geoffroy) and on the skulls of the different kinds. *Proc. Zool. Soc. London* 1873: 38-72.

GÜNTHER, A. C. L. G. 1864. The reptiles of British India. Ray Soc., London. xxvii + 452 pp. + I-XXVI pl. Reprinted 1982. Oxford and IBH Publ. Co., New Delhi, Bombay and Calcutta.

HARTWEG, N. 1938. *Kinosternon flavescens stejnegeri*, a new turtle from northern Mexico. *Occ. Pap. Mus. Zool.* Univ. Michigan 317: 1-5.

HAY, O. P. 1908. The fossil turtles of North America. *Carnegie Inst. Washington Publ.* 75: 1-568.

INTERNATIONAL COMMISSION Of ZOOLOGICAL NOMENCLATURE (ICZN). 1999. International Code of Zoological Nomenclature. Fourth edition. The International Trust for Zoological Nomenclature, London. XXIX + 306 pp. (in English and French).

ISKANDAR, D. T. 2000. Kura-kura & buaya Indonesia & Papua Nuigini, dengan catatan mengenai jenis-jenis di Asia Tenggara. IUCN, Inst. Technology Bandung, World Bank. [Also published in an English-language version with the title "Turtles and crocodiles of insular southeast Asia & New Guinea."] 191 pp.

IVERSON, J. B. 1979. A Taxonomic Reappraisal of the Yellow Mud Turtle, *Kinosternon flavescens* (Testudines: Kinosternidae) *Copiea* 1979: 212-225.

________.1992. A revised checklist with distribution maps of the turtles of the world. Privately published, Richmond, Indiana. 363 pp.

JACKSON, D. J. 1978. *Chrysemys nelsoni*. *Cat. Amer. Amph. Rept.* 210: 1-2.

JAEKEL, O. 1911. Die fossilen Schildkrötenreste von Trinil. pp. 75-81, pl. XV. In: Selenka, M. L. & M. Blanckenhorn (Eds.) 1911. Die Pithecanthropus-Schichten auf Java. Geologische und Paläontologische Ergebnisse der Trinil-Expedition (1907 und 1908). Wilhelm Engelmann, Leipzig

KING, F. W. & R. L. BURKE. 1989. Crocodilian, tuatara and turtle species of the world. Assn. Syst. Coll. Washington, D.C. 215 pp.

KINNEAR, N. B. 1925. The dates of publication of the Plates of the birds in Gray and Hardwicke's "*Illustrations of Indian Zoology*," with a short account of General Hardwicke. *Ibis*: 484-489.

KITIMASAK, W. & K. THIRAKHUPT. 2002. New Record of *Chitra chitra* Nutaphand, 1986 in Mae Ping River, Thailand. *Nat. Hist. J., Chulalongkorn U.* 2(1): 62-63.

KUCHLING, G. 1995. Turtles at a market in western Yunnan: Possible range extensions for some Asiatic chelonians in China and Myanmar. *Chelonian Conser. & Biol*. 1 (3): 223-226.

LIM, B. L. & I. DAS. 1999. The turtles of Borneo and Peninsular Malaysia. Nat. Hist. Publ. (Borneo), Kota Kinabalu. 151 pp.

MARTENS, E. C. VON. 1876. Die Preussische Expedition nach Ost-Asien. Nach amtlichen Quellen. Zoologischer Theil. Erster Band. Allgemeines und Wirbelthiere. Königl. Geheimen Ober-Hofbuchdruckerei (R. von Decker), Berlin. xii, 412 pp.

MAYR E. & P. D. ASHLOCK. 1991. Principles of systematic zoology. McGraw-Hill, Singapore 475 pp.

MEYLAN, P. A. 1987. The phylogenetic relationships of soft-shelled turtles (family Trionychidae). *Bull. American Mus. nat. Hist*. 186 (1): 1-101.

MINTON, S. A. 1966. A contribution to the herpetology of West Pakistan. *Bull. American Mus. nat. Hist*. 134: 29-184.

MOLL, E. O. 1980. Natural History of the River Terrapin. *Batagur baska* (Gray) in Malaysia (Testudines: Emyidae). *Malaysian J. Sci.* 6A: 23-62.

________. 1984. River Terrapin Recovery Plan for Malaysia. *The J. Wildl. & Parks* 3: 37-47.

________. 1989. New Protection for Malaysian Turtles. Turtles & Tortoises *(IUCN Tortoise & Freshwater Turtle Specialist Group Newsl.)*. (4): 8-9.

MÜLLER, L. 1923. Neue oder seltene Reptilien und Batrachier der Zoologischen Sammlung des bayr. Staates. *Zool. Anz., Leipzig* 57 (3/4): 49-61.

NUTAPHAND, W. 1979. The Turtles of Thailand. Siamfarm Zoological Garden, Bangkok. 222 pp.

________. 1986. [Manlai.The world's biggest softshell turtle]. In Thai. *Thai Zool. Mag.* 1 (4): 64-70.

________. 1990. [Softshelled Turtles]. (in Thai). *Thai Zool. Mag.* 5 (56): 93-104.

OWEN, R. 1853. Descriptive catalogue of the osteological series contained in the Museum of the Royal College of Surgeons. Pisces, Reptilia, Aves, Marsupialia. Taylor and Francis, London. (1): 350 pp.

PLATT, S. G. 2001. An investigation into the conservation status of *Kachuga trivittata* and other turtles of the upper Ayeyarwady and Dokhtawady (Myitnge) Rivers, Myanmar. Report to Wildlife Conservation Society, New York. 46 pp.

________, KALYAR & WIN KO KO. 2000. Exploitation and conservation status of tortoises and freshwater turtles in Myanmar. In: P.-P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds), Asian turtle trade; Proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. Phnom Penh. *Chelonian Res. Monogr*. 2: 95-100.

POPE, C. H. 1935. Natural History of Central Asia. Vol. X. The reptiles of China. Amer. Mus. Natur. Hist., New York. 604 pp.

PRITCHARD, P. C. H. 2001. Observations on body size, sympatry, and niche divergence in softshell turtles (Trionychidae). *Chelonian Conserv. and Biol.* 4(1): 5-27.

RASHID, S. M. A. & S. M. M. H. KHAN. 2000. Trade and conservation status of turtles and tortoises in Bangladesh. *In*: P.-P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds), Asian turtle trade; Proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. Phnom Penh. *Chelonian Res. Monogr.* 2: 77-85.

ROMER, A.S. 1956. The osteology of the reptiles. Univ. Chicago Press, Chicago. 772 pp.

SAMEDI & D. T. ISKANDAR. 2000. Freshwater turtle and tortoise conservation and utilization in Indonesia. *In*: P.-P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds), Asian turtle trade; Proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. Phnom Penh. *Chelonian Res. Monogr*. 2: 106-111.

SAWYER, F. C. 1971. A short history of the libraries and list of mss. and original drawings in the British Mus. (nat. Hist). *Bull. British Mus. (nat. Hist.)* 4: 77-204.

SHRESTHA, T. K. 1996a. New survival of rare chelonian in the altered habitats of Himalayan rivers in Nepal. *In:* Proc. Internat. Conf. Chelon. Conserv., Gonfaron, France: 52-56.

________. 1996b. Wetland use, habitat fragmentation and their impacts on turtles in Nepal. *In:* Proc. Internat. Conf. Chelon. Conserv., Gonfaron France: 57-61.

SCHWEIGGER, A. F. 1812. Prodromus monographiae cheloniorum. *Königsberg. Arch. Naturw. Math., Königsberg* 1: 271-368, 406-462.

SHARMA, D. S. K. & O. B. TISEN. 2000. Freshwater turtle and tortoise utilization and conservation status in Malaysia. In: P.-P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds), Asian turtle trade; Proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. Phnom Penh. *Chelonian Res. Monogr*. 2: 120-128.

SHEPHERD, C. R. 2000. Export of live turtles and tortoises from North Sumatra and Riau, Indonesia: a case study. In: P.-P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds), Asian turtle trade. Proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. Phnom Penh. *Chelonian Res. Monogr*. 2: 112-119.

SIEBENROCK, F. 1909. Synopsis der rezenten Schildkröten mit Berücksichtigung der in historischer Zeit ausgestorbenen. *Arten. Zool. Jahrb*., suppl. 10: 427-618.

SMITH, M. A. 1922. On a collection of reptiles and batrachians from the mountains of Penang, Malay Peninsula. *J. Fed. Malay Sta. Mus*. 10: 263-282.

________. 1930. The Reptilia and Amphibia of the Malay Peninsula from the Isthmus of Kra to Singapore, including the adjacent islands. (A Supplement to Dr. G. A. Boulenger's Reptilia and Batrachia, 1912). *Bull. Raffles Mus. Singapore, Straits Settlements* 3: 1-138.

________. 1931. The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. 1. Loricata, Testudines. Taylor & Francis Ltd. for the India Office, London. xxviii + 185 pp.

SMITH, H. M. & R. B. SMITH. 1973 "1972". Chresonymy ex synonymy. *Syst. Zool*. 21: 445.

STRAUCH, A. 1890. Bemerkungen über die Schildkrötensammlung in zoologischen Museum der kaiserlichen Akademie der

Wissenschaften zu St. Petersburg. *Mém. Acad. Impér. Sci. St. Pétersbourg* 7: 1- 127.

SWAN, L. W. & A. E. LEVITON. 1962. The herpetology of Nepal: A history, check list, and zoogeographic analysis of the herpetofauna. *Proc. California Acad. Sci*. 32 (6): 103-147.

TECHACHAROENSUKCHERA, V. 1991. [illustrations of Thai *Chitra*]. *J. Wildl. Thailand* 1 (1): 8-14.

TAYLOR, E. H. 1970. The turtles and crocodiles of Thailand and adjacent waters with synoptic herpetological bibliography. *Univ. Kansas. Sci. Bull*. 49: 87-179.

THEOBALD, W. 1868. Catalogue of the reptiles of British Birma, embracing the provinces of Pegu, Martaban, and Tenasserim, with descriptions of new or little-known species. *J. Linn. Soc., Zool*. 10: 4-67.

________. 1876. Descriptive catalogue of the reptiles of British India. Thacher, Spink & Co., Calcutta. 238 pp.

________. 1882. Burma, its people and productions, or, Notes on the fauna, flora, and minerals of Tenasserim, Pegu, and Burma. Vol. 1, Geology, mineralogy and zoology [Herpetology]. Hertford: Published by order of the Chief Commissioner of British Burma by S. Austin, Edition: [3rd ed.] p. 288-344.

THIRAKHUPT, K. & P. P. VAN DIJK. 1994. Species diversity and conservation of turtles of western Thailand. *nat. Hist. Bull. Siam Soc*. 42: 207-259.

VAN DIJK, P. .P. 1992. Variation in the southeast Asian soft-shelled turtle, *Amyda cartilaginea*. Unpublished Traveling Studentship Examination thesis submitted to the National University of Ireland, Galway. v + 79 pp. (+ 13 pp appendices.)

________. 1994. Report on a visit to Myanmar. 18-28 January 1994. Report to the Turtle Recovery Program. American Museum of Natural History and The World Conservation Union. 23 pp.

WAGLER, J. 1830. Naturliches System der Amphibien, mit Vorangehander Classification der Säugthiere und Vögel. J. G. Cotta'schen Buchhandlung, Munchen. 354 pp.

WEBB, R. G. 1980. Gray, Hardwicke, Buchanan-Hamilton, and drawings of Indian softshell turtles (family Trionychidae). *Amphibia-Reptilia* 1: 61-74.

________. 1981. The narrow-headed softshell turtle, *Chitra indica* (Testudines: Trionychidae), in peninsular India. *Rec. Zool. Surv. India* 79: 203-204.

________. 1995. Redescription and neotype designation of *Pelochelys bibroni* from southern New Guinea (Testudines: Trionychidae). *Chelonian Conser. & Biol*. 1 (4): 301-310.

WEISROCK, D. W. & F. J. JANZEN. 2000. Comparative molecular phylogeography of North American softshell turtles (*Apalone*): Implications for regional and wide-scale historical evolutionary forces. *Mol. Phylogenetics & Evol.* 14: 152-164.

WERMUTH, H. & R. MERTENS. 1961. Schildkröten, Krokodile, Brückenechsen. Gustav Fischer Verlag, Jena. 422 pp.

________&________ .1977. Liste der rezenten Amphibien und Reptilien. Testudines, Crocodylia, Rhynchocephalia. Das Tierreich. Berlin. 100: i-xxvii, 174 pp.

WHEELER, A. 1998. Dates of publication of J. E. Gray's Illustrations of Indian Zoology (1830-1835). *Arch. Nat. Hist*. 25 (3): 345-354.

ZHAO, E-M. & K. ADLER. 1993. Herpetology of China. S. S. A. R., Oxford, Ohio. 521 pp.

APPENDIX I

The following chronological chresonymy (Smith and Smith, 1973) presents original descriptions, synonyms, authors, dates and pagination of first use authorship for the narrow-headed softshell turtles of the genus *Chitra* and is the result of reviewing (with citation) the reference list herein. Authors of original descriptions are indicated by lack of colon or parentheses in the nominal-complex (Dubois, 2000). The type locality along with data for all available types is given. "In part" connotes inappropriate synonymy (= inapp. syn.) and that the author(s) included other forms (correctly or incorrectly) under the same name at that time. Explanation for names not presently in use is given. A bracketed [ ] nominal-complex is the currently accepted genus and species for that given synonym.

***Chitra indica* (Gray, 1831a)**

Trionyx Indicus Gray, 1831a: 18. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality is stated as "India" in Gray (1831a), "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864:92), later again revised to

"Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Objectively synonymized as "Trionyx Indicus, *Gray, Syn. Rept*. 47" under *C. indica* (Gray, 1831a:18) by Gray (1844: 49). [= *C. indica* (Gray, 1831a: 18)].

Trionyx Egyptiacus, Var. [sic] *Indicus* Gray, 1831a: Gray (1831b: 47; in part, includes Ganges and Barrackpore, India and Penang, Malaysia in locality data). Presently treated as an objective synonym (same type). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "In India, fl. Ganges, Penang" in Gray (1831b), revised to "India: Ganges; Futtaghur" by Gray (1864:92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17). Synonymized under *Trionyx indicus* Gray,1831a: 18 by Gray (1831b: 47). [= *C. indica* (Gray, 1831a: 18)].

Testudo Chitra Buchanan-Hamilton (unpublished): Gray (1831b: 47; in part, includes Ganges and Barrackpore, India and Penang, Malaysia in locality data). Illustration drawn 1804-5, # 522 India Office, London. Declared *nomen nudum* by Wermuth and Mertens (1961) since only published as a synonym, with no description, and not treated as an independent taxon before 1961 (ICZN Code). Type locality: specimens collected in India, Nepal and Burma were painted in Barrackpore, India (Archer, 1962: 39, 72); stated as "In India, fl. Ganges, Penang" in Gray (1831b), revised to "India: Ganges; Futtaghur" by Gray (1864:92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fategarh on the river Ganges, India." Subjectively synonymized under *Trionyx indicus* Gray, 1831a:18, by Gray (1831b: 47). [= *C. indica* (Gray, 1831a: 18)].

Testudo membranacea Blumenbach, 1779: Gray (1831b: 47, referring to "Mus. Col. Surg." specimen #1238.B; in part, includes Ganges and Barrackpore, India and Penang, Malaysia in locality data). *Nomen dubium* (available evidence is insufficient to permit recognition of the species to which this name was applied). Holotype: None designated. Type locality: "Guiana", South America (= *ex errore*). Questionable synonymy under *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 by Schweigger (1812: 366); *Trionyx indicus* Gray, 1831a: 18, by Gray (1831b: 47); and *Trionyx cartilaginea* (Boddaert, 1770) by Wermuth and Mertens (1961: 263). [= possibly *Amyda cartilaginea* (Boddaert, 1770: 1-39)].

TRIONYX AEGYPTIACUS. Var. Indica Gray, 1831a: Gray (1831 ["1830-35"] Plate 80 in *Illus. Ind. Zool*. (1): "part" 8, see Sawyer 1971: 50; Webb, 1980: 62). [See as "*Trionyx AEgyptiacus,* var. Indica" on second introductory page, Gray (1830-35) *Illus. Ind. Zool*., R. Webb, pers. comm.]. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17). Objective synonymy under *Trionyx indicus* Gray 1831a: 18 prior to publication of Plate 80 (see Webb, 1980: 62, 70), by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Gymnopus lineatus Duméril and Bibron, 1835: 491. Holotype: MNHN 6968. Type locality: "le Gange" river, India, later revised to "India: Ganges; Futtaghur" by Gray (1864:92). Conditionally and subjectively synonymized in Duméril & Bibron (1835: 492) with Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]), and *T. indicus* in Gray (1831b: 47). Subjectively synonymized with "Trionyx Indicus, *Gray, Syn. Rept.* 47" under *Chitra indica* (Gray, 1831a: 18) by Gray (1844: 49). [= *Chitra indica* (Gray, 1831a: 18)].

Trionyx AEgyptiacus, var. *Indicus* Gray, 1831a: Gray (1844: 49; in part, includes India, Philippine Islands, and Penang, Malaysia in locality data, [Synonym not italicized in original work here, nor in Gray 1855: 70 with same improper spelling (letter case); correctly italicized and proper case as *Trionyx aegyptiacus,* var. *indicus* in Gray 1864: 91, 1872: 332, 1873: 41; proper case, but italicized incorrectly as Trionyx aegyptiacus, *var*. indicus in Gray 1870: 89; proper case, with nothing italicized (with publication date of Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]) incorrectly given as "1832") as Trionyx aegyptiacus, var. indicus in Boulenger (1889: 264)]. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a), stated as "Ganges" on Plate 80, as both "Philippine Islands" and "India" in Gray (1844: 49), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17). Objective synonymy under *Trionyx indicus* Gray 1831a:18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Chitra indica (Gray, 1831a): Gray (1844: 49; in part, includes India, Philippine Islands, and Penang, Malaysia in locality data; synonym not italicized in original work). See Nutaphand's (1986: 68) subspecific designation; declared invalid by us. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as both "Philippine Islands" and "India" in Gray (1844: 49), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." [= *C. indica* (Gray, 1831a: 18)].

Gymnopus indicus (Gray, 1831a): Cantor (1847: 10, 616; in part, includes "*Pinang, Malayan Peninsula*, (*Estuaries, Sea Coast*). Rivers in India, Philippine Islands" in locality data; synonym not italicized in original work). Holotype (for synonym): specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]); but here used by Cantor (1847) is

BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from same specimen (see Boulenger 1889: 263 cite same BMNH specimens as "a. Hgr. [half grown], stffd., skull separate. Pinang. Dr. Cantor. (Type.)" under *P. cantoris* [= *P. cantorii* Gray, 1864: 90]). Type locality (for synonym): originally "India" in Gray (1831a); stated as quoted above in Cantor (1847), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Cantor, unaware of the then undescribed genus *Pelochelys*, incorrectly synonymized his "*Pinang*" specimen with "Chitra indica, Gray: Catal." (= Gray, 1844: 49); see footnote in Cantor (1847: 616) "In the living adult no …. is apparent, nor the outline of the costae, as represented in the figure [Plate 80] in *Illustrations of Indian Zoology*". The synonym itself was objectively synonymized under "CHITRA INDICA. (Plate VI. fig. C. [thought to be a *P. cantorii* Gray, 1864: 90, with an erroneous *Chitra* pattern])" by Günther (1864: 50). [= *C. indica* (Gray, 1831a: 18)].

Pelochelys cantorii Gray, 1864: 90; in part, due to synonymy here with "*Chitra indica*" (Gray, 1831a: 18) and "*Gymnopus indicus*" (Gray, 1831a: 18); synonym not italicized in original work. Holotype: Jointly BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull (see Figs. 9 and 10) from same specimen (see reference here to Cantor (1847) specimen); also see Boulenger's (1889: 263) [Cantor (1847)] specimen "a" as "Type". Type locality: here as "Malacca" (Malaysia); includes India, Penang, Malaysia and Philippines in locality data through synonymy; revised to "all other [excluding New Guinea] *Pelochelys* populations" by Webb (1995: 308). Inapp. syn. with Günther's (1864: 50) erroneously illustrated (see text) "*Chitra indica*" [although stated "not Gray", meaning here, not *Chitra indica* (Gray, 1831a: 18)] by Gray (1864: 90), and under *Trionyx (Gymnopus) Bibroni* Owen, 1853: 185, by Günther (1864: 108), Smith (1931: 160) and Wermuth and Mertens (1961: 260). See Webb (1995: 308) for proper designation. [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys cumingii Gray, 1864: 90; in part, due to synonymy here with "*Chitra indica*" (Gray, 1831a: 18); synonym not italicized in original work. Note incorrect subsequent spelling (*P. cummingii*) in Smith (1931: 160). Holotype: none designated. Syntypes (see inapp. syn. with *C. indica* (Gray 1831a: 18), as "a" and "b" in Gray (1844: 49); see also same specimens "f" and "g" designated by Boulenger (1889: 263) as "Types of *P. cumingii*"): BMNH 1947.3.4.5 and BMNH 1946.1. 22.13. Type locality: here as "Philippines"; includes India, Penang, Malaysia and Philippines in locality data through synonymy. Inapp. syn. with "Chitra indica, *Gray, Cat. Tort. B. M.* 49" by Gray (1864: 90, see reference to "Gray, Cat. Shield Rept. B.M. p. 70"). Proper synonymy under *Pelochelys cantoris* [sic, = *P. cantorii* Gray, 1864:90], but inapp. syn. with "Chitra indica, part., *Gray, Cat. Tort. P.* 49 (1844)" by Boulenger (1889: 263). Properly synonymized with *P. cantorii* Gray, 1864: 90, but inapp. syn. under *P. bibroni* (Owen, 1853: 185) by Smith (1931: 160), and Wermuth and Mertens (1961: 260). See proper subjective synonymy ("line priority") under *Pelochelys cantorii* Gray, 1864: 90, by Webb (1995: 308). [= *Pelochelys cantorii* Gray, 1864: 90].

Trionyx lineatus (Duméril and Bibron, 1835): Martens (1876: 196; in part, includes both India and Philippines in locality data; synonym not italicized in original work). Holotype: MNHN 6968. Type locality: originally "le Gange" by Duméril and Bibron (1835); stated as "Philippinischen inseln" (Philippine Islands) in Martens (1876). Conditionally and subjectively synonymized in Duméril & Bibron (1835: 492) with Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]), and *T. indicus* in Gray (1831b: 47). Inapp. syn. here placing Philippine *P. cantorii* Gray, 1864: 90 under *Trionyx* (*Gymnopus*) *lineatus* (Duméril and Bibron, 1835). See also inapp. syn. under "Philippinen" *C. indica var.* [sic] *cumingi* (= *P. cantorii* Gray, 1864: 90) by Boettger (1886: 93). Subjectively synonymized with "Trionyx Indicus, *Gray, Syn. Rept*. 47" under *Chitra indica* (Gray, 1831a:18), by Gray (1844: 49). [= *Chitra indica* (Gray, 1831a: 18)].

Chitra Indica var. [sic] *Cumingi* (Gray, 1864): Boettger (1886: 93; in part, includes India, Nepal, Penang, Malaysia and Philippines in locality data). Holotype: none designated. Syntypes (see inapp. syn. with *C. indica* (Gray 1831a: 18), as "a" and "b" in Gray (1844: 49); see also same specimens "f" and "g" designated by Boulenger (1889: 263) as "Types of *P. cumingii*"): BMNH 1947.3.4.5 and BMNH 1946.1.22.13. Type locality: originally "Philippinen" in Gray (1864: 90). Inapp. syn. as ssp. of *C. indica* (Gray, 1831a: 18). Inapp. syn. with "Chitra indica, *Gray, Cat. Tort. B. M.* 49" by Gray (1864: 90, see reference to "Gray, Cat. Shield Rept. B.M. p. 70"). Proper synonymy under *Pelochelys cantoris* [sic, = *P. cantorii* Gray, 1864: 90], but inapp. syn. with "Chitra indica, part., *Gray, Cat. Tort. p.* 49 (1844)" by Boulenger (1889: 263). Properly synonymized with *P. cantorii* Gray, 1864: 90, but inapp. syn. under *P. bibroni* (Owen, 1853: 185) by Smith (1931: 160), and Wermuth and Mertens (1961: 260). See proper subjective synonymy ("line priority") under *Pelochelys cantorii* Gray, 1864: 90 by Webb (1995: 308). [= *Pelochelys cantorii* Gray 1864: 90].

Pelochelys cantoris [sic] Gray, 1864: Boulenger (1889: 263; in part, due to synonymy here with "Chitra indica" (Gray, 1831a: 18), "Gymnopus indicus" (Gray, 1831a: 18) and "Pelochelys bibronii" (Owen, 1853: 185, 207); synonym not italicized in original work). Holotype: Jointly BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from the same specimen (here as Cantor's specimen "a", identified as the "Type"). Type locality: originally "Malacca" in Gray (1864: 90); stated here as "Ganges, Burma, Malay Peninsula, Borneo, Philippines"; revised to "all other [excluding New Guinea] *Pelochelys* populations" by Webb (1995: 308). Declared "an unjustified emendation" of *P. cantorii* Gray, 1864: 90 by Webb (1995: 308), and an incorrect subsequent spelling by us. Inapp. syn. here with "Chitra indica, part., *Gray, Cat. Tort. P.* 49 (1844)". [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys bibronii (Owen, 1853): Boulenger (1889: 263; in part, includes "Ganges, Burma, Malay Peninsula, Borneo, Philippines" in locality data; synonym not italicized in original work). Incorrect subsequent spelling. Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" [*ex errore*, by Owen (1853) and Gray (1864)]; stated as quoted above by Boulenger (1889), revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. here with "Chitra indica, part., *Gray, Cat. Tort. P.* 49 (1844)". [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Trionyx aegyptianus, var. *indicus* Gray, 1831a: Boulenger (1890: 16; in part, includes "Ganges and Irrawaddy" and Penang (Malaysia, through synonymy) in locality data; synonym not italicized in original work). Incorrect subsequent spelling. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as given above by Boulenger (1890: 16), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775:17). Objective synonymy under *Trionyx indicus* Gray, 1831a: 18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Pelochelys bibroni (Owen, 1853): Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data; synonym not italicized in original work; see also reference to "Australia" [*ex errore*, by Owen (1853) and Gray (1864)], under *Trionyx (Gymnopus) bibroni* Owen, 1853: 185). Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" (see above) by Owen (1853: 185); stated as quoted above by Smith (1931: 161), later revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. here with "*Chitra indica* (in part) Günther ….. 1864, p. 50, pl. vi." , thought to represent a *P. cantorii* Gray, 1864: 90 erroneously bearing a *Chitra* pattern. [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Pelochelys poljakowii Strauch, 1890: Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data). Species name correctly emended here to lower case. Holotype: none designated by Strauch (1890). Syntypes: Strauch (1890: 18) lists two skeletal specimens (#'s 7896 and 7897) in the Zool. Inst., Russian Acad. of Sci., St. Petersburg (= ZISP). Type locality: "Fu-tschau" [= Fuzhou, Fujian Prov., see Zhao and Adler (1993: 431)], China by Strauch (1890); as quoted above by Smith (1931: 161). Proper subjective synonymy with *P. cantorii* Gray, 1864: 90, but inapp. syn. here with the name "*Chitra indica* (in part) Günther …. 1864, p. 50, pl. vi.", even though thought to represent a *P. cantorii* Gray, 1864: 90, erroneously bearing a *Chitra* pattern taken from Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]), see text. [= *Pelochelys cantorii* Gray 1864: 90].

Trionyx indica Gray, 1831a: Taylor (1970: 152; in part, gives "Fategarh, Ganges 'Northern India'", but through synonymy also Penang, Malaysia and Philippines included in locality data). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864:92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), as quoted above by Taylor (1970), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Proper objective synonymy as "Trionyx Indicus, *Gray, Syn. Rept*. 47" under *C. indica* (Gray, 1831a:18), by Gray (1844: 49). [= *C. indica* (Gray, 1831a: 18)].

Trionyx AEgyptianns [sic], var. Indica Gray, 1831a: Webb (1980: 63; typographical error for *Trionyx AEgyptiacus,* var. Indica on second introductory page, Gray (1830-35) *Illus. Ind. Zool*., R. Webb, pers. comm.). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx* A*Egyptiacus* Geoffroy Saint-Hilaire 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål 1775: 17). Objective synonymy under *Trionyx indicus* Gray, 1831a:18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

***Chitra vandijki* sp. nov.**

Chitra Indica (Gray, 1831a): Theobald (1876: 27; in part, includes "the Ganges, Bengal, the Irawadi, and the estuaries of the Indian and Malayan coasts" in the locality data; synonym not italicized in original work). See also Theobald (1882: 340); Boulenger (1889: 263, 264); Annandale (1912: 152); Smith (1922: 264); Wermuth and Mertens (1961: 247); Taylor (1970: 153); Nutaphand (1979: 205, 1986: 68). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as both "Philippine Islands" and "India" in Gray (1844: 49), as "India: Ganges; Futtaghur" by Gray (1864: 92), as quoted above by Theobald (1876: 27), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. with "Irawadi" *Chitra*. [= *C. indica* (Gray, 1831a: 18)].

Testudo chitra Buchanan-Hamilton (unpublished): Theobald (1876: 27; in part, includes "the Ganges, Bengal, the Irawadi, and the estuaries of the Indian and Malayan coasts" in the locality data). See also Wermuth and Mertens (1961: 247). Justified emendation of the original spelling. Illustration drawn 1804-5, # 522 India Office, London. Declared *nomen nudum* by Wermuth and Mertens (1961) since only published as a synonym, with no description, and not treated as an independent taxon before 1961 (ICZN Code). Type locality: specimens collected in India, Nepal and Burma were painted in Barrackpore, India (Archer, 1962: 39, 72); revised to "India: Ganges; Futtaghur" by Gray (1864: 92), stated as quoted above in Theobald (1876: 27), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fategarh on the river Ganges, India." Subjectively synonymized under *Trionyx indicus* Gray, 1831a: 18, by Gray (1831b: 47). Inapp. syn. with "Irawadi" *Chitra*. [= *C. indica* (Gray, 1831a: 18)].

Gymnopus lineatus Duméril and Bibron, 1835: Theobald (1876: 27; in part, includes "the Ganges, Bengal, the Irawadi, and the estuaries of the Indian and Malayan coasts" in the locality data). See also Boulenger (1889: 264) and Wermuth and Mertens (1961: 247). Holotype: MNHN 6968. Type locality: originally "le Gange" river, India in Duméril and Bibron (1835); revised to "India: Ganges; Futtaghur" by Gray (1864:92); stated as quoted above in Theobald (1876). Conditionally and subjectively synonymized in Duméril & Bibron (1835: 492) with Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]), and *T. indicus* in Gray (1831b: 47). Subjectively synonymized with "Trionyx Indicus, *Gray, Syn. Rept.* 47" under *Chitra indica* (Gray, 1831a: 18) by Gray (1844: 49). Inapp. syn. with "Irawadi" *Chitra.* [= *Chitra indica* (Gray, 1831a: 18)].

Gymnopus indicus (Gray, 1831a): Boulenger (1889: 263; in part, with "Ganges, Burma, Malay Peninsula, Borneo, Philippines" in locality data; synonym not italicized in original work; also see reference to Cantor (1847: 10) which includes "*Pinang, Malayan Peninsula*, (*Estuaries, Sea Coast*). Rivers in India, Philippine Islands" in locality data). Holotype (for synonym): specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]); but here used by Cantor (1847) is BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from same specimen (see Boulenger 1889:263 cite same BMNH specimens as "a. Hgr. [half grown], stffd., skull separate. Pinang. Dr. Cantor. (Type.)" under *P. cantoris* [=*P. cantorii* Gray, 1864: 90]). Type locality (for synonym): originally "India" in Gray (1831a); revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as quoted above in Boulenger (1889) and earlier by Cantor (1847), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Cantor, unaware of the then undescribed genus *Pelochelys*, incorrectly synonymized his "*Pinang*" specimen with "*Chitra indica*, Gray: Catal." (= Gray, 1844: 49); see footnote in Cantor (1847: 616): "In the living adult no …. is apparent, nor the outline of the costae, as represented in the figure [Plate 80] in *Illustrations of Indian Zoology*". The synonym itself was objectively synonymized here with "Chitra indica, part., *Gray, Cat. Tort. P.* 49 (1844)", and under "CHITRA INDICA. (Plate VI. fig. C. [thought to be a *P. cantorii* Gray, 1864: 90, with an erroneous *Chitra* pattern])" by Günther (1864: 50). Inapp. syn. with "Burma" *Chitra.* [= *C. indica* (Gray, 1831a: 18)].

Pelochelys cantorii Gray, 1864 [= *P. cantoris* in Boulenger (1889: 263)]: Boulenger (1889: 263; in part, due to synonymy here with "Chitra indica" (Gray, 1831a: 18), "Gymnopus indicus" (Gray, 1831a: 18) and "Pelochelys bibronii" (Owen, 1853: 185, 207); synonym not italicized in original work [see Theobald "Burma" specimens "b" and "c", see also reference to Theobald (1876: 28)]). Holotype: Jointly BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from same specimen, listed here as "a. Hgr., stffd., skull separate. Pinang. Dr. Cantor. (Type.)". Type locality: originally as "Malacca" (Malaysia) in Gray (1864: 90); stated here as "Ganges, Burma, Malay Peninsula, Borneo, Philippines"; revised to "all other [excluding New Guinea] *Pelochelys* populations" by Webb (1995: 308). Inapp. syn. with "Burma" *Chitra*; see Webb (1995: 308) for proper designation. [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys cumingii Gray, 1864: Boulenger (1889: 263; in part, due to synonymy here with "Chitra indica" (Gray, 1831a: 18), "Gymnopus indicus" (Gray, 1831a: 18) and "Pelochelys bibronii" (Owen, 1853: 185, 207); synonym not italicized in original work). Holotype: none designated. Syntypes (see inapp. syn. with *C. indica* (Gray 1831a: 18), as "a" and "b" in Gray (1844: 49); see same specimens listed here as "f" and "g" and noted as "Types of *P. cumingii*"): BMNH 1947.3.4.5 and BMNH 1946.1. 22.13. Type locality: originally "Philippines" in Gray (1864: 90); stated here as "Ganges, Burma, Malay Peninsula, Borneo, Philippines" [but see reference to Gray (1864: 90)]. Proper synonymy under *Pelochelys cantoris* [sic, = *P. cantorii* Gray, 1864: 90], but inapp. syn. with "Burma" *Chitra* by Boulenger (1889: 263). Properly synonymized with *P. cantorii* Gray, 1864: 90, but inapp. syn. under *P. bibroni* (Owen, 1853: 185) by Smith (1931: 160), and Wermuth and Mertens (1961: 260). See proper subjective synonymy ("line priority") under *Pelochelys cantorii* Gray, 1864: 90 by Webb (1995: 308). [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys bibronii (Owen, 1853): Boulenger (1889: 263; in part, with "Ganges, Burma, Malay Peninsula, Borneo, Philippines" in locality data; synonym not italicized in original work). Incorrect subsequent spelling. Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" [*ex errore*, in Owen (1853: 185) and Gray (1864: 90)]; as quoted above by Boulenger (1889), revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. with "Burma" *Chitra*. [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Trionyx indicus Gray, 1831a: Boulenger (1889: 264; in part, with "Ganges and Irawaddy" as locality data; synonym not italicized in original work). See also Wermuth and Mertens (1961: 247). Justified emendation of original spelling. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as quoted above by Boulenger (1889), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Objectively synonymized here with "Chitra indica, part., *Gray, Cat. Tort. p.* 49 (1844)." Inapp. syn. with "Irawaddy" *Chitra*. [= *C. indica* (Gray, 1831a: 18)].

Trionyx aegyptiacus, var. *indicus* Gray, 1831a: Boulenger (1889: 264; in part, with "Ganges and Irawaddy" as locality data; synonym not italicized in original work). Justified emendation using lower case lettering, but incorrect subsequent spelling in reference here to Plate 80 in *Illus. Ind.*

Zool. (Gray, 1831 ["1830-35"], incorrectly given as "1832" in Boulenger [1889: 264]). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as quoted above by Boulenger (1889: 264), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17), and with "Irrawaddy" *Chitra*. Proper objective synonymy under *Trionyx indicus* Gray, 1831a: 18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Trionyx aegyptianus, var. *indicus* Gray, 1831a: Boulenger (1890: 16; in part, includes "Ganges and Irrawaddy" and Penang (Malaysia, through synonymy) in locality data; synonym not italicized in original work). Incorrect subsequent spelling. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as given above by Boulenger (1890: 16), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17), and with "Irrawaddy" *Chitra*. Objective synonymy under *Trionyx indicus* Gray, 1831a: 18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Trionyx (Gymnopus) Bibroni Owen, 1853: Pope (1935: 56; in part, includes "southern China and Burma southward through the Malay Archipelago to the Philippines and New Guinea." and "Australia" in the locality data). Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" by Owen (1853: 185); as quoted above by Pope (1935), later revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. with "Burma" *Chitra*. . [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Pelochelys poljakowii Strauch, 1890: Pope (1935: 56; in part, includes "southern China and Burma southward through the Malay Archipelago to the Philippines and New Guinea." in the locality data). Species name correctly emended here to lower case. Holotype: none designated by Strauch (1890). Syntypes: Strauch (1890: 18) lists two skeletal specimens (#'s 7896 and 7897) in the Zool. Inst., Russian Acad. of Sci., St. Petersburg (= ZISP). Type locality: originally "Fu-tschau" [= Fuzhou, Fujian Prov., see Zhao and Adler (1993: 431)], China by Strauch (1890: 18); as quoted above, but specifically as "Foochow" (China) by Pope (1935). Proper subjective synonymy under *P. cantorii* Gray, 1864: 90, but inapp. syn. under *P. bibroni* (Owen, 1853: 185), and with "Burma" *Chitra* by Pope (1935: 56). [= *Pelochelys cantorii* Gray, 1864: 90].

Trionyx indica Gray, 1831a: Taylor (1970: 152, 153; in part, with "India, Burma, and the Malay Peninsula" in the locality data). Justified emendation of original spelling. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "In India, fl. Ganges, Penang" in Gray (1831b), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), revised again to "Fatehgahr, Ganges" by Smith (1931: 162), as "Fatehgarh, Ganges 'Northern India'" and as quoted above in Taylor (1970: 152, 153), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Proper objective synonymy with "Trionyx Indicus, *Gray, Syn. Rept.* 47" under *Chitra indica* (Gray, 1831a: 18) by Gray (1844: 49). Inapp. syn. with "Burma" *Chitra*. [= *C. indica* (Gray, 1831a: 18)].

Trionyx aegyptiacus var. *indica* Gray, 1831a: Taylor (1970: 152, 153; in part, with "India, Burma, and the Malay Peninsula" in the locality data). Justified emendation using lower case lettering in reference here to Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), revised again to "Fatehgahr, Ganges" by Smith (1931: 162), as "Fatehgarh, Ganges, India" and as quoted above in Taylor (1970: 152,153), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17), and with "Burma" *Chitra.* Proper objective synonymy under *Trionyx indicus* Gray, 1831a: 18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

***Chitra chitra* Nutaphand, 1986: comb. nov. [new combination].**

Trionyx Indicus Gray, 1831a: Gray (1831b: 47; in part, with "In India, fl. Ganges, Penang" in locality data). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); as quoted above by Gray (1831b), as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864:92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Objectively synonymized as "Trionyx Indicus, *Gray, Syn. Rept*. 47" under *C. indica* (Gray, 1831a: 18) by Gray (1844: 49). Inapp. syn. with "Penang" (Malaysia) *Chitra.* [= *C. indica* (Gray, 1831a: 18)].

Trionyx Egyptiacus, Var. [sic] *Indicus* Gray, 1831a: Gray (1831b: 47; in part, includes Ganges and Barrackpore, India and Penang, Malaysia in locality data). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); as "In India, fl. Ganges, Penang" in Gray (1831b), as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12

(= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17), and with "Penang" (Malaysia) *Chitra.* Proper objective synonymy under *Trionyx indicus* Gray, 1831a: 18, by Gray (1831b: 47). [= *C. indica* (Gray, 1831a: 18)].

Testudo Chitra Buchanan-Hamilton (unpublished): Gray (1831b: 47; in part, includes Ganges and Barrackpore, India and Penang, Malaysia in locality data). Illustration drawn 1804-5, # 522 India Office, London. Declared *nomen nudum* by Wermuth and Mertens (1961) since only published as a synonym, with no description, and not treated as an independent taxon before 1961 (ICZN Code). Type locality: specimens collected in India, Nepal and Burma were painted in Barrackpore, India (Archer, 1962: 39, 72); revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Subjectively synonymized under *Trionyx indicus* Gray, 1831a: 18, by Gray (1831b: 47). Inapp. syn. with "Penang" (Malaysia) *Chitra.* [= *C. indica* (Gray, 1831a: 18)].

Testudo membranacea Blumenbach, 1779: Gray (1831b: 47, referring to "Mus. Col. Surg." specimen #1238.B; in part, includes Ganges and Barrackpore, India and Penang, Malaysia in locality data). *Nomen dubium* (available evidence is insufficient to permit recognition of the species to which this name was applied). Holotype: None designated. Type locality: "Guiana", South America (= *ex errore*). Questionable synonymy under *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12, by Schweigger (1812: 366); *Trionyx indicus* Gray 1831a: 18, by Gray (1831b: 47); and *Trionyx cartilaginea* (Boddaert, 1770) by Wermuth and Mertens (1961: 263). [= possibly *Amyda cartilaginea* (Boddaert, 1770: 1-39)].

Chitra indica (Gray, 1831a): Gray (1844: 49; in part, includes India, Philippine Islands, and Penang, Malaysia in locality data; synonym not italicized in original work). See also Cantor (1847: 616); Günther (1864: 50); Nutaphand (1979: 205). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as both "Philippine Islands" and "India" in Gray (1844: 49), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. with "Penang" (Malaysia) *Chitra.* [= *C. indica* (Gray, 1831a: 18)].

Trionyx AEgyptiacus, var. *Indicus* Gray, 1831a: Gray (1844: 49; in part, includes India, Philippine Islands, and Penang, Malaysia [by synonymy here with Gray, 1831b: 47] in locality data; synonym not italicized in original work here). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a), stated as "Ganges" on Plate 80, as both "Philippine Islands" and "India" in Gray (1844: 49), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775: 17), and with "Penang" (Malaysia) *Chitra*. Objective synonymy under *Trionyx indicus* Gray 1831a: 18 (see Webb, 1980: 62, 70), by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Gymnopus indicus (Gray, 1831a): Cantor (1847: 10, 616; in part, includes "*Pinang, Malayan Peninsula*, (*Estuaries, Sea Coast*). Rivers in India, Philippine Islands" in locality data; synonym not italicized in original work). Holotype (for synonym): specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]); but here used by Cantor (1847) is BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from same specimen (see Boulenger 1889: 263 cite same BMNH specimens as "a. Hgr. [half grown], stffd., skull separate. Pinang. Dr. Cantor. (Type.)" under *P. cantoris* [= *P. cantorii* Gray, 1864: 90]). Type locality (for synonym): originally "India" in Gray (1831a); stated as quoted above in Cantor (1847), revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Cantor, unaware of the then, undescribed genus *Pelochelys*, incorrectly synonymized his "*Pinang*" specimen with "Chitra indica, Gray: Catal." (= Gray, 1844: 49); see footnote in Cantor (1847: 616): "In the living adult no …. is apparent, nor the outline of the costae, as represented in the figure [Plate 80] in *Illustrations of Indian Zoology*". The synonym itself was objectively synonymized under "CHITRA INDICA. (Plate VI. fig. C. [thought to be a *P. cantorii* Gray, 1864: 90, with an erroneous *Chitra* pattern])" by Günther (1864: 50). Inapp. syn. with "*Pinang, Malayan Peninsula*" *Chitra.* [= *C. indica* (Gray, 1831a: 18)].

Pelochelys cantorii Gray, 1864: 90; in part, due to synonymy here with "*Chitra indica*" (Gray, 1831a: 18) and "*Gymnopus indicus*" (Gray, 1831a: 18); synonym not italicized in original work. Holotype: Jointly BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull (see Figs. 9 and 10) from same specimen (see reference here to Cantor (1847) specimen); also see Boulenger's (1889: 263) [Cantor (1847)] specimen "a" as "Type". Type locality: here as "Malacca" (Malaysia); includes India, Penang, Malaysia and Philippines in locality data through synonymy; revised to "all other [excluding New Guinea] *Pelochelys* populations" by Webb (1995: 308). Inapp. syn. with "Penang, Malaysia" *Chitra*; see Webb (1995: 308) for proper designation. [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys cumingii Gray, 1864: 90; in part, due to synonymy here with "*Chitra indica*" (Gray, 1831a: 18); synonym not italicized in original work. Note incorrect subsequent spelling (*P. cummingii*) in Smith (1931: 160). Holotype: none designated. Syntypes (see inapp. syn. with *C. indica* (Gray 1831a: 18), as "a" and "b" in Gray (1844: 49); see also same specimens "f" and "g" designated by Boulenger (1889: 263) as "Types of *P. cumingii*"): BMNH 1947.3.4.5 and BMNH 1946.1. 22.13. Type locality: here as "Philippines"; includes India, Penang, Malaysia and Philippines in locality data through synonymy. Inapp. syn. with "Penang" [Malaysian, by synonymy with Gray (1831b: 47) through reference to Gray (1855: 70)] *Chitra*, by Gray (1864: 90). Proper synonymy under *Pelochelys cantoris* [sic] Gray, 1864:90, but inapp. syn. with "Malay Peninsula" *Chitra* by Boulenger (1889: 263). Properly synonymized with *P. cantorii* Gray, 1864: 90, but inapp. syn. under *P. bibroni* (Owen, 1853: 185), by Smith (1931: 160), and Wermuth and Mertens (1961: 260). See proper subjective synonymy ("line priority") under *Pelochelys cantorii* Gray, 1864: 90 by Webb (1995: 308). [= *Pelochelys cantorii* Gray, 1864: 90].

Chitra Indica var. [sic] *Cumingii* (Gray, 1864): Boettger (1886: 93; in part, includes India, Nepal, Penang, Malaysia and Philippines in locality data). Holotype: none designated. Syntypes (see inapp. syn. with *C. indica* (Gray 1831a: 18), as "a" and "b" in Gray (1844: 49); see also same specimens "f" and "g" designated by Boulenger (1889: 263) as "Types of *P. cumingii*"): BMNH 1947.3.4.5 and BMNH 1946. 1. 22.13. Type locality: originally "Philippinen" in Gray (1864: 90). Inapp. syn. here as ssp. of *C. indica* (Gray, 1831a: 18), and with "Penang" [Malaysia, see references lead to Gray (1831b: 47)] *Chitra*. Proper synonymy under *P. cantoris* [sic] Gray, 1864: 90, but inapp. syn. with "Penang" and "Pinang" [Malaysia, see references to Gray (1831b: 47) and Cantor (1847:10)] *Chitra*, by Boulenger (1889: 263). Proper subjective synonymy ("line priority") under *P. cantorii* Gray, 1864: 90 by Webb (1995: 308). [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys cantoris [sic] Gray, 1864: Boulenger (1889: 263; in part, due to synonymy here with "Chitra indica" (Gray, 1831a: 18), "Gymnopus indicus" (Gray, 1831a: 18) and "Pelochelys bibronii" (Owen, 1853: 185, 207); synonym not italicized in original work). Holotype: Jointly BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from the same specimen (here as Cantor's specimen "a" identified as the "Type"). Type locality: originally "Malacca" in Gray (1864: 90); stated here as "Ganges, Burma, Malay Peninsula, Borneo, Philippines"; revised to "all other [excluding New Guinea] *Pelochelys* populations" by Webb (1995: 308).Declared "an unjustified emendation" of *P. cantorii* Gray, 1864: 90 by Webb (1995: 308), and an incorrect subsequent spelling by us. Inapp. syn. with "Malay Peninsula" *Chitra*. [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys bibronii (Owen, 1853): Boulenger (1889: 263; in part, includes "Ganges, Burma, Malay Peninsula, Borneo, Philippines" in locality data; synonym not italicized in original work). Incorrect subsequent spelling. Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" [*ex errore*, by Owen (1853: 185) and Gray (1864: 90)], as quoted above by Boulenger (1889), revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. with "Malay Peninsula" *Chitra*. [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Trionyx aegyptianus, var. *indicus* Gray, 1831a: Boulenger (1890: 16; in part, includes "Ganges and Irrawaddy" and Penang (Malaysia, through synonymy) in locality data; synonym not italicized in original work). Incorrect subsequent spelling. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); stated as "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as given above by Boulenger (1890: 16), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. as ssp. of *Trionyx AEgyptiacus* Geoffroy Saint-Hilaire, 1809: 12 (= *nomen substitutum* (Wermuth and Mertens, 1961: 282) for *Testudo triunguis* Forskål, 1775:17), and with "Penang" (Malaysia) *Chitra*. Objective synonymy under *Trionyx indicus* Gray, 1831a:18 (see Webb, 1980: 62, 70) by Gray (1831b: 47). [= *Chitra indica* (Gray, 1831a: 18)].

Pelochelys bibroni (Owen, 1853): Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data; synonym not italicized in original work; see also reference to "Australia" [*ex errore*, by Owen (1853) and Gray (1864)], under *Trionyx* (*Gymnopus*) *bibroni* Owen, 1853: 185). Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" (see above) by Owen (1853: 185); as quoted above by Smith (1931: 161), later revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. with "Malay Peninsula" *Chitra.* See Smith (1931: 161) mention "Cantor's type [presently *P. cantorii* Gray, 1864: 90, but here considered *P. bibroni* (Owen, 1853: 185) by Smith (1931)], said to have come from Malacca, is the only known example from the Malay Peninsula." [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Pelochelys poljakowii Strauch, 1890: Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data). Species name correctly emended here to lower case. Holotype: none designated by Strauch (1890). Syntypes: Strauch (1890: 18) lists two skeletal specimens (#'s 7896 and 7897) in the Zool. Inst., Russian Acad. of Sci., St. Petersburg (= ZISP). Type locality: "Fu-tschau" [= Fuzhou, Fujian Prov., see Zhao and Adler (1993: 431)], China by Strauch (1890); as quoted above by Smith (1931: 161). Proper subjective synonymy with *P. cantorii* Gray, 1864: 90, but inapp. syn. with "Malay Peninsula" *Chitra* by Smith (1931: 160). [= *Pelochelys cantorii* Gray, 1864: 90].

Trionyx indica Gray, 1831: Taylor (1970: 152; in part, gives "Fategarh, Ganges 'Northern India'", but through synonymy also Penang, Malaysia and Philippines included in locality data). Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool*. (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a); "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), as quoted above by Taylor (1970), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Proper objective synonymy with "Trionyx Indicus, *Gray, Syn. Rept.* 47" under *Chitra indica* (Gray, 1831a: 18) by Gray (1844: 49). Inapp. syn. with "Penang" (Malaysia) *Chitra*. [= *C. indica* (Gray, 1831a: 18)].

Chitra chitra Nutaphand, 1986: 64. Subspecific status by Nutaphand (1986: 68) declared invalid by us; synonym herein designated as nominate subspecies. See also Nutaphand (1990: 103). Holotype: herein designated as the specimen illustrated on page 65 in the original description.

Type locality: restricted to "Kanburi (presently Kanchanaburi), where the Khwae Noi and the Khwae Yai rivers join to form the Mae Klong River in Kanchanaburi Province, Thailand", by us [= *Chitra chitra chitra* Nutaphand, 1986: 64].

***Chitra chitra javanensis* ssp. nov.**

Chitra indica (Gray, 1831a): Müller (1923: 54; in part, having India, Philippine Islands, Penang, Malaysia and "Buitenzorg, Java" in the locality data). See Smith (1931: 160) for "Sumatra" locality. Holotype: specimen illustrated on Plate 80 in *Illus. Ind. Zool.* (Gray, 1831 ["1830-35"]). Type locality: originally "India" in Gray (1831a), "Ganges" on Plate 80, revised to "India: Ganges; Futtaghur" by Gray (1864: 92), as given above by Müller (1923), later again revised to "Fatehgahr, Ganges" by Smith (1931: 162), accepted by Webb (1980: 72) and us as "Fatehgahr on the river Ganges, India." Inapp. syn. with "Java" and "Sumatra" *Chitra*. [= *C. indica* (Gray, 1831a: 18)].

Pelochelys bibroni (Owen, 1853): Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data; synonym not italicized in original work; see also reference to "Australia" [*ex errore*, by Owen (1853) and Gray (1864)], under *Trionyx* (*Gymnopus*) *bibroni* Owen, 1853: 185). Holotype: Jointly RCS (London) 954-959 and 1093-1094, a group of skull and other skeletal parts from one specimen (see Webb, 1995: 301) – all lost in WW II. Neotype: AMS 3425, designated by Webb (1995: 302). Type locality: originally "Australian" (see above) by Owen (1853:185); as quoted above by Smith (1931: 161), later revised to "southern New Guinea" by Webb (1995: 302). Inapp. syn. with "Sumatra" *Chitra.* [= *Pelochelys bibroni* (Owen, 1853: 185, 207)].

Pelochelys poljakowii Strauch, 1890: Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China [specifically "type loc. Fuchow, China"]; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data). Species name correctly emended here to lower case. Holotype: none designated by Strauch (1890). Syntypes: Strauch (1890: 18) lists two skeletal specimens (#'s 7896 and 7897) in the Zool. Inst., Russian Acad. of Sci., St. Petersburg (= ZISP). Type locality: "Fu-tschau" [= Fuzhou, Fujian Prov., see Zhao and Adler (1993: 431)], China by Strauch (1890); as quoted above by Smith (1931: 161). Proper subjective synonymy with *P. cantorii* Gray, 1864: 90, but inapp. syn. with "Sumatra" *Chitra* by Smith (1931: 160). [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys cantorii Gray, 1864: Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data). Holotype: Jointly BMNH 1947.3.6.21, stuffed subadult, and BMNH 1947.3.6.22, skull from same specimen; see reference here to Cantor (1847) specimen in Gray (1864: 90); also see Boulenger's (1889: 263) [Cantor (1847)] specimen "a" as "Type". Type locality: originally "Malacca" (Malaysia) by Gray (1864: 90); as quoted above by Smith (1931: 161); revised to "all other [excluding New Guinea] *Pelochelys* populations" by Webb (1995: 308). Inapp. syn. with "Sumatra" *Chitra*. See Webb (1995: 308) for proper designation. [= *Pelochelys cantorii* Gray, 1864: 90].

Pelochelys cummingii Gray, 1864: Smith (1931: 160, 161; in part, includes "? Bengal; the Indo-Chinese Peninsula and Southern China; Hainan; ? the Malay Peninsula; Sumatra; Borneo; the Philippine Islands; New Guinea" in the locality data). Incorrect subsequent spelling. Holotype: none designated. Syntypes (see inapp. syn. with *C. indica* (Gray 1831a: 18), as "a" and "b" in Gray (1844: 49); see also same specimens "f" and "g" designated by Boulenger (1889: 263) as "Types of *P. cumingii*"): BMNH 1947.3.4.5 and BMNH 1946.1. 22.13. Type locality: originally "Philippines" by Gray (1864: 90); Smith (1931: 160) cites Gray (1864: 90) as "type loc. Philippine Is."; and as quoted above by Smith (1931: 161). Proper subjective synonymy with *P. cantorii* Gray, 1864: 90, but inapp. syn. with "Sumatra" Chitra by Smith (1931: 160, 161). See proper subjective synonymy ("line priority") under *Pelochelys cantorii* Gray, 1864: 90 by Webb (1995: 308). [= *Pelochelys cantorii* Gray, 1864: 90].

Chitra chitra Nutaphand, 1986: Iskandar (2000: 82; in part [subspecific status by Nutaphand (1986: 68) declared invalid by us; synonym herein designated as nominate subspecies], giving "South Thailand, Peninsular Malaysia, Sumatra and Java" in the locality data). See also Samedi and Iskandar (2000: 106). Holotype: herein designated as the specimen illustrated on page 65 in the original description. Type locality: restricted to "Kanburi (presently Kanchanaburi), where the Khwae Noi and the Khwae Yai rivers join to form the Mae Klong River in Kanchanaburi Province, Thailand", by us. Proper synonymy prior to *Chitra chitra javanensis* ssp. nov. described herein. Presently inapp. syn. (as *C. c. chitra*) with "Sumatra and Java" *Chitra*. [= *Chitra chitra chitra* Nutaphand, 1986: 64].

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NOTES ADDED IN PROOF

Jaekel (1911) described two new fossil *Chitra* species from the Trinil formations (approximately one million years old) of eastern Java. He based his new species *Chitra minor* upon a single xiphiplastron and associated hypoplastron, and his *Chitra Selenkae* upon a large entire carapace, a partial carapace, two entoplastra, a xiphiplastron, and various other bones. Although Jaekel himself (1911: 81) concluded that his two fossil *Chitra* species were not conspecific with any living *Chitra* species, because these taxa were named much earlier than either Nutaphand's *Chitra chitra* or our new living subspecies of *C. chitra* from Java, they need to be discussed. An examination of the Jaekel material and discussion in the light of the ICZN Rules is thus presented.

The two plastral bones attributed to *Chitra minor*, in our opinion, are not correctly assigned to the genus *Chitra*. Jaekel himself noted various points for which the material differed from typical *Chitra*, including the relatively small size in combination with the robust callosities typical of a fully adult turtle; the very small protrusions from the xiphiplastron; and the much deeper inward curvature of the inguinal notch.

Comparison of Jaekel's illustrations with actual skeletal specimens of *Chitra chitra*, *Chitra indica*, and other trionychids in the Chelonian Research Institute collection indicates beyond reasonable doubt that they are attributable to *Pelochelys*, not to any species of *Chitra*. Both bones are broken off on the left side (i.e., the right side of the living animal), with loss of some diagnostic areas; but the inguinal incurving is much deeper than in *Chitra* although appropriate for *Pelochelys*, and in *Chitra* the hyo-hypoplastral suture on each side is transverse for most of its length but strongly curved posteriorly in its distal section. In the Jaekel specimen, the suture is straight for at least the entire width of the specimen as preserved, showing no such posterior redirection. Furthermore, in younger *Chitra* specimens, there is a large, circular fontanelle in the posterior part of the line of contact between the xiphiplastra, and even in very old, large specimens the fontanelle is still present although somewhat narrower. In the Jaekel specimen, there is no trace of this fontanelle, and only a few minor projections are present on the midline and anterior margins of the bone. All of these features are characteristic of *Pelochelys*. We propose that *Chitra minor* be considered a junior synonym of the extant form of *Pelochelys* on the island of Java; i.e., *P. cantorii*.

The other Jaekel species (*C. Selenkae*) presents many typical *Chitra* characteristics, including a series of neural bones that separate all pleural bone pairs except for the posterior part of the eighth pair, and a xiphiplastron showing evidence of a large fontanelle in the posterior part of the midline xiphiplastral junction. Also present is a strong anterolateral xiphiplastral prong adjacent to a deep notch and a second, much shorter prong; this is typical of *Chitra* whereas in *Pelochelys* the outer prong is much less developed. The interdigitations along both the anterior and the midline edges of the bone are well developed, as in typical *Chitra* and contrasting with the condition in *Pelochelys*.

The carapace of *C. Selenkae* is shown inverted in Jaekel's illustration (Fig. 1, Plate XV), but is essentially complete, although the rib tips are either missing or covered by the outer edges of the pleural bones (not normal for *Chitra*, but possible in this very large [64 cm midline length] specimen). Overall, the carapace is less rounded than the typical bony carapace of *Chitra indica* or *C. chitra*, which are nearly circular, but not dissimilar to an even larger fossil *Chitra* carapace examined in central Java by PCHP in 1997. This is illustrated in Pritchard (2001, fig. 2), and has a maximum CL of 738 mm and midline CL of 702 mm. The two largest museum specimens of contemporary *Chitra chitra* are in the collection of Chulalongkorn University (Bangkok) and both measure 610 mm. An assumption at the time of inspection of the 738 mm specimen was that it was possibly a cast or a "man-made" gigantic contemporary specimen rather than a real fossil; but our subsequent reading of the Jaekel paper lends support to the likelihood that it is genuine, and a further example of *Chitra Selenkae*.

Although we find scant morphological justification for recognizing the fossil *Chitra Selenkae* and the living *Chitra chitra* as different species, there is also insufficient diagnostic evidence to confirm them as conspecific, thus we do not propose unjustified nomenclatural changes for the extant species solely on the grounds of chronological priority.

Paleontology and neontology are "different worlds", with such different techniques that conclusive comparisons are often difficult or even impractical. Modern *Chitra* species are differentiated primarily by genetic divergence, coloration, pattern, and superficial features such as forelimb lamellae and pseudodigits. Such characters are not an option for fossils, which have to be based upon whatever is available, often a few skeletal fragments.

Because Jaekel's *Chitra Selenkae* was described long before Nutaphand's proposal of *Chitra chitra*, strict priority consideration would affect the nomenclature, not only of the contemporary *Chitra* taxon in Java, but of *Chitra chitra* as a whole (i.e. in Thailand and Malaysia as well as Indonesia). As stated by Mayr and Ashlock (1991: 153) "The overriding need for stability dictates that accepted taxa and their names be maintained in all cases except when they are strongly contradicted by the evidence". Such changes to current or popular usage based entirely upon discovery of an unused possible senior synonym are strongly discouraged by the latest edition of the Rules of Nomenclature (see Article 23 etc., ICZN 1999).

Similar, yet different precedents where the fossil name was retained or resurrected were less taxonomically destabilizing than potentially seen here. In the case of *Elseya lavarackorum* (Gaffney et al., 1989) the subsequently discovered living form had not received a new name at the time they were recognized as conspecific with the fossil form. Iverson's (1979) synonymy of *Kinosternon flavescens stejnegeri* Hartweg, 1938 under *Kinosternon flavescens arizonense* Gilmore, 1922, involved what was then thought to be only subspecific forms from the same restricted locality, not affecting the taxonomic stability of the entire *Kinosternon flavescens* (Agassiz, 1857) species "complex". A precedent more directly comparable was the naming of *Pseudemys nelsoni* by Carr (1938), and the retention of this name by all modern authors despite the demonstration by Jackson (1978) that the fossil forms *Trachemys jarmani* and *Deirochelys floridana*, both of Hay (1908), where actually conspecific with *P. nelsoni*.

As first reviewer, for the reasons above, and with the knowledge that Jaekel's *Chitra Selenkae* is a name not used since its original description 91 years ago, therefore effectively "lost" to science for that period of time, we will continue here to recognize the extant Java *Chitra* as a subspecies of Nutaphand's (1986) *Chitra chitra*. With respect to the field of Paleontology, having given allochronic speciation serious consideration, these authors (having found over 25 works, by over 10 authors, over a period of more than 10 years using Nutaphand's *C. chitra* as an accepted valid name), have proceeded to petition the ICZN to declare Jaekel's *Chitra Selenkae* a *nomen oblitum*, thereby requiring the currently accepted name (*C. chitra*) to be maintained until a decision is rendered, for the sake of taxonomic stability.

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RANA (*HYLARANA*) *SENSU* DUBOIS (1992) IN INDIA AND THE IDENTITY OF *HYLORANA TYTLERI* THEOBALD, 1868

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(with four text-figures)

ABSTRACT.– **Morphometric comparison of frogs of the subgenus *Rana (Hylorana)* (s. str., Dubois, 1992) showed siginificant differences between the populations from West Bengal, India and those of *Rana erythraea* and *Rana taipehensis* from more eastern regions. Study of the holotype of *Hylorana tytleri* shows that for the Indian and Nepalese populations the name *Rana (Hylarana) tytleri* is available. A key to the species of *Rana (Hylarana)* and the known distributions of *Rana tytleri*, *Rana erythraea* and *Rana taipehensis* are provided.**

KEY WORDS.– ***Rana tytleri*, Ranidae, taxonomy.**

INTRODUCTION

Theobald (1868) described *Hylorana tytleri* from a single specimen from "Dacca" collected by Lt.-Col. Robert Francis Christopher Alexander Tytler (?-1916), British Administrator in the Andaman Islands. Thus the name is based on a holotype by monotypy. The specimen is extant in the collection of Zoological Survey of India, Kolkata, ZSI 10035 (Chanda et al., 2000). It is in a poor state of conservation (Fig. 1), the cranium being linked to the vertebral column, but the limbs are lost, except for a left side femur and tibia.

The original description is very short: "In size equal to *H. erythraea*, but with much more pointed snout, though not so narrow a muzzle as *H. macrodactyla.* Upper lip and beneath white. Back reddish brown. No pale lateral stripe". Boulenger (1882) listed it as a valid species, but later (Boulenger, 1890: 458) he considered it a synonym of *Rana erythraea*. His concept of this species was very broad and Sclater (1892a) tried a revision dividing it into two species. The first was *Rana erythraea* defined by broad laterodorsal folds; it included *Hylorana tytleri* and *Rana leptoglossa* (Cope, 1868) as synonyms. The second, *Rana nigrovittata*, was stated to have narrow dorsolateral folds and its synonymy included "*Rana tytleri*" Boulenger and *Rana pipiens* (Jerdon, 1870). Sclater (1892a: 345) stated that the type specimen of *Hylorana tytleri* is morphologically close to *Rana erythraea* and consequently he listed this specimen under this name in his list of amphibian specimens in the Indian Museum (Sclater,1892b: 10). Boulenger (1920: 152) mentioned the name of Theobald in the synonymy of *Rana erythraea*, as did Bourret (1942: 329) and it has remained in this synonymy until now (Frost, 2000).

Hylorana tytleri belongs to a group of species that includes the nominal species *Hyla erythraea* Schlegel, 1837, *Hylarana macrodactyla* Günther, 1859, *Rana taipehensis* Van Denburgh, 1909 and *Rana albolineata* Dubois, 1987 (replacement name of *Rana bilineata* Pillai and Chanda, 1981). The first available genus-group name for this group is *Hylarana* Tschudi, 1838 (type-species by monotypy: *Hyla erythraea* Schlegel, 1837). The name *Tenuirana* Fei et al., 1991 (type-species by original designation: *Rana taipehensis* Van Denburgh, 1909) is a subjective junior synonym of the latter. *Hylarana* is considered by most authors to be a subgenus of the genus *Rana* Linnaeus, 1758.

The systematics and nomenclature of *Hylarana macrodactyla* Günther, 1859 is clear. The status of this species has never been questioned since its establishment. It can easily be recognised by its elongated body, its long legs and specially long feet, its distinct longitudinal dark stripes on the body and its middorsal line (Taylor, 1962: 421-423; Chan-Ard et al., 1999: 77 for life photo). The nomenclatural situation of the four other nomina was and is still confusing. As a consequence, data on biology and distribution also can only tentatively be attached to one or another species.

Hyla erythraea Schlegel, 1837 was described on a large series of syntypes, that include RMNH 1744 (four specimens), RMNH 1746 (nine specimens), RMNH 1749 (one specimen) and MNHN 4570-4572, from Java. It is a large-sized frog. The males are about 50 mm and females may attain more than 70 mm. In 1909 a third close species was described, *Rana taipehensis*, which is of small size, males about 30 mm, females not more than 42 mm. The two forms are species that, beside size, can be distinguished by several characters, including extension of webbing and presence or absence of vocal sac in males. Nonetheless, Boulenger (1920: 152) put *Rana taipehensis* in the synonymy of *Rana erythraea*, arguing that the small specimens are young. We know other cases (AD & AMO, personal observations, Dubois, 1976, 1983, 1987) where Boulenger did not mention presence of sexual characters, particularly in small specimens when nuptial pads are formed of fine whitish spines, so we may suppose that he did not use optic instruments of technical quality sufficient to observe such structures. Smith (1923) confirmed the distinctness of *Rana taipehensis* and separated two species. Bourret (1937; 1942) followed these conclusions and gave morphological characteristics and distribution for the two species. Since then, two species have been recognised as distinct (Frost, 2000).

A fourth nomen was created by Pillai and Chanda (1981) for a frog present in north-eastern India (Garo Hills) *Rana bilineata*, which being preoccupied, was replaced by Dubois (1987) by the nomen *Rana albolineata*. This is clearly a taxon of the *Hylarana* group close to *Rana erythraea* and *Rana taipehensis*. Dubois (1992: 341) referred it to the synonymy of *Rana* (*Hylarana*) *taipehensis*. The holotype is a small-sized frog with dorsolateral folds, greenish colour and a white rictal gland. The authors did compare it to *Rana* (*Sylvirana*) *danieli* Pillai and Chanda, 1977 and *Rana* (*Hydrophylax*) *malabarica* Tschudi, 1838, two frogs of the *Hylarana* section *sensu* Dubois from north-eastern India. The species is known only from the holotype.

The frogs of the *Hylarana* subgenus from north-eastern India have for a long time been named *Rana erythraea* (Boulenger, 1920; Chanda, 1994; Frost, 2000). Romer (1951) stated that the frogs he collected in Mymensingh, Bengal are identical to *Rana taipehensis*. His determination was confirmed by Smith (Romer, 1951: 51). Only Dutta (1992) in his list of Indian frogs changed the name of the Indian *Hylarana* frogs to *Rana taipehensis*, recognizing a distinct species *Rana albolineata* for the frog from Meghalaya. Referring the Indian frogs to the biological taxon that bears the name *Rana taipehensis* leads us, as taxonomists, to reconsider the identity of the name *Hylorana tytleri* and the synonymy and distribution range of the frogs of the *Hylarana* group.

MATERIALS AND METHODS

Specimens studied.– *Rana erythraea*: MNHN 2001.0244-0246, BMNH 2000.0126, Cardamom Mountains, Cambodia; MNHN 1997.8390-8391, 1997.8393, 1997.8395-8396, 1997.8410-8412, Luang Prabang Laos; MNHN 4570-4572, syntypes, Java, Indonesia; MNHN 1987.3359-3360, Phu Kradung, Thailand; MNHN 1945.0043-0045, 1989.3465-3466, Siam [Thailand]; MNHN 1911.0202-0203, Annam, Vietnam.

Rana taipehensis: BMNH H2000.0129, Cambodia; CAS 18007, holotype, female, Taipeh, Taiwan, China; MNHN 4569, 1989.3488, China; MNHN 1987.3361-3372, Khao Yai, Thailand; MNHN 1997.5399-5401, Ben En, Vietnam; MNHN 1938.0041, 1938.0044-0045, Hadong, Vietnam; 1938.0040, 1938.0042-0043, 1991.0075, Tiênhô, Vietnam; MNHN 1996.3381-3387, Vietnam.

Hylorana tytleri: ZSI 10035, holotype, "Dacca" (= Dhaka, 90°36' E, 23°71' N), Bangladesh.

Rana sp.: PKM 1-12, Duillya, Howrah district, Bengal, India; MNHN 1997.8412, Birtamode, Nepal.

Measurements were taken with a slide caliper to the nearest 0.1 mm (by AMO or PKM), or, for values below 5 mm, with an ocular micrometer to the nearest 0.01 mm (by AMO). The list of measurements is given above. In order to facilitate comparisons, the description's methodology and plan were the same as those used in previous works on Asian anurans (Dubois and Ohler, 1998, 1999, 2000; Ohler and Dubois, 1999; Veith et al., 2001). The webbing formula is given according to Myers and Duellman (1982). As far as possible, subgroups of samples according to sex and age were treated separately in order to avoid sex dimorphism and growth allometry. Analyses were performed in three steps. First, multivariate factor analyses were performed in order to find groups in overall sample. These groups are then treated separately. Nonparametric Kruskall-Wallis test, Oneway analysis and multivariate analysis were used to describe variation between these groups of *Rana (Hylarana)* (Norusis, 1992). Then the holotype of *Rana tytleri* was allocated to one of these samples. Nomenclatural decisions follow the 4th edition of the International Code of Zoological Nomenclature (Anonymous, 1999).

Museums, collections and persons.– AD, Alain Dubois; AMO, Annemarie Ohler; CAS, California Academy of Sciences, San Francisco, California, USA; MNHN, Muséum National d'Histoire Naturelle, Paris, France; PKM, Pranab Kumar Mallick; RMNH, Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands; ZSI, Zoological Survey of India, Kolkata, India.

Measurements.– SVL: Snout-vent length. *Head:* HW: Head width; HL: Head length (from back of mandible to tip of snout); MN: Distance from back of mandible to nostril; MFE: Distance from back of mandible to front of eye; MBE: Distance from back of mandible to back of eye; IFE: Distance between front of eyes; IBE: Distance between back of eyes; IN: Internasal space; EN: Distance from front of eye to nostril; EL: Eye length; NS Distance from nostril to tip of snout; SL Distance from front of eye to tip of snout; TYD: Greatest tympanum diameter. Forearm: HAL: Hand length (from base of outer palmar tubercle to tip of finger III); FLL: Forelimb length (from elbow to base of outer tubercle); TFL: Third finger length (from base of first subarticular tubercle). Hindlimb: FL: Femur length (from vent to knee); TL: Tibia length; FOL: Foot length (from base of inner metatarsal tubercle to tip of toe IV); FTL: Fourth toe length (from base of first subarticular tubercle); IMT: Length of inner metatarsal tubercle; ITL: Inner toe length.

RESULTS

Multivariate analysis shows important variation in the sample of *Rana* (*Hylarana*) studied (Fig. 2, Table 1). In fact the sample of frogs from Bengal forms a distinct nonoverlapping group with the specimens of *Rana erythraea* and *Rana taipehensis*. This difference between the three samples is also evident from non-parametrical statistics. Of the 21 measurements studied, 11 show significant differences (Table 2).

In particular size (SVL) and relative length of shank (TL) are significantly different between the three subsamples. Only these two measurements can be used for allocation of the holotype of *Hylorana tytleri*: SVL as length of the unit cranium – vertebral column and the length of the tibia. Despite the poor state of the holotype of *Hylorana tytleri*, both measurements should be rather precise being based upon bony structures. Table 3 gives the values of SVL and RTL for males and females of three samples. The range of variation is rather high for these measurements in the samples of *Rana erythraea* and *Rana taipehensis* from Indochinese region, because the specimens originated from several geographically distant locations in each sample. *Rana (Hylarana)* from Bengal is morphologically much less variable due to its restricted origin. The value for RTL of the holotype of *Rana tytleri* falls within the range of all samples. It is very close to the mean value for *Rana (Hylarana)* from Bengal and lies at the upper range for *Rana* *erythraea* (Fig. 3). The values for SVL and RTL of the holotype lie outside the range of *Rana erythraea* of similar size (Fig. 4). Only large, female specimens of *Rana erythraea* have such relatively longer shanks (Table 2). The holotype of *Hylorana tytleri* has a SVL of 33.0 mm. As there are no primary or secondary sexual characters observable in the current state of the specimen, and previous authors did not state any such characters, we cannot ascertain the sexual identity of the specimen.

CONCLUSIONS

Rana erythraea is a large-sized form. The frogs from north-eastern India clearly do not belong to this species as the maximum body size reported from this region is about 45 mm. The Indian frogs are very similar to *Rana taipehensis*, but show some morphological differences to the populations from the Indochinese region and China (including the holotype). Males and females of the Bengal populations are slightly but significantly larger than those from more eastern populations and show differences concerning measurements of various body parts. Specimens in life show differentiation in dorsal colour pattern showing in the Indian and Nepalese specimens a pair of distinct brown stripes along the inner side of the latero-dorsal folds, which are white in colour (Pillai and Chanda, 1981; Deuti and Bharati Goswami, 1995; Dubois, unpublished data). In contrast, in the Indochinese and Chinese specimens such bands are usually absent or indistinct and discontinuous. Morphometrical variation and colour pattern differences are strong indications for genetic isolation of the two samples.

The taxonomic identity of the Indian populations of *Rana (Hylarana)* should be established. It would be particularly interesting to study populations usually referred to *Rana taipehensis* from all over their range, in particular those close to the Indian populations. The morphological differentiation indicates a rather high degree of evolutionary isolation, which suggests that the Indian populations should be treated as a distinct taxon at the subspecies or species level, depending on the genetic situation in the zone of contact.

The nomenclatural consequences of separating the Indian populations and recognizing for them a distinct species are restriction of the use of the nomen *Rana (Hylarana) taipehensis* for the Chinese and Indochinese populations and use of the nomen *Rana tytleri* for the populations from the Indian subcontinent. The taxonomic identity of the Indian *Rana (Hylarana)* has never been clear and no consensus could be claimed for conservation of any nomen.

The holotype of *Rana tytleri* is slightly larger than the 11 males of *Rana (Hylarana)* from Bengal that we measured. It is distinctly smaller than the females from India (Table 2, Sarkar, 1984). It is probably an adult male. In order to stabilize the nomenclatural situation (Anonymous, 1999: Article 75.5), a request to the Commission of Nomenclature should be made for setting aside the name-bearing type and for designation of a neotype from the type locality should be made. This type-specimen should come from a place with good management conditions that can be expected to be a perennial location, and it should be deposited in an international collection.

KEY TO FROGS OF THE SUBGENUS *RANA (HYLARANA) SENSU* DUBOIS

1. Size of adult male over 35 mm, size of adult female over 55 mm; head relatively blunt; webbing with not more than 2 phalanges of toe IV free of web .... *R. erythraea*
– Size of adult male up to 33 mm, size of adult female up to 43 mm; head elongate; webbing with more than two phalanges free of web 2
2. Body with five longitudinal golden or yellowish lines and a distinct middorsal line; head very elongated; toes very elongated, feet longer than shanks, three phalanges of toe IV free of web .... *R. macrodactyla*
– Body uniformly greenish with two whitish or yellow lines laterally on back but without middorsal line; head moderately elongated; 2 ½ phalanges of toe IV free of web 3

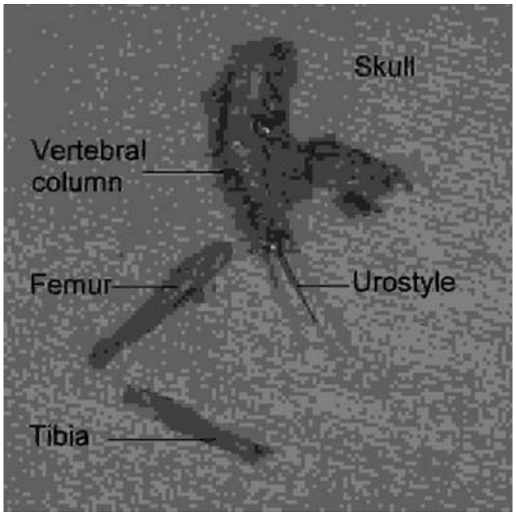

FIGURE 1: *Hylorana tytleri*, ZSI 10035, holotype, "Dacca" (= Dhaka, Bangladesh); SVL 30 mm.

TABLE 1: Results of principal component analysis using Varimax rotation with Kaiser Normalization on a sample of adult males of *Rana erythraea*, *Rana taipehensis* and *Rana* sp.

Component	Initial Eigenvalues Total	% of Variance	Cumulative %
1	13.993	77.737	77.737
2	1.439	7.992	85.730
3	0.797	4.429	90.158
4	0.543	3.017	93.175
5	0.283	1.571	94.746
6	0.228	1.268	96.014
7	0.154	0.854	96.868
8	0.144	0.797	97.666
9	0.105	0.581	98.247
10	7.737E-02	0.430	98.677
11	7.178E-02	0.399	99.075
12	5.723E-02	0.318	99.393
13	3.461E-02	0.192	99.586
14	2.631E-02	0.146	99.732
15	1.850E-02	0.103	99.835
16	1.305E-02	7.252E-02	99.907
17	1.115E-02	6.193E-02	99.969
18	5.577E-03	3.098E-02	100.0

Component	1	2	3
LIFE	0.909	0.212	0.281
LIBE	0.893	0.303	0.135
LMFE	0.793	0.346	0.347
LMBE	0.787	0.309	0.270
LMN	0.675	0.518	0.450
LIN	0.597	0.456	0.425
LHAL	0.375	0.820	0.256
LTYD	0.514	0.775	0.208
LEN	0.131	0.688	0.631
LHW	0.599	0.669	0.394
LHL	0.588	0.669	0.378
LEL	0.327	0.665	0.573
LFOL	0.449	0.660	0.543
LSVL	0.559	0.600	0.553
LFTL	0.251	0.126	0.937
LTFL	0.237	0.489	0.767
LTL	0.459	0.435	0.734
LFLL	0.497	0.422	0.692

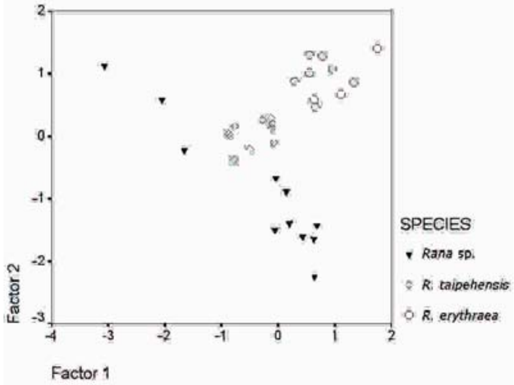

FIGURE 2: Scatter plot of first and second factors of principal component analysis based on 18 ln-transformed measurements of adult males of *Rana (Hylarana)*.

3\. Two distinct brown lines on inner side of latero-dorsal folds; males less than 33 mm, females less than 45 mm............*Rana tytleri*

– Back without distinct stripes on inner side of latero-dorsal folds; males less than 30 mm, females less than 42 mm ....*Rana taipehensis*

DISTRIBUTION

Distribution cannot be used as a taxonomic character, but as both distribution of a taxon and distribution of its characters are the result of the same history, they should be concordant. The two species *Rana erythraea* and *Rana taipehensis* were confused by many authors. In

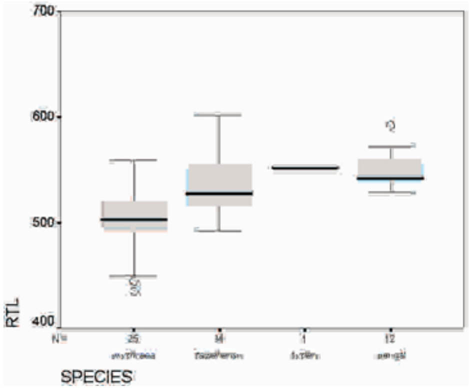

FIGURE 3: Relative length of tibia of *Rana erythraea*, *Rana taipehensis* (diverse origins), *Rana* sp. from Bengal and holotype of *Hylorana tytleri*.

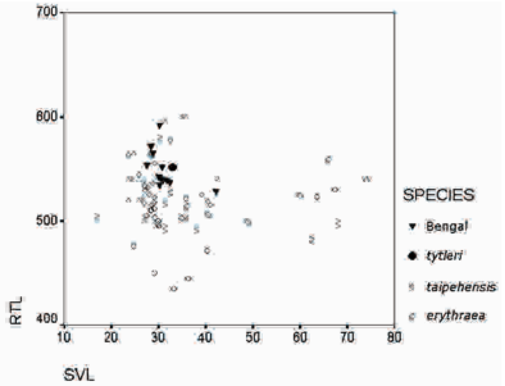

FIGURE 4: Scatter plot of size (SVL) and relative length of tibia of males and females in *Rana erythraea*, *Rana taipehensis* (diverse origins), *Rana* sp. from Bengal and holotype of *Hylorana tytleri*.

TABLE 2: Comparison of adult male of *Rana erythraea*, *Rana taipehensis* and *Rana tytleri*.

	Rana erythraea (n = 10)	*Rana taipehensis* (n = 10)	*Rana tytleri* (n = 11)	Kruskall-Wallis Test
REL	137 ± 7.75 125 – 149	136 ± 6.37 124 – 145	140 ± 16.59 113 – 159	$\chi^2 = 1.449$ p = 0.485 n.s.
REN	99 ± 6.58 91 - 112	100 ± 5.82 90 – 107	105 ± 18.81 81 – 131	$\chi^2 = 0.337$ p = 0.845 n.s.
RFL	461 ± 24.67 415 – 506	453 ± 10.35 440 – 471	449 ± 18.91 424 – 474	$\chi^2 = 1.936$ p = 0.380
RFLL	202 ± 12.54 170 - 220	199 ± 12.37 176 – 216	215 ± 14.26 185 – 237	$\chi^2 = 8.508$ p = 0.014 *
RFOL	559 ± 25.82 508 - 588	553 ± 38.12 511 – 626	534 ± 40.18 450 – 576	$\chi^2 = 2.297$ p = 0.317 n.s.
RFTL	344 ± 22.66 302 – 387	358 ± 22.78 333 – 407	437 ± 24.50 393 – 468	$\chi^2 = 20.910$ p = 0.000 ***
RHAL	275 ± 16.22 250 - 292	285 ± 13.21 267 – 306	238 ± 28.74 207 – 287	$\chi^2 = 12.184$ p = 0.002 **
RHL	417 ± 24.26 392 - 473	397 ± 10.86 370 – 409	378 ± 20.50 336 – 409	$\chi^2 = 12.662$ p = 0.002 **
RHW	315 ± 22.22 288 - 353	288 ± 7.23 275 - 299	274 ± 16.40 252 – 302	$\chi^2 = 15.216$ p = 0.000 ***
RIBE	255 ± 14.32 238 - 286	241 ± 13.12 220 - 257	226 ± 44.45 109 – 270	$\chi^2 = 5.173$ p = 0.075 n.s.
RIFE	185 ± 13.41 167 - 206	176 ± 8.33 165 - 194	179 ± 33.92 101 – 216	$\chi^2 = 2.325$ p = 0.313 n.s.
RIN	95 ± 6.23 85 - 104	96 ± 4.25 88 - 101	98 ± 15.52 72 - 117	$\chi^2 = 0.924$ p = 0.630 n.s.
RMBE	137 ± 16.58 113 - 169	134 ± 15.63 114 - 170	128 ± 26.38 74 - 163	$\chi^2 = 0.506$ p = 0.776 n.s.
RMFE	255 ± 27.96 236 - 333	244 ± 15.37 217 - 274	245 ± 36.13 170 - 290	$\chi^2 = 1.410$ p = 0.494 n.s.
RMN	344 ± 10.75 332 - 364	341 ± 13.49 316 - 361	337 ± 31.49 274 - 391	$\chi^2 = 2.177$ p = 0.337 n.s.
RNS	82 ± 6.56 72 – 90	83 ± 3.27 77 - 88	55 ± 14.62 32 - 81	$\chi^2 = 17.821$ p = 0.000 ***
RSL	189 ± 9.48 173 – 201	186 ± 7.09 175 - 194	164 ± 10.78 146 - 177	$\chi^2 = 19.851$ p = 0.000 ***
RTFL	166 ± 11.77 147 – 181	177 ± 7.90 168 - 189	190 ± 18.99 155 - 223	$\chi^2 = 11.164$ p = 0.004 **
RTL	496 ± 27.01 445 – 533	525 ± 18.78 503 - 564	552 ± 17.97 535 - 592	$\chi^2 = 19.021$ p = 0.000 ***
RTYD	128 ± 7.18 115 – 141	128 ± 11.46 104 - 145	109 ± 9.87 98 - 125	$\chi^2 = 15.486$ p = 0.000 ***
SVL	39.3 ± 4.16 34.7 - 48.9	27.4 ± 1.71 23.7 - 29.2	30.2 ± 1.41 27.6 - 32.4	$\chi^2 = 24.163$ p = 0.000 ***

TABLE 3: Morphometric measurments and ratios for males and females of *Rana erythraea*, *Rana taipehensis*, *Rana tytleri* from Bengal and holotype of *Rana tytleri*.

Species	*Rana tytleri*	*Rana tytleri* Bengal		*Rana erythraea*		*Rana taipehensis*	
		Males (n = 11)	Females (n = 1)	Males (n = 16)	Females (n = 7)	Males (n = 19)	Females (n = 13)
SVL	33.0	30.2 ± 1.41 27.6 - 32.4	42.2	34.2 ± 5.54 28.4 - 48.9	65.9 ± 4.64 59.9 - 74.0	27.1 ± 1.86 23.6 - 29.2	34.9 ± 5.17 26.6 - 42.3
RHL		274 ± 16.4 252 - 302	266	323 ± 14.0 292 – 353	313 ± 11.7 289 - 324	291 ± 16.9 248 - 319	279 ± 16.2 254 - 319
RHW		378 ± 20.496 336 - 409	374	410 ± 14.8 390 - 431	389 ± 7.5 381 – 400	399 ± 27.9 310 – 449	377 ± 13.0 353 - 399
RTL	552	552 ± 18.0 535 - 592	528	493 ± 27.9 435 - 527	522 ± 25.5 482 - 559	532 ± 19.0 502 - 565	537 ± 37.0 492 - 602

the following list we give data of distribution for both taxa using original data, data from authors that recognize both species, or that give measurements and descriptions that allow allocation of specimens to one or the other species. For example, Boulenger (1920) gave measurements of adult females that are all larger than 55 mm, so these are likely to be all *Rana erythraea*. On the other hand, specimens cited by Sarkar (1984) as *Rana erythraea* adult females with a body length of 41-45 mm cannot belong to the same biological species, but should belong to a small-sized taxon.

Rana erythraea.– Cambodia (personal data); Laos, Luang Prabang (personal data); Indonesia, Java (type-locality), Penang (Boulenger, 1920), Perak (Boulenger, 1920) (personal data); Thailand, Bangkok (Boulenger, 1920), Nakon Si Tamarat (Boulenger, 1920), Paknam Kabin (Boulenger, 1920), Phu Kradung (personal data); Vietnam, Annam (personal data).

Rana taipehensis.– Cambodia (Ohler et al., 2002); China, Yunnan, Pingbian and Hekou (Yang, 1991: 152-153); Yunnan (Hekou, Pingbian), Guizhou (Rongjiang, Dujun, Sandu), Fujian (Xiamen, Nanjing), Taiwan, Guangdong (Guangzhou, Lianjiang), Hainan (Qiongzhong, Lingshui, Luodiaoshan, Zhaxian, Yanxian, Baisha), Guangxi (Nanning, Pingxiang, Longzhou, Jinxiu, Wuxuan, Tengxian, Longshan, Yulin, Debao, Guiping, Pingmian, Dongxing), Hong Kong (Fei et al., 1991); Thailand; Vietnam (personal data); Vietnam, Buon Luoi and Buon Geng Lanh, (Inger et al., 1999: 22);

Rana tytleri.– Bangladesh, Dacca (Theobald, 1868); India, Dianadubi forest, Garo Hills (Pillai and Chanda, 1981); Uttar Pradesh, Dudhwa National Park (Tilak and Ray, 1990); Mymensingh, Bengal (Romer, 1951); 24-parganas, Haora, (Sarkar, 1984: 223); 24-parganas, Haora, Hugli, Medinipur, Bardhaman, Bankura, Birbhum and Nadia of West Bengal (Deuti and Bharati Goswami, 1995); Assam (Deuti and Bharati Goswami, 1995); Meghalaya, (Deuti and Bharati Goswami, 1995); Mizoram (Deuti and Bharati Goswami, 1995); Orissa (Deuti and Bharati Goswami, 1995); Nepal, Birtamode (Dubois, 1974: 411).

Remarks.– The specimens mentioned by Stoliczka (1870: 148, pl. 9, fig. 1) seem to be members of the *Rana (Sylvirana)* subgenus, having green brown dorsal colouration and blackish colour on side of head and body. Allocation to species can be done only after study of actual specimens. Thus, the identity of Myanmar frogs of the *Rana (Hylarana)* group still need clarification.

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LITERATURE CITED

ANONYMOUS [International Commission on Zoological Nomenclature] 1999. International code of zoological nomenclature. Fourth edition. International Trust for Zoological Nomenclature, London. xxix + 306 pp.

BOULENGER, G. A. 1882. Catalogue of the Batrachia Gradentia s. Caudata in the collection of the British Museum. Taylor and Francis, London. vii + 127 pp., 9 pl..

________1890. The fauna of the British India, including Ceylon and Burma. Reptilia and Batrachia. Taylor and Francis, London. xviii + 541 pp.

________1920. A monograph of the South Asian, Papuan, Melanesian, and Australian frogs of the genus *Rana*. *Rec. Indian Mus.* 20: 1-126.

BOURRET, R. 1937. Notes herpétologiques sur l'Indochine française. XIV. Les batraciens de la collection du Laboratoire des Sciences naturelles de l'Université. Descriptions de quinze espèces ou variétés nouvelles. *Bull. gén. Instr. publ.* 1937: 5-56.

________1942. Les batraciens de l'Indochine. Institut Océanographique de l'Indochine, Hanoi. i-x + 1-547 pp., 4 pl.

CHAN-ARD, T., W. GROSSMANN, A. GUMPRECHT & K.-D. SCHULZ. 1999. Amphibians and reptiles of Peninsular Malaysia and Thailand: an illustrated checklist/Amphibien und Reptilien der Halbinsel Malaysia und Thailands: eine illustrierte Checkliste. Bushmaster Publications, Würselen. 240 pp.

CHANDA, S. K. 1994. Anuran (Amphibia) fauna of northeast India. *Mem. Zool. Surv. India* 18: vi + 143 pp., 21 maps.

CHANDA, S. K., I. DAS & A. DUBOIS. 2001. Catalogue of amphibian types in the collection of the Zoological Survey of India. *Hamadryad* 25(2): 100-128.

DEUTI, K. & B. C. BHARATI GOSWAMI. 1995. Amphibians of West Bengal plains. World Wide Fund for Nature, Calcutta. (10) + 53 pp.

DUBOIS, A. 1974. Liste commentée d'amphibiens récoltés au Népal. *Bull. Mus. nat. Hist Nat.* (3), 213 (Zool. 143): 341-411.

________1987. Miscellanea nomenclatorica batrachologica (X). *Alytes* "1985", 4(4): 153-154.

________1992. Notes sur la classification des Ranidae (Amphibiens Anoures). *Bull. Mens. Soc. Linn. Lyon* 61(10): 305-352.

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

________&________ . 1999. Asian and Oriental toads of the *Bufo melanostictus*, *Bufo scaber* and *Bufo stejnegeri* groups (Amphibia, Anura): a list of available and valid names and redescription of some name-bearing types. *J. South Asian nat. Hist.* 4(2): 133-180.

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

DUTTA, S. K. 1992. Amphibians of India: updated species list with distribution record. *Hamadryad* 17: 1-13.

FEI, L, YE, C. & Y. HUANG. 1991. Key to Chinese Amphibia. Editions of Sciences and Techniques, Chongqing. [iv] + 2 + 364 pp. [In Chinese.]

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

INGER, R.F., N. ORLOV & I. DAREVSKY. 1999. Frogs of Vietnam: a report on new collections. *Fieldiana Zool. n.s.* 92: 1-46.

MYERS, C. W. & W. E. DUELLMAN. 1982. A new species of *Hyla* from Cerro Colorado, and other tree frog records and geographical notes from western Panama. *Am. Mus. Novit.* 2752: 1-32.

NORUSIS, M. J. 1992. SPSS for Windows. Professional Statistics Release 5. SPSS Inc., Chicago. [xii] + 348 pp.

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

________, S. SWAN & J. C. DALTRY. 2002. A recent survey of the amphibian fauna of the Cardamom Mountains, southwest Cambodia with description of three new species. *Raffles Bull. Zool.* in press.

PILLAI, R. S. & S. K. CHANDA. 1981. Amphibian fauna of Garo Hills, Meghalaya with description of a new species of *Rana*. *Rec. Zool. Surv. India* 79: 159-168.

POPE, C. H. 1931. Notes on the amphibians from Fukien, Hainan, and other parts of China. *Bull. American Mus. nat. Hist.* 61: 397-611.

ROMER, J. D. 1951. Surface locomotion of certain frogs (*Rana*), and the occurrence of *Rana taipehensis* in India. *J. Bombay nat. Hist. Soc.* 50: 414-418.

SARKAR, A. K. 1984. Taxonomic and ecological studies on the amphibians of Calcutta and its environs. *Rec. Zool. Surv. India* 81: 215-236.

SCHLEGEL, H. 1837. Abbildungen neuer oder unvollständig bekannter Amphibien. (Première livraison). Arnz and Comp., Düsseldorf. 32 pp., 10 pl.

SCLATER, W. L. 1892a. On some specimens of frogs in the Indian Museum, Calcutta, with descriptions of several new species. *Proc Zool. Soc., London* 1892: 341-348.

________1892b. List of Batrachia in the Indian Museum. Trustees of the Indian Museum, London. viii + 43 pp.

SMITH, M. A. 1923. On a collection of Reptiles and Batrachians from the Island of Hainan. *J. nat. Hist. Soc. Siam* 6: 195-212.

STOLICZKA, F. 1870. Observations on some Indian and Malayan Amphibia and reptiles. *J. Asiatic Soc. Bengal* 39: 134-158.

TAYLOR, E. H. 1962. The amphibian fauna of Thailand. *Univ. Kansas Sci. Bull.* 43(8): 265-599.

THEOBALD, W. 1868. Catalogue of reptiles in the Museum of the Asiatic Society of Bengal. *J. Asiat. Soc. Bengal*, 37, suppl.: vi + 7-88 + iii pp, 4 pl.

TILAK, R. & P. RAY. 1990. Range extension and notes on *Rana erythraea* (Schlegel, 1837) from Dudhwa National Park, Uttar Pradesh. *J. Bombay nat. Hist. Soc*. 87: 380-384.

TSCHUDI, J. J. 1838. – Classification der Batrachier, mit Berücksichtigung der fossilen Thiere dieser Abtheilung der Reptilien. Petitpierre, Neuchâtel. 102 pp., 6 pl.

VAN DENBURGH, J. 1909. New and previously unrecorded species of reptiles and amphibians from the island of Formosa. *Proc. California Acad. Sci.* ser. 4, 3: 49-56.

VEITH, M., J. KOSUCH, A. DUBOIS & A. OHLER. 2001. Systematics of *Fejervarya limnocharis* (Gravenhorst, 1829) (Amphibia, Anura, Ranidae) and related species. 2. Morphological and molecular variation from the Great Sunda Islands (Sumatra, Java, Borneo) with definition of two species. *Alytes* 19: 5-28.

YANG, D. (Ed). 1991. The amphibia-fauna of Yunnan. China Forestry Publishing House, Kunming. [vii] + iv + 259 pp. [In Chinese.]

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MOLECULAR SUPPORT FOR THE TAXONOMIC CONCLUSIONS OF McCORD AND PRITCHARD (2002), REGARDING *CHITRA*

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ABSTRACT.– **McCord and Pritchard (2002) have presented a taxonomic revision of the trionychid turtle genus *Chitra*, in which they describe one new species (*Chitra vandijki*) from Myanmar, name two subspecies within *Chitra chitra* and consider *Chitra indica* to be monotypic across its wide range from Pakistan to Bangladesh. Here we present DNA sequence data from mitochondrial ND4 gene, which support their taxonomic conclusions. There is deep molecular divergence among the three recognized species of *Chitra* and a low level of geographically structured variation within *Chitra chitra* corresponding with mainland and island subspecies. In contrast, *Chitra indica* shows almost no molecular variation across its broad range from Pakistan to Bangladesh. This apparent genetic uniformity is an interesting biogeographic phenomenon, which merits further investigation.**

KEYWORDS.– ***Chitra*, mtDNA, phylogeny.**

INTRODUCTION

McCord and Pritchard (2002) have presented a taxonomic revision of the softshell turtle genus *Chitra*, in which they define and explain both similarities and differences between molecular results and the "phenotypic groups" for all known forms of *Chitra*. The herpetological literature is rich with examples in which species and subspecies boundaries based on phenotypic and morphological characters are inconsistent with phylogenetic history of animals inferred from molecular markers (Burbrink et al., 2000; Rodriguez-Robles and DeJesús-Escobar, 2000), and also cases in which phenotypic and morphological uniformity belies cryptic genetic diversity (Wüster and Thorpe, 1994; Bruna et al., 1996; Roman et al., 1999; Rodriguez-Robles and DeJesús-Escobar, 2000). Therefore confidence in taxonomic conclusions is often stronger when they are supported by a detailed combination of phenotypic, morphological and molecular data. Here we present molecular evidence from mitochondrial DNA sequence data, which supports the taxonomic conclusions drawn by McCord and Pritchard (2002).

METHODS

Molecular data are included for a total of 20 *Chitra* from across the known range of the genus from Pakistan to the islands of Sumatra and Java. These represent a subset of the animals examined morphologically by McCord and Pritchard (2002). Much of these data have been presented previously (Engstrom et al., 2002), however this paper also includes new data from increased sampling of animals (WPM collection) from Bangladesh and Java and a novel geographic locality in Pakistan.

Blood and tissue samples were collected from living animals or salvaged from dead animals in the private collection of WPM. Blood samples were drawn by a lateral approach from the front

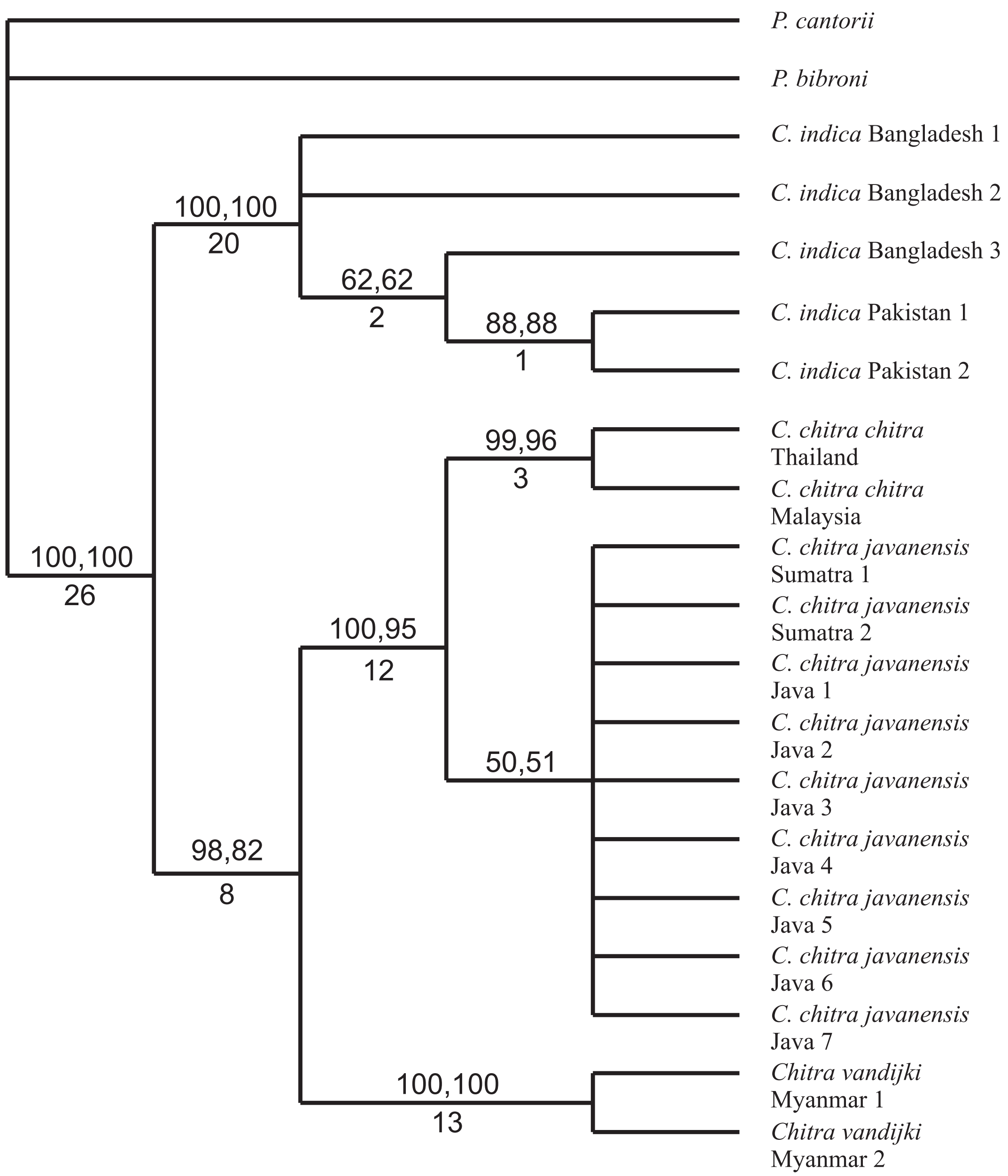

FIGURE 1: Bootstrap consensus phylogeny depicting the relationships of the genus *Chitra* based on likelihood and parsimony analysis (both indicate identical relationships) of the ND4 gene. Numbers above the node represent the bootstrap support for the node in 1000 replicates under likelihood on the left, under parsimony on the right. Numbers below the node indicate decay index for the node.

TABLE 1: Sequence divergence in ND4 among the outgroup taxa, *Pelochelys cantorii* and *Pelochelys bibroni*, and all unique *Chitra* sequences. Uncorrected ("p") distance if given below the diagonal, absolute number of differences is given above the diagonal.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. *P. bibroni*	–	53	87	88	91	90	93	92	87	88	94
2. *P. cantorii*	0.072	–	82	83	86	85	86	85	80	81	79
3. *C. indica* Bangladesh 1,2	0.119	0.112	–	1	4	3	62	61	58	57	58
4. *C. indica* Bangladesh 3	0.120	0.113	0.001	–	3	2	63	62	59	58	59
5. *C. indica* Pakistan 1	0.124	0.117	0.005	0.004	–	1	66	65	62	61	62
6. *C. indica* Pakistan 2	0.123	0.116	0.004	0.002	0.001	–	65	64	61	60	61
7. *C. chitra chitra* Thailand	0.127	0.117	0.084	0.086	0.090	0.089	–	1	8	7	39
8. *C. chitra chitra* Malaysia	0.126	0.116	0.083	0.085	0.089	0.088	0.001	–	7	6	38
9. *C. chitra javanensis* Sumatra	0.119	0.109	0.079	0.081	0.085	0.083	0.011	0.010	–	1	37
10. *C. chitra javanensis* Java	0.120	0.111	0.078	0.079	0.083	0.082	0.010	0.008	0.001	–	38
11. *C. vandijki* Myanmar	0.128	0.108	0.079	0.081	0.085	0.083	0.053	0.052	0.051	0.051	–

leg at the junction of the distal humerus and the proximal radius and ulna, and preserved in lysis buffer (10 mM EDTA, 100mM Tris-HCl, and 1.0% SDS at pH 8.0) at a blood:buffer ratio of 1:10. All samples were stored at 4^{o}C. DNA was extracted using standard Phenol:Chloroform proteinase K methods (Hillis et al., 1996). PCR amplification of the mitochondrial ND4 gene was carried out using primers ND4 (5'TGACTACCAAAAGCTCATGTACAAGC -3'), and Hist-ND4 (5'CCTATTTTAGAGC CACAGTCTAATG3'), which are slightly modified versions of primers described by Forstner et al. (1995). Reactions were run for 35 cycles at 94º C (1 min), 50º C (1 min), 72º C (1 min). PCR products were sequenced at the Division of Biological Sciences Sequencing Facility at the University of California, Davis. All sequences were confirmed by sequencing both the forward and reverse strands. Sequences were aligned by eye using the program SeqEd (ABI) and deposited in Genbank with accession numbers (AF494489-93).

Phylogenetic analysis was conducted using parsimony and maximum likelihood methods as implemented in PAUP* ver 4.0b10 (Swofford, 2000). All trees were rooted using *Pelochelys cantorii* and *P. bibroni* as outgroups. Parsimony searches were conducted using the branch and bound search algorithm with all characters equally weighted. Maximum likelihood analysis was conducted using parameter estimates provided by Modeltest Vers. 3.0 (Posada and Crandall, 2001). Statistical support for topologies was assessed using non-parametric bootstrap resampling with 1000 bootstrap replicates.

RESULTS AND DISCUSSIONS

Our primer set consistently amplified a 731 bp fragment consisting of 708 nucleotide positions coding for 236 amino acids at the 3' end of the mitochondrial ND4 gene and 23 nucleotide positions of the adjacent histidine tRNA gene. The sequences contained no indels and were unambiguously aligned. The $\mathrm{tRNA}^{\mathrm{hist}}$ secondary structure is consistent with other published $\mathrm{tRNA}^{\mathrm{hist}}$ and all ND4 sequences successfully translated into protein products similar to published turtle ND4 proteins (Starkey, 1997; Zardoya and Meyer, 1998; Kumazawa and Nishida, 1999; Mindell et al., 1999).

Parsimony analysis resulted in five equally parsimonious trees (length = 182; CI = 0.896; RI = 0.951). The strict consensus of these trees was identical to the bootstrap consensus trees for both parsimony and likelihood (Fig. 1). Maximum likelihood analysis resulted in a single tree, which is very similar to the bootstrap consensus trees, but also provides weak support for the reciprocal monophyly of the mainland and island forms of *Chitra chitra*.

The inclusion of these new data do little to change the results presented in Engstrom et al. (2002) and are completely consistent with the taxonomic conclusions presented by McCord and Pritchard (2002). In all molecular analyses there is strong support for five monophyletic groups within *Chitra*: 1) a *Chitra indica* clade including new Pakistani animals, 2) a non *Chitra indica* clade, 3) a clade consisting of the two individuals from Myanmar, 4) a *Chitra chitra* clade consisting of individuals from Thailand, Malaysia, Sumatra and Java and 5) a mainland *Chitra chitra* clade including Malaysia and Thailand specimens. Sequence divergence between the *Chitra indica* clade and the clade including *Chitra chitra* and the *Chitra* from Myanmar was as high as 8.6% (Table 1) which is comparable to divergence levels among other well-recognized species in the family Trionychidae (Weisrock and Janzen, 2000; Engstrom et al., unpublished data). The 5.3% sequence divergence between *Chitra chitra* and *Chitra* from Myanmar is greater than that reported within other trionychid species (Weisrock and Janzen, 2000), and is evidence that these two lineages have experienced a long period of independent evolution. The clear phylogenetic pattern in the molecular data, and the evidence of long independent evolution of these lineages offer strong support for McCord and Pritchard's (2002) interpretation of the *Chitra* from Myanmar as a new species, *Chitra vandijki*.

Molecular divergence within the *Chitra chitra* clades was low but showed consistent geographic structure. Sequences from the four newly sequenced individuals from Java were identical to the three previously reported sequences and together these seven animals from Java differed by a single transition substitution from the two animals from Sumatra. The two island populations show 1% sequence divergence from the mainland form represented here by individuals from Thailand and Malaysia. This level of sequence divergence is similar to levels of divergence seen among subspecies of North American softshell turtles (Weisrock and Janzen, 2000) and is consistent with McCord and Pritchard's (2002) subspecies delineations.

In contrast, within *Chitra indica,* we observed a maximum of 0.5% divergence among the five animals sampled from two localities. One at the western edge of its range in Pakistan and the other at the eastern edge of the range in Bangladesh. Two of the individuals from Bangladesh were identical while the third was more closely related to the two from Pakistan. Our sampling of *C. indica* is far from comprehensive, and should be interpreted as a suggestion of genetic uniformity across the entire range of the species. This apparent genetic uniformity across such a broad geographic area is itself an interesting biogeographic phenomenon, which merits further investigation.

LITERATURE CITED

BRUNA, E. M., R. N. FISHER & T. J. CASE. 1996. Morphological and genetic evolution appear decoupled in Pacific skinks (Squamata: Scincidae: *Emoia*). *Proc. Roy. Soc. London Series B, Biol. Sci.* 263: 681-688.

BURBRINK, F. T., R. LAWSON & J. B. SLOWINSKI. 2000. Mitochondrial DNA phylogeography of the polytypic North American rat snake (*Elaphe obsoleta*): A critique of the subspecies concept. *Evolution* 54: 2107-2118.

ENGSTROM, T. N., H. B. SHAFFER & W. P. MCCORD. 2002. Phylogenetic diversity of endangered and critically endangered southeast Asian softshell turtles (Trionychidae: *Chitra*). *Biol. Conser.* 104: 173–179.

FORSTNER, M. R. J., S. K. DAVIS & E. AREVALO. 1995. Support for the hypothesis of anguimorph ancestry for the Suborder Serpentes from phylogenetic analysis of mitochondrial DNA sequences. *Mol. Phylogenetics & Evol.* 4: 93-102.

HILLIS, D. M., C. MORITZ & B. K. MABLE. 1996. Molecular systematics. Sinauer Associates, Sunderland, Mass. 655 pp.

KUMAZAWA, Y. & M. NISHIDA. 1999. Complete mitochondrial DNA sequences of the green turtle and blue-tailed mole skink: Statistical evidence for archosaurian affinity of turtles. *Mol. Biol. & Evol*. 16: 784-792.

McCORD, W. P. & P. C. H. PRITCHARD. 2002. A review of the softshell turtles of the genus *Chitra*, with the description of new taxa from Myanmar and Indonesia (Java). *Hamadryad* 27(1): 11-56.

MINDELL, D. P., M. D. SORENSON, D. E. DIMCHEFF, M. HASEGAWA, J. C. AST & T. YURI. 1999. Interordinal relationships of birds and other reptiles based on whole mitochondrial genomes. *Systematic Biol.* 48: 138-152.

POSADA, D. & K. A. CRANDALL. 2001. Selecting the best-fit model of nucleotide substitution. *Systematic Biol*. 50: 580-601.

RODRIGUEZ-ROBLES, J. A. & J. M. DEJESÚS-ESCOBAR. 2000. Molecular systematics of new world gopher, bull, and pinesnakes (*Pituophis*: Colubridae), a transcontinental species complex. *Mol. Phylogenetics & Evol*. 14: 35-50.

ROMAN, J., S. D. SANTHUFF, P. E. MOLER & B. W. BOWEN. 1999. Population structure and cryptic evolutionary units in the alligator snapping turtle. *Conser. Biol.* 13: 135-142.

STARKEY, D. E. 1997. Molecular systematics and biogeography of the new world turtle genera *Trachemys* and *Kinosternon*, Texas A&M University, College Station, Texas. 149 pp.

SWOFFORD, D. L. 2000. PAUP* Phylogenetic Analysis Using Parsimony (*and other Methods). Sinauer Assoc., Sunderland, Mass.

WEISROCK, D. W. & F. J. JANZEN. 2000. Comparative molecular phylogeography of North American softshell turtles (*Apalone*): implications for regional and wide-scale historical evolutionary forces. *Mol. Phylogenetics & Evol*. 14: 152-164.

WÜSTER, W. & R. S. THORPE. 1994. *Naja siamensis*, a cryptic species of venomous snake revealed by mtDNA sequencing. *Experientia* (Basel) 50: 75-79.

ZARDOYA, R. & A. MEYER. 1998. Complete mitochondrial genome suggests diapsid affinities of turtles. *Proc. Nat. Acad. Sci.,U. S. A*. 95: 14226-14231.

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TADPOLES OF *INDIRANA BEDDOMII* (ANURA: RANIDAE)

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(with four text-figures)

ABSTRACT.– External and internal morphology of the semiterrestrial tadpoles of *Indirana beddomii* (stages 37 and 39) from south-western India was examined. Advanced tadpoles had well-developed hind limbs with nearly the same ratio to head-body length as in adults. However, the fore limbs were still in the early stages of development and most skeletal components were cartilaginous. These indicate that the hind limbs develop precociously. In spite of their semiterrestrial life, the tadpoles did not have lungs. With strongly serrated beaks and branched, curved labial teeth, they feed on green algae and diatoms. Comparisons with previously described tadpoles of the genus *Indirana* and with semiterrestrial tadpoles in other anuran taxa are discussed.

KEY WORDS.– ***Indirana beddomii,*** **semiterrestrial tadpole, larval morphology, India**

INTRODUCTION

Annandale (1918) described "remarkable" tadpoles of *Indirana beddomii* from Cochin hills which have a long and slender tail, large eyes directed upwards, and strongly hooked beaks like that of a parrot. He cited the observation by F. H. Gravely, the collecter, that the tadpoles skipped rapidly over damp rocks when disturbed. Boulenger (1920) emphasized a long tail of *I. beddomii* tadpoles as "three times the length of the body, with mere rudiments of crests." He added Sewell's observation that "the front legs [of tadpoles] remain concealed beneath the skin for a long period. In their two-legged stage they cling to damp rocks, both horizontal and vertical, and are extremely active out of water, leaping powerfully when disturbed". This semiterrestrial tadpole is thus very peculiar, both in morphology and behaviour, among anurans.

The Indian genus *Indirana* includes 10 nominal species, *I. beddomii, I. brachytarsus, I. diplosticta, I. gundia, I. leithii, I. leptodactyla, I. longicrus, I. phrynoderma, I. semipalmata,* and *I. tenuilingua* (Duellman, 1993; Bossuyt and Dubois, 2001). These are rather small frogs (SVL less than 55 mm) with disks on the tips of digits, numerous long or short longitudinal dermal ridges on the dorsum, and dark brownish dorsal colouration. It is unknown whether tadpoles of the genus *Indirana* have the same morphological and behavioral characteristics as those of *I. beddomii.* Chari and Daniel (1953) described tadpoles of *I. leithii* which are similar to those of *I. beddomii* in shape and habitat, whereas tadpoles of *I. leptodactyla* and *I. semipalmata* were reported to be normal in shape (Annandale, 1918). The tadpoles of the two species were collected in a small pond and are therefore fully aquatic. Tadpoles of the other *Indirana* species have not been described. Also unclear is the relationship between *Indirana* and the Sri Lankan genus *Nannophrys* which has semiterrestrial tadpoles, as well (Kirtisinghe, 1958).

We describe here morphological characteristics of the tadpoles of *Indirana beddomii* from Karnataka, south-western India. Internal anatomy is here reported for the first time.

MATERIALS AND METHODS

A total of 13 tadpoles were collected from the front yard of a house in Talagini (14° 10' N; 74° 50' E; 558 m alt.), ca. 35 km NE of Bhatkal and 25 km W of Sagar, Karnataka, on 13 August 2001. This site is located within the Western Ghats and the ground is always wet throughout the rainy season. We assigned the larvae as those of *Indirana beddomii* because adult *I. beddomii* were collected from the same microhabitat.

The tadpoles were fixed in a mixture (1:1) of 70% ethanol and 10% formalin solution. The following parts were measured (two tadpoles which died before fixation were not measured); total length (from the tip of snout to the end of tail), head-body length (from the tip of snout to the base of tail), tail length (from the base to the end of tail), body width (at the most widest part), body depth (at the middle of head-body), tail depth (at the base of tail), and hind limb length (from the anterior base of leg to the tip of longest toe). One specimen was used to make microscopic preparations for histological examination, and another to make a cleared skeletal preparation, following the method of Klymkowsky and Hanken (1991) without trypsin treatment.

RESULTS

The tadpoles collected were 17.3–22.4 mm in total length. Of 11 specimens, nine had well-developed hind limbs (stage 39) and two had small hind limbs (stage 37) (Table 1).

Description of tadpoles at stage 37 (Fig. 1) follows: Head and body elongated oval with rounded snout. Eyes large, dorso-lateral (Fig. 2A). Nostril very indistinct, nearer to eye than to tip of snout. Mouth antero-ventral with large oral disk. Dental formula 4(2-4)/4(1-2) or 4(3-4)/4(1-2). Labial teeth with many projections curved inwards (Figs. 3A, B). Lower beak prominent, deeply notched with sharply serrated upper edge; upper beak weak on both sides, but with well-developed and serrated middle piece. Serrations prominent at the tip of both beaks (Figs. 3C, D). Medium-sized papillae on both corners of oral disk and smaller papillae on lower labium. Spiracle on left side, ventro-lateral, small and very indistinct aperture not projecting as a tube (Fig. 2C). Anus median, tubular. Tail muscular and slender, tapering gradually toward the tip, with rudimentary dorsal and ventral fins. Colour (in fixative) dark brown above, pale grey below. Tail with uniformly arranged thick dark bands.

The shape of stage 39 tadpoles did not differ from that of stage 37 tadpoles except for their longer hind limbs, larger head-body, and absence of anal tube. The ventral fin was more reduced than in stage 37 tadpoles. Swelling of toe tips and webs between toes was apparent in stage 39 tadpoles. Dental formula of all of the stage 39 tadpoles was the same as in the stage 37 tadpoles.

As a measure for more detailed developmental stage, the ratio between hind limb length/body length (L-B ratio) is used below. Tail length relative to head-body length becomes smaller with development (Fig. 4A). The negative correlation was highly significant ($r = -0.739$, $P < 0.01$). In tadpoles with small hind limbs, tail length is about three times head-body length as reported by Boulenger (1920). Correlation between L-B ratio and total length was also highly significant ($r = 0.792$, $P < 0.01$), and this is largely attributable to the increase of head-body length because body lengths are correlated significantly with L-B ratio ($r = 0.857$, $P < 0.01$; Fig. 4B) whereas tail lengths are not ($r = 0.586$, $P > 0.05$).

We calculated L-B ratio of adult *Indirana beddomii* from the list in Boulenger (1920). The ratio ranges from 1.58 to 2.00 with a mean of 1.81 ($n = 13$), and there is no correlation between L-B ratio and SVL ($r = 0.043$), implying isometry with growth. The largest L-B ratio in our tadpoles is just the lowest value of the adult, and it seems highly probable that the most advanced tadpole in our materials was just before metamorphosis so far as the leg length is concerned. Yet, its tail does not show any indication of retrogression. There was no indication of fore limb development, too (Fig. 2B). Apparently the tadpole live for a long term in this two-leg condition.

In a skeleton preparation of a stage 39 tadpole, almost all bones were stained blue with Alcian Blue 8GX indicating that they were cartilaginous. Only middle portions of femur and tibiofibula bones were bony, being stained red with Arizarin Red S. In the tadpoles of *Rana catesbeiana,* all vertebrae and frontparietal bones become bony before Gosner's stage 30 (Kuramoto, personal observation). Histological observations on the stage 39 tadpole also showed that the development of vertebrae is incomplete (Fig. 2D) and the development of fore limbs is still at the early stages (Fig. 2B). These strongly suggest that the hind limbs of larval *I. beddomii*

TABLE 1: Measurements on tadpoles of *Indirana beddomii* (in mm).

	1	2	3	4	5	6	7	8	9	10	11
Total length	21.2	21.8	22.4	21.2	21.9	20.7	19.6	20.2	18.0	18.3	17.3
Head-body length	6.6	6.8	6.3	5.4	6.2	5.6	5.8	6.0	5.1	4.5	4.0
Tail length	14.6	15.0	16.1	15.8	15.7	15.1	13.8	14.2	12.9	13.8	13.3
Body width	4.0	4.0	4.1	3.8	3.6	3.4	3.4	3.2	3.3	3.0	2.8
Body depth	3.1	2.9	3.2	2.9	2.9	2.7	2.5	2.7	2.5	2.2	2.1
Tail depth	1.9	1.9	2.0	1.9	2.0	1.8	1.8	1.8	1.6	1.8	1.6
Hind limb length	10.4	9.8	8.8	7.0	7.4	7.2	6.8	6.3	5.8	2.9	3.0
L-B ratio	1.58	1.44	1.40	1.30	1.19	1.29	1.17	1.05	1.14	0.64	0.75
Gosner's stage	39	39	39	39	39	39	39	39	39	37	37

develop very precociously, and staging by Gosner's table (1960), which is based on hind limb development may not be directly applicable to *I. beddomii* or other frog species with similar developmental traits. This osteological evidence supports Annandale's view that the hind limbs appear at an early stage of development.

We observed that the tadpoles hopped actively, leaping over 10 cm in the air, when we attempted to catch them. Well-developed eyes and optic lobes (Figs. 2A, B) would serve to perceive the danger. Because the tadpoles with short hind limbs (stage 37) hopped, it is obvious that the hopping is aided largely by the muscular tail. In a plastic bag, the tadpole adhered to the side and the ceiling, and large oral disk may assist in this adhering ability and for life on the vertical surface of rock in nature. In spite of their semiterrestrial life, the tadpoles had no lungs and the respiration apparently relies on gills (Fig. 2A) and skin. In the intestine we found green algae (Conjugatae species) and diatoms. It is apparent that the tadpoles rake up the algae and diatoms growing on the wet ground using the specialized beaks and labial teeth.

DISCUSSIONS

Annandale (1918) noted that in the tadpoles of *Indirana beddomii,* "a narrow groove extends inwards in a slanting direction from near the middle of each eye to meet its fellow on the opposite side; the combined groove extends backwards from a line joining the posterior third of the eye as far as the base of the dorsal fin". Chari and Daniel (1953) noted similar grooves in the tadpoles of *I. leithii* and they argued that the materials of Annandale were not *I. beddomii* but *I. leithii.* We could not observe these grooves in our materials, and Inger et al. (1984) did not refer to these grooves in larval *I. beddomii* from Kerala. Our materials have distinct serrations on both beaks, whereas Annandale (1918) described that both beaks have smooth edges.

According to Annandale (1918), the anus of larval *Indirana beddomii* is slightly dextral and does not form a tube, but in our tadpoles (stage

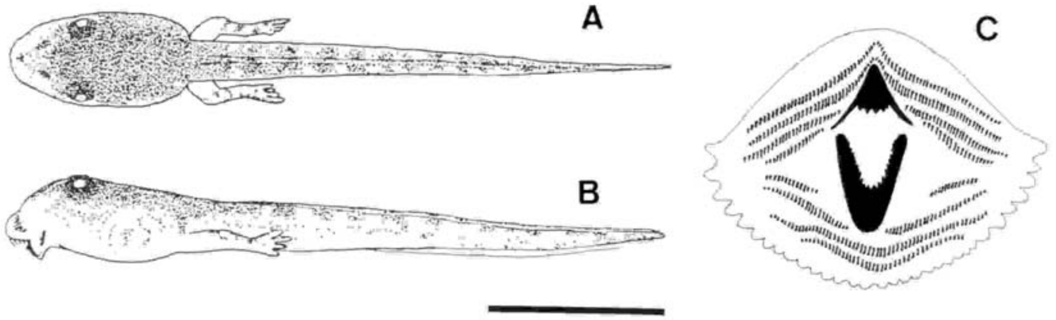

FIGURE 1: Tadpole of *Indirana beddomii* at Gosner's Stage 37. Dorsal (A) and lateral view (B) and oral disk (C). Scales in A and B = 5 mm.

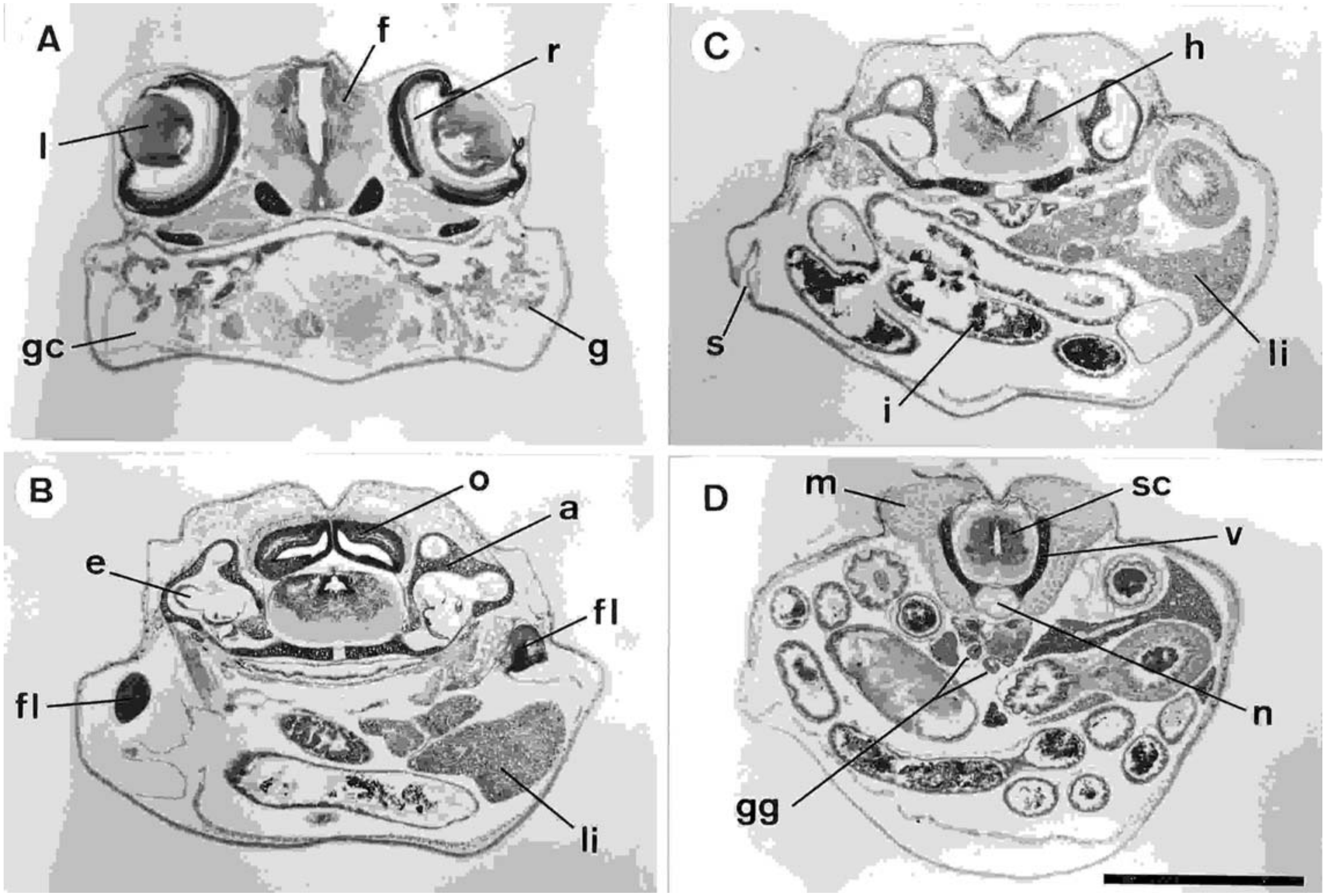

FIGURE 2: Cross sections of a Stage 39 tadpole of *Indirana beddomii*. Distances from the tip of snout are 37.6% (A), 48.7% (B), 55.6% (C) and 71.1% (D) of the head-body length. Scale = 1 mm. Abbreviations are: a. auditory capsule; e. ear; f. fore brain; fl. fore limb bud; g. gill; gc. gill chamber; gg. genital gland; h. hind brain; i. intestine; l. lens; li. liver; m. muscle; n. notochord; o. optic lobe; r. retina; s. spiracle; sc. spinal cord; v. vertebra.

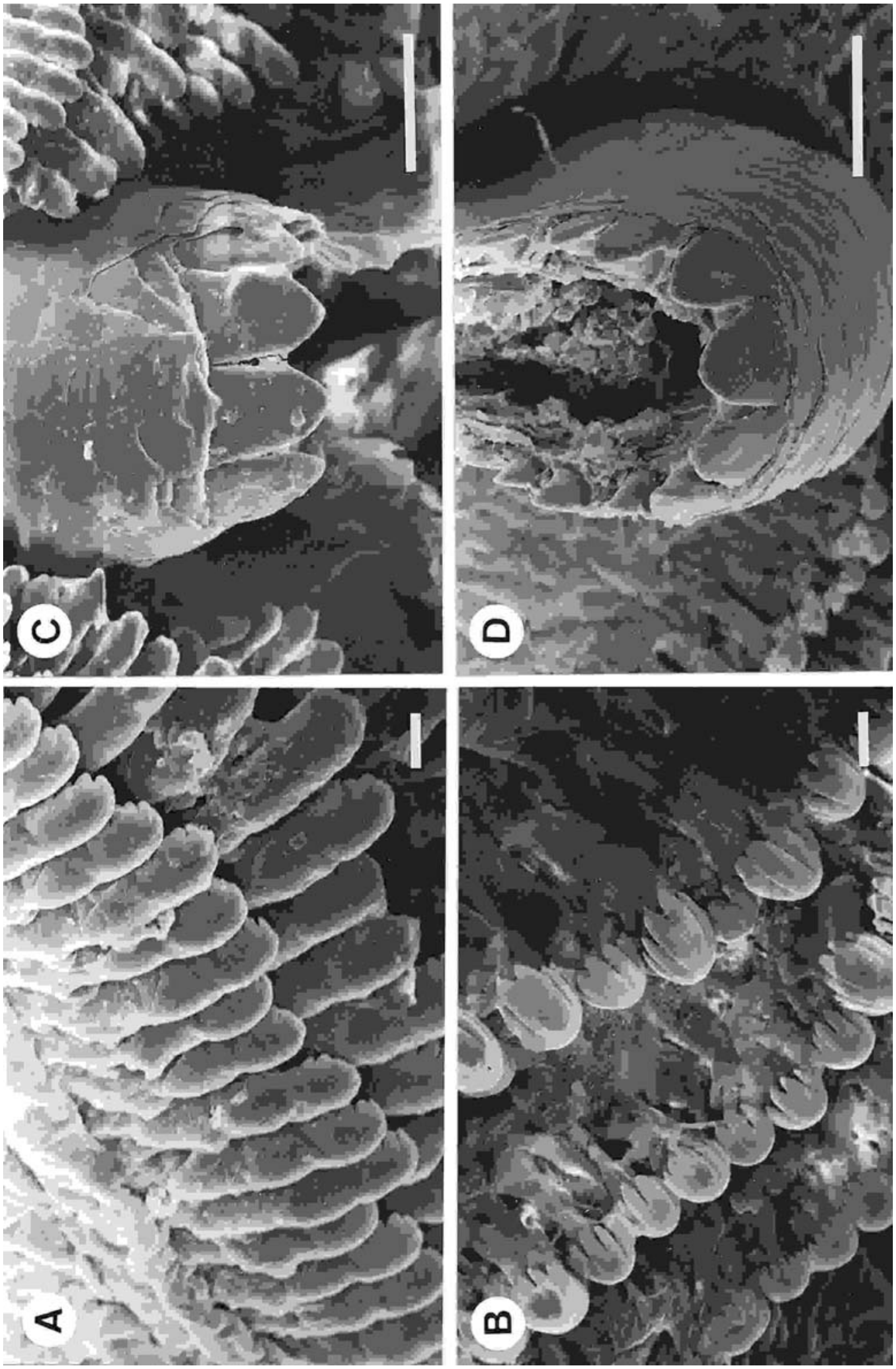

FIGURE 3: Scanning electron photomicrographs of labial tooth rows on upper lip (A), those on lower lip (B), upper beak (C) and lower beak (D) of *Indirana beddomii* tadpole. Scale 10 µm in A and B, and 50 µm in C and D.

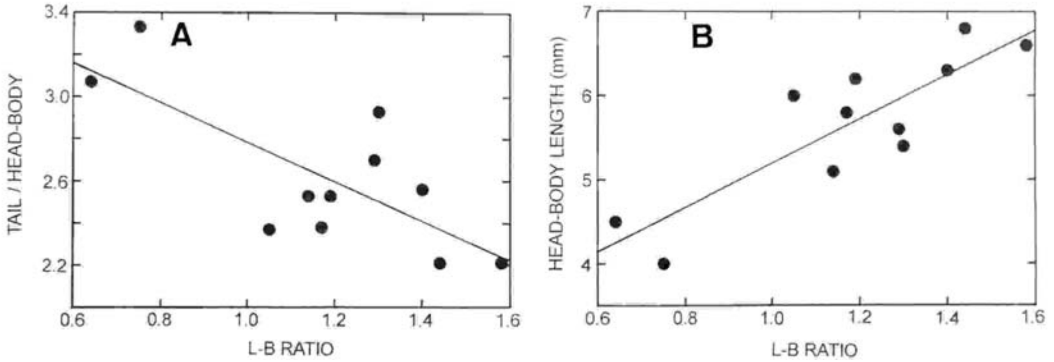

FIGURE 4: Correlation between tail length/head-body length and L-B ratio (A) and between head-body length and L-B ratio (B) in *Indirana beddomii* tadpoles.

37) the anus forms a distinct tube. Larval *I. leithii* was reported to have an anal tube (Chari and Daniel, 1953). As noted in our observation, presence or absence of the anal tube depends on the developmental stages of tadpoles, and therefore it is necessary to mention the stages of tadpoles under observations. Clarke (1983) noted that stage 38 tadpoles of Sri Lankan *Nannophrys ceylonensis* have an anal tube whereas stage 40 and 41 tadpoles do not have it.

In contrast to the tadpoles of *Indirana beddomii*, the tadpoles of *I. leptodactyla* and *I. semipalmata* were reported to be nearly normal in shape (Annandale, 1918). They have a round head-body, a short tail (about two times head-body length) with broad dorsal and ventral fins, small eyes directed forwards and outwards, and a spiracle situated nearer the dorsal surface. Their oral disks were remarkable in lacking horny teeth. Annandale (1918) stated "it is very curious that a frog [*I. beddomii*] so closely allied to *R. leptodactyla* [*I. leptodactyla*] and *R. semipalmata* [*I. semipalmata*] should possess a larva so different." In our brief observation on *I. semipalmata*, however, the tail of tadpoles of this species at the time of hatching was about three times head-body length. Because the egg-laying site of *I. semipalmata* was margin of a small depression (where a male retreats) on a cliff and there were no water pools, the tadpoles should live on the wet surface on the cliff as in *I. beddomii*.

Annandale's tadpoles of *I. leptodactyla* and *I. semipalmata* were obtained from a small pool beside a stream, together with larvae of *Rana verrucosa* [current name: *Limnonectes keralensis*]. There is a possibility of misidentification, and it seems necessary to re-examine the life history, including larval morphology, of *I. leptodactyla* and *I. semipalmata*.

The Sri Lankan frog *Nannophrys ceylonensis* has tadpoles similar to those of *I. beddomii* both in shape and habit (Kirtisinghe, 1958; Clarke, 1983). The former differs from the latter mainly in its flatter ventral surface and in dentition (2(2)/2(1)). Bossuyt and Milinkovitch (2000) showed by analysis of DNA sequence data that the morphological features associated with semiterrestrial mode of life evolved independently in India and Sri Lanka, that is, the genera *Indirana* and *Nannophrys* are not closely related in terms of phylogeny. The tadpoles of leptodactylid genera *Thoropa* and *Cycloramphus* are known to live on the wet surface of rock (Lutz, 1947; Heyer, 1983a), and they closely resemble those of *Indirana* and *Nannophrys* (Bokerman, 1965; Heyer, 1983a, b). The tadpoles of the African ranid *Ptychadena broadleyi* which develop on a thin film of water have long and slender bodies (Channing, 2001). Apparently, this larval morphotype developed independently in different phyletic lines. In the two leptodactylid genera and *Ptychadena*, precocious development of hind limbs has not been reported. If the elongated tadpoles of the leptodactylid genera characterize a fossorial way of life (Wassersug and Heyer, 1983), precocious hind limb development would be disadvantageous.

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LITERATURE CITED

ANNANDALE, N. 1918. Some undescribed tadpoles from the hills of southern India. *Rec. Indian Mus*. 15: 17-23.

BOKERMANN, W. C. A. 1965. Notas sôbre as espéces de *Thoropa* Fitzinger (Amphibia, Leptodactylidae). *An. Acad. Brasil Cienc*. 37: 525-537.

BOSSUYT, F. & A. DUBOIS. 2001. A review of the frog genus *Philautus* Gistel, 1848 (Amphibia, Anura, Ranidae, Rhacophorinae). *Zeylanica* 6(1): 1-112.

________. & M. C. MILINKOVITCH. 2000. Convergent adaptive radiations in Madagascan and Asian ranid frogs reveal covariation between larval and adult traits. *Proc. Nat. Acad. Sci.* 97: 6585-6590.

BOULENGER, G. A. 1920. A monograph of the south Asian, Papuan, Melanesian and Australian frogs of the genus *Rana. Rec. Indian Mus*. 20: 1-226.

CHANNING, A. 2001. Amphibians of central and southern Africa. Cornell Univ. Press, Ithaca. x + 470 pp. + Pl. 1-24.

CHARI, V. K. & J. C. DANIEL. 1953. The tadpole of *Rana leithii* Boulenger. *J. Bombay nat. Hist. Soc*. 51: 512-514. +1 pl.

CLARKE, B. T. 1983. A morphological re-examination of the frog genus *Nannophrys* (Anura: Ranidae) with comments on its biology, distribution and relationships. *Zool. J. Linn. Soc*. 79: 377-398.

DUELLMAN, W. E. 1993. Amphibian species of the world: additions and corrections. Univ. Kansas Mus. Nat. Hist., Special Publ., No. 21: iii + 372 pp.

GOSNER, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica* 16: 183-190.

HEYER, W. R. 1983a. Notes on the frog genus *Cycloramphus* (Amphibia: Leptodactylidae), with descriptions of two new species. *Proc. Biol. Soc. Washington* 96: 548-559.

________. 1983b. Variation and systematics of frogs of the genus *Cycloramphus* (Amphibia, Leptodactylidae). *Arq. Zool*. 30: 235-339.

INGER, R. F., H. B. SHAFFER, M. KOSHY & R. BAKDE. 1984. A report on a collection of amphibians and reptiles from the Pomundi, Kerala, south India. *J. Bombay nat. Hist. Soc*. 81: 406-427.

KIRTISINGHE, P. 1958. Some hitherto undescribed anuran tadpoles. *Ceylon J. Sci. (Biol. Sci.)* 1: 171-176.

KLYMKOWSKY, M. W. & J. HANKEN. 1991. Whole-mount staining of *Xenopus* and other vertebrates. *Meth. Cell Biol*. 36: 419-441.

LUTZ, B. 1947. Trends towards non-aquatic and direct development. *Copeia* 1947: 242-252. +2 pls.

WASSERSUG, R. J. & W. R. HEYER. 1983. Morphological correlates of subaerial existence in leptodactylid tadpoles associated with flowing water. *Canadian J. Sci*. 61: 761-769.

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TADPOLE OF THE PENINSULAR MALAYSIAN RANID, *LIMNONECTES TWEEDIEI* (SMITH, 1935)

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(with five text-figures)

ABSTRACT.– The diagnostic larval identity of the Peninsular Malaysian-endemic ranid frog *Limnonectes tweediei* (Smith, 1935) is described for the first time. Its microhabitat consists of shallow, stagnant, but clear pools of water on the forest floor. The tadpole of this species may be positively identified by (i) the presence of evenly distributed dark bands confined to the dorsum of the tail, which extend onto the posterior dorsal surface of the body at the body-tail junction; and (ii) the distinctively double-arched arrangement in the first labial tooth row of the posterior labium.

KEY WORDS.– Peninsular Malaysia, Ranidae, *Limnonectes tweediei*, Anura, tadpole.

INTRODUCTION

Limnonectes (previously *Rana*) *tweediei* was described by Malcolm Arthur Smith in 1935 from the headwaters of the Plus River, Perak, at an elevation of ca. 670 m asl., in Peninsular Malaysia. It was named after the legendary naturalist Michael W. F. Tweedie (Curator/Director of the Raffles Museum between 1932-1957) who has been an invaluable contributor to our knowledge of the natural history of Malaysia. The diagnostic features of adult *L. tweediei* include the presence of fine dorsolateral folds, smooth skin, incompletely webbed toes, slightly expanded finger and toe tips. In life, the venter is bright yellow, while the undersides of the limbs are bright orange. However, these and other characteristics are shared with another ranid, *Limnonectes* (previously *Rana*) *nitidus* (Smedley, 1931). In the earlier opinions of Kiew (1974) and Berry (1975), both species were considered synonymous. According to Grandison (1972) and Dring (1979), both species were significantly distinct; most noticeably, from differences in their (a) size ranges (snout vent length of *L. nitidus* greater than that of *L. tweediei*) and (b) altitudinal distribution (*L. nitidus* confined to montane forests while *L. tweediei* inhabits hilly to lowland forests). The two species have since been recognised as valid taxa (Frost, 1985; Inger, 1999; Iskandar and Colijn, 2000).

Past references with descriptions of *L. tweediei* have merely focused on the adult and subadult stages, with no mention of larval forms. During herpetofaunal surveys conducted at the Forest Research Institute Malaysia (FRIM; 03° 14’ N; 101° 38’ E), Kepong, Selangor, which began in April 1999, a localized population of *L. tweediei* was discovered. This small, yet apparently stable population was found to congregate around a perpetually water-logged area, which form a shallow puddle (ca. 2 x 3 m, deepest point 5 cm) on the side of a forest trail. At night, adult males have been observed to vocalise in the vicinity. Adult females (Fig. 1) and subadults (Fig. 2) were also regularly sighted. Additional species of anura recorded within this microhabitat include four other ranids (*Fejervarya limnocharis*, *Limnonectes blythii*, *L. plicatellus*, *Occidozyga laevis*), two bufonids (*Bufo parvus*, *Leptophryne borbonica*), one microhylid (*Microhyla heymonsi*) and one rhacophorid (*Polypedates leucomystax*). From this single pool, a developmental series was obtained, examined and proven to belong to *L. tweediei*. Late metamorphic stages exhibit characteristics also found in the adults.

MATERIALS AND METHODS

From the above-mentioned locality, representative voucher specimens of adults were collected and deposited at the herpetological (amphibian) collection of the Malaysian Department of Wildlife and National Parks (DWNP.A.0543, 0603). Additional specimens were deposited at the Raffles Museum of Biodiversity Research Zoological Reference Collection [Adult males (ZRC.1.7433-7436, 7962, 8052; SVL: 37.6-44.0 mm, enlarged heads with cephalic bumps, mandibular odontoids present); adult females (ZRC.1.5581-5582, 7437; SVL: 37.9-42.3 mm, pigmented ova present); sub-adults (ZRC.1.5583-5585, 7438-7439, 7963, 8053-8058; SVL: 11.2-32.3 mm)]. A clutch of freshly deposited ova was encountered, collected and preserved in 60% alcohol (ZRC.1.8060; total 21 eggs, pigmented, ova diameter ca. 2 mm, expanded jelly coat diameter ca. 8-9 mm). It had been laid within a crater-like depression created in the smooth, moist sediment at the water's edge and was partially submerged underwater. The diagnostic developmental series (ZRC.1.7984, 8008-8015, 8177-8220; n = 53, Stages 26-46) was collected from the same pool and preserved in 10% formaldehyde. Staging is in accordance with Gosner (1960). Morphometric measurements were taken using a slide vernier calliper (to 0.1 mm). These include BL (body length: measured from snout tip to body-tail junction), TAL (tail length: from body-tail junction to tail tip), TL (total length: from snout tip to tail tip), MTH (maximum tail height: greatest distance between dorsal and ventral fin margins), IOD (interorbital distance: between centres of the pupils), IND (internarial distance: between centers of narial apertures); abbreviations and definitions follow Altig and McDiarmid, 1999. In addition, BW (body width: widest part of body) and BH (body height: measured at mid-body) were also taken. Description of oral apparatus and labial tooth row formula (LTRF) is in accordance with Altig, 1970.

DESCRIPTION OF TADPOLE

Diagnosis.- A benthic larvae, inhabiting lentic microhabitat of clear, still, shallow forest pools which may be permanent or semi-permanent. Uniformly distributed dark bands beginning at body-tail junction and continuing onto tail; bands visible only from dorsal perspective. LTRF 2(2)/2(1). First row of posterior labium divided and gently arched; with each half arched convex posteriorly.

Larval morphology.- (Figs. 3-4) Body ovoid, snout tip rounded, BW 0.63-0.72 of BL; slightly depressed, BH 0.64-0.75 of BW; maximum width around mid-body; eyes dorsal, directed laterally, not visible from below, IOD 0.36-0.41 of BW, 1.27-1.61 of oral disc width; nostrils dorsal, open, midway between eye and snout tip; IND 0.33-0.39 of IOD; spiracle sinistral, located laterally, continuous with body wall, spiracular opening directed posteriodorsally, snout-spiracle 0.47-0.55 of BL; anal tube dextral, attached to ventral fin. Tail lanceolate, dorsal and ventral margins weakly convex, gradually tapering towards a narrow, rounded tip. TAL 1.71-2.02 of BL, MTH 0.20-0.26 of TAL; caudal muscle deeper than both fins for proximal 3/4 of tail. Dorsal fin originating shortly after body-tail junction, gently sloping towards mid-tail convex, dorsal fin deeper than ventral at midtail only. No observable lateral line pores or subdermal glands.

Colouration.- In life, dorsum and flanks olive, venter cream. Body and tail speckled with fine melanophores. Distinct dark band at body-tail junction (root of tail), not extended onto sides. Thereafter, five to seven uniformly spaced bands distributed over entire length of tail confined to dorsal margin, not extended onto lateral portion of tail. Ventral portion of body (including oral disc) and tail unpigmented. Dorsal and ventral fins largely clear, but speckled with fine iridocytes, melanophores on anterior margin of dorsal fin. In preservative, the olive colour degrades to a pale yellow, the iridocytes on the tail

FIGURE 1: Adult female *Limnonectes tweediei* in situ (SVL ca. 45 mm).

FIGURE 2: Juvenile *Limnonectes tweediei* in situ (SVL ca. 20 mm).

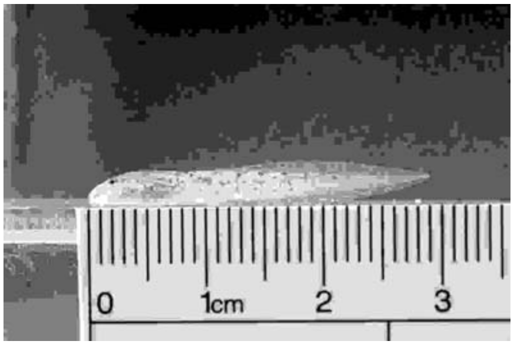

FIGURE 3: Lateral view of larval *Limnonectes tweediei* (Gosner Stage 26).

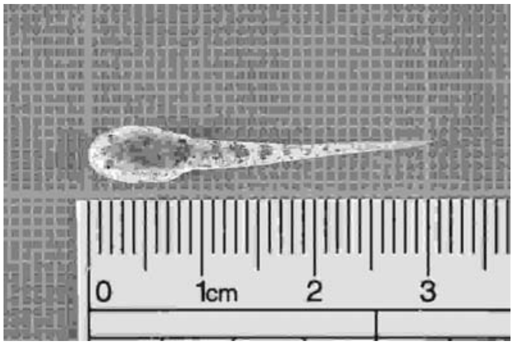

FIGURE 4: Dorsal view of larval *Limnonectes tweediei* (Gosner Stage 26).

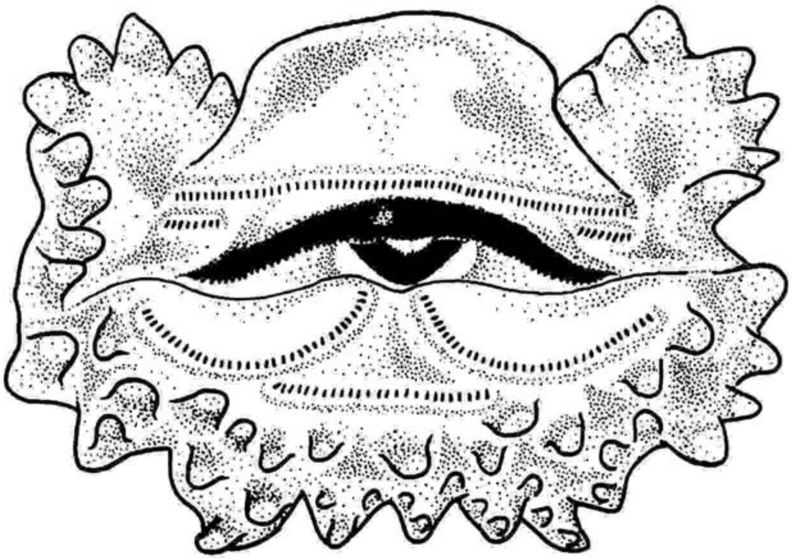

FIGURE 5: Oral disc of *Limnonectes tweediei* tadpole, illustrating the diagnostic double-arch pattern in the first, divided labial tooth row of the posterior labium.

TABLE 1: Developmental changes in BL (body length) and TL (total length) of larval *Limnonectes tweediei* (ZRC.1.7984, 8008-8015, 8177-8220; n = 53, Stages 26-46).

Gosner Stage	No.	BL (mm)	TL (mm)
26	13	4.0-6.3	12.1-17.3
27	8	6.2-7.8	17.1-21.2
28	9	6.9-8.3	18.8-22.7
29	2	7.9-8.0	21.1-22.4
30	1	9.0	24.1
31	3	7.9-8.3	22.1-23.9
32	1	9.2	26.5
34	2	9.1-9.2	26.7-27.8
36	1	9.4	27.4
37	1	10.4	28.2
38	1	10.0	29.9
40	3	10.1-10.4	28.6-30.9
42	2	8.6-8.7	25.8-26.2
45	1	8.4	9.7
46	5	SVL: 8.5-9.4	

fins disappear, but all melanophores (speckles and bands) are retained.

Oral disc.- (Fig. 5) Mouth ventral, sub-terminal, width 0.23-0.29 of BW, marginal papillae of anterior labium confined to lateral portions, consisting of single row of conical papillae; lower labium drawn out into fleshy, triangular appendages lined with short, conical papillae. Jaw sheath finely serrated, upper jaw sheath with gentle median convexity, heavily pigmented black; lower jaw sheath with a strong "v" arch, edged with black.

LTRF.- 2(2)/2(1), rarely 2(2)/2(1-2); second row of anterior labium divided, 1/5-1/6th width of first row, confined to lateral region. First row of posterior labium divided, with each row arched into an almost semi-circular arrangement. Second row of posterior labium undivided, 1/4-1/3rd width of oral disc, usually straight, occasionally gently convex. In one individual, however, the second row was divided and also arched in a similar fashion as the first row.

DISCUSSION

In the emergents (Stage 46), diagnostic characters of the adult are already prominent. The pair of dorso-lateral folds is distinct, in contrast with the smooth skin. The incompletely webbed toes and their bulbous tips are visible. A dark interorbital band is usually present on the head. The larvae of *Limnonectes tweediei* have been found to be sympatric with those of *L. plicatellus*, sharing the same microhabitat. Larval *L. plicatellus* has already been previously described (Leong and Chou, 1999) and may be distinguished from larval *L. tweediei* by comparing dorsal markings and oral disc characteristics. *L. tweediei* is the first species in its genus known to exhibit such a unique double-arched arrangement in their larval mouthparts.

From the morphological similarities between adult *Limnonectes tweediei* and *L. nitidus*, it may be deduced that both species are most closely related, compared to the other forest-specific species of *Limnonectes* found in Peninsular Malaysia. Although the larval identity of *L. nitidus* remains as yet unknown, it can be predicted that its tadpole will share comparable characters with those of *L. tweediei*.

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LITERATURE CITED

ALTIG, R. 1970. A key to the tadpoles of the continental United States and Canada. *Herpetologica* 26: 180-207.

________& R. W. McDIARMID. 1999. Body plan: development and morphology. pp:

24-51. *In*: Tadpoles: the biology of anuran larvae. R. W. McDiarmid & R. Altig (Eds). The University of Chicago Press, Chicago & London.

BERRY, P. Y. 1975. The amphibian fauna of Peninsular Malaysia. Tropical Press, Kuala Lumpur. x + 130 pp.

DRING, J. C. M. 1979. Amphibians and reptiles from northern Trengganu, Malaysia, with descriptions of two new geckoes: *Cnemaspis* and *Cyrtodactylus*. *Bull. British Mus. nat. Hist. (Zool.)* 34(5): 181-241; 2 pls.

FROST, D. R. 1985. Amphibian species of the world, a taxonomic and geographic reference. Allen Press Inc. and the Association of Systematics Collection, Lawrence, Kansas. 732 pp.

GOSNER, K. L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica* 16: 183-190.

GRANDISON, A. G. C. 1972. The Gunong Benom Expedition 1967: 5. Reptiles and amphibians of Gunong Benom with a description of a new species of *Macrocalamus*. *Bull. British Mus. nat. Hist. (Zool.)* 23(4): 43-101.

INGER, R. F. 1999. Distribution of amphibians in southern Asia and adjacent islands. In: Patterns of distribution of amphibians: a global perspective. pp: 445-482. W. E. Duellman (Ed). The John Hopkins Press, Baltimore & London.

ISKANDAR, D. T. & E. COLIJN, 2000. Preliminary checklist of Southeast Asian and New Guinean Herpetofauna. I. Amphibians. *Treubia* 31(Part 3; suppl.): 1-134.

KIEW, B. H. 1974. A note on the genus *Rana*: *Rana tweediei* Smith is synonymous with *Rana nitida* Smedley. *Malay. nat. J.* 28(2): 107-109.

LEONG, T.-M. & L.-M. CHOU. 1999. Larval diversity and development in the Singapore Anura (Amphibia). *Raffles Bull. Zool.* 47(1): 81-137.

SMEDLEY, N. 1931. Amphibians and reptiles from the Cameron Highlands, Malay Peninsula. *Bull. Raffles Mus*. 6: 105-123, pl. 2.

SMITH, M. A. 1935. On a collection of reptiles and amphibians from Perak, Malay Peninsula. *Bull. Raffles Mus.* 10: 61-63.

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A NEW SPECIES OF MOUNTAIN REED SNAKE, *MACROCALAMUS GENTINGENSIS*, FROM GENTING HIGHLANDS, PAHANG, PENINSULAR MALAYSIA

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(with three text-figure)

ABSTRACT.– A fifth species of the Peninsular Malaysian endemic genus *Macrocalamus* is described from Genting Highlands, Pahang. The new species is distinguishable from all others in the genus using a combination of meristic and pattern characters. Twenty-three preserved specimens including live and dead specimens were examined. The dried and shriveled specimens found upon collection were soaked in water for 24 h prior to fixation in 10% formalin. An updated key is provided for the identification of all known species.

KEYWORDS.– *Macrocalamus*, reed snakes, new species, *Macrocalamus gentingensis*, Genting Highland.

INTRODUCTION

The genus *Macrocalamus* is endemic to the forested mountains of Peninsular Malaysia (Tweedie, 1983). This genus has been previously represented by three species, namely *M. lateralis* Günther, 1864, *M. tweediei* Lim, 1963 and *M. jasoni* Grandison 1972. Vogel and David (1999) revised the *M. lateralis* complex and recognised a valid, fourth species, *M. schulzi*. A fifth species is now being reported from the Genting Highlands, Pahang.

MATERIALS AND METHODS

Twenty-three specimens of this new snake (eight adults and 15 juveniles) were collected from Genting Highlands, Pahang, Peninsular Malaysia between April to October, 2001. All were collected on the road and pavement of buildings at the radar and Telekom stations. Some specimens collected from the road during the day were already shrivelled and dried and all these were juvenile specimens. All live adults together with several juveniles were collected on the pavement of the housing quarters of the staff at the radar station at night. The dehydrated specimens were soaked in water for 24 h to rehydrate and subsequently fixed in a 10% formalin solution. All specimens were then stored in 70% alcohol and deposited in the reference collection of the Department of Wildlife and National Parks (DWNP), Kuala Lumpur, Malaysia and also at the Raffles Museum of Biodiversity Research, National University of Singapore, Singapore.

SYSTEMATICS

Macrocalamus gentingensis sp. nov.

(Fig. 1)

Holotype.- ZRC 2.5062 (formerly DWNP.R.0037), adult female from Genting Highlands, about 32 km north-east of Kuala Lumpur, in the vicinity of the water pump at 1181 m in elevation, Pahang, Peninsular Malaysia (03° 26’N, 101° 47’E). Collector, Oh Kim Sang, found on the ground at the wire fencing area on June 2001.

Paratypes.- Four adult specimens (2 males, 2 females) were designated paratypes. These are DWNP.R.0038 (♂), DWNP.R.0040 (♂), DWNP.R.0028 (♀), and DWNP.R.0093 (♀). Same locality as holotype and were collected by Oh Kim Sang between April and Oct 2001. Two of the paratypes, DWNP.R.0028 and DWNP.R.0038 were collected alive. They were found under rotten logs near the wire fencing area

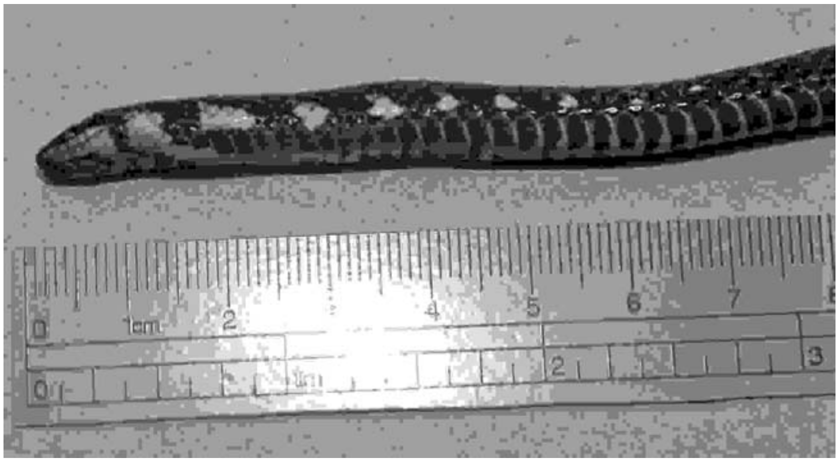

FIGURE 1: Paratype of *Macrocalamus gentingensis* sp. nov. (DWNP.R.0038), showing throat and anterior of body.

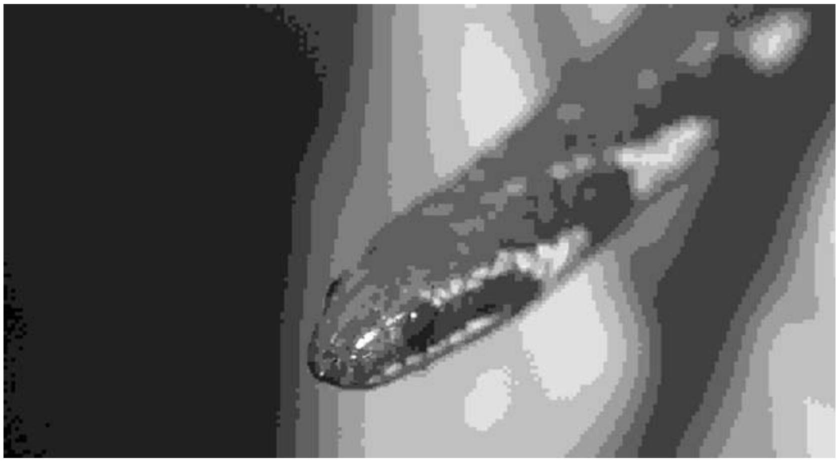

FIGURE 2: Paratype of *Macrocalamus gentingensis* sp. nov. (DWNP. R. 0038), in life.

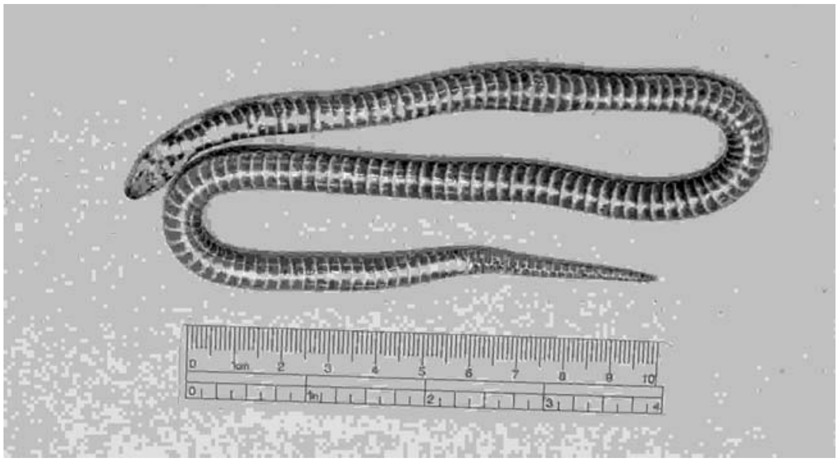

FIGURE 3: Live paratype of *Macrocalamus gentingensis* sp. nov. (DWNP. R. 0038), in ventral view.

at the radar station at 1,689 m asl. The other two specimens were found dead on the laterite road towards the radar station.

Diagnosis.- Eight supralabials, seven lower labials; body iridescent black, belly lighter, with a median yellowish stripe from nape to anus, series of yellow blotches from behind nape towards the flanks; series of yellow lateral spots from tip of tail towards anterior; yellow stripe from postocular to below neck.

Description of holotype.- The rostral scale is longer than broad, separating the nasals, and shorter and in contact with the prefrontals. The frontal is slightly longer than broad, and much shorter than the parietals. The loreal is twice as long as broad, and touching the second and third supra labials but no internasal. One preocular and one postocular. One anterior and two posterior temporals. Eight supra and seven lower labials, the fourth and fifth supralabials touching the eye and also in contact with the preocular and postocular. Anal scale entire; mid- body scales in 15 rows, ventral scales 134, and subcaudal 28. It has a stoutly built posture, the head is small and wedge-shaped, tail tapering and generally pointed.

Colour in life.- The colour in life was iridescent black on the dorsum with conspicuous yellow blotches on lateral portion immediately behind the head. Ventral slightly lighter in colour with pronounced yellow median line (1/10 width of ventral scale) starting from the throat to end of anus, broaden slightly at the anal plate. Tail uniformly black, spotted with lateral spots on each side of tail extending past anus anteriorly up to the position of 26th ventral scale. Underside of tail dark with a thinner median yellowish streak, in between subcaudals, from anus to tail tip. Top of head blackish with yellowish streak from behind eye extending posterior towards the nape, uniting with the yellow pattern on ventral side of neck. The supra labials are yellowish. The mental

TABLE 1: Measurements (in mm) and scale counts of 22 specimens of *Macrocalamus gentingensis* sp. nov. ? = not determined.

No	DWNP.R.	Sex	Date	SVL	TL	T	Ventrals	Subcaudals	Remarks
1	0038	M	June 2001	315	369	52	128	27	adult; paratype
2	0040	M	17 June 2001	245	279	54	129	30	adult; paratype
3	0028	F	15 May 2001	336	378	42	139	27	adult; paratype
4	0093	F	Oct 2001	255	283	28	138	24	adult; paratype
5	0058	F	25 July 2001	194	218	24	148	28	adult
6	0045	F	1 July 2001	189	211	22	142	27	adult
7	0088	?	Sept 2001	196	219	23	138	24	adult
8	0048	F	1 July 2001	162	186	24	139	27	juvenile
9	0041	?	27 June 2001	161	186	25	139	30	juvenile
10	0039	M	27 June 2001	163	196	33	122	27	juvenile
11	0030	?	25 May 2001	156	177	21	140	27	juvenile
12	0034	?	May 2001	162	185	23	145	27	juvenile
13	0047	F	1 July 2001	143	160	17	135	27	juvenile
14	0033	?	May 2001	137	155	18	137	27	juvenile
15	0057	?	16 June 2001	120	133	13?	136	27	juvenile
16	0044	F	3 July 2001	119	132	13?	136	27	juvenile
17	0046	M	3 July 2001	106	122	16?	127	28	juvenile
18	0031	?	May 2001	90	104	14?	122	27	juvenile
19	0089	?	Sept 2001	127	147	20	129	30	juvenile
20	0090	?	Sept 2001	138	159	21	131	33	juvenile
21	0091	?	Sept 2001	173	197	23	138	25	juvenile
22	0092	?	23 Oct 2001	104	119	15	124	27	juvenile

TABLE 2: Measurements (in mm) of the type series of *Macrocalamus gentinensis* sp. nov.

No	DWNP.R.	Head length	Head width	Eye-snout-tip length	Eye-nostril-length	Nostril-snout-tip length	Width at tail base	Head depth	Max body width	Max eye diameter
1	0028	12.55	5.95	3.15	2.95	0.20	5.15	4.40	8.70	1.90
2	0030	8.50	4.60	2.70	2.05	0.65	2.90	3.20	4.6	1.70
3	0031	8.00	2.20	2.15	2.00	0.15	1.85	2.00	2.8	1.10
4	0033	8.85	5.00	2.20	1.45	0.75	2.15	2.25	3.55	1.60
5	0034	8.05	3.90	2.45	1.70	0.75	1.70	2.65	4.50	1.20
6	0038	11.20	5.50	3.25	2.80	0.45	5.00	4.10	8.10	1.70
7	0039	8.95	4.75	2.60	1.60	1.00	2.90	3.30	5.30	1.55
8	0040	11.05	6.90	3.50	3.20	0.30	4.75	3.45	6.55	1.35
9	0041	8.20	3.60	3.00	1.70	1.30	2.50	2.70	3.70	1.70
10	0044	8.55	4.80	2.20	1.60	0.60	2.10	2.25	3.10	1.50
11	0045	9.15	5.10	2.70	1.85	0.85	3.25	3.00	4.85	1.10
12	0046	8.40	3.95	2.15	1.80	0.35	2.25	2.10	3.20	1.30
13	0047	8.55	4.45	2.50	1.60	0.9	2.50	2.70	3.75	1.35
14	0048	7.45	4.35	2.90	2.10	0.80	2.75	3.75	6.30	1.25
15	0057	8.80	3.70	2.00	1.50	0.50	2.15	2.50	3.50	1.20
16	0058	9.15	5.10	2.85	2.25	0.60	3.50	3.65	6.10	1.20
17	0088	8.75	4.50	2.45	2.20	0.25	3.15	3.60	5.60	1.20
18	0089	8.80	3.70	2.10	1.90	0.20	2.10	2.10	3.55	1.20
19	0090	7.40	3.75	2.50	2.15	0.35	2.50	3.10	4.05	1.15
20	0091	9.25	5.70	3.15	2.35	0.80	3.15	2.75	5.15	1.10
21	0092	6.20	3.55	2.35	1.85	0.50	2.10	2.60	3.90	1.35
22	0093	8.65	4.30	3.15	2.75	0.40	3.60	3.85	5.10	1.10

is darkish, lower labials 2 – 7 are yellowish and anterior chin shields are darkish.

Measurements.- Head length 12.50 mm; head width 5.25 mm; eye to snout tip 3.80 mm; eye to nostril length 2.52 mm; nostril to snout tip 0.60 mm; width at tail base 5.15 mm; head depth 3.35 mm; maximum body width 8.70 mm; maximum eye diameter 1.70 mm; total body length 378 mm; and tail length 42 mm.

Variation in paratypes.- The colouration of the paratypes is identical to that of the holotype except there is a slight difference on the underside of the tail. The thin median yellowish streak in between subcaudals from the anus to the tail tip, which is clearly defined in the holotype, is not pronounced in all the paratypes examined. The rest of the morphological characteristics are identical to the holotype. The body measurements and scale counts of the paratypes are as shown in Table 1 and Table 2.

Variation in non-types.- Of the 18 nontypes, three specimens are adults, DWNP.R.0058, 0045 and 0088 (Table 1: Nos. 5-7). The rest of the 15 specimens are young. A majority of the non types were dead and most of them were shrivelled during collections. The colouration of the three adults is identical to the holotype. The thin median yellowish on the underside of the tail streak is distinct in two of these (DWNP.R. 0045 & 0058), but it is not pronounced in DWNP.R.0088. They are slightly shorter than the paratypes with the total lengths of 211 mm (DWNP.R.0045), 218mm (DWNP.R.0058) and 219 mm (DWNP.R.0088) (Table 1).

The 15 juvenile specimens (Table 1: Nos 8-22) though were obtained dead and dehydrated, their general colours were blackish dorsally with yellowish to whitish blotches. The heads are similar to that of the holotype and paratypes. In three specimens (Table 1: DWNP.R. 0031, 0046, 0092) the yellowish median line starting from the throat to the end of the anus is obscured, although there is an inkling of such impression. The morphological characteristics of these young specimens are identical to that of the holotype and paratypes. The total length of these specimens ranged from 104-197 mm; ventrals 122-145 and subcaudals 25-33. They are also stoutly-built as in the paratypes. Scale counts and body measurements of the type series are in Tables 1 and 2.

Etymology.- The specific name is for the type locality, Genting Highlands.

NATURAL HISTORY

All specimens of the new snake species were collected in and around the area surrounding the radar station at 1,689 m asl except for the holotype, which was collected in the water pump area at 1,181 m asl. The specimen was found on the floor at the gate fencing area of the station. The surrounding forest is the lower montane forest or oak laurel forest of altitudinal range from 1,000 – 1,400 m, is characterised by the predominance of tree species belonging to oak (Fagaceae) and laurel (Lauraceae) families. Also common are tree ferns, conifers including vascular epiphytes, particularly orchids and ferns.

The forest type associated with the paratypes and nontypes is upper montane forest commonly known as the montane ericaceous forest above 1,750 m asl. It is represented by dwarf trees (1.5 to 1.8 m height), with flat crowns, due to constant exposure to wind. The trees are festooned with epiphytes lichens, mosses and leafy liverworts, the latter giving the forest a mossy appearances. The ground layers is spongy consisting of a deep layer of *Sphagnum* moss growing on peat soil. The most characteristics vegetation is rhododendrons, pitcher plants, orchids and the gelum gunung trees with its twisted bonsai trunk and assemblage of ant plant epiphytes. At night, the forest floor is damp, and when it rains or drizzle the floor turns soggy and waterlogged. Forest streams are scarce and when encountered they are drips from under the rock boulders flowing along the forest. The fact that a majority of the specimens were found either dead or alive on the road and on pavement of buildings, suggest that they move out from concealment to warm themselves in more open habitats, where most of the juveniles died from heat of the sun during the day. Such behaviour is also known in *Macrocalamus verterbralis* and *M. schulzi* from

Cameron Highlands, Pahang, that were collected on the roads during the late morning, either freshly dead or dried up (Lim, 1967).

COMPARISONS

The newly described species, *Macrocalamus gentingensis* is distinguished from the rest of the *Macrocalamus* species by its pattern of colouration, as described in the preceding text. It can be separated from *M. lateralis* and *M. schulzi*, which are brown to dark brown in colour dorsally and with the ventral reddish to yellowish uniformly. The iridescent black dorsal colour of this new species is similar to that of *M. tweediei* and *M. jasoni*. It differs from the former species, the ventral of which is marked with a black and yellow-checkered pattern below; from the latter species, the ventrals, apart from their black lateral margins and medial black flecks on ventral 1-8 are bright yellow. The identification between these species is given below in an updated key to the genus *Macrocalamus*.

KEY TO SPECIES OF *MACROCAMALUS*

1. Seven supralabials, body uniformly black above, chequered black and yellow below ....*tweediei*
   Eight supralabials, without black markings forming chequered pattern.........................2
2. Body brown..3
   Body black or iridescent black...................4
3. Body dark brown or greyish brown, with white, dark edged dorsal ocelli, one pair of dark ventrolateral stripes, belly pink or coral red with scattered spots..........*lateralis*
   Body uniformly brown, ventrolateral stripes absent, belly yellow and unspeckled ....*schulzi*
4. Body black above, with a yellow stripe on each side of the back, belly bright yellow, ventrals tipped with black ....*jasoni*
   Body black above with scattered yellow patches on each side of the nape, belly black with a median thin yellowish line throughout its length ....*gentingensis*

DISCUSSIONS

All known species of *Macrocalamus* have been found in the main range of montane terrain from Selangor to Pahang and Perak States of Peninsular Malaysia. With the exception of *M. lateralis* which have been recorded in more than one mountain locality (Fraser Hill, Cameron Highland, Genting Highland and Kuala Tahan in Pahang and Maxwell hill or now known as Bukit Larut, Perak), the other four species have been recorded to restrict to one at the most two mountain localities; *M. schulzi* in Cameron Highland, Pahang, *M. jasoni* from Gunong Benom, Pahang, *M. tweediei* from Cameron Highland and Genting Highlands, Pahang and *M. gentingensis* from Genting Highland, Pahang. Besides being strictly confined to mountainous terrain, another interesting observation made on the preference of ecological niches by each of these species in forest types covered with *Sphagnum* moss in damp environment.

The revelation of the *Macrocalamus* from a single species *M. lateralis* described by Günther (1864) to five species to date; *M. tweediei* (Lim, 1964), *M. jasoni* (Grandison, 1972), *M.schulzi* (Vogel and David, 1999) and *M. gentingensis* (Norsham and Lim, 2002) indicates that the species complex of this genus is quite interesting. There has not been any record of the other genus of snakes with a short period of less than four decades so many species have been detected and described.

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LITERATURE CITED

GRANDISON, A. G. C. 1972. The Gunong Benom Expedition 1967. 5. Reptiles and amphibians of Gunong Benom with a description of a new species of *Macrocalamus*. *Bull. British Mus. nat. Hist. (Zool.)* 23: 45-101.

GÜNTHER, A. C. L. 1864. The reptiles of British India. Ray Society, London. xxvii + 452 pp, Pl. 1-26.

LIM, B.-L. 1963. *Macrocalamus tweediei*, a new species of reed snake from Malaya. *Bull. Nat. Mus., Singapore* 32: 99-102.

________. 1967. Snakes collected in Gunung Brinchang, Cameron Highlands, Pahang. *Malay. nat. J.* 20: 121-127

TWEEDIE, M. W. F. 1983. The snakes of Malaya. Third edition. Singapore National Printers Pte. Ltd., Singapore. 167 pp, Pl. 1-12.

VOGEL, G. & P. DAVID. 1999. A revision of the genus *Macrocalamus* (Serpentes: Colubridae), with description of new species and a key to the genus. *Raffles Bull. Zool.* 47(2): 309-332.

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OBSERVATIONS ON GEOGRAPHIC VARIATION IN THE ASIAN FROG, *HOPLOBATRACHUS RUGULOSUS* (ANURA: RANIDAE)

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(with three text-figures)

ABSTRACT.– This study examines a series of morphometric, meristic, and colouration traits in the wide-ranging *Hoplobatrachus rugulosus*. Comparison of four samples (Myanmar, Thailand, Hong Kong, Taiwan) reveals minor differences within and among the sample localities, but the differences do not display concordant patterns of geographic variation of the twenty-three traits examined. All populations display sexual dimorphism in morphometric traits, no dimorphism in hindfoot webbing or dorsal rugosity, and dimorphism of colouration in Taiwan and Myanmar populations. Discriminant analysis of the morphometric traits provides evidence of modest segregation of the sample localities, but the small sample sizes make these results equivocal. Eastern *H. rugulosus* averages larger and more rugose than western populations. Taiwan frogs usually have spotted bellies, and spotting decreases westward to immaculate bellies in Myanmar frogs. Hong Kong frogs have less hindfoot webbing than the three other populations. Other traits differ, but their geographic patterns do not match that of the preceding ones or display another single pattern.

KEYWORDS.– Anura, Ranidae, *Hoplobatrachus rugulosus*, geographic variation, sexual dimorphism, morphometry, Hong Kong, Myanmar, Taiwan, Thailand.

INTRODUCTION

Many species of Asian frogs have distributions that extend from the Indian subpeninsula to the coast and islands of eastern Asia. Some of these species clearly are composites, consisting of numerous similar appearing allopatric species, for example, the *Fejervarya limnocharis* complex (Dubois and Ohler, 2000). Other presumably widespread species are less obvious composites, and their composite nature is revealed only by close examination of behavioral, molecular, or morphological characteristics (e.g., *Kalophrynus interlineatus* and *K. pleurostigma*; Matsui et al., 1996). These two extremes of hidden (unrecognized) species suggest that many more of the widespread Asian frogs consist of multiple species.

Frog monitoring at the Chatthin Wildlife Sanctuary in north-central Myanmar (Zug et al., 1998) and the joint California Academy of Sciences – Smithsonian Institution and Myanmar Wildlife Division herpetofaunal survey have encouraged a systematic examination of the Myanmar anuran fauna, both because of the discovery of new species and the need to identify correctly the resident species. *Hoplobatrachus rugulosus* or the Chatthin frogs that fit the "*rugulosus*" paradigm are a major component of the Chatthin paddy frog community. Being large frogs with numerous dorsal longitudinal ridges, they are easily labeled *rugulosus*. But is this name designation correct? Specifically, are Myanmar "*rugulosus*" populations part of a genetic continuum from the nominal population in the Hong Kong area? The following analysis is a preliminary investigation of this question through an examination of regional variation in external morphology.

MATERIALS AND METHODS

We selected four geographic areas for analysis: Taiwan (TA); Hong Kong (HO; type locality of *Hoplobatrachus rugulosus*); Thailand (TH); and Myanmar (MY); see list of specimens examined in the Appendix I. These four localities encompass the longitudinal expanse of this species' distribution, although they certainly do not encompass all the variation therein. We limited our sample selection to the availability of series in the United States National Museum's collections (USNM), with the addition of a Hong Kong topotypic series from the Museum of Comparative Zoology, Harvard University (MCZ). These samples provide adequate adults for interpopulational comparisons. For our comparison, we specifically restricted our samples to adults from a single geographic area in order to limit intraregional variation. Additionally, all data were recorded by the first co-author to ensure consistency, and as recommended by Hayek et al. (2001), a single specimen (USNM 132075, adult female, Taiwan) was measured multiple times (15) to provide an estimate of intra-observer variation. This last data set was captured on five different days and at three different times during a session measuring frogs from other samples.

Our characters include sets of quantitative (mensural and meristic) and qualitative (colour pattern) features. The characters include the basic frog mensural set as well as additional measurements and traits that appeared on an initial examination to characterize "*rugulosus*." The characters are:

Mensural. [mm; all bilateral measurements recorded from the right side.] Snout-vent length (SVL): The distance from the tip of snout to the vent. The measurement is taken with the frog's venter adpressed against a flat, firm surface. Head length (HeadL): Straight-line, horizontal distance from the tip of snout to the posterior corner of the jaws. Head width-mid (HeadWm): Straight-line, transverse distance from the left to right edges of the lips at the posterior edge of the eyes. Head width-posterior (HeadWp): Straight-line, transverse distance from the left to right edges of the corner of the jaws. Internarial distance (Intnar): Distance between the left and right nares. Naris-eye distance (NarEye): Distance between the naris and the anterior corner of the orbit. Eye-ear distance (EyeEar): Distance between the posterior corner of the orbit and the anterior, internal border of tympanic annulus. Tympanum diameter (Tymp): Horizontal diameter of the tympanum from outer edge of annulus. Trunk length (TrnkL): Straight-line, horizontal distance from axilla to inguen. Trunk width (TrnkW): Transverse distance from outer edges of left and right sacral diapophyses. Forelimb length (ForlL): Straight-line distance from elbow to wrist. Thigh length (ThghL): Straight-line distance from vent to knee. Crus length (CrusL): Straight-line distance from knee to ankle. Tarsus length (TarsL): Straight-line distance from ankle joint to heel. Hindfoot length (HndfL): Straight-line distance from heel to tip of 4th toe.

Meristic. Hindfoot webbing: coding of Savage and Heyer (1997), with the exception that webbing is recorded only in halves and whole numbers. Toes are identified by Roman numerals, and inner (anterior) and outer (posterior) edges by integers; for example, the inside edge of third toes is III1, its outside edge III2. Glandular fold development; folds are glandular elevations 5X or more longer than wide. Anterior body folds (AntFold): number of folds across dorsum at level of forelimb insertions. Posterior body folds (PstFold): number of folds across dorsum at level of sacral diapophyses.

Qualitative Colour pattern. These traits are coded arbitrarily in a numerical sequence. Dorsum (DorsC), three states: unicolour [0]; spotted or blotched [1]; reticulate [2]. Thigh (ThigC), rear surface: four states: reticulate [0]; vertical bars [1]; spotted or blotched [2]; horizontal stripe(s) [3]. Chin & throat, midline (ChinMC): longitudinal stripe, present [1] or absent [0]. Chin & throat, lateral (ChinLC): immaculate [0]; lightly spotted [1]; moderate to strongly spotted or reticulate [2]. Chest (ChesC): three states: immaculate [0]; spotted or blotched [1]; reticulate

[2]. Belly (BelC): immaculate [0]; spotted or blotched [1]; reticulate [2]. All observations on colour pattern derive from preserved specimens.

We examined the gonads of all specimens to determine maturity and sex. We used SYSTAT version 9 for all statistical analyses; Student's *t*-test compared means of adult female and male mensural and meristic variables for identifying sexual dimorphism; ^{2} test provided tests of colour pattern sharing among samples; principal components analysis (PC) performed with a correlation matrix and no rotation; and linear discriminant function analysis (DA) with a stepwise model-backward entry of variables provided evaluations of regional differentiation. Unless noted otherwise, all analyses used untransformed data.

RESULTS

Mensural.- The intra-observer variation was modest. The adult female selected for repetitive measurement ($n = 15$) is one of the two largest females in our samples. The coefficient of variations (*CV*) for her variables range from 0.008 to 0.091: *CV* 3% SVL, TrnkL, HeadL, HeadWp, Intnar, NarEye, CrusL, TarsL, HndfL; *CV* = 4-6% TrnkW, HeadWm, EyeEar, Tymp, ThghL; *CV* = 9 ForlL. SVL has the lowest *CV* (0.8%) and a standard deviation (*s*) of 0.85 mm, indicating an accuracy of 1 mm for this measurement. The *s* of TrnkL, TrnkW, HeadL, HeadWm, ForlL, and ThghL exceed 1.0 mm (1.2-1.8). These *CV* are less than those of the individual sample localities. For example, the larger (*n* 9) male (TA, TH, MY) and female (TA, MY) samples have CV ranges of 0.054-0.186, 0.070-0.161, 0.102-0.130, 0.085-0.190, 0.106-0.191, respectively. With the exception of Taiwan male sample, *CV*s are predominantly 10%, although 16%; the Taiwan males are mostly < 10%. The *CV*s show males to be less variable than females, that is, they have a narrower size range as adults.

A comparison of the adult females and males in each sample (Table 1) reveals that the males average smaller than females at all localities, although the means between the sexes are significantly different (pooled variance $p < 0.05$) only for the Taiwan and Myanmar samples. This result highlights the role and necessity of nearly equal sample sizes for statistical confirmation of sexual dimorphism. The result further demands that all subsequent interregional comparisons be among individuals of the same sex.

PC analysis provides an independent assessment of adult dimorphism (Fig. 1) at each locality and the possibility of identifying variables with the greatest discriminatory potential. All four localities have the first component (PC1) denoting size. Although there is overlap between females and males, males typically are negative and females positive on the PC1 axis (Fig. 1 left). Females and males overlap strongly on PC2. All characters load heavily (0.44-0.99) on PC1 at all localities, and most loadings are > 0.80 (Table 2). Size (PC1) accounts for 72.4%, 80.3%, 76.7%, and 90.2%, respectively (Taiwan, Hong Kong, Thailand, Myanmar), of the total variance of the measurements. Either CrusL or SVL are the highest loading variables for PC1 in the four samples, but often, other variables are nearly equal in this component loading. PC2 loadings are mostly low (-0.30 to 0.30 for 75% or more of the variables in each sample), and account for 6.9%, 9.2%, 7.8%, and 2.3% of the variance, respectively. The variables with the highest loading on PC2 are Tymp and Intnar (Taiwan), ThghL and TrnkL (Hong Kong), ThghL (Thailand), and ThghL (Myanmar). Log transformation of the data did not alter the amount of segregation among the sexes; it simply reversed the signs of the components. On this basis, transformation was not used in subsequent analyses.

PC comparison of adult females and males (Fig. 1 right; results presented for males only) independently from all four localities show no discrete clustering for any locality. Again, all variables load heavily (0.75-0.98) on PC1 and much less so on PC2 (Table 2). The highest loading PC2 variables for females (see Table 2 for males) are EyeEar (0.50), TrnkL (-0.48), and ThghL (-0.46); all other variable loadings are 0.26 to 0.002. PC1 accounts for 77.8% and PC2 for 5.9% of the variance in females, and 67.7% and 8.4%, respectively, in males.

DF analyses of the samples examined the differentiation of the four localities using all vari-

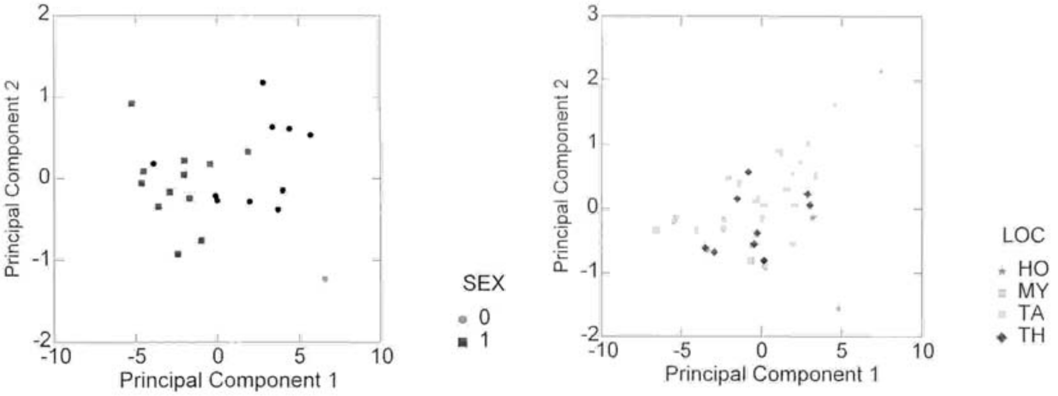

FIGURE 1: Principal component analyses of *Hoplobatrachus rugulosus*. Left. A comparison on adult females and males from Myanmar; females represented by circles, males by squares. Right. A comparison of adult males from the four Asian localities: Taiwan, squares; Hong Kong, stars; Thailand, diamonds; Myanmar, circles.

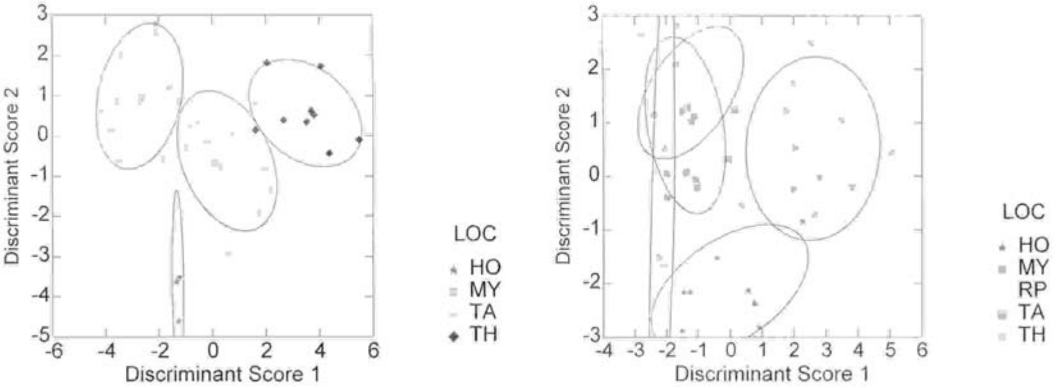

FIGURE 2: Discriminant function analyses of adult male *Hoplobatrachus rugulosus*. The variables used in the final stepwise DF model are in Table 3; the confidence ellipse defines $p = 0.68$ of the sample. The clusters are: Taiwan, squares, open squares for repeat-measured female; Hong Kong, stars; Thailand, diamonds; Myanmar, circles.

ables except ForlL and a subset consisting of the highest loading variables in the PC analyses, i.e., SVL, CrusL, TrnkL, ThghL, Tymp, and Intnar. Stepwise DF of the "total" variable set identified five variables for females and four for males (Table 3) as the "best" ones for the discriminatory models. Only the HeadWp and ThghL variables are shared between the two sexes. These reduced variable sets yield an overall classification of 89% (83% jackknifed) for females and 94% (83%) for males (Table 3). The sample-locality clusters observed on bivariate plots of the first three DF scores for females show modest segregation of Taiwan, Hong Kong, and Myanmar (Fig. 2 left); the Thai sample consists of only three individuals and overlaps the Taiwan cluster. Males also show modest segregation (Fig. 2 right) of the four localities, also with slight cluster overlap. For males, the smallest sample (Hong Kong) is distinctly separated from the other three localities. Using the six PC-identified variables, only the Thailand sample yields 100% correct classifications (standard & jackknifed) in the female analysis, and 100% and 89%, respectively, in the male analysis; the average overall jackknifed accuracy is low (69, 67%) for both females and males. Adding the repeat-female sample to the female DF stepwise model increases the size (variation) of the Taiwan cluster (Fig. 2 left), but the repeat measures do not overlap with

TABLE 1: Select measurements of the four samples of *Hoplobatrachus rugulosus*. Abbreviations and definition of characters are explained in the Materials and Methods section. * denotes significantly different means for female and male samples, using a pooled variance $p < 0.05$.

	N	SVL	Head Width-mid	Tympanum Diameter	Crus Length
Taiwan					
female	14	95.9 ± 9.18*	26.6 ± 2.61*	6.7 ± 0.57*	39.9 ± 4.11*
male	12	81.1 ± 4.34	22.9 ± 1.53	6.2 ± 0.54	35.2 ± 2.34
Hong Kong					
female	8	105.2 ± 14.31	29.5 ± 5.10	7.2 ± 1.15	45.2 ± 7.11
male	3	90.4 ± 8.02	25.9 ± 1.15	6.5 ± 0.58	41.3 ± 2.85
Thailand					
female	3	84.4 ± 7.88	25.4 ± 3.87	5.8 ± 0.55	38.6 ± 5.30
male	9	77.2 ± 5.83	22.6 ± 2.32	5.5 ± 0.50	35.2 ± 3.59
Myanmar					
female	11	88.3 ± 11.07*	23.8 ± 2.53*	6.9 ± 0.98*	38.1 ± 4.50*
male	12	71.3 ± 7.4	18.8 ± 2.04	5.3 ± 0.66	30.4 ± 3.14

TABLE 2: Principal component loading values for the comparisons of morphometric characteristics of Myanmar adult females and males (Fig. 1 top) and of adult males of *Hoplobatrachus rugulosus* for the four sample locality sites (Fig. 1, bottom). The loading values are similar for the female-male comparisons at the other sites and for comparison of females among the four sites.

	Females & Males		Sample Localities	
	PC1	PC2	PC3	PC4
SVL	0.99	0.06	0.97	0.03
HeadL	0.95	0.10	0.85	0.07
HeadWm	0.96	0.17	0.90	-0.27
HeadWp	0.99	0.12	0.90	-0.33
Intnar	0.92	-0.25	0.81	0.08
NarEye	0.93	0.12	0.76	0.31
EyeEar	0.91	0.08	0.67	-0.33
Tymp	0.92	-0.23	0.74	0.25
TrnkL	0.94	0.05	0.57	0.61
TrnkW	0.96	0.02	0.92	-0.15
ForlL	-	-	0.81	0.39
ThghL	0.90	-0.34	0.58	0.35
CrusL	0.98	-0.001	0.95	-0.16
TarsL	0.98	0.02	0.87	-0.18
HndfL	0.98	0.04	0.90	-0.24

Myanmar and Hong Kong. The repeats, however, indicate that larger samples of each of these three localities would increase the overlap among them.

TABLE 3: Summary of linear discriminant function results for interpopulational comparison of *Hoplobatrachus rugulosus*. Females and males were compared separately owing to sexual dimorphism of mensural traits. Abbreviation: J%, jackknifed classification.

	Males			Females		
	Variables in final model					
	HeadWp			HeadL		
	NarEye			HeadWp		
	ThghL			EyeEar		
	HndfL			ThghL		
				CrusL		
	Classification accuracy					
Locality	n	%	J%	n	%	J%
Taiwan	12	92	67	14	93	93
Hong Kong	3	100	100	8	63	50
Thailand	9	89	89	3	100	100
Myanmar	12	100	92	11	100	91
Total	36	94	83	36	89	83

Meristic.- Webbing of the hindfoot shows no sexual dimorphism within samples; the probabilities for all *t*-tests exceed 0.08 and most are > 0.30. The extent of interdigital webbing varies between localities (Table 4). Hong Kong adults have less webbing than adults of the other localities, and although variation in webbing occurs

TABLE 4: Variation in extent of hindfoot webbing in the four samples of *Hoplobatrachus rugulosus*. The data are means for each sample; the abbreviations are explained in the Materials and Method section.

	n	I	II1	II2	III1	III2	IV1	IV2	V
TA	30	0.78	2.00	0.87	2.20	1.57	2.97	3.33	1.77
HO	18	0.67	2.00	0.53	2.17	1.14	2.83	3.00	1.00
TH	18	0.97	2.00	0.84	2.38	1.36	2.94	3.22	1.28
MY	25	0.82	2.00	1.00	2.47	1.56	3.00	3.47	1.72
Greatest Difference		0.30	0.00	0.47	0.20	0.43	0.17	0.47	0.77

TABLE 5: The density of glandular body folds on the trunk of adult *Hoplobatrachus rugulosus*. The mean number of body folds is presented on the mid-diagonal of the locality-locality matrix; first number is PstFold, the second AntFold. The right upper half of the matrix shows significant difference between AntFold of paired localities, and lower left half the significance difference between PstFold. * = p = 0.05-0.002, ** = p $\leq$0.001, - = p > 0.05.

	n	TA	HO	TH	MY
TA	26	9.7\10.0	*	-	**
HO	11	*	6.5\7.6	-	-
TH	12	*	-	8.1\8.7	*
MY	23	**	-	**	6.0\6.9

among these latter localities, they are more similar to one another than each is to Hong Kong. The greatest difference in web attachment among the localities is for the fifth toe (V), roughly a difference of three-quarters of a phalanx in attachment. Although hindfoot webbing in Hong Kong frogs is reduced relative to the other populations, webbing is still well developed.

We quantified rugosity by counting the number of glandular folds at the shoulder (AntFold) and the "hips" (PstFold). As for toe webbing, there is no evidence of sexual dimorphism but rugosity has high intrasample variation (AntFold *CV* = 19-41%, PstFold *CV* = 19-63%). In all samples, the glandular folds average more numerous anteriorly than posteriorly (Table 5). Our westernmost and easternmost samples, respectively, are the least and most rugose. Samples from Taiwan are significantly more anteriorly rugose than those from Hong Kong and Myanmar, and posteriorly more rugose than the other three samples. Even though samples from Hong Kong and Thailand are not significantly different from one another, the rugosity of those from Hong Kong is more similar to those from Myanmar than Myanmar is to its nearest neighbour Thailand.

Colour.- Our colouration variables document overall dorsal colouration (DorsC), thigh pattern (ThghC), and ventral colouration in four areas (ChinMC, ChinLC, ChesC, BelC). Because we arbitrarily assigned numerical values to different patterns (e.g., spots vs. immaculate) within each colour variable, we can test the similarity of patterns between sexes and among localities by χ^2 analysis of frequency tables. There is only slight evidence for sexual dimorphism in colouration and that is in a single trait, DorsC, and at one locality, Myanmar. All Myanmar males are spotted but only 64% of the females (*df* 1, χ^2 = 5.28, p = 0.02). Only Taiwan also has adults without spots or blotches on the dorsum, although these dorsally unicoloured individuals are all females, the

TABLE 6: Summary of adult colouration of *Hoplobatrachus rugulosus* from Taiwan, Hong Kong, Thailand, and Myanmar. The abbreviation for variable names are in the Materials and Methods section; all values are percent of total adults at a locality. An asterisk denotes that the frequency distribution of colour states among localities is significantly different, p < 0.01.

	DorsC		ThghC*		ChinMC*		ChinLC		ChesC*		BelC*	
	unicolour	spotted	reticulate	spotted	absent	present	light	moderate	immaculate	spotted	immaculate	spotted
TA	12	85	36	66	20	80	20	80	0	100	24	76
HO	0	100	100	0	36	64	9	91	27	73	73	27
TH	0	92	58	33	0	100	0	100	0	100	83	17
MY	17	83	87	13	0	100	13	87	52	48	100	0

larger Taiwan sample does not yield significance (*df* 1, $\chi^2 = 2.95$, $p = 0.23$).

Examining adult colouration among the samples (Table 6) shows that frequency distribution of the colour states for DorsC and ChinL are statistically equivalent among the four localities, and the distributions of states are different for the other four colour traits. There is no striking concordance of colour patterns among the localities. The pattern on the rear of the thigh is predominantly reticulate at Hong Kong, Thailand, and Myanmar. A distinct midline stripe occurs on the chin of all Thailand and Myanmar individuals, but on two-thirds of the Hong Kong and three-quarters of the Taiwan frogs. Most frogs in all populations have moderate to heavy markings on the sides of the chin. The chest of Taiwan, Hong Kong, and Thailand always or usually bear some spots or streaks, but only about half of the Myanmar frogs have markings on the chest. The belly of most Taiwan frogs is marked, and this marking becomes less frequent westward with the Myanmar frogs lacking any belly marks.

DISCUSSION

Mensural.- Hayek et al. (2001) recommended 20 repeated measures of the same individual to examine intra-observer variation. Our sample size is somewhat smaller ($n = 15$), but our results match their result and, thus, appear adequate. SVL has the lowest variation ($CV < 1\%$), and similarly all our measurements, except ForlL, have $CV \leq 6\%$ as in their study (Hayek et al., 2001: Table 4). This low variation argues for measurement consistency within our data set and shows our ability to obtain fairly reliable data sets from specimens that are variably preserved and positioned. We also interpret the low variation of the repeated-measures data as confirmation that the higher variation observed within the locality samples reflects the natural variation of adult *Hoplobatrachus rugulosus* populations, although the repeat data remind us that larger samples will increase the range of variation and likely reduce the segregation of samples in multivariate space. Thus, the repeat data make us more cautious in the interpretation of a sample's uniqueness, especially for the small sample sizes of this study. Because *CV* is sample size dependent, the variation of our samples is increased by their small size.

Size sexual dimorphism is a common aspect of anuran morphology (Zug et al., 2001). Our inability to confirm this dimorphism statistically in the Hong Kong and Thailand samples likely results from few individuals of one sex and the resulting strong inequality of sample size between the sexes. With the exception of Thailand sample, females average about 15 mm larger than males (Table 1), and this difference occurs in the populations with the largest (Hong Kong) and smallest (Myanmar) individuals. Our data suggest a somewhat clinal decrease in size from east to west.

Neither the PC nor the DF analyses of the morphometric variables argue strongly for regional differentiation of *H. rugulosus* populations. The PC results segregate individuals on the basis of size on the first component. The second component also appears to size influenced, with head size being most important for the Taiwan population, and trunk and thigh length for the other populations. The DF results also show an influence of head and hindlimb variables.

The modest segregation of localities through DF analyses (Fig. 2) hints at some regional differentiation. With our bias toward Myanmar *H. rugulosus*, we see the nonoverlap of Thailand and Myanmar samples as a suggestion of speciation of Myanmar *rugulosus*; however, until samples are enlarged and their number increased, any nomenclatural change is inappropriate. Similarly, the differences of the Hong Kong sample require a detailed comparison with mainland China populations because Hong Kong is the nominate population of *H. rugulosus*.

Meristic.- Hindfoot webbing shows no sexual differentiation but shows regional differences (Table 4). Hong Kong frogs have the least amount of webbing, but this least is relative because webbing is still extensive on the hindfeet. Webbing is usually recorded in smaller fractional units (Savage and Heyer, 1997) than halves;

however, preliminary data collection showed our accuracy (consistency) was higher at half-unit recording. We are unable to judge the influence of this aspect of data-capture on observed regional difference.

Rugosity also lacks evidence of sexual dimorphism and shows evidence of regional differentiation (Table 5) with Taiwan frogs being the most rugose and Myanmar ones the least. This most to least rugosity is not, however, a cline. Hong Kong and Thailand frogs are intermediate but Hong Kong rugosity is more similar to the Myanmar condition than it is to Thailand's.

Colour.- Of the six colouration variables, only dorsal colouration hints at sexual dimorphism and only in the Taiwan and Myanmar samples. In both, some females have unicolour or near unicolour backs. None of the other colouration variables show sexual dimorphism, and there is no strong signal of regional differentiation in colouration although some regional differences exist (Table 6). The rear of the thigh in Taiwan frogs is usually spotted, whereas it mostly reticulate in Hong Kong and Myanmar frogs, somewhat less so in the Thailand sample. Taiwan and Hong Kong frogs occasionally (20 and 36%) lack the midline chin stripe, which is invariably present in the Thailand and Myanmar individuals. Only belly colouration displays a geographic trend with the sequential loss of spotting on the belly from east to west.

Conclusions.- Our original question, "Are Myanmar "*rugulosus*" populations part of a genetic continuum from the nominal population in the Hong Kong area?," cannot be answered unequivocally by our analysis. The analyses of regional differentiation within the four sets of morphological characters reveal differences between each of the four populations examined. These differences, however, do not support a hypothesis of unquestionable regional differentiation and can as easily be interpreted as a genetic continuum as speciation. Mensural data shows sexual dimorphism if the samples are sufficient large. Additionally, eastern populations average larger than the western ones (Thailand, Myanmar). Webbing suggests differentiation of Hong Kong *H. rugulosus* from the other localities. Rugosity and colouration show differences among the samples and hint at regional differentiation. The small sample sizes likely contributed to our inability to discern regional differentiation. We predict that the patterns seen within and between samples will be re-enforced by larger samples. We also predict that the addition of new localities will introduce new patterns of intrasample variation. Our data do not declare the absence of regional genetic differentiation in *Hoplobatrachus rugulosus*, rather they indicate that such differences cannot be verified by external morphology alone. Behavioral and molecular data also are required.

ACKNOWLEDGEMENTS

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LITERATURE CITED

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

HAYEK, L.-A. C., W. R. HEYER & C. GASCON. 2001. Frog morphometrics: a cautionary tale. *Alytes* 18: 153-177.

MATSUI, M., T. CHAN-ARD & J. NABHITABHATA. 1996. Distinct specific status of *Kalophrynus pleurostigma interlineatus* (Anura, Microhylidae). *Copeia* 1996: 440-445.

SAVAGE, J. M. & W. R. HEYER. 1997. Digital webbing formulae for anurans: a refinement. *Herpetol. Rev.* 28: 131-132.

ZUG, G. R., HTUN WIN, THIN THIN, THAN ZAW MIN, WIN ZAW LHON & KYAW KYAW. 1998. Herpetofauna of the Chatthin Wildlife Sanctuary, north-central Myanmar with preliminary observations of their natural history. *Hamadryad* 23: 111-120.

________, L. J. VITT & J. P. CALDWELL. 2001. Herpetology. An introductory biology of amphibians and reptiles. Second edition. Academic Press, San Diego, San Francisco, New York, Boston, London, Sydney and Tokyo. xiv + 630 pp.

APPENDIX I

Examined specimens.- Arranged from west to east. Taiwan: USNM 38209-211, 38218-219, 132075, 133157, 139958-962, 141635-651. Hong Kong: MCZ 109353-359, 115680-682, 115685, 115688-690, 115692, 117035, 117037; USNM 37512. Thailand: USNM 206086, 206090-091, 206093-094, 206096-106. Myanmar: USNM 520470-489, 524039-042, 537465.

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OBSERVATIONS ON THE GIANT SOFTSHELL TURTLE, *PELOCHELYS CANTORII,* WITH DESCRIPTION OF A NEW SPECIES

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(with one text-figure)

ABSTRACT.– **The population of *Pelochelys* in northern New Guinea (Papua New Guinea and Irian Jaya, Indonesia) is described herein as a new species; it is diagnosed by the unique juvenile carapace pattern of contrasting, close-set, dark markings. The new species differs from the distinctive *P. bibroni* in lowland parts of southern New Guinea, and from the geographically isolated *P. cantorii* in south-east Asia. The early history of some specimens of *P. cantorii* (including holotype), previously treated as *Chitra,* is discussed. *Pelochelys cantorii* in western Thailand may be distinctive. The occurrence of *P. cantorii* in the Philippines is discussed.**

KEYWORDS.–**Testudines, Trionychidae, *Pelochelys* taxonomy, New Guinea, Thailand, Philippines.**

INTRODUCTION

Previous study of giant softshell turtles (*Pelochelys*) in New Guinea resulted in restriction of *P. bibroni* to southern New Guinea (Webb, 1995) with all other known populations referred to *P. cantorii*. The distinctive population of *Pelochelys* confined to the lowlands of northern New Guinea is described as a new species. Previous commentary has indicated two distinctive populations of *Pelochelys* in New Guinea (Rhodin et al., 1993; Webb, 1995, 1997; Rhodin and Genorupa, 2000).

MATERIALS AND METHODS

All specimens and specific localities of the new taxon from northern New Guinea were previously discussed by Webb (1995, as *P. cantorii*); no new material has been forthcoming so that the map in Webb (1995: 306, Fig. 5) still suffices for the known distribution of the new taxon. Measurement abbreviations include CL- carapace length, CW- carapace width, PL- plastron length and HW— head width (CL and CW both straight-line). Museum codes include BMNH- British Museum (Natural History), London, now The Natural History Museum but BMNH retained for cited specimens in publications (Colin McCarthy, in litt.); CUMZ(R)- Chulalongkorn University Museum of Zoology (Reptile Collection), Bangkok; MNHN- Muséum National d'Histoire Naturelle, Paris; NMW-Naturhistorisches Museum, Vienna; MCZ-Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; SMF-Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt-am-Main; UMMZ-Museum of Zoology, University of Michigan, Ann Arbor, Michigan; and USNM- National Museum of Natural History (formerly U.S. National Museum), Smithsonian Institution, Washington, D.C.

SYSTEMATICS

In allusion to the unique juvenile pattern of close-set, dark markings on the carapace the new species may be known as (Latin, *signifer*, *-a*, *-um*, bearing marks, figures, signs):

Pelochelys signifera sp. nov.
Variegated Giant Softshell Turtle
(Fig. 1)

Holotype.- BMNH 1921.11.11.4, unsexed juvenile in fluid (paper tag with inked number 216 tied to right ankle), from the "Wanggar River, Weyland Range, Geelvinck Bay, N. New Guinea" (Papua Province, Indonesia), presented by C. B. Pratt. The holotype has a CL of about 111 mm, CW of 113 mm, and a PL of 85 mm (precise maximal HW measurement prevented by skin folds). Girgis (1961: 77, as *P. bibroni*) mentioned the holotype noting its weight as 122.7 gm and carapace dimensions of 10.6 and 10.2 cm. The holotype is illustrated in Webb (1995: 304, Fig. 3, upper right).

Diagnosis.- *Pelochelys signifera* differs from the other two species of the genus, *P. bibroni* and *P. cantorii,* in having (in combination) a juvenile carapace with a close-set, indistinct, reticulated pattern emphasized by distinct, small dark dots and markings, and the adult carapace patternless, uniformly olive-brownish (see Comparisons).

Description.- Juvenile pattern aspects of *Pelochelys signifera* are based on the holotype (BMNH 1921.11.11.4) and colour slides (A. Rhodin, P-354) of MCZ 153921 when alive (photographs in Rhodin et al., 1993: 27, Fig. 8; no measurements, now skeletal material). Small turtles are prominently patterned with dark markings on the head, neck, and carapace; the dorsal soft body parts and carapace overall are olive or green-brown. The carapace may be narrowly edged in yellow (except anteriorly), but usually lacks any pale margin. The juvenile carapace pattern is a close-set irregular reticulation (with intervening pale areas), parts of which vary in pigment intensity (pale to dark); the conspicuous aspect of the juvenile patten is the small dark brownish dots and markings, which overlie the subdued reticulated background (Fig. 1). Dark markings on the head occur on the snout, side of head, upper and lower lips, with a few dark spots on the underside of the head. Small dark markings on the neck (somewhat subdued) occur ventrolaterally. This dorsal, dark variegated pattern is reduced on the forelimbs, absent on hind limbs. The nuchal region of the carapace has some small, low knobby tubercles that are more diffuse laterally. The carapace otherwise is smooth, except for longitudinal ridges of varying length (not individual tubercles) confined to the central bony disc area.

Larger specimens have smooth, uniformly brownish carapaces, lacking longitudinal ridges and dark-spotted patterns, but retain small dark markings on the head. The carapace of the smallest overall brownish specimen (UMMZ 68808, CL 174 mm, CW 162 mm, PL 135 mm, HW 30.0 mm) lacks a definite pattern; a dorsal view photograph of this specimen is in Webb (1995: 304, Fig. 3, lower right). The largest turtle is "uniformly brown with very indistinct paler markings" (data from Andrew Stimpson, in litt, BMNH 1978.2179, CL 315 mm, CW 305 mm, PL 295 mm, HW ca. 48 mm; bony CL 240 and CW 245 mm).

Data on skulls or bony plastra of *P. signifera* are not available. Rhodin et al. (1993) commented on some bony carapaces of *P. signifera* noting eight neurals (n = 6, first neural not here counted as two) in their discussion of neural reversal.

Distribution.- Lowlands of northern New Guinea extending from the Madang region in Papua New Guinea (Sepik and Ramu drainages) westward to the Wanggar River (Nabire region, southern shore of Cenderawasih Bay) in Irian Jaya, Indonesia (Rhodin and Genorupa, 2000: 131). The extent of range encompasses the known localities (not repeated here) listed and mapped in Webb (1995, as *P. cantorii*).

New Guinea species of *Pelochelys* are isolated. Specimens of *Pelochelys* are undocumented from the intervening islands west of New Guinea and east of Java and Borneo (localities in De Rooij, 1915: 332). However, Anders Rhodin (pers. convers.) observed a *Pelochelys* in a market in Ujung Pandang, Sulawesi. Personal travel (with Anders Rhodin in 1993) to some of the Lesser Sunda Islands tended to confirm negative evidence of occurrence (complete ignorance on

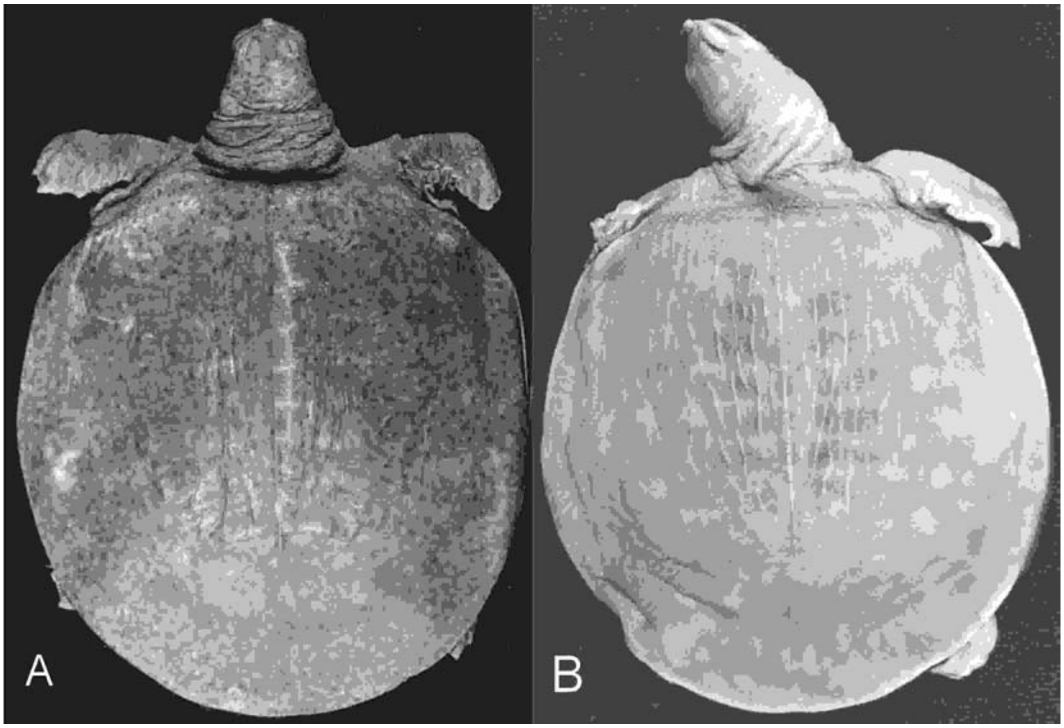

FIGURE 1: Juvenile carapace patterns of *Pelochelys*. A, holotype of *P. signifera* (BMNH 1921.11.11.4, CL about 111 mm, Wanggar River, Irian Jaya, Indonesia). B, *P. cantorii* (NMW 30327, CL about 78 mm, "Phuc Son" Vietnam).

the part of guides and native residents regarding photographs of trionychid turtles) on at least western Timor, Roti, Flores, and Sumba.

Comparisons.- Of the three species of *Pelochelys*, *P. bibroni* in southern New Guinea is most distinctive, differing from the other two species (*P. signifera* and *P. cantorii*) in juveniles having an overall rough-textured (tuberculate) brownish carapace, and large adults having contrasting, irregularly arranged, yellow markings on the carapace and yellow neck stripes. *Pelochelys signifera* most closely resembles *P. cantorii.* Adults of both species have smooth, uniform brownish or olive carapaces with no distinct pattern, but with some small dark markings on the head. Juveniles of *P. signifera* and *P. cantorii* have smooth carapaces, except for some small, low, knobby tubercles in the nuchal region and longitudinal ridges over the central bony disc area, but differ in carapace patterns. *Pelochelys signifera* has a distinct pattern of small, close-set, dark markings (also on head-neck), whereas *P. cantorii* is overall uniformly brownish, but may have some indistinct pale spots (Fig. 1). Juveniles of *P. cantorii* may have a few tiny black dots on the carapace (see photographs in Ernst et al., 2000). *Pelochelys signifera* also seems to differ from *P. cantorii* in juveniles having the longitudinal rows of ridges confined to the central bony disc area, whereas these ridges in *P. cantorii* extend anteriorly into the tuberculate nuchal region of the carapace.

Dorsal view photographs of juvenile and adult patterns of the two New Guinea species, *P. signifera* and *P. bibroni,* are compared in Webb (1995: 304, Fig. 3). Juvenile patterns of *P. signifera* (holotype) and *P. cantorii* are compared in Fig. 1 (this report). Siebenrock (1903: 350-351) described the specimen of *P. cantorii* depicted here in Fig. 1, NMW 30327, ca 58 mm PL, 78 mm CL (curvature), from Vietnam-"Annam (Phuc Son)."

Three species of *Pelochelys* are recognized (*P. bibroni, P. cantorii, P. signifera*). Farkas and

Fritz (1998) discussed the taxonomic status of Zhang's *Pelochelys taihuensis* (1984) and Zhou's use of *P. maculatus* (1997), and concluded that both names refer to *Rafetus swinhoei*. The three species of *Pelochelys* can be distinguished by the following brief key:

1A. Juveniles with overall rough-textured, tuberculate carapace; adults with yellow neck stripes and contrasting yellow markings on carapace........................*P. bibroni.*

B. Juvenile carapace smooth, except for low tubercles in nuchal region and longitudinal ridges over central bony disc area; adult carapace uniformly brownish (no distinct pattern)..2.

2A. Juvenile carapace covered with distinct, dark pattern of close-set, small dots and markings (Fig. 1)...................*P. signifera.*

B. Juvenile carapace lacking distinct, close-set variegated pattern of dark markings, mostly uniform brownish, may have indistinct, pale spots (Fig. 1). ....*P. cantorii.*

HISTORY OF *PELOCHELYS CANTORII*

Specimens of *Pelochelys cantorii* were treated as *Chitra* prior to Gray (1864) distinguishing *Chitra* and *Pelochelys* and describing *P. cantorii*. Gray's account of *Chitra indica* (1844: 49) was a composite of *Chitra* and *Pelochelys*; his two listed specimens "a" and "b" ultimately became the two syntypes (BMNH 1947.3.4.5, stuffed and BMNH 1946.1.22.13, young in fluid) of *Pelochelys cumingii* [= *P. cantorii*] (Gray, 1864: 90), whereas Gray's new genus *Chitra* was based on examination of a *Chitra* skull (BMNH 1849.2.5.1, now lost). These same two specimens (also cited "a" and "b") and the skull were listed as *Chitra indica* in Gray's Catalogue ("1855"[1856]: 70) and the skull illustrated (Pl. XLI).

Likewise, Cantor's account of *Gymnopus indicus* (1847: 616) from "Pinang" is based on the now stuffed holotype of *P. cantorii* (BMNH 1947.3.6.21). Gray's (1864) recognition of *Pelochelys* was based primarily on a comparison of the earlier-accessed *Chitra* skull (again illustrated, Gray 1864: 92, Figs. 11 [dorsal] and 12 [ventral view]; Gray, 1870: 90, Fig. 28; and same in Boulenger, 1889: 264, Fig. 70) and the skull (BMNH 1947.3.6.22) that was removed from the holotype of *P. cantorii* and illustrated by Gray (1864: 90, Figs.. 9 and 10; Gray, 1870: 91, Fig. 29; and same in Boulenger, 1889: 262, Fig. 69).

Günther's report of *Chitra indica* (1864: 50), written prior to Gray's (1864) distinction of *Chitra* and *Pelochelys*, has been regarded as a composite. Günther (1864: 50) reiterated some of the same information that appeared in Cantor (1847) and illustrated (Fig. VI, Fig. C) the holotype of *P. cantorii*; however, Gray (1870: 91) noted that "the markings and colour [were] added from General Hardwicke's figure of the living *Chitra indica*. Dr. Günther believed they represented the same animal." This strange composite of a *Pelochelys* body form/*Chitra* pattern has been maintained by subsequent authors (Theobald, 1876; Boulenger, 1889; and Smith, 1931).

As a side issue, the type-locality of *P. cantorii* ("Pinang," Cantor, 1847), as well as Gray's "Penang" for an unidentified Henderson specimen (1831: 47, as *Trionyx indicus*), may be incorrect. The Henderson specimen (see Farkas, 1994), perhaps *Chitra* but might well have been a *Pelochelys*, was in the fluid collection of the Royal College of Surgeons (Owen, 1859: 104, entry 685) and was destroyed during the London bombing in World War II. Smith (1931: 6) noted Cantor's localities, "particularly those labelled Penang—are incorrect." Although circumstances of collection are unknown, the Pinang (Cantor, 1847) and Penang (Gray, 1831) labelled specimens may be of unknown origin and sourced from a Chinese temple on Pinang Island that keeps various kinds of captive turtles acquired from different geographic areas (Annandale, 1912: 165).

VARIATION IN *PELOCHELYS CANTORII*

The foregoing descriptive comments may not be applicable to all populations of the widespread *Pelochelys cantorii* (see comments in Niekisch et al., 1997: 30, and Thirakhupt and van Dijk, "1994"[1995]: 247). A general lack of specimens (especially juveniles) from certain areas has hampered a thorough and convincing appraisal of geographic variation.

The general concept is that juveniles of *Pelochelys cantorii* have a mostly uniform olive to brownish carapace but may have some discernable, indistinctly margined, pale circular spots. Gray (1844: 49, as *Chitra indica*) noted the carapace of the small syntype of *P. cumingii* (see above) as "Olive,...; head olive, minutely black-dotted; throat olive, minutely white-dotted." In my examination of this syntype in 1973, I recorded the head, lips, and limbs as patternless, brownish, and the brownish carapace lacking a definite pattern with ridging on the central disc area; the CL is about 81 mm, the PL 61 mm. Cantor (1847: 616, as *Gymnopus indicus*) described the stuffed holotype of *P. cantorii* (see above), PL about 215 mm, as having the carapace "greenish-olive, vermiculated and spotted with brown or rust colour".

A distinctive population may occur in the Mae Klong drainage in western Thailand. A large adult *Pelochelys* (examined by author, BMNH 1921.4.1.179, head, limbs, part of carapace, in fluid, Malcolm A. Smith No. 1868) from this drainage (Thirakhupt and van Dijk, "1994"[1995]: 238) is unlike all other adult *Pelochelys* (few examined and published photos) in having distinct white dots and spots on the carapace and soft body parts. Smith (1931: 160, 161) noted "Olive above, dotted all over with yellow" presumably in reference to the "four specimens from central Siam" he had seen. Nutphand (1979: 206), in referring to Thailand *Pelochelys*, noted "Carapace of young leaf-green with yellow spots all over." Mocquard (1907: 14) reported a *Pelochelys* from "Siam" (now MNHN 8003, as *Chitra* in MNHN catalogue; not examined, large, mounted), which Roger Bour (in litt., 9 March 1988) related as a *Pelochelys* having a pattern of "very small round whitish spots...probably near Bangkok, in 1867" These white or yellow-spotted *Pelochelys* may be confined to the Mae Klong (and Chao Phraya) drainage in Thailand. Cox et al. (1998: 6) noted a probable barrier of "an elevated plateau with extensive sandstone outcrops" between the valleys of the Chao Phraya and (adjacent eastward) the Mekong River drainage, which is inhabited by non white-spotted *Pelochelys* (CUMZ(R) 1993.1.7.5 and CUMZ(R) 1993.2.15.1). However, Thirakhupt and van Dijk ("1994"[1995]: 246) reported that *Pelochelys* seems to have disappeared from the Chao Phraya and Mae Klong, and van Dijk and Palasuwan (2000: 144) noted the species as "locally extinct Chao Phraya and Mae Klong systems and probably from other minor river systems".

OCCURRENCE OF *PELOCHELYS* IN THE PHILIPPINES

General statements of distribution of Giant Softshell Turtles, *Pelochelys*, have included the Philippines for many years, since Gray (1844) to the present (Meylan, 1987; Iverson, 1992; Ernst et al., 2000).

Gray (1844: 49) first mentioned the two syntypes of *Pelochelys cumingii* (Gray, 1864: 90) as specimens "a. Adult stuffed. Philippine Islands. From Mr. Cuming's collection." and "b. In spirits, very young...India." This same information accompanied specimens "a" and "b" in Gray ("1855"[1856]: 70), except that the locality of specimen "b" (the young in spirits) was changed from India to the Philippine Islands. In neither report (1844 or "1855"[1856]) was Cuming associated with specimen "b." In the description of *P. cumingii*, Gray (1864: 90) linked Cuming with the young specimen. The Philippine Islands and Cuming were associated with both syntypes by Gray (1873: 76) and Boulenger (1889: 263). Thus, there may be some question concerning at least the locality of the young syntype in fluid, initially recorded from India and not associated with Cuming. Old registration BMNH numbers were not associated with the two Cuming specimens now catalogued as 1946.1.22.13 (young) and 1947.3.4.5 (stuffed).

Hugh Cuming (1791-1865), ardent shell collector, did visit the Philippines and vicinity. Dance (1966: 154) noted that he arrived in Manila on 24 July 1836, and visited "Bantoyan, Bohol, Burias, Camiguin de Misamis, Capul, Cebu, Corregidor in the mouth of Manila Bay, Cuyo, Guimaras, Leyte, Lubang, Masbate, Mindoro, Negros, Samar, Siquijor, Tablas, Temple and Ticao. On the island of Mindanao he visited the Province of Misamis and on the island of Luzon the Provinces of Albay, Bulacan, Cagayan, South Camarines, North and South Ilocos, Laguna, Nueva Ecija, Pampanga, Pangasinan, Tayabas, Tondo [Rizal] and Zambales." Dance (1966: 157) also noted that "About 11 November 1839 Cuming left Manila for Singapore and from there he paid short visits to Malacca and Sumatra before...[arriving]...back in London on 5 June 1840." Dance (1966: 165) also quoted a letter of Cuming to the Trustees of the British Museum (offering the sale of his shell collection) in which Cuming noted his voyage to "the Eastern Ocean (when the Philippine Islands were carefully explored), in 1836, 1837, 1838 and 1839; and to Sincapore [sic], Sumatra, and the Malayan Peninsula, in 1840."

Dance (1966: 167) also commented that "several authorities have questioned the accuracy of the statements of habitat accompanying the original published descriptions of many species (shells) described from the Cuming collection,...[and further that]...many other Cumingian localities have been shown to be completely erroneous, so many in fact that the accuracy of all Cuming's data is seriously impugned."

Baur (1891) mentioned a *Pelochelys* skull in the Philadelphia Academy from the Philippines (No. 111). This skull cannot be found. Baur presumably referred to the Academy of Natural Sciences, Philadelphia, where no *Pelochelys* skull now exists (Edmond Malnate, in litt.).

Taylor (1921: 186) mentioned the Philippine trionychid turtles cited by Casto de Elaras (1895, not seen by author), who listed *Dogania subplana, Chitra indica,* and *Trionyx sinensis*. Taylor noted the *Chitra* record based on Gray's account (1844) of *C. indica* and dismissed occurrence of the other species. Taylor (1921: 188) transcribed data of collection of a captive Philippine *Pelochelys* in the Bureau of Science Aquarium (Manila) as "captured in 1918 at San Miguel, Bulacan Province, Luzon, by Mr. Genesio Pating, and was presented to the aquarium by Mr. George Symmonds, of Manila"; he noted that this specimen (footnote) died, was preserved, but destroyed by a fire in 1920. Taylor (1921: 187) provided measurements (CL 350 mm, CW 315 mm, and PL 295 mm) and photographs (Pl. 16, Figs. 3 [dorsal], 4 [ventral view]) of this specimen, and used the description and photographs of the same specimen in his account of Thailand turtles (1970: 151, Fig. 13).

Smith (1931: 161-162) noted that specimens of *Pelochelys* examined by him from "the Philippine Islands have seven neural plates and the last two pairs of costals in contact with one another." It is not certain as to which specimens Smith refers; some of Malcolm A. Smith's specimens at least are now in the BMNH and MCZ. The only BMNH "Philippine" specimens are the two syntypes of *P. cumingii* (Colin J. McCarthy, in litt., 2 May 2002); the stuffed syntype has eight neurals and only the eighth pair of costals in medial contact. No Philippine specimens of *Pelochelys* are catalogued in MCZ (José Rosado, in litt., 3 May 2002).

Three museum catalogue entries indicate occurrence of *Pelochelys* in the Philippines. MNHN 1883-416 is a mounted specimen from Luzon; received from Marche. SMF 8069 (SMF number when visited in 1973) is listed in Boettger (1893: 16, as *Pelochelys cantoris*) with the number "3163" from "Laguna de Bay, Luzon (Philippinen). Gesch. 1890 von Konsul Dr. O. Fr. von Moellendorff, Manila." Finally, the only USNM (Ron Crombie) specimen from the Philippines was "purchased from local apothecary" (Traci Hartsell, in litt., March 2002). None of these were examined by the author.

The above-mentioned excerpts imply that *Pelochelys* occurs or may have occurred in the Philippine Islands. However, Alcala (1986) did not mention *Pelochelys* in his survey of the Philippine herpetofauna, and remarked (in litt., 15 July 1992) that "I can say that there has been no recent publication or written record to indicate that this genus is found on Luzon or elsewhere in the country. Considering the past (post-Taylor) and present collecting activity of field workers on Luzon and other parts of the country, it is very likely that *Pelochelys* does not occur in the Philippines." Records of past occurrence may have been based on waifs, escapees, market purchases, or on populations now extirpated. Feral populations of *Pelodiscus sinensis* (import date unknown) do occur on the islands of Luzon and Cebu (Indraneil Das, and photos, in litt., 17 December 1993). The occurrence of viable, reproducing populations of *Pelochelys* in the Philippines is uncertain. Extensive trapping activities in the major rivers (especially Luzon) and monitoring of the markets are necessary to fortify conclusions of presence or absence. It is hoped this discussion will stimulate colleagues to focus on the status of *Pelochelys* in the Philippine Islands.

Thus, the overall "Philippines" type-locality of *Pelochelys cumingii* is questionable, especially in view of the spurious data of collection associated with at least some of Cuming's shell collections. Characteristics of the two syntypes of *P. cumingii* do not negate their assignment to *P. cantorii*. The type-locality may well be one of the other places visited by Cuming (Singapore, Sumatra, Malayan Peninsula) in 1840.

However, *Pelochelys* most probably does occur in the Philippines in the vicinity of the small islands (Sulu Archipelago) off the north-east coast of Sabah (Borneo). The only here-accepted record of occurrence of *Pelochelys* in the Philippines is from Balabac Island (Siebenrock, 1903: 351), north of Sabah and just south of Palawan.

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LITERATURE CITED

ALCALA, A. C. 1986. Guide to Philippine flora and fauna. Vol. X. Amphibians and reptiles. Natural Resources Management Centre, Ministry of Natural Resources, Univ. Philippines, Manila. 195 pp.

ANNANDALE, N. 1912. The Indian mud-turtles (Trionychidae). *Rec. Indian Mus*., 7: 151-180, 2 pls.

BAUR, G. 1891. Notes on the trionychian genus *Pelochelys*. *Ann. Mag. nat. Hist*., *Ser*. 6, 7: 445-446.

BOETTGER, O. 1893. Katalog der Reptilien-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfkurt am Main. I. Teil (Rhynchocephalen, Schildkröten, Krokodile, Eidechen, Chamäleons). Gebrüder Knauer, Frankfurt a. M. x + 140 pp.

BOULENGER, G. A. 1889. Catalogue of the chelonians, rhynchocephalians, and crocodiles in the British Museum (Natural History). Taylor & Francis, London. x + 311 pp.

CANTOR, T. E. 1847. Catalogue of reptiles inhabiting the Malayan Peninsula and islands. *J. Asiatic Soc. Bengal,* 16: 607-656, 897-952, 1026-1078. (Reprinted A. Asher, Amsterdam, 1966.)

COX, M. J., P. P. VAN DIJK, J. NABHITABHATA & K. THIRAKHUPT. 1998. A photographic guide to snakes and other reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publ. (UK) Ltd., London. 144 pp.

DANCE, S. P. 1966. Shell collecting. An illustrated history. University of California Press, Berkeley. 344 pp., 35 pls.

DE ROOIJ, N. 1915. The reptiles of the Indo-Australian Archipelago. I. Lacertilia, Chelonia, Emydosauria. E.J. Brill Ltd., Leiden. 384 pp.

ERNST, C. H., R. G. M. ALTENBURG, & R. M. BARBOUR. 2000. Turtles of the world. ETI (Expert Center for Taxonomic Identification), World Biodiversity Database, CD-Rom Series (Windows Version 1.2), University of Amsterdam, Amsterdam.

FARKAS, B. L. 1994. Notes on type and type locality of the narrow-headed softshell turtle, *Chitra indica* (Gray, 1831) (Testudines, Trionychidae). *Misc. Zool. Hungarica* 9: 117-119.

________& U. FRITZ. 1998. On the identity of *Rafetus swinhoei* (Gray, 1873) and *Pelochelys maculatus* (Heude, 1880) (Reptilia: Testudines: Trionychidae). *Zool. Abh. Staatlich. Mus. Tierkunde Dresden* 50: 59-75.

GIRGIS, S. 1961. Observations on the heart in the Family Trionychidae. *Bull. British Mus. (nat. Hist.), Zool.* 8: 73-107.

GRAY, J. E. 1831. Synopsis Reptilium; or short descriptions of the species of reptiles. Part I.- Cataphracta. Tortoises, Crocodilians, and Enaliosaurians. Treuttel, Wurtz; G.B. Sowerby; and W. Wood, London. viii + 85 + [2] pp; 10 pls.

________. 1844. Catalogue of the tortoises, crocodiles, and amphisbaenians in the collection of the British Museum. E. Newman, London. viii + 80 pp.

________. "1855"[1856]. Catalogue of shield reptiles in the collection of the British Museum. Part I. Testudinata (Tortoises). Taylor & Francis, London. [3] + 79 + [2] pp., 50 pls. (published 8 March 1856.)

________. 1864. Revision of the species of Trionychidae found in Asia and Africa, with the descriptions of some new species. *Proc. Zool. Soc. London* 1864: 76-98.

________. 1870. Supplement to the catalogue of shield reptiles in the collection of the British Museum. Part I. Testudinata (Tortoises). With figures of the skulls of 36 genera. Taylor & Francis, London. ix + [1] + 120 pp.

________. 1873. Hand-list of the specimens of shield reptiles in the British Museum. E. Newman, London. iv + 124 pp.

GÜNTHER, A. C. L. G. 1864. The reptiles of British India. Ray Society, London. xxvii + 452 pp., 26 pls. (Reprint edition about 1982, Oxford & IBH Publ. Co., New Delhi.)

IVERSON, J. B. 1992. A revised checklist with distribution maps of the turtles of the world. Privately published, Richmond, Indiana. xiii + 363 pp.

MEYLAN, P. A. 1987. The phylogenetic relationships of soft-shelled turtles (Family Trionychidae). *Bull. American Mus. Nat. Hist.* 186: 1-101.

MOCQUARD, F. 1907. Les reptiles de L'Indo-Chine. Revue Coloniale, Librairie Maritime et Coloniale, Paris. 59 pp.

NIEKISCH, M., B. FARKAS, U. FRITZ, & H. D. DÚC. 1997. Rekordgrössen bei weichschildkröten im stadtzentrum von Hanoi, Veitnam. *Herpetofauna* 19: 28-34.

NUTPHAND, W. 1979. The turtles of Thailand. Siam Farm Zool. Garden, Bangkok. [8] + 1-222 pp.

OWEN, R. 1859. Descriptive catalog of the specimens of natural history in spirit contained in the Museum of the Royal College of Surgeons of England. Vertebrata: Pisces, Reptilia, Aves, Mammalia. Taylor & Francis, London. xxii + 148 pp.

RHODIN, A. G. J. & V. R. GENORUPA. 2000. Conservation status of freshwater turtles in Papua New Guinea. *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 129-136. P. P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds). *Chelonian Res. Monogr.* No. 2.

________, R. A. MITTERMEIER & P. M. HALL. 1993. Distribution, osteology, and natural history of the Asian giant softshell turtle *Pelochelys bibroni* in Papua New Guinea. *Chelonian Conserv. & Biol.* 1: 19-30.

SIEBENROCK, F. 1903. Schildkröten des östlichen hinterindien. *Sitzungsber. Kaiserl. Akad. Wissensch. Wien* 112: 333-352.

SMITH, M. A. 1931. The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. I.- Loricata, Testudines. Taylor and Francis, London. xxviii + 185 pp.; 2 pls.

TAYLOR, E. H. 1921. Amphibians and turtles of the Philippines. *Philippine J. Sci.* 15: 1-193, 17 pls. (Reprinted A. Asher & Co., Amsterdam, 1966.)

________. 1970. The turtles and crocodiles of Thailand and adjacent waters with a synoptic herpetological bibliography. *Univ. Kansas Sci. Bull.* 49: 87-179.

THEOBALD, W. 1876. Descriptive catalogue of the reptiles of British India. Thacker, Spink and Co., Calcutta. x + 238, i-xxxviii [synopsis]; i + xiii [index] pp.; 3 pls.

THIRAKHUPT, K. & P. P. VAN DIJK. “1994"[1995]. Species diversity and conservation of turtles of western Thailand. *nat. Hist. Bull. Siam Soc.* 42: 207-259 (issued July 1995.)

VAN DIJK, P. P. & T. PALASUWAN. 2000. Conservation, status, trade, and management of tortoises and freshwater turtles in Thailand. *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 137-144. P. P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds). *Chelonian Res*. *Monogr*. No. 2.

WEBB, R. G. 1995. Redescription and neotype designation of *Pelochelys bibroni* from southern New Guinea (Testudines: Trionychidae). *Chelonian. Conserv. & Biol.* 1: 301-310.

________. 1997. Geographic variation in the giant softshell turtle, *Pelochelys bibroni*. Linnaeus Fund Research Report. *Chelonian Conserv. & Biol.* 2: 450.

ZHANG, M. 1984. A new species of *Pelochelys* from Zhejiang, with subfossil description. *Acta Herpetol*. *Sinica*, *Chengdu* [*new ser.*.] 3: 71-76. [Chinese text, English abstract.]

ZHOU, K. 1997. Studies on the classification of Chinese soft-shelled turtles (Trionychidae). *In*: Chinese Chelonian Research, pp. 55-64. E. Zhou, J. Zhou & T. Zhou (Eds). Herpetol. Ser. 9; *Sichuan J. Zool*. 15 (suppl.), [6] + 1-159 + [3] pp. [Chinese text, English summary.]

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TYPHLOPS ETHERIDGEI, A NEW SPECIES OF AFRICAN BLINDSNAKE IN THE *TYPHLOPS VERMICULARIS* SPECIES GROUP FROM MAURITANIA (SERPENTES: TYPHLOPIDAE)

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(with one text-figure)

ABSTRACT.– A new species of Typhlopidae is described from West Africa (Amsâga of western Mauritania, ca. 21° N, 13° W), based upon a single adult female. With 424 middorsals, 24 midbody scale rows, T-III supralabial imbrication pattern, multicameral lung with 36 air chambers and type A foramina, straight liver with 6/7 segments, the affinity of *Typhlops etheridgei* n. sp. appears to be with *Typhlops vermicularis* of Balkan Europe, south-western Asia, and Egypt. Visceral differences between the two taxa are observed in the heart, liver, adrenals, kidneys, caecum, and lungs. The 4450 km separation of populations of *Typhlops etheridgei* from *Typhlops vermicularis* by the Sahara Desert precludes the possibility of conspecificity; together these two species form a basal species group within the Typhlopidae. Fossil records of undetermined Scolecophidia or *Typhlops* occur throughout Europe from the Eocene to the Pleistocene that may be referred to *T. vermicularis* or a related lineage. It is suggested that the ancestors of *T. etheridgei* migrated across the Gibraltar land bridge during the Messinian Salinity Crisis.

KEY WORDS.– *Typhlops etheridgei*, *T. vermicularis*, visceral anatomy, Mauritania, Mediterranean Sea, Miocene.

INTRODUCTION

The Typhlopidae of northern and western Africa are poorly known due to the paucity of material in museum collections. While it is true that the majority of the Sahara Desert remains unexplored herpetologically, representatives of the family have not yet been reported from Morocco and Western Sahara (Bons and Geniez, 1996), Algeria (Gauthier, 1967), Tunisia (Chpakowsky and Chnéour, 1953), Libya (Kramer and Schnurrenberger, 1963), the Saharan portions of Mali (Papenfuss, 1969), Niger (Villiers, 1950), Chad (Roussel and Villiers, 1965), and Sudan (Corkill, 1935), or the Sahara in general (Le Berre, 1989; Schleich et al., 1996). The most recent works on Mauritania (Dekeyser and Villiers, 1956; Villiers, 1950b) do not list any Typhlopidae. However, two subsaharan species of *Typhlops* are currently known from north-western Africa. *Typhlops punctatus* (Leach, 1819) has been reported from the dry savanna of southern Mauritania (also extending eastward into southern Mali, southern Niger, and south-western Chad) and *T. lineolatus* (Jan, 1864) extends as far north-westward as Sénégal (Hahn, 1980; Roux-Estève, 1974; Villiers, 1950a, 1975).

The discovery of an unidentified *Typhlops* from the arid regon of western Mauritania that shows no affinity to African *Typhlops* but closely resembles *T. vermicularis* of south-eastern Europe and south-western Asia is thus a perplexing surprise. The purpose of this report is to describe this new taxon, ascertain its relationships, and explain its historical origin.

MATERIALS AND METHODS

Middorsal scale counts include all scales between the rostral and terminal spine of tail. Longitudinal scale rows were counted 20 scales caudad of mental, at midbody, and 10 scales craniad of vent. Subcaudal counts include the

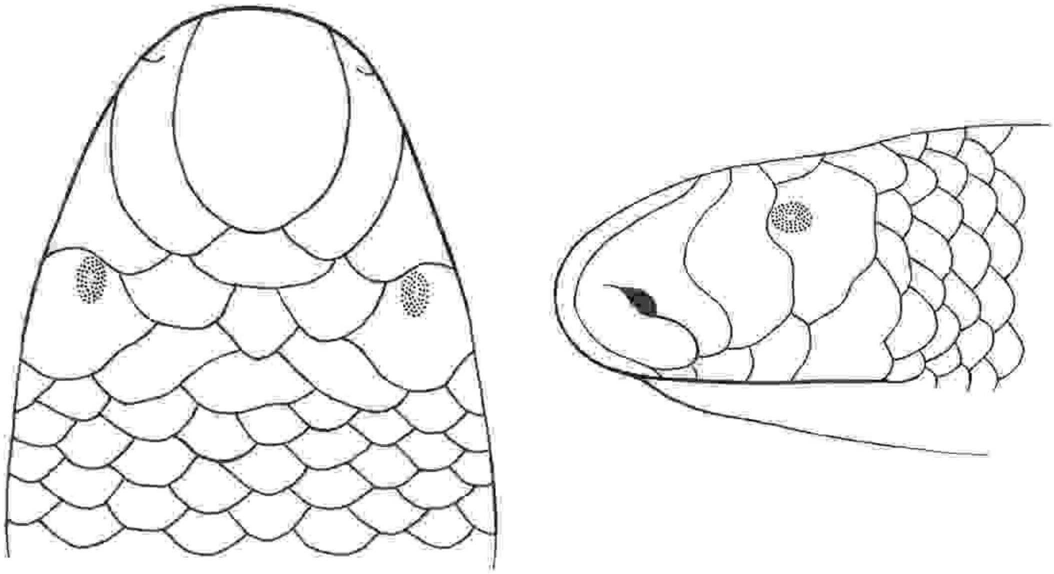

FIGURE 1: Dorsal (left) and lateral (right) views of head of holotype (MHNG 1326.62) of *Typhlops etherdidgei.*

minimum number of midventral scales between the vent and terminal spine; dorsocaudal counts begin at middorsal scale along perpendicular axis to lateral edge of vent and do not include apical spine. Measurements were made to the nearest 0.5 mm. Midbody and midtail diameters were measured in horizontal plane. Descriptions and definitions of scolecophidian visceral characters are found in Wallach (1985, 1991, 1993a,b, 1998a,b) and Wallach and Ineich (1996) with the exception of the "prefrontal" (= frontal) and "frontal" (= postfrontal). In the description of the visceral anatomy, percentages of organ lengths and midpoints (MP) represent percent snout-vent length (% SVL); in contrast, ratios of two visceral characters are presented as fractions/decimals.

DESCRIPTION

Typhlops etheridgei n. sp.

Fig. 1

Type.- Holotype, MHNG 1326.62 (field no. E. Kramer 11443), an adult female collected by J. Garzoni, 1967.

Type locality.- Between Atar (20°31'N, 13°03'W) and Choûm (21°20'N, 12°59'W) along Route Nationale 1, a distance of ca. 85 air km through the Amsâga region, western Adrar Region, west-central Mauritania, elevation ca. 200 m. Original museum label reads "Zwischen Atar und Shoun, Mauritanie." Type locality is near the south-eastern corner of Western Sahara.

Diagnosis.- *Typhlops etheridgei* can be distinguished from all other African Typhlopidae by the following combination of characters: T-III supralabial imbrication pattern (SIP) and 24 midbody scale rows. *Typhlops etheridgei* is separable from *Rhinotyphlops* by the T-III SIP (vs. T-0 or T-II), from *Acutotyphlops* by the 24 midbody scale rows (vs. 26-36) and rounded snout (vs. pointed snout), from *Cyclotyphlops* by its typical head shields (vs. circular arrangement), and from *Xenotyphlops* by the T-III SIP (vs. T-0) and papillaless rounded snout (vs. pointed snout with papillae). *Typhlops etheridgei* shares the T-III SIP with *Ramphotyphlops* and because it is represented solely by a female specimen, the status of the hemipenis cannot be ascertained. However, it is unlikely that *T. etheridgei* belongs in the genus *Ramphotyphlops* as the only African representative is *R. braminus,* the parthenogenetic species that has colonized the world. *Typhlops etheridgei* can be distinguished from *R. braminus* by the infranasal suture contacting the second supralabial (vs. preocular) and 24 midbody scale rows (vs. 20 rows).

Etymology.- This species is dedicated to Richard Etheridge, emeritus professor at San

TABLE 1: Visceral differences between *Typhlops etheridgei* and *T. vermicularis* (with mean and range) as % SVL.

Character	T. etheridgei (n = 1)	T. vermicularis (n = 7)
Sternohyoid posterior tip	8.3	11.2 (10.6 - 12.0)
Sternohyoid-heart gap	0.71	0.61 (0.58 - 0.63)
Heart length	3.9	4.6 (4.3 - 5.1)
Left liver length	28.5	22.1 (15.2 - 27.3)
Left liver midpoint	48.0	44.3 (40.4 - 47.2)
Right liver midpoint	49.7	47.2 (43.8 - 49.4)
Posterior liver asymmetry	0.03	0.16 (0.09 - 0.27)
Left liver/right liver	1.05	0.89 (0.78 - 0.99)
Liver-gall bladder gap	1.1	5.0 (4.2 - 5.8)
Gall bladder-gonad gap	12.6	5.5 (2.2 - 9.4)
Right adrenal midpoint	86.0	82.8 (81.2 - 84.8)
Left adrenal midpoint	88.6	86.4 (84.5 - 88.1)
Total adrenal midpoint	87.3	84.6 (83.2 - 86.5)
Right kidney length	3.4	5.2 (4.5 - 5.8)
Left kidney length	3.4	4.7 (4.0 - 5.4)
Total kidney length	6.8	10.0 (8.5 - 11.0)
Kidney-vent gap	4.4	2.8 (1.9 - 4.2)
Rectal caecum/left kidney	0.53	0.37 (0.31 - 0.47)
Rectal caecum-vent interval	9.0	10.7 (9.3 - 12.1)
Tracheal rings/10% SVL	79.8	72.8 (65.6 - 79.2)
Tracheal lung anterior tip	7.8	9.3 (8.1 - 10.2)
Cardiac lung length	3.9	4.6 (4.3 - 5.1)
Right lung length	30.8	20.4 (14.1 - 30.6)
Right lung midpoint	48.0	43.3 (39.4 - 47.5)
Bronchus/right lung	0.23	0.37 (0.27 - 0.52)
Right lung posterior tip	63.4	53.5 (46.9 - 62.8)
Total lung length	55.6	44.2 (38.4 - 52.9)
Trachea-bronchus/total lung	0.69	0.89 (0.74 - 1.00)

Diego State University and iguanid systematist, who was my undergraduate mentor and whose guidance and support started me on my present path in herpetology (snake viscera and systematics).

Description.- An adult female with snout-vent length 217.5 mm, tail length 2.5 mm, total length 220 mm, tail/total length ratio 1.14, midbody diameter 4.0 mm, body length/width ratio 55.0, midtail diameter 2.5 mm, tail length/width ratio 1.0; longitudinal scale rows 24-24-20, total middorsals 424, subcaudals 10, dorsocaudals 10; five anal scales; small, short, straight apical spine with expanded base.

Head not distinct from neck, tapered in dorsal view with rounded snout; dorsal rostral oval with rounded apex, maximum width 40% of head width at eye level, not reaching interocular level; ventral rostral broad, oval, slightly convex, 65% of snout width at nostril level, with anterior and posterior constrictions; superior nasal suture just visible on anterior portion of nasal shield in dorsal view; frontal transversely enlarged, twice as broad as deep, separating postnasals along midline; postfrontal small, pentagonal, one-half the size of supraoculars; supraoculars transversely oriented, twice as broad as postfrontal; parietals enlarged, 2.5 times the width of costals, obliquely oriented to body axis; enlarged occipitals lacking.

Head depressed with rounded snout in lateral profile, snout protruding beyond lower jaw; nasal broad, semi-divided, with shallow concavity in posterior border; nostril midway between preocular and rostral borders, directed laterally, oriented at 45° angle; superior nasal suture extending horizontally for 50% of nostril-rostral gap; inferior nasal suture contacting second supralabial and covering enlarged striated inferior nasal gland; one preocular, smaller than ocular, with small notch in posterodorsal border; ocular polygonal, as broad as nasal, with small eye beneath anterodorsal corner, fitting into notch of preocular, dark iris and pupil discernible; two postoculars between parietal and fourth supralabial; four supralabials with T-III imbrication pattern, first and second broader than tall, third and fourth taller than broad; second supralabial twice the size of first; third supralabial 1.5 times the second, overlapping lower edge of ocular; fourth supralabial largest, more than twice the size of third, with notch in posteroventral border.

Dorsum light brown (11 dorsal rows), venter pale yellowish-white (13 ventral rows), with sharp demarcation between the two, outermost lateral row with lighter pigmentation than more dorsal rows; dorsal pigmentation lighter anteriorly and heavier posteriorly; venter yellowish-white anteriorly, beige posteriorly; each dorsal scale pigmented with brown vermiculations along posterior half, bordered anteriorly by dark transverse median line; snout and lateral head yellow; tail almost entirely brown, only subcaudals unpigmented like venter. Cephalic gland line on first supralabial joining that of nasal, that of second supralabial joining that of preocular and meeting nasal line near nasal-preocular junction, that of third supralabial joining that of ocular and meeting that of preocular near ocular-preocular-third supralabial junction.

Internal anatomy.- Sternohyoideus muscle 8.3%, extending 0.7 snout-heart gap; heart elongate 3.9% (MP 30.7%), snout-heart interval 32.6%; liver nearly touching heart with heart-liver gap 1.1%, liver entirely straight (29.4%, MP 48.5%), nearly symmetrical (LL/RL 1.05), with 6 left and 7 right segments, left liver 28.5% (MP 48.0%), right liver 27.1% (MP 49.7%), total liver 55.6%, anterior liver asymmetry 0.08, posterior liver asymmetry 0.03; heart-liver interval 34.5%, gall bladder (1.8%, MP 65.3%) nearly touching liver, liver-gall bladder gap 1.1%, liver-gall bladder interval 30.1%; liver-kidney gap 27.1%, liver-kidney interval 61.8%; gall bladder 1.8% (MP 65.3%), gall bladder-gonad gap 12.6%, gall bladder-kidney gap 24.1%, gall bladder-kidney interval 31.3%; pancreas 1.4%, adjacent and posterior to gall bladder; spleen 0.9%, adjacent and anterior to gall bladder, connected to pancreas by pancreatic limb; right ovary 3.7% (MP 80.7%) with four follicles, left ovary 2.5% (MP 82.6%) with two follicles, total ovary 6.2% (MP 81.7%); right adrenal MP 86.0%, left adrenal MP 88.6%, total adrenal MP 87.3%; right kidney 3.4% (MP 92.1%), left kidney 3.4% (MP 93.9%), total kidney 6.8% (MP 93.0%); kidney-vent gap 4.4%, kidney-vent interval 9.7%, kidney overlap 0.30, gonad-kidney gap 6.4%; rectal ceacum 1.8%, equal in diameter to adjacent small intestine (ileum), caecum/left kidney 0.53, caecum-vent interval 9.0%.

Trachea 31.5% (MP 16.9%) with 253 rings (or 80/10% SVL), with short free tips; anterior tip of tracheal lung 7.8%, multicameral tracheal lung 20.9% (MP 20.2%) with 4 paucicameral niches cranially, followed by 26 chambers with large type A foramina, each air chamber with a single layer of faveoli internally, mid-tracheal lung equal in circumference to trachea (TM/CR = 1.0); multicameral cardiac lung 3.9% with 5 chambers; multicameral right lung 30.8% (MP 48.0%) with 5 chambers and 2 paucicameral niches; right bronchus 7.1%, posterior tip at 39.8%, bronchus/right lung 0.23; trachea-bronchus 38.6% (MP 20.5%; right lung posterior tip 63.4%; right lung/tracheal lung 1.47, total lung 55.6% (MP 35.6%0, trachea-bronchus/total lung 0.69; left lung complex (lung, bronchus, and orifice) absent.

Ecology.- The Atar-Choûm region is considered by authorities to occur within the arid South Sahara zone (Lambert, 1984; Le Berre, 1989), within the semi-arid Sahel (or subdesert steppe fide Keay and Aubreville, 1959 and Papenfuss, 1969), or within the West Sahara zone (Quézel, 1965). As the definition of the Sahara depends upon a mean annual preciptation of less than 100 mm (Lambert, 1984; Quézel, 1965), and the yearly rainfall average varies in different years, the limit between these two ecotones may migrate over a north-south latitude of 100-200 km. Vegetation in the South Saharan zone is transitional between the more xeric desert to the north and more mesic thornland and subdesert steppe to the south. Xerification of the Sahara is a recent occurrence, having occurred during the past 3,000 years (Quézel, 1965).The type locality (and route 1) occurs just west of the north-south aligned escarpments between Atar and Choûm in the Atlantic Basin of the Sahara (Le Berre, 1989). The Atar-Choûm region is a lowland plain covered by north-east to south-west aligned dunes (*sbar*), from 2-20 miles wide, that are separated by clay depressions (*aftouts*); ridges and scarps of underlying rocks are frequently exposed. The dunes, which may be stabilized or mobile, support perennial vegetation of low woody and herbaceous plants, such as Saharan grass (*Aristida pungens*) and wooded steppe plants like *Acacia radiana, Calligonum comosum,* and *Cornulaca monocantha.* In areas of rocky outcrop, a savanna vegetation of tufted grasses (*Aristida* and *Adropogon*) and *Acacia seyal* occurs. On stony ground or old river deposits (*reg*), a steppe vegetation is dominant, composed mainly of chenopods like *Nucularia perrini, Aerva persica, Salsola foetida* and *S. monodiana*, and *Traganum nudatum* (Mason, 1943, 1944; Quézel, 1965). Species of plants characteristic of the Adrar region of Mauritania include *Acacia senegal, Bauhinia rufescens*, and *Tamarindus indica* in addition to the genera *Barleria, Bergia, Blepharis, Bouchea, Cleome, Combretum, Crotalaria, Fimbristylis, Fuirena, Indigofera, Jatropha, Loranthus, Melhania, Momordica, Peristrophe, Pluchea*, and *Tephrosia* (Quézel, 1965).

The climate is characterized by extremely sparse rain, northeasterly winds, and a contrast between diurnal and nocturnal temperatures. Mean annual precipitation over a ten year period at Atar is 77 mm. More than two-thirds of the yearly total occurs in August and September with the monthly average from November to May being less than 1.5 mm; no measurable precipitation occurs during February. The months of October to June average less than one day of precipitation. Mean annual evaporation equals 4,373 mm. Mean annual maximum and minimum daily temperatures are 36°C and 20°C, respectively, with an annual range of 15°C. The hottest months are June-September (mean maximum = 42-43°C, minimum = 25-28°C), the coolest months are December-January (mean maximum = 27-31°C, minimum = 12-13°C). The absolute maximum and minimum temperatures recorded are 49°C in April and 4°C in December, respectively. The air is very dry with a relative humidity of 30% in the morning and 15% in the afternoon (Mason, 1944; Quézel, 1965). Snakes recorded from this region include *Leptotyphlops macrorhynchus* (Jan, 1864), *Malpolon moilensis* (Reuss, 1834), *Spalerosophis diadema* (Schlegel, 1837), *Bitis arietans* (Merrem, 1820), *Cerastes cerastes* (Linnaeus, 1758), *Cerastes vipera* (Linnaeus, 1758), and *Echis leucogaster* Roman (1972) (Le Berre, 1989; Villiers, 1950b). Gauthier (1967) reports that *Leptotyphlops macrorhynchus* inhabits the *erg* and sandy terrain among oasis and *oued* in Algeria.

DISCUSSION

In a phylogenetic analysis of the Typhlopidae (Wallach, 1998b: Fig. 4), based upon 41 species groups in which *Typhlops vermicularis* formed a separate group, *T. vermicularis* was the basal taxon in an African clade containing the *caecatus* (*T. caecatus, T. zenkeri*) and *cuneirostris* (*T. cuneirostris*) species groups. This clade formed the sister group to the derived "*Letheobia*" clade of *Rhinotyphlops*, including the *leucostictus* (*T. leucostictus*), *uluguruensis* (*T. uluguruensis*), *obtusus* (*T. decorosus, T. obtusus*), *unitaeniatus* (*R. ataeniatus, R. scorteccii, R. unitaeniatus*), *caecus* (*R. acutirostratus*, *R. caecus*, *R. praeocularis*, *R. stejnegeri*), *gracilis* (*R. debilis*, *R. gracilis, R. graueri, R. kibarae, R. lumbriciformis, R. pallidus, R. rufescens, R. sudanensis*), and *simoni* (*R. crossii, R. feae, R. newtonii, R. simoni, R. somalicus*) species groups. The relationships of the species groups are as follows: ((*T. vermicularis* (*T. caecatus*, *T. cuneirostris*)), (*T. leucostictus* (*T. uluguruensis* (*T. obtusus* (*R. unitaeniatus* (*R. caecus* (*R. gracilis*, *R. simoni*))))))).

Typhlops etheridgei more closely resembles the Eurasian *Typhlops vermicularis* in size, colouration, body proportions, scale counts, and arrangement of head shields than any other African species. Thus these two species can be considered to form the primitive *Typhlops vermicularis* species group. Externally, the two species can be distinguished by the following characters (*T. etheridgei* data first, followed parenthetically by *T. vermicularis* data): number of middorsal scales 424 (302-413), prefrontal twice as broad as deep (as broad as deep), frontal less than 0.5 prefrontal (1.0), posterior border of preocular with dorsal concavity (border straight), superior nasal suture visible dorsally (not visible), total length/midbody diameter ratio 55 (34-52), tail length/total length 1.1% (1.8-2.5%), tail length/midtail width 1.0 (1.3-1.5), and rostral width/head width 0.41 (0.30-0.38). The soft anatomy of *T. vermicularis* is well studied (Heyder, 1968a-b, 1973, 1974; Wallach, 1998). Internal differences between *T. etheridgei* and *T. vermicularis* are tabulated in Table 1, the most significant being a shorter sternohyoideus muscle, a longer more symmetrical liver nearly in contact with the gall bladder, more caudal position of adrenals, shorter kidneys, and longer right lung.

One compelling character indicating a relationship of *T. etheridgei* to *T. vermicularis* is the T-III supralabial imbrication pattern (SIP, Wallach, 1993a). The SIP of typhlopids is a taxonomic character that is essentially invariable at the species level (exceptions noted in Wallach, 2000); at the species group level, the SIP is diagnostic of more than 3/4 of the recognized groups (Wallach, 1998b), and at the generic level the SIP is diagnostic for at least two genera (Australasian *Ramphotyphlops* and Caribbean *Typhlops*). A T-III pattern is found in only two African species: *T. caecatus* Jan (1864) of West Africa (Ghana and Ivory Coast) and *T. platyrhynchus* Sternfeld (1910) of East Africa (Tanzania). *Typhlops caecatus* is a diminutive species with only 18-20 midbody scale rows, fewer than 335 middorsals, and a maximum length of 172 mm. *Typhlops platyrhynchus* is known only from the types, has evaded rediscovery for 90 years in spite of heavy herpetological collecting (Broadley and Howell, 1991), and shows affinity to the *Typhlops madagascariensis* group of Madagascar (Sternfeld, 1910; Wallach, 1998b). It would not be surprising to find out that *T. platyrhynchus* is actually a member of the Malagasy fauna and that Sternfeld's collection data are in error. The T-III pattern is the most common typhlopid pattern outside of Africa (which has T-0 and T-II patterns), and is distributed as follows: the monotypic *Cyclotyphlops* (Sulawesi), all but one species of *Acutotyphlops* (Solomon Islands), all *Ramphotyphlops* (Australia, East Indies, and south-east Asia), the *T. comorensis* and *T. ocularis* species groups (Madagascar and Comoros), most of the *T. porrectus* species group (southern Asia), the *T. ruficaudus* species group (the Philippines), and all New World *Typhlops.*

The general distribution of *Typhlops vermicularis* includes extreme south-eastern Europe (Arnold and Burton, 1978; Darevsky, 1997; Grillitsch and Grillitsch, 1993; Mertens and Wermuth, 1960; Steward, 1971), south-western Asia (Leviton et al., 1992), and extreme north-eastern Africa (Saleh, 1997). This species inhabits elevations from sea level to at least 1,900 m (Said-Alijew, 1979). *Typhlops vermicularis* has not yet been recorded from Saudi Arabia (Gasperetti, 1988) but may occur in the northernmost part. Welch (1983) and Darevsky (1997) reported it from Pakistan but its occurrence there has not confirmed by other sources (Hahn, 1980; Khan, 1982, 1993, 1994; Mertens, 1969; Smith, 1943).

Typhlops vermicularis occurs in western Albania (Buresch and Zonkow, 1934; Kopstein and Wettstein, 1921), southern Serbia (Buresch and Zonkow, 1934), southern Montenegro (Pozzi, 1966; Radovanovic, 1964), Kosovo (Buresch and Zonkow, 1934), Macedonia (Buresch and Zonkow, 1934; Dimovsky, 1959; Radovanovic, 1959, 1960), southern Bulgaria (Buresch and Zonkow, 1934), Greece, including Kérkira,

TABLE 2: Fossil record of Scolecophidia indet. and *Typhlops* in Europe and North Africa (MY = million years before present).

Taxon	MY	Epoch	Stage	Locality	Source
Typhlops cf. vermicularis	1	Middle Pleistocene	PM	Tourkobounia, Greece	Szyndlar, 1991
Typhlops cf. vermicularis	2	Upper Pliocene	MN 16	Tourkobounia, Greece	Szyndlar, 1991
Scolecophidia indet.	2	Upper Pliocene	MN 16	Çalta, Turkey	Rage & Sen, 1976
Scolecophidia indet.	4	Lower Pliocene	MN 14	Maritsa, Greece	Szyndler, 1991
Scolecophidia indet.	5	Upper Miocene	MN 13	Algora, Spain	Szyndlar, 1985
Scolecophidia indet.	6	Upper Miocene	MN 12	Cherevichnoie, Ukraine	Szyndlar & Zerova, 1992
Scolecophidia indet.	11	Upper Miocene	MN 9	Gritsev, Ukraine	Szyndlar & Zerova, 1990
Typhlops grivensis	13	Middle Miocene	MN 8	La-Grive-St.-Alban, France	Hoffstetter, 1946
Scolecophidia indet.	14	Middle Miocene	MN 7	Beni Mellal, Morocco	Hoffstetter, 1961
Typhlops sp.	18	Lower Miocene	MN 4b	Córcoles, Spain	Alférez-Delgado & Brea-López, 1981
Scolecophidia indet.	20	Lower Miocene	MN 4	Dolnice, Czechoslovakia	Szyndlar, 1987
Scolecophidia indet.	40	Upper Eocene	ES p	Quercy, France	Rage, 1974, 1978
Scolecophidia indet.	50	Middle Eocene	MP 13	Saint-Maximin, France	Duffaud & Rage, 1997
Scolecophidia indet.	55	Lower Eocene	EI c	Dormaal, Belgium	Godinot et al., 1978

Levkás, Nidri, Kíthira, Salamis, Eúboia, Skíros, Thásos, Náxos, Ándros, Lésvos, Khíos, Sámos, Patmos, Léros, Kalímnos, Kos, Ródhos, Kriti (Boettger, 1898; Calabresi, 1923; Clark, 1969, 1970, 1989, 1999; Darevsky, 1997; Erber, 1868; Werner, 1929, 1930, 1937, 1938), Cyprus (Schätti and Sigg, 1989), Turkey (Baran and Atatür, 1997; Baran, 1976; Basoglu and Baran, 1980; Bodenheimer, 1944; Boulenger, 1928; Clark and Clark, 1973; Werner, 1930), western Syria (Angel, 1936; Boulenger, 1923; Lortet, 1883; Werner, 1939), Jordan (Amr and Al-Oran, 1995; Bodenheimer, 1944; Disi, 1985; Disi et al., 1988, 2001; El-Oran et al., 1994; Shafeë, 1990), western Lebanon (Hraoui-Bloquet, 1981; In Den Bosch, 1998), Israel (Barbour, 1914; Cyren, 1941; Sivan and Werner, 1992; Werner, 1995, Bouskila and Amitai, 2001), Iran (Haas and Werner, 1969; Latifi et al., 1991; Schleich, 1977), north-eastern Iraq (Corkill, 1932; Reed and Marx, 1959), north-western Afghanistan (Leviton and Anderson, 1970; Mahdi and Georg, 1969), eastern Georgia (Muskhelishvili, 1970), Azerbaijan (Sobolevsky, 1929), southern Armenia (Darevsky, 1957), eastern Daghestan (Alkhasov, 1980; Terent'ev and Chernov, 1949), southern Turkmenistan (Bogdanov, 1962), western Uzbekistan (Terent'ev and Chernov, 1949; Yadgarov, 1971), southern Tajikistan (Chernov, 1959), southern Kazakhstan (Paraskiv, 1956), Russia (Ananjeva et al., 1998; Bannikov et al., 1971, 1977; Bruno and Maugeri, 1990; Nikolsky, 1916; Strauch, 1873; Terent'ev and Chernov, 1949), Sinai Peninsula (Corkill and Cochrane, 1966; Duméril and Bibron, 1844; Werner, 1973), and north-eastern Egypt (Flower, 1923; Saleh, 1997).

The only African records are from Egypt and the Sinai Peninsula (Duméril and Bibron, 1844; Flower, 1923; Saleh, 1997), which were accepted by Marx (1956, 1968), Hahn (1980), and Schleich et al. (1996) but not accepted by Le Berre (1989). However, neither of the specimens discussed by Flower (1923, 1933) are deposited in the British Museum, and identification is suspect. One specimen, purchased from an Arab at the seaport Damietta, was suggested by Flower (1923) that it might be an introduction from some other Mediterranean locality. The data on the other specimen from Cairo are 22 or 24 scale rows, snout-vent length 267 mm, tail 4 mm, total length 271 mm, tail/total length ratio 1.48, and body length/width ratio 54. Without even a middorsal scale count, identification is tentative at best. The relative tail length ratio of 1.5 is below the known range of *T. vermicularis* of 1.8-2.5. One of the specimens from the base of Mt. Sinai, southern Sinai Peninsula, reported by Duméril and Bibron (1844), is in the Leiden Museum (RMNH 3719). Saleh (1997) reported two specimens collected in 1993-1994 from Tahreer Province (Nile Delta NW of Cairo). Two unpublished Egyptian specimens (USNM 130429 from Faiyum and USNM 134717 from Kafr Ash Shaykh, El Amanya) have 390 and 413 middorsals, respectively (A.H. Wynn, in litt.).

The type locality of *Typhlops etheridgei* in Mauritania is thus separated from the nearest population of *T. vermicularis* in Egypt by 4,450 km of the Sahara Desert. Other than the type of *T. etheridgei* and the Cairo specimens of *T. vermicularis, Typhlops* is unknown in Africa from the Sahara Desert northwards.

The Messinian Salinity Crisis (Hsü et al., 1977) is a unique and dramatic oceanic event that occurred during the latest Miocene (Messinian) and lasted for 400,000—640,000 years (Krijgsman et al., 1999; Riding et al., 1988). During the MSC, 10^6 km^3 of evaporite was deposited on the floor of the Mediterranean (Weijermars, 1988). The Messinian Gap, the period of complete dessication and formation of a continuous land bridge between Africa and Europe, has been calibrated to be 5.59-5.50 million years before the present (MYBP), or approximately 90,000 years (Krijgsman et al., 1999). This land bridge between Morocco and Spain, and possibly another one between Tunisia and Sicily, allowed migration of the herpetofauna, and snakes from North Africa are believed to have invaded Europe during this time (Busack, 1986; Schleich et al., 1996; Szyndlar, 1985). During the Messinian, the climate alternated from subtropical to temperate, in relation to the oceanic circulation patterns and a general global cooling (Martín and Braga, 1994).

Although the fossil history of scolecophidian snakes is poorly known and the families cannot be adequately diagnosed based solely on vertebrae (Holman, 1979, 2000; Rage, 1984), there are numerous unidentified European fossils from the Lower Eocene to the Middle Pleistocene that are parsimoniously attributable to *T. vermicularis* or a related lineage (Holman, 1998; Szyndlar, 1991) since *T. vermicularis* is the only extant typhlopid inhabiting Europe. These fossils are known from the Eocene of Belgium and France, the Miocene of Czechosolvakia, France, Morocco, Spain, and Ukraine, the Pliocene of Greece and Turkey, and the Pleistocene of Greece (Table 2).

Either of two scenarios can therefore be inferred. The most likely is that *T. vermicularis*, or a related lineage, had a much broader range in earlier times and that it covered much of present day Europe. Its presence in Spain during the early to late Miocene is sufficient evidence to conclude that a population could have migrated into Africa during the Messinian before the opening of the Gibraltar flood gates, thus stranding a population in north-western Africa since the Pliocene. Busack (1986) has shown, based on genetic distances, that fossorial reptiles are the least likely to have rafted across the Strait of Gibraltar. Conversely, if the ancestors of *T. vermicularis* originated in Gondwanaland, then a migration from North Africa into Europe during the Messinian is possible, and the *T. etheridgei* line may have given rise to that of *T. vermicularis*. In such a scenario, the Eocene fossils of Europe represent a scolecophidian not ancestral to *T. vermicularis*.

The possibility exists that undiscovered populations of *Typhlops etheridgei* (or even *T. lineolatus* or *T. punctatus*, both of which occur in Sénégal and The Gambia) occur in suitable habitat in Morocco and/or Western Sahara (Hahn, 1980; Roux-Estève, 1974). Several subsaharan snakes have been discovered as relict populations in this region of Africa (*Lamprophis fuliginosus, Dasypeltis scabra*, and *Bitis arietans*) (Bons and Geniez, 1996; Le Berre, 1989; Schleich et al., 1996). Adequate collections of the herpetofauna from any locality are lacking in north-western Africa, there being only scattered collections of a few specimens. Since scolecophidians are undoubtedly the most difficult snake group to find, it is not surprising that our knowledge of blind snake distribution north of Sénégal is virtually nil.

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LITERATURE CITED

ALFÉREZ-DELGADO, F. & P. BREA-LÓPEZ. 1981. Estudio preliminar de los restos de peces, anfibios y reptiles del yacimiento Mioceno de Córcoles (Guadalajara). *Bol. Real Soc. Esp. Hist. Nat.* 79: 5-20.

ALKHASOV, M. M. 1980. Rasprostranenie nekotorykh vidov zmei v Dagestane. *Biol. Prod. Landsch. Dagestan* 3: 80-81. [not seen.]

AMR, Z. S. & R. AL-ORAN. 1995. Venomous animals in Jordan. Part 1. The snakes of Jordan. Mutah University. 88 pp.

ANANJEVA, N., L. BORKIN, I. DAREVSKY & N. ORLOV. 1998. Encyclopedia of Russian nature: amphibians and reptiles. ABF Publications, Moscow. 574 pp.

ANDERSON, S. C. 1963. Amphibians and reptiles from Iran. *Proc. California Acad. Sci., Ser. 4*, 31: 417-498.

ANGEL, F. 1936. Reptiles et batraciens de Syrie et de Mésopotamie récoltés par M. P. Pallary. *Bull. Inst. Égypte* (1935-1936) 18: 107-116.

BARAN, I. 1976. Türkiye yilanlarinin taksonomik revizyonu ve cografi dagilislari. *Tübitak Yayinlari* 309, Seri no. 9: 1-177.

________& M. K. ATATÜR. 1997. [Turkish herpetofauna (amphibians and reptiles).] Ministry of Environment. 214 pp. [in Turkish.]

BARBOUR, T. 1914. Notes on some reptiles from Sinai and Syria. *Proc. New England Zool. Club* 5: 73-92.

BODENHEIMER, F. S. 1944. Introduction into the knowledge of the Amphibia and Reptilia of Turkey. *Rev. Fac. Sci. Univ. Istanbul* 9B: 1-83.

BOETTGER, O. 1898. Katalog der Reptilien-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, II. Teil (Schlangen). Gebrüder Knauer, Frankfurt am Main. 160 pp.

BOGDANOV, O. P. 1962. [Reptiles of Turkmenistan.] Academy of Sciences of Turkmen Soviet Socialist's Republic, Ashabad. 235 pp. [in Russian.]

BONS, J. & P. GENIEZ. 1996. Amphibiens et reptiles du Maroc (Sahara Occidental compris): Atlas biogéographique. Asociación Herpetológica Española, Barcelona. 320 pp.

BOULENGER, G. A. 1923. Étude sur les batraciens et les reptiles rapportés par M. Henri Gadeau de Kerville de son voyage zoologique en Syrie (Avril-Juin 1908). Voy. Zool. Henri Gadeau Kerville en Syrie, Rouen 4: 41-55.

________. 1928. Étude sur les batraciens et les reptiles rapportés par M. Henri Gadeau de Kerville de son voyage zoologique en Asie-Mineure (Avril-Mai 1912). Voy. Zool. Henri Gadeau Kerville en Asie-Mineure, Paris 2: 135-144.

BOUSKILA, A. & P. AMITAI. 2001. [Handbook of amphibians & reptiles of Israel.] Keter Publishing House, Jerusalem. 345 pp.

BROADLEY, D. G. & K. M. HOWELL. 1991. A checklist of the reptiles of Tanzania, with synoptic keys. *Syntarsus* (1): 1-70.

BRUNO, S. & S. MAUGERI. 1990. Serpenti d'Italia e d'Europa. Giorgio Mondadori, Milano. 223 pp.

BURESCH, I. & J. ZONKOV. 1934. [Untersuchungen über die Verbreitung der Reptilien und Amphibien in Bulgarien und auf der Balkanhalbinsel. II Teil: Schlangen (Serpentes).] *Mitt. Kön. Naturw. Inst. Sofia – Bulgarien* 7: 106-188. [in Russian.]

BUSACK, S. D. 1986. Biogeographic analysis of the herpetofauna separated by the formation of the Strait of Gibraltar. *Nat. Geog. Res.* 2: 17-36.

CALABRESI, E. 1923. Escursioni zoologische del Dott. E. Festa nell'isola di Rodi. *Boll. Mus. Zool. Anat. Comp. Univ. Torino* 38: 1-16.

CHERNOV, S. A. 1959. [Fauna of the Tadjhikistan. Vol. 18. Reptiles.] *Trudy Inst. Zool. Parazit., Akad. Nauk Tadjhik. S.S.R.* 98: 1-202. [in Russian.]

CHPAKOWSKY, N. & A. CHNÉOUR. 1953. Les serpents de Tunisie. *Bull. Soc. Sci. nat. Tunisie* 6: 125-145.

CLARK, R. J. 1969. A collection of snakes from Greece. *British J. Herpetol*. 4: 45-48.

________. 1970. A further contribution to the herpetofauna of the islands of the Argo-Saronic Gulf Greece. *British J. Herpetol.* 4: 185-188.

________. 1989. A check list of the herpetofauna of the Argo-Saronic Gulf District, Greece. *British Herpetol. Soc. Bull.* (28): 8-24.

________. 1999. Herpetofauna of Thassos, north Aegean Sea, Greece. *British Herpetol. Soc. Bull.* (66): 14-18.

CLARK, R. J. & E. D. CLARK. 1973. Report on a collection of amphibians and reptiles from Turkey. *Occ. Pap. California Acad. Sci*. (104): 1-62.

CORKILL, N. L. 1935. Notes on Sudan snakes. A guide to the species represented in the collection in the Natural History Museum, Khartoum. *Sudan Govt. Mus. (Nat. Hist.) Publ.* (3): 1-41.

DAREVSKY, I. S. 1957. [Reptile fauna of Armenia and its zoogeographical analysis.] Ph.D. Dissertation, University of Erevan. [in Russian.]

________. 1997. Reptilia. *Typhlops vermicularis* Merrem, 1820. *In*: Atlas of amphibians and reptiles in Europe. pp: 376-377. J.-P. Gasc (Ed). Societas Europaea Herpetologica and Muséum National d'Histoire Naturelle, Paris.

DEKEYSER, P. L. & A. VILLIERS. 1956. Contribution à l'étude du peuplement de la Mauritanie. Notations écologiques et biogéographiques sur la faune de l'Adrar. *Mém. Inst. Franç. Afr. Noire* (44): 1-222.

DIMOVSKY, A. S. 1959. Beitrag zur verbreitung und Lebensweise der *Typhlops vermicularis* Merr. in Mazedonien. Frag. *Balcan. Mus. Macedon. Sci. Nat.* 3: 13-19.

DISI, A. M. 1985. A contribution to the herpetofauna of Jordan. 2. New records and a systematic list of snakes from Jordan. *Snake* 17: 31-42.

________, Z. S. AMR & D. DEFOSSE. 1988. Contribution to the herpetofauna of Jordan. III. Snakes of Jordan. *Snake* 20: 40-51.

________, D. MODRY, P. NECAS & L. RIFAI. 2001. Amphibians and reptiles of the Hashemite Kingdom of Jordan. Edition Chimaira, Frankfurt am Main. 408 pp.

DUFFAUD, S. & J.-C. RAGE. 1997. Les remplissages karstiques polyphasés (Éocène, Oligocène, Pliocène) de Saint-Maximin (Phosphorites du Gard) et leur apport à la connaissance des faunes Européennes, notamment pour l'Éocène moyen (MP 13). 2.– Systématique: amphibiens et reptiles. *Mém. Trav. E.P.H.E., Inst. Montpellier* 21: 729-735.

DUMÉRIL, A. M. C. & G. BIBRON. 1844. Erpétologie générale ou histoire naturelle complète des reptiles. Tome sixième. Librairie Encyclopédique de Roret, Paris. 609 pp.

EL-ORAN, R. M., W. N. AL-MELHEM & Z. S. AMR. 1994. Snakes of southern Jordan. *Boll. Zool.* 61: 359-367.

ERBER, J. 1868. Bericht über eine Reise nach Rhodus. Verh. Zool. Bot. Ges. Wien 18: 903-908.

FLOWER, S. S. 1923. On additions to the snake fauna of Egypt. *Proc. Zool. Soc. London* 1923: 1079-1083.

________. 1933. Notes on the Recent reptiles and amphibians of Egypt, with a list of the species recorded from that kingdom. *Proc. Zool. Soc. London* 1933: 735-851.

GAUTHIER, R. 1967. Écologie et éthologie des reptiles du Sahara nord-occidental (région de Béni-Abbès). *Ann. Mus. Roy. Afr. Cen., Ser. 8, Sciences Zoologiques* (155): 1-83.

GODINOT, M., F. DE BROIN, E. BUFFETAUT, J.-C. RAGE & D. RUSSELL. 1978. Dormaal: une des plus anciennes faunes Éocènes d'Europe. *C. R. Séances Acad. Sci., Paris* 287D: 1273-1276.

GRILLITSCH, B. & H. GRILLITSCH. 1993. *Typhlops vermicularis* Merrem, 1820–Wurmschlange oder Blödauge. *In*: Handbuch der Reptilien und Amphibien Europas. Band 3/I. Schlangen (Serpentes) I. pp: 15-32. W. Böhme (Ed). AULA, Wiesbaden.

HAAS, G. & Y. L. WERNER. 1969. Lizards and snakes from southwestern Asia, collected by Henry Field. *Bull. Mus. Comp. Zool.* 138: 327-406.

HAHN, D. E. 1980. Liste der rezenten Amphibien und Reptilien: Anomalepididae, Leptotyphlopidae, Typhlopidae. *Das Tierreich* 101: 1-93.

HEYDER, G. 1966. Ein Beitrag zur Anatomie der inneren Organe von *Typhlops vermicularis* Merrem (1820). Ph. D. Dissertation, Martin-Luther-Universität, Halle-Wittenberg. 104 pp.

HEYDER, G. 1968a. Das Respirationssystems von *Typhlops vermicularis* Merrem (1820) unter besonderer Berücksichtigung der "Tracheallunge." *Z. Wiss. Zool.* 177: 393-402.

________. 1968b. Das Urogenitalsystem von *Typhlops vermicularis* Merrem (1820). *Gegenbaurs Morph. Jb.* 112: 594-605.

________. 1973. Das Blutgefäßsystem von *Typhlops vermicularis* Merrem (1820). *Gegenbaurs Morph. Jb.* 119: 492-513.

________. 1974. Das Verdauungssystem von *Typhlops vermicularis* Merrem (1820). *Gegenbaurs Morph. Jb.* 120: 185-197.

HOFFSTETTER, R. 1946. Les Typhlopidae fossiles. *Bull. Mus. Natl. Hist. Nat., Paris* 18: 309-315.

________. 1961. Le gisement de vertébrés Miocènes de Beni Mellal (Maroc): Squamates. *Notes Mém. Serv. Geol. (Maroc)* (155): 95-102.

HOLMAN, J. A. 1979. A review of North American Tertiary snakes. *Publ. Mus. Michigan St. Univ., Paleont.* Ser., 1: 200-260.

________. 1998. Pleistocene amphibians and reptiles in Britain and Europe. Oxford University Press, New York. 254 pp.

________. 2000. Fossil snakes of North America: origin, evolution, distribution, paleoecology. Indiana University Press, Bloomington. 357 pp.

HRAOUI-BLOQUET, S. 1981. Les reptiles du Liban, 1) nomenclature et note écologique. *Ecol. Mediterr*. (7): 93-101.

HSÜ, K. J., L. MONTADERT, D. BERNOULLI, M. B. CITA, A. ERICKSON, R. E. GARRISON, R. B. KIDD, F. MÈLIERÉS, C. MÜLLER & R. WRIGHT. 1977. History of the Mediterranean salinity crisis. *Nature* 267: 399-403.

JAN, G. 1864, *in* Jan & Sordelli, 1860-1866. Iconographie général des ophidiens. Tome premier. G. Jan and F. Sordelli, Milan. 11 pp., 102 pls.

KEAY, R. W. J. & A. AUBREVILLE. 1959. Vegetation map of Africa south of the Tropic of Cancer. Oxford University Press, Oxford.

KHAN, M. S. 1982. An annotated checklist and key to the reptiles of Pakistan. Part III. Serpentes (Ophidia). *Biologia, Lahore* 28: 215-254.

________. 1993. [Snakes of Pakistan.] Urdu Science Board, Lahore. 208 pp. [in Urdu.]

________. 1994. Key for identification of amphibians and reptiles of Pakistan. *Pakistan J. Zool*. 26: 249-255.

KOPSTEIN, F. & O. WETTSTEIN. 1921. Reptilien und Amphibien aus Albanien. *Verh. Zool. Bot. Ges. Wien* (1920), 70: 387-409.

KRAMER, E. & H. SCHNURRENBERGER. 1963. Systematik, Verbreitung und Ökologie der Libyschen Schlangen. *Rev. Suisse Zool*. 70: 454-568.

KRIJGSMAN, W., C. G. LANGEREIS, W. J. ZACHARIASSE, M. BOCCALETTI, G. MORATTI, R. GELATI, S. IACCARINO, G. PAPANI & G. VILLA. 1999. Late Neogene evolution of the Taza-Guercif Basin (Rifian Corridor, Morocco) and implications for the Messinian salinity crisis. *Mar. Geol*. 153: 147-160.

LAMBERT, M. R. K. 1984. Amphibians and reptiles. *In*: Key environments: Sahara Desert. pp: 205-227. J. L. Cloudsley-Thompson (Ed). Pergamon Press, Oxford.

LEACH, W. E. 1819. Appendix. No. IV. Reptilia. (Reptiles.). *In*: Mission from Cape Coast castle to Ashantee. pp: 493-494. T. E. Bowdich. John Murray, London.

LE BERRE, M. 1989. Faune du Sahara. 1. Poissons-amphibiens-reptiles. Raymond Chabaud-Lechevalier, Lyon. 332 pp.

LEVITON, A. E. & S. C. ANDERSON. 1970. The amphibians and reptiles of Afghanistan, a checklist and key to the herpetofauna. *Proc. California Acad. Sci., Ser. 4*, 38: 163-206.

________, S. C. ANDERSON, K. ADLER & S. A. MINTON, JR. 1992. Handbook to Middle East amphibians and reptiles. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 252 pp.

LINNAEUS, C. 1758. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus differentiis, synonymis, locis. Tomus I. Editio decima, Reformata. Laurentii Salvii, Holmiae. 824 pp.

LORTET, L. 1883. Poissons et reptiles du Lac de Tibériade et de quelques autres parties de la Syrie. *Arch. Mus. Hist. nat. Lyon* 3: 99-194.

MARTÍN, J. M. & J. C. BRAGA. 1994. Messinian events in the Sorbas Basin in southeastern Spain and their implications in the recent history of the Mediterranean. *Sediment. Geol.* 90: 257-268.

MARX, H. 1956. Keys to the lizards and snakes of Egypt. *Res. Rep. U.S. Naval Med. Res. Unit* No. 3, Cairo. 8 pp.

________. 1968. Checklist of the reptiles and amphibians of Egypt. *Spec. Publ. U.S. Naval Med. Res. Unit* No. 3 (3): 1-91.

MASON, K. (Ed). 1943. French West Africa. Vol. I. The federation. Geographical Handbook Series B.R. 512, University of Oxford, Oxford.

________. (Ed). 1944. French West Africa. Vol. II. The colonies. Geographical Handbook Series B.R. 512a (Restricted), University of Oxford, Oxford.

MERREM, B. 1820. Versuch eines Systems der Amphibien. Johann Christian Krieger, Marburg. 191 pp.

MERTENS, R. 1969. Die Amphibien und Reptilien West-Pakistans. *Stuttgarter Beitr. Naturk*. (197): 1-96.

MUSKHELISHVILI, T. A. 1970. [Lizardlike reptiles of eastern Georgia.] Mezhiereba Publications, Tsibili. 242 pp. [in Russian.]

PAPENFUSS, T. J. 1969. Preliminary analysis of the reptiles of arid central West Africa. *Wasmann J. Biol*. 27: 249-325.

PARASKIV, K. P. 1956. [Reptiles of Kazakhstan.] Alma-Ata. 228 pp. [in Russian.]

POZZI, A. 1966. Geonemia e catalogo ragionato degli anfibi e dei rettili della Jugoslovia. *Riv. Soc. Ital. Sci. Nat. Mus. Civ. Stor. Nat. Milano* 57: 1-55.

QUÉZEL, P. 1965. La végétation du Sahara. Du Tchad à la Mauritanie. Gustav Fischer Verlag, Stuttgart.

RADOVANOVIC, M. 1959. Einige Beobachtungen an Amphibien und Reptilien. *Zool. Anz*. 159: 130-137.

________.1960. Zur Kenntnis der Lebensweise des *Typhlops vermicularis* Merrem. *Zool. Anz*. 165: 276-279.

________.1964. Die Verbreitung der Amphibien und Reptilien in Jugoslawien. *Senck. Biol.* 45: 553-561.

RAGE, J.-C. 1978. La poche a phosphate de Sainte-Neboule (Lot) et sa faune de vertébrés du Ludien Supéieur. 5 – Squamates. *Palaeovertebrata* 8: 201-215.

________& S. SEN. 1976. Les amphibiens et les reptiles du Pliocène supérieur de Çalta (Turquie). *Géol Méditerr*. 3: 127-134.

REED, C. A. & H. MARX. 1959. A herpetological collection from northeastern Iraq. Tran. *Kansas Acad. Sci*. 62: 91-122.

REUSS, A. 1834. Zoologische miscellen. Reptilien. Ophidier. *Mus. Senck*. 1: 129-162.

RIDING, R., J. C. BRAGA, J. M. MARTÍN & I. M. SÁNCHEZ-ALMAZO. 1988. Mediterranean Messinian salinity crisis: constraints from a coeval marginal basin, Sorbas, southeastern Spain. *Mar. Geol*. 146: 1-20.

ROMAN, B. 1972. Deux sous-espèces de la vipere *Echis carinatus* (Schneider) dans les territoires de Haute-Volta et du Niger: *Echis carinatus ocellatus* Stemmler – *Echis carinatus leucogaster* n. ssp. *Notes Doc. Voltaïques* 5: 3-13.

ROUSSEL, M.-R. & A. VILLIERS. 1965. Serpents du Mayo-Kebbi (Tchad). *Bull. Inst. Franç. Afr. Noire* 27A: 1522-1533.

ROUX-ESTÈVE, R. 1974. Révision systématique des Typhlopidae d'Afrique: Reptilia-Serpentes. *Mém. Mus. Natl. Hist. nat., Paris, Sér. 2*, 87A: 1-313.

SAID-ALIJEW, S. A. 1979. Zemnowodnyje i presmykajuscijesja Tadzikistana. Dusanbe, Donis. [In Russian.]

SALEH, M. A. 1997. Amphibians and reptiles of Egypt. Egypt. *Dept. nat. Protec. Nat. Biodiver. Unit, Cairo* (6): 1-234.

SCHÄTTI, B. & H. SIGG. 1989. Die Herpetofauna der Insel Zypern. Teil 2: Schildkröten, Echsen und Schlangen. *Herpetofauna* 11: 17-26.

SCHLEGEL, H. 1837. Essai sur la physionomie des serpens. II. Partie descriptve. Arnz & Companie, Leiden. 606 pp.

SCHLEICH, H. 1977. Distributional maps of reptiles of Iran. *Herpetol. Rev*. 8: 126-129.

________, W. KÄSTLE & K. KABISCH. 1996. Amphibians and reptiles of North Africa: biology, systematics, field guide. Koeltz Scientific Books, Koenigstein. 627 pp.

SEN, S., G. BOUVRAIN & D. GERAADS. 1998. Pliocene vertebrate locality of Çalta, Ankara, Turkey. 12. Paleoecology, biogeography and biochronology. *Geodiversitas* 20: 497-510.

SHAFEË. 1990. [Snakes in Jordan.] 75 pp. [in Arabic.]

SIVAN, N. & Y. L. WERNER. 1992. Survey of the reptiles of the Golan Plateau and Mt. Hermon, Israel. *Israel J. Zool.* 37: 193-211.

SMITH, M. A. 1943. The fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese sub-region. Reptilia and Amphibia. Vol. III.– Serpentes. Taylor and Francis, London. 583 pp.

SOBOLEVSKY, N. I. 1929. [The herpetofauna of the Talysh and of the Lenkoran lowalnd.] *Mém. Séct. Zool. Soc. Sci. nat. Anthro. Ethnogr*. 5: 1-141. [in Russian.]

STERNFELD, R. 1910. Neue Schlangen aus Kamerun, Abessynien und Deutsch-Ostafrika. *Mitt. Zool. Mus. Berlin* 5: 67-70.

STRAUCH, A. 1873. Die Schlangen des Russiechen Reichs, in systematischer und zoogeographischer Beziehung. *Mém. Acad. Imp. Sci. St.-Pétersbourg*, Sér. 7, 21: 1-287.

SZYNDLAR, Z. 1985. Ophidian fauna (Reptilia, Serpentes) from the uppermost Miocene of Algora (Spain). *Estud. Geol*. 41: 447-465.

________. 1987. Snakes from Lower Miocene locality of Dolnice (Czechoslovakia). *J. Vert. Paleont*. 7: 55-71.

________. 1991. A review of Neogene and Quaternary snakes of central and eastern Europe. Part I: Scolecophidia, Boidae, Colubrinae. *Estud. Geol*. 47: 103-126.

________& G. A. ZEROVA. 1992. Miocene snake fauna from Cherevichnoie (Ukraine, USSR), with description of a new species of *Vipera. Neues Jb. Geol. Paläont., Abh*. 184: 87-99.

TERENT'EV, P. V. & S. A. CHERNOV. 1949. [Synopsis to the reptiles and amphibians of the U.S.S.R.] 3rd ed. Sovetskaya Nauka, Moscow. 340 pp. [in Russian.]

VILLIERS, A. 1950a. La collection de serpents de l'I.F.A.N. *Bull. Inst. Franç. Afr. Noire, Cat*. 6: 1-155.

________. 1950b. Contribution à l'étude du peuplement de la Mauritanie. *Bull. Inst. Franç. Afr. Noire* 12: 984-998.

________. 1975. Les serpents de l'Ouest Africain. 3rd ed. Université de Dakar, Dakar. 195 pp.

WALLACH, V. 1985. A cladistic analysis of the terrestrial Australian Elapidae. *In*: Biology of Australasian frogs and reptiles. pp: 223-253. G. Grigg, R. Shine & H. Ehmann (Eds). Royal Zoological Society of New South Wales, Chipping Norton.

________. 1991. Comparative visceral topography of African colubrid snakes of the subfamilies Aparallactinae and Atractaspidinae. M. S. Thesis, Louisiana State University, Baton Rouge. 490 pp.

________. 1993a. The supralabial imbrication pattern in the Typhlopoidea (Reptilia: Serpentes). *J. Herpetol*. 27: 214-218.

________. 1993b. A new species of blind snake, *Typhlops marxi*, from the Philippines (Serpentes: Typhlopidae). *Raffles Bull. Zool*. 41: 263-278.

________. 1994. The status of the Indian endemic *Typhlops acutus* (Duméril & Bibron) and the identity of *Typhlops psittacus* Werner (Reptilia, Serpentes, Typhlopidae). *Bull. Inst. Roy. Sci. Nat. Belgique* 64: 209-229.

________. 1995. A new genus for the *Ramphotyphlops subocularis* species group (Serpentes: Typhlopidae), with description of a new species. *Asiatic Herpetol. Res*. 6: 132-150.

________. 1996. Systematic status of *Ramphotyphlops flaviventer* (Peters) and related forms (Serpentes: Typhlopidae). *Amphibia-Reptilia* 17: 341-359.

________. 1997. Two new blind snakes of the *Typhlops ater* species group from Papua New Guinea (Serpentes: Typhlopidae). *Russian J. Herpetol*. 3: 107-118.

________. 1998a. The lungs of snakes. *In*: Biology of the Reptilia. Vol. 19 (Morphology G). pp: 93-295. C. Gans & A. S. Gaunt. (Eds). Society for the Study of Amphibians and Reptiles, Oxford.

________. 1998b. The visceral anatomy of blindsnakes and wormsnakes and its systematic implications (Serpentes: Anomalepididae, Typhlopidae, Leptotyphlopidae). Ph. D. Dissertation, Northeastern University, Boston. 611 pp.

________. 2000. Critical review of some recent descriptions of Pakistani *Typhlops* by M. S. Khan, 1999 (Serpentes: Typhlopidae). *Hamadryad* 25: 63-77.

________& I. INEICH. 1996. Redescription of a rare Malagasy blind snake, *Typhlops grandidieri* Mocquard, with placement in a new genus (Serpentes: Typhlopidae). *J. Herpetol*. 30: 367-376.

WEIJERMARS, R. 1988. Neogene tectonics in the western Mediterranean may have caused the Messinian salinity crisis and an associated glacial event. *Tectonophysics* 148: 211-219.

WELCH, K. R. G. 1983. Herpetology of Europe and southwest Asia: a checklist and bibliography of the orders Amphisbaenia, Sauria and Serpentes. Robert E. Krieger, Malabar. 135 pp.

WERNER, F. 1929. Zoologische Forschungsreise nach den Jonischen Inseln und dem Peloponnes. V. Teil. Reptilia, Amphibia, Orthoptera, Embidaria und Scorpiones. *Sitz.-ber. Akad. Wiss. Wien, Math.-naturwiss. Kl.* 138: 471-485.

________. 1930. Contribution to the knowledge of the reptiles and amphibians of Greece, especially the Aegean Islands. *Occ. Pap. Mus. Zool., Univ. Michigan* (211): 1-46.

________. 1937. Beiträge zur Kenntnis der Tierwelt der Peloponnes, der Inseln Kythira und Euboia so wie der kleine Inseln im Saronische Golf. Sitz.-ber. *Akad. Wiss. Wien, Math.-naturwiss. Kl.* 146: 135-153.

________. 1938. Ergebnisse der achten zoologischen Forschungsreise nach Griechenland (Euboea, Tinos, Skiathos, Thasos usw.). *Sitz.-ber. Akad. Wiss. Wien, Math.-naturwiss. Kl.* 147: 151-173.

WERNER, Y. L. 1973. Introduction to the fauna (fishes, amphibians and reptiles): The reptiles of the Sinai Peninsula. Hebrew University of Jerusalem, Tel-Aviv. 46 pp.

________. 1995. [A guide to the reptiles and amphibians of Israel.] Nature Reserves Authority, Jerusalem. 86 pp. [In Hebrew.]

YADGAROV, T. Y. 1971. [A contribution to the ecology and distribution of *Typhlops vermicularis* in the Surkhandarja Basin.] *Zool. Zh*. 50: 598-599. [in Russian.]

APPENDIX I

MATERIAL EXAMINED

Typhlops etheridgei. MAURITANIA: between Atar and Choum, MHNG 1326.62 (holotype), *Typhlops vermicularis*. ISRAEL: Jerusalem, FMNH 74392, 233386; TURKMENISTAN: 2 km. SE Saivan, CAS 185210, 185216, 185218, 185220, 185225.

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THE HERPETOLOGICAL TYPE SPECIMENS OF THE MUSEUM ZOOLOGICUM BOGORIENSE COLLECTION

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ABSTRACT.– **An annotated checklist of the herpetological type specimens of the Museum Zoologicum Bogoriense is presented. A total of 28 holotypes, three syntypes and 176 paratypes (representing 59 specific and/or subspecific names) are housed in the MZB collection. A number of types representing six forms are at present temporarily located in European and Australian museums. Two paratypes (of *Tropidonophis multiscutellatus*) are destroyed and three others missing. Two holotypes (of *Typhlops soensis* and *Emydura branderhosti*) are considered missing. The holotype of *Leucocephalon yuwonoi* did not arrive at the MZB collection and is destroyed. Nonetheless, MZB is one of the largest repository of herpetological types among the museums in south-east Asia.**

KEYWORDS.– **Catalogue, Amphibians, reptiles, type specimen, Museum Zoologicum Bogoriense, Cibinong, Indonesia.**

INTRODUCTION

Some of the zoological type specimens in the Museum Zoologicum Bogoriense (MZB), Research and Development Centre for Biology, Indonesian Institute of Sciences have been published (Somadikarta et al., 1964, 1965, 1966, 1968, 1970). The collection was started in the year 1894, and served at that time as temporary depository for material destined for museums in the Netherlands, particularly in Leiden and Amsterdam. For this reason, a number of types cannot be found, although the original description clearly specified that the types will be deposited in the MZB collection. Despite lacking an eminent herpetologist for nearly 40 years, the collection still harbours many historical specimens associated with the work of Ouwens, de Rooij and van Kampen, as well as those from Kopstein and de Jong. The oldest herpetological specimen is a *Meristogenys kinabaluensis* deposited just after the museum was built and probably resulted from an exchange with ZRC (Hanitsch, 1900). De Rooij visited New Guinea, although her work covered all Indonesian reptiles, based on museum collections from all over the world. However, van Kampen apparently never visited Indonesia. Hence few specimens in the MZB collection actually collected by de Rooij (i.e., *Tribolonotus novaeguineae*) and none by van Kampen. At present, the MZB collection can be considered the largest and most complete collection in the world for amphibians of Sumatra, Java, and Sulawesi, as well as Borneo, especially in the representation of species but not in the number of specimens. Unfortunately the reptile collection is not as comprehensive as the amphibians. During the period 1976-1978, the first author worked at this institution, tracing and making a list of all herpetological type specimens. This work is has now been completed with the addition of types acquired recently. In addition, we also include some type specimens, which were previously in the MZB collection, but are known to have been sent to several institutions, either for examination or long-term loan after World War II, but for some reason, were never returned. In cases where more information is needed, a complete list of the amphibian and snake types for south-east Asia can be consulted (Iskandar and Colijn, 2000, 2002).

In recent years, the progress of collections all over the world, including Indonesia has become more controlled by local legislation. On one hand, the species-rich Third World nations are pressured by those in the First World to preserve biodiversity. On the other, many leading scientists and museums still obtain specimens illegally, either through field collections or from the herpetocultural trade. According to the Indonesian regulation, imposed in 1970 by the Indonesian Institute of Sciences as the only authoritative institution, holotypes and about 40-50% of all recent collection including paratypes should be shared with Indonesian government institutions. This regulation was enforced later by Presidential Decree No. 100/1993, chapter 2.2, which stipulates that all foreigner who wish to conduct research in Indonesia must have a written permit, issued by the head of Indonesian Institute of Sciences. This decree implied by a new regulation issued by the Indonesian Institute of Sciences, also stipulates that every holotype and 50% of other specimens including the paratypes should be deposited in an Indonesian government institution. As some unauthorized collections are being made and illegal trade cannot be stopped, several leading museums retain specimens collected during or after 1993.

In the present catalogue, the original designation of the species is mentioned in the first row. The current valid name will follow the original description name, if different compared to the original combination. Only the holotype or syntypes are mentioned in each species, whether it is deposited in MZB or not. Paratypes are only mentioned for the MZB specimens.

Abbreviations of systematic institutions are as follows:

AMNH: American Museum of Natural History, New York

AMS: Australian Museum, Sydney

FMNH: Field Museum of Natural History, Chicago

MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, MA

MZB: Museum Zoologicum Bogoriense, Bogor

RMNH: Nationaal Natuurhistorisch Museum, Leiden (formerly Rijksmuseum van Natuurlijke Histoire, Leiden), the Netherlands

SMF: Forschungsinstitut und Natur-Museum, Senckenberg, Frankfurt am Main

UF: Florida State Museum, Gainesville

UPNG: University of Papua New Guinea, Port Moresby

ZRC: Raffles Museum of Biodiversity Research, National University of Singapore, Singapore

WAM: Western Australian Museum, Perth

ZFMK: Zoologische Forschunginstitut und Museum König, Bonn

ZIP: Zoological Institute, St. Petersburg

ZMA: Zoologisch Museum, Amsterdam

ZMB: Zoologische Museum, Universität Humbolt, Berlin

LIST OF HERPETOLOGICAL TYPES

Class: Amphibia
Order: Anura
Family: Bombinatoriidae
Genus: *Barbourula* Taylor & Noble, 1924

Barbourula kalimantanensis Iskandar, 1978.

Holotype.- MZB Amph. 2330, 1 ex., adult male, Nangah Sayan, Pinoh River, 33 km South of Nangah Pinoh, West Kalimantan at about 100 m asl., by S. Wirjoatmodjo and T.R. Roberts - Smithsonian Exp. coll, 1976.

Note.- Up to present, only two specimens, one of each sex, are known. The second specimen is in ZRC (Iskandar, 1995).

Family: Bufonidae
Genus: *Bufo* Laurenti, 1768

Bufo kumquat Das & Lim, 2001

(Holotype.- ZRC 1.3137 from 0.63 km from 35 km point on Sungai besar Tanjung Malim Road, Sabak Bernam, North Selangor, Malaysia, by K. K. P. Lim, on 18-IX-1992).

Paratype.- MZB Amph. 4374 (ex. ZRC 1.3584) 1 ex, adult male, from north Selangor, Malaysia, by H. H. Tan, on 18-IX-1992.

Family: Limnodynastidae (Myobatrachidae)
Genus: *Limnodynastes* Fitzinger, 1843

Phanerotis novae-guineae van Kampen, 1909

Current status.- *Limnodynastes convexiusculus* (Macleay, 1877)

Syntype.- MZB Amph. 223 (ex. 353), 1 ex., sex undetermined, south-west Papua (formerly Irian Jaya), by J. W. R. Koch, on 19-I-1905.

Note.- Originally, MZB had all the specimens, but our catalogue note that one of them was exchanged with the MCZ (on behalf of E. H. Taylor in 1923) and another with E. H. Taylor's private collection on the same occasion. The specimen from the E. H. Taylor collection is now in FMNH. Daan and Hillenius (1966) stated that one of the syntype is in their collection, one probably in MCZ (that exchanged by E. H. Taylor in 1923). One other is in AMS (Cogger, et al., 1983), and the two other specimens unknown. Therefore, the repository of all specimens (five), originally used to describe this form are now known.

Family: Microhylidae
Subfamily: Asterophryinae
Genus: *Hylophorbus* Macleay, 1898

Hylophorbus sextus Günther, 2001

Holotype.- MZB Amph. 6918, from Headwater of Wapoga river, Papua (3º0 86' 87"S and 136º 34' 423"E) Wapoga Alpha Exploration Camp at 1070 m asl. by S. R. Richards, 9-IV-1998.

Genus: *Xenobatrachus* Peters and Doria, 1878

Xenobatrachus schiefenhoeveli Blum and Menzies, 1988

(Holotype.- UPNG 7399, Munggona, Eipomek Valley, Papua, 1800 m asl., by J.P. Blum)

Paratype.- MZB Amph. 2801, 1 ex, Munggona, Eipomek Valley, Papua at 1800 m asl., by J. P. Blum, on IV-VI 1976.

Xenobatrachus multisica Blum and Menzies, 1988

(Holotype.- UPNG 7405, Munggona, Eipomek Valley, Papua, 1800 m asl., by J. P. Blum)

Paratypes.- MZB Amph. 2800 a,b,c,d,e, 5 ex, Munggona, Eipomek Valley, Papua at 1800 m asl., by J. P. Blum, on IV-VI 1976.

Genus: *Xenorhina* Peters, 1863

Xenorhina eiponis Blum and Menzies, 1988

(Holotype.- UPNG 7407, Base Camp, Eipomek Valley, Papua, 1800 m asl., by J.P. Blum)

Paratype.- MZB Amph. 2803, Munggona, Eipomek Valley, Papua at 1800 m asl., , by J. P. Blum, on VI-1979.

Subfamily: Genyophryinae
Genus: *Austrochaperina* Fry, 1912

Austrochaperina blumi Zweifel, 2000

Holotype.- MZB Amph. 3562 (ex. UPNG 9538, J.P. Blum 1979-59), from Kosarek, at 1400 m asl., Jayawijaya District, Papua, by J. P. Blum, on VII-1979

Austrochaperina derongo Zweifel, 2000

(Holotype.- AMNH A 82289 from Derongo, 400 m asl. Western Province, Papua New Guinea, by F. Parker, 7 -IV-1968).

Paratype.- MZB Amph. 3563 from Wapoga Alpha Exploration camp, Papua, at 1070 m asl. 3º 08' 687"S and 136º 34' 423"E) by S. Richards & D.T. Iskandar, on 13-IV-1998.

Austrochaperina kosarek Zweifel, 2000

Holotype.- MZB Amph. 3561 (ex. UPNG 9532, J.P. Blum 1979-38), from Kosarek, at 1400 m asl., Jayawijaya District, Papua, by J. P. Blum, on VII-1979

Genus: *Oreophryne* Boettger, 1895

Oreophryne atrigularis Günther, Richards & Iskandar, 2001

(Holotype.- ZMB 6226 from Wondowoi Mts, at the base of Wandamen Peninsula 8 km west of the coastal village Yeretuar (2º 56'S; 134º 36'E), Nabire District, Papua by R. Günther, on 30-VI-1998). Paratypes.- MZB Amph. 7361-7362, 2 ex., same data as of the holotype, but collected between 350-750 asl., collected between 28-VII – 1-VIII-1998.

Oreophryne darewskyi Mertens, 1965

Current status.- *Oreophryne jeffersoniana* Dunn, 1928

(Holotype.- SMF from Rinca Island, by R. Mertens).

Paratypes.- MZB Amph. 3 ex, same data as for the holotype.

Note.- The original description specified that three of the paratypes belong to the MZB collection, but are still in the SMF collection.

Oreophyne minuta Richards & Iskandar, 2000

Holotype.- MZB Amph. 3877 from an unnamed mountain, Derwo River Basin, Papua, at 2000 m asl. (3º 26’ 527"S and 136º 28’ 365"E) by S. Richards & D. T. Iskandar, on 7-IV-1998

Paratype.- MZB Amph. 3878, same data as for the holotype

Oreophyne wapoga Günther, Richards & Iskandar, 2001

Holotype.- MZB Amph. 7358 from Wapoga Alpha Exploration Camp, Papua, at 1070 m asl. 3º 08’ 687"S and 136º 34’ 423"E) by S. Richards & D.T. Iskandar, on 11-IV-1998

Paratypes.- MZB Amph. 7359-7360, 2 ex., same data as for the holotype, except collected by M. Moore, on 16-IV-1998

Oreophryne rookmakeri Mertens, 1927b

(Holotype.- SMF 22090, Ranamese, West Flores at 1200 m asl., by Sunda Expedition Rensch).

Paratypes.- MZB Amph. 041. 6 ex, 4 ads + 2 juv., Ranamese, west of Flores Island at 1200 m asl., by Sunda Expedition Rensch, on 25-VI-1927.

Subfamily Microhylinae

Genus: *Kalophrynus* Tschudi, 1830

Kalophrynus minusculus Iskandar, 1998

Holotype.- MZB Amph. 367, male, from Cigeunteur, Ujung Kulon, West Java, by A.M.R. Wegner, on 15 July 1955.

Paratypes.- MZB Amph. 365 from Nyewaan, MZB 366, from Cikarang, MZB 375 and MZB 376 from Cidaun, 6 ex, all around the type locality and by the same collector, and collected during the same period. MZB Amph. 2924 from Cidaun, Ujung Kulon, by H. Kurniati. MZB Amph. 2339 from Gelugur, Wai Kramat, Wai Sekampung, Lampung by D.T. Iskandar.

Family: Hylidae (Pelodryadidae)

Genus: *Litoria* Tschudi, 1838

Litoria elkeae Günther & Richards, 2000

(Holotype.- ZMB 59375 from Tetslaff, Kalibumi River, between Nabire and Mapia, Papua by R. Günther, on 9-VIII- 1998).Paratypes.- MZB Amph. 3838, 3866, 3869, 3 ex., all from Siewa, Wapoga Alpha Expedition, Papua, by S. Richards & D. T. Iskandar, on IV 1998.

Litoria macki Richards, 2001

Holotype.- MZB Amph. 3870 an adult male, from head water of Wapoga river, Wapoga Alpha Exploration Camp, Papua, at 1070 m asl. 3º 08’ 687"S and 136º 34’ 423"E) by S. Richards & M. Moore, on 17-IV-1998

Paratypes.- MZB Amph. 3871-3872, 2 ex., same data as for the holotype.

Litoria wapogaensis Richards & Iskandar, 2001

Holotype.- MZB Amph. 3873 from head water of Wapoga river, Wapoga Alpha Exploration Camp, Papua, at 1070 m asl. 3º 08’ 687"S and 136º 34’ 423"E) by S. Richards & D.T. Iskandar, on 12-IV-1998

Paratypes.- MZB Amph. 3874-3875, 2 ex., same data as for the holotype, except collected on 9-IV-1998; MZB Amph. 3876, collected on 15-IV-1998

Family: Ranidae

Genus: *Limnonectes* Fitzinger, 1843

Rana microdisca dammermani Mertens, 1929

Current status.- *Limnonectes dammermani* (Mertens, 1929)

(Holotype.- SMF 22100, Sembalun, Lombok, by Sunda Expedition Rensch).

Paratypes.- MZB Amph. 091, 3 ex, subadult, Badjawa, Flores Island, by Sunda Expedition Rensch, on 17-VI-1927.

Limnonectes kadarsani Iskandar, Boeadi and Sancoyo, 1996.

Holotype.- MZB Amph. 2940 (ex. 2654). 1 ex, an adult male, from Jaran Pasang, Lombok Island, by D. Hardjono, on 14-III-1978.

Paratypes.- MZB Amph. 009, 3 (of 5) ex, 2 males, 1 females, Wolowaru, Flores Island, by R. Mertens, Sunda-Exp. Rensch, on 16-VII-1927. MZB Amph. 120, 1 ex, female, Batu Dulang, Sumbawa Island, by R. Mertens, Sunda Exp. Rensch, on 6-V-1927. MZB Amph. 2935-2936 (ex.193), 2 ex, females and MZB Amph. 2959, 2960 (ex. 215), 2 ex. (partly cleaned), males; Semangkat Atas, Sumbawa Island, by R. Mertens, Sunda Exp. Rensch, on 11-V-1927; MZB Amph. 214. 1 ex, female, Bajawa, Flores Island, by R. Mertens, Sunda Exp. Rensch, on 6-VII-1927. MZB Amph. 2937-2939 (ex. 398). 3 ex, 2 females and 1 male. Rana Mese, Flores Island, by Fr. J. M. Vianney, on 10-IV-1958. MZB Amph. 1025-1026. 2 ex, males, Hinga, Adonara Island, by Fr. J. M. Vianney, on 10-V-1959. MZB Amph. 1024, 1 ex, male, Wure, Adonara Island, by Fr. J. M. Vianney, on 3-V-1959. MZB Amph. 2952-2956 (ex. 2507), 5 ex, Sariberu, near Simpasai market, Monta county, Bima, Sumbawa Island, by M. Siluba, on 7-II-1984. MZB Amph. 2943-2945 (ex. 2651), 3 ex, 2 males, 1 female, Jaran Pasang, Lombok Island, by D. Hardjono, on 8-14-III-1978. MZB Amph. 2941-2942 (ex. 2652), 2 ex, male and female, Jaran Pasang, Lombok Island, by D. Hardjono, on 8-III-1984. MZB Amph. 2946-2948 (ex. 2653), 3 ex, 2 males and 1 female, Jaran Pasang, Lombok Island, by D. Hardjono, on 14-III-1978. MZB Amph. 2949-2951 (ex. 2645), 3 ex, 2 males and 1 female, from west of Lombok Island, no exact locality by Rachmatun, on V-1982. MZB Amph. 2654. 1 ex, male, Jaran Pasang, Lombok Island, by D. Hardjono, on 14-III-1984. MZB Amph. 2957-2958 (ex. 2805), 2 ex, male and female, along stream creek near Air Merah, Batu Hijau, southwest of Sumbawa Island, by K. Martin, on II-1994.

Rana rhacoda Inger, Boeadi & Taufik, 1996.

Current status.- *Limnonectes rhacoda* (Inger, Boeadi & Taufik, 1996)

Holotype.- MZB Amph. 2991, an adult female from Kalang River, Mentaya Hulu District, East Kotawaringin, (1.25’S; 112.20’E), Central Kalimantan, Indonesia by A. W. Taufik, on I-1995.

Paratypes.- MZB Amph. 2992-2994, 3 ex, same data as for the holotype.

Rana asperata Inger, Boeadi & Taufik, 1996.

Current status.- *Limnonectes asperatum* (Inger, Boeadi & Taufik, 1996)

Holotype.- MZB Amph. 3117, an adult female from Kalang river, Mentaya Hulu District, East Kotawaringin, (1º 25’S/112º 20’E), Central Kalimantan, Indonesia, by Agustinus W. Taufik and E. Roezzaman, on I-1995.

Paratypes.- MZB Amph. 3118-20, 3 ex, collected together with the holotype.

Genus: *Meristogenys* Yang, 1991

Amolops orphnocnemis Matsui, 1986.

Current status.- *Meristogenys orphnocnemis* (Matsui, 1986)

(Holotype.- OMNH Am. 8052, Bundu Tuhan, Kinabalu, Malaysia at 990 m asl., by M. Matsui.)

Paratypes.- MZB Amph. 2721-2728, 8 ex., Muruk river, at 1050-1150 m, near Pa Nado, Sarawak border of Krayan county, North Borneo, Malaysia by M. Matsui.

Genus: *Platymantis* Günther, 1858

Platymantis batantae Zweifel, 1966.

(Holotype.- AMNH 74192, Mt. Besar, Wailebet, 1500 ft, Batanta Island, by S. Somadikarta and G. Gilliard)

Paratype.- MZB Amph. 2084, 1 ex., female from Mt. Besar, above Wailebet at 1500 ft, Batanta Island, West of Papua, by S. Somadikarta and G. Gilliard on 20-VI-1964.

Platymantis papuensis occidentalis Menzies, 1998

Holotype MZB Amph. 2470 (ex. UPNG 5258) from near Piliana, south coast of Seram Island, Indonesia, by J. I. Menzies.

Paratypes.- MZB Amph 2471-2473, 3 ex, from near Piliana, south coast of Seram Island, Indonesia by J. I. Menzies.

CLASS REPTILIA
ORDER: SQUAMATA

Family: Agamidae
Genus: *Aphaniotis* Peters, 1864

Japalura nasuta de Jong, 1930

Current status.- *Aphaniotis ornata* (van Lith de Jeude, 1893)

Holotype.- MZB Lace. 175a. 1 ex, male, from North Kalimantan, by Mohari, in 1912.

Paratypes.- MZB Lace. 175b, 3 ex, sex undetermined, same data as for the holotype.

Note.- Two other paratypes are in ZMA.

Family: Gekkonidae
Genus: *Aeluroscalabotes* Boulenger, 1885

Aeluroscalabotes dorsalis multituberculatus Kopstein, 1927

Current status.- *Aeluroscalabotes multituberculatus* Kopstein, 1927

Holotype.- MZB Lace. 073, 1 ex, male from Sanana, Sula Island, by Tarip, in 1914.

Paratype.- MZB Lace. 076, 1 ex, male from Kalimantan, by Mohari, in 1912.

Note.- MZB has another specimen (MZB Lace. 075) from Sula Island, collected together with the holotype, but it does not have type status. The species is considered doubtfully valid. However, further studies, perhaps also using molecular data, are needed to determine its systematic status. The Bornean paratype, clearly belongs to *A. felinus,* is at present in the SMF collection.

Genus: *Cyrtodactylus* Gray, 1827

Cyrtodactylus laevigatus Darevskyi, 1964

(Holotype.- ZIP 17617, from Komodo Island at 1000 ft., 2 -VIII-1962 by I. S. Darevsky).

Paratype.- MZB Lace. 979, 1 ex, female, from Komodo Island at 1000 ft., by I. S. Darevsky, on 2-VIII-1962.

Genus: *Lepidodactylus* Fitzinger, 1843

Lepidodactylus intermedius Darevsky, 1964

(Holotype.- ZIP 17614 from Komodo Isl. at 100 m 27-VIII-1962, by I. S. Darevsky.)

Paratype.- MZB Lace. 978, 1 ex, female from Komodo Island, at 100 m, by I. S. Darevsky, on 27-VIII-1962.

Note.- Auffenberg (1980) consider this form at most as a subspecies of *L. lugubris,* but it was listed as a distinct species by Kluge (2001).

Genus: *Luperosaurus* Gray, 1845

Luperosaurus iskandari Brown, Supriatna & Ota, 2000

Type.- MZB Lace. 2114, 1 ex., adult female, from Mt. Tompotika, Siuna, Pagimana, Banggai Island, Central Sulawesi, By R. M. Brown, on 15-VI-1998.

Family: Scincidae
Genus: *Cryptoblepharus* Wiegemann, 1834

Cryptoblepharus sumbawanus Mertens, 1928

(Holotype.- SMF 22096 from Sumbawa Besar, Sumbawa Isl., by Sunda Expedition Rensch).

Paratypes.- MZB Lace. 364. 8 ex., sexes undetermined, from Sumbawa Besar, Sumbawa Island., on 30-III-1927, by Sunda Expedition Rensch.

Genus: *Emoia* Gray, 1845

Lygosoma mivarti obscurum de Jong, 1927

Current status.- *Emoia obscura* de Jong, 1927

Holotype.- MZB Lace. 369, 1 ex, sex undetermined Prauwenbivak, Idenburg River, Papua by W.C. van Heurn on XI-1920

Paratype.- MZB Lace. 372, 1 ex, sex undetermined, North New Guinea, by K. Gjellerup, in 1911.

Note.- *Emoia obscura* was described from eight specimens, four from the type locality, three from Pioneerbivak, Mamberamo river, and another one from North New Guinea. Among them, MZB Lace. 369 is clearly labelled as "*typen nov. var*" and signed by de Jong himself as indicated in the original description. As shown by Brown (1953), the type serie of this form are composite based on the ZMA and RMNH specimens. Article 74a of the ICZN Code (1985) sets aside the lectotype designation of of the ZMA paratype (ZMA 11445, was designed as lectotype by Brown, 1991), because the holotype still exist. Daan and Hillenius (1966) stated that other than their specimen, there is another specimen in RMNH and other specimens are considered as lost.

Emoia irianensis Brown, 1991

(Holotype.- RMNH 21239, female from Tussen Tage, Paniai lake, Papua by L. D. Brongersma, M. Boeseman and party, 3 Jan 1955)

Paratypes.- MZB Lace. 1087-97, 8 ex; MZB Lace. 1079-86 from Hitalipa, 8 ex., from Kumopa; MZB Lace. 1055-56, 2 ex., from Beoga; MZB Lace. 1078 from Usaciga, Central Mountains of Papua, Indonesia, by the same collectors as for the holotype.

Emoia kitcheneri How, Durrant, Smith & Saleh, 1998

Holotype.- MZB Lace. 4152 (WAM R101877) from Ngalu (10º 06’ 30"S, 120º 41’ 30"E), East Sumba, Indonesia, by R.A. How, D. J. Kitchener, N. K. Cooper, J. Dell & A Suyanto, on 8-VI-1989.

Paratypes.- MZB Lace. 4153-4165 (WAM R 101867, 101873, 101874; 101875; 101883; 101886; 101888; 101889; 101891; 101893; 101884; 101892; 101890) 13 ex, same data as for the holotype.

Leiolopisma kadarsani kadarsani Darevsky, 1964

Current status.- *Emoia similis* Dunn, 1927

Holotype.- MZB Lace. 976, 1 ex., female, from Komodo Island., at 500 m asl., by I. S. Darevsky, on 2-VIII-1962.

Leiolopisma kadarsani padariensis Darevsky, 1964

Current status.- *Emoia similis* Dunn, 1927

Holotype.- MZB Lace. 978, 1 ex., female, from Komodo Island, at 500 m asl., by I. S. Darevsky, on 6-VIII-1962.

Leiolopisma sembalunicum rintjana Darevsky, 1964

Current status.- *Emoia similis* Dunn, 1927

Holotype.- MZB Lace. 977, 1 ex, female, Rinca Island, by I.S. Darevsky, on 10-VIII-1962.

Note.- Auffenberg (1980) considered *Leiolopisma kadarsani* (with two subspecies) and *L. sembalunicum rintjana*, all described by Darevsky, as synonymous with *Emoia similis.* No other specimens of *E. similis* and *L. sembalunica* have been collected since the original description despite careful investigations at the type locality by several major expeditions. The description of *E. similis* is similar to the two *Leiolopisma* species and a larger series show that the supranasal scale might be present or absent that leads to the separation of *E. similis* and *Leiolopisma*. Solving of this problem leads to the removal of the genus *Leiolopisma* from the fauna of Indonesia.

Genus: *Eugongylus* Fitzinger, 1843

Lygosoma (Riopa) sulaense Kopstein, 1927

Current status.- *Eugongylus sulaensis* (Kopstein, 1927)

Holotype.- MZB Lace. 361, Sanana, Sula Island, by Tarip in 1914.

Paratype.- MZB Lace. 4166 (ex 361b), 1 ex, same data as for the holotype.

Note.- Originally described from three specimens, all from the type locality. One other paratype is probably in RMNH as mentioned in the original description. The species is variously considered as a synonym of *Eugongylus rufescens*, but such decision necessities examination of the types.

Genus: *Mabuya* Fitzinger, 1843

Mabuya multifasciata balinensis Mertens, 1927a

(Holotype.- SMF, 22087 from Gitgit, Bali Island, by R. Mertens)

Paratypes.- MZB Lace. 564, 1 ex, juv. from Gitgit, North Bali, 500 m asl., by R. Mertens, on 1-VIII-1927. MZB Lace. 2132, 2133, 2134, 2257, 2259, (ex. 569), 5 ex., from Gitgit, North Bali, 500 m asl., by R. Mertens, on 1-VIII-1927. MZB Lace. 570, 5 ex., from Baturiti, Central Bali at 850 m asl., by Sunda Expedition Rensch, on 4-VIII- 1927.

Mabuya multifasciata tjendekianensis Mertens, 1956

Holotype.- MZB Lace. 807, 1 ex., female, Cendekian Island., Karimundjawa Isls., by A. Hoogerwerf, on 17-II-1955.

Paratype.- MZB Lace. 808, 1 ex., male same data as the holotype.

Note.- These specimens have been sent to SMF on 24 May 1957, and the holotype now bears a SMF number 55147.

Genus: *Glaphyomorphus* Wells & Wellington, 1984

Sphenomorphus mertensi Darevsky, 1964

Current status.- *Glaphyromorphus mertensi* (Darevsky, 1964)

Holotype.- MZB Lace. 975, 1 ex, female, Padar Island., at sea level, by I. S. Darevsky, on 8-VIII-1962

Glaphyromorphus butlerorum Aplin, How & Boeadi, 1993

Holotype.- MZB (WAM R101829) from Ngalu, (10º 06’ 30"S, 120º 41’ 30"E) Sumba Island

Paratype.- MZB (WAM R101908) same data as for the holotype.

Note.- These specimens are still in WAM, for a long-term loan and have not yet been catalogued.

Genus: *Sphenomorphus* Fitzinger, 1843

Sphenomorphus puncticentralis Iskandar, 1996

Holotype.- MZB Lace. 1865, 1 ex, female?, from Batu Raden, Southern slope of Mt. Slamet at 1200 m asl., by D. T. Iskandar on IX-1976.

Lygosoma dammermani Kopstein, 1927

Current status.- *Sphenomorphus undulatus* (Peters & Doriae, 1878)

Holotype.- MZB Lace. 339, 1 ex, sex undetermined Sula Island, by Tarip, in 1912.

Note.- This holotype, the only specimen from Sula Island, is partially destroyed, especially the head and the forelimbs are practically no more discernable when examined on 23-X-1976.

Family: Varanidae

Genus: *Varanus* Merrem, 1820

Varanus cerambonensis Philipp, Böhme & Ziegler, 1999.

Holotype.- MZB (ZMFK 70617) adult male from Laimu (3º 19’S; 129º 44’E) Seram Island, Indonesia, by H. Kotter, X-1996

Paratypes.- MZB (ZMFK) 2 ex., same data as for the holotype.

Note.- These specimens (the holotype and paratypes) have not yet been sent back to Indonesia.

Varanus komodoensis Ouwens, 1912.

Syntype.- MZB Lace. 946, 1 ex., juv. Komodo Isl. near Flores, by S. Hensbroek and R. Bitjara in 1908

Note.- Other syntypes could not be found in the MZB collections, and are probably in RMNH, where they were sent after the Second World War. Dunn (1927) stated that he has the opportunity to examine the entire type series in MZB in September 1927.

ORDER OPHIDIA

Family Typhlopidae

Genus: *Ramphotyphlops* Fitzinger, 1843

Typhlops iridescens de Jong, 1930

Current status.- *Ramphotyphlops erycinus* (Werner, 1901)

Holotype.- MZB Oph. 261. 1 ex., sex undetermined, Albatros bivak, Mamberamo river, Papua, by W. Docteurs van Leeuwen, on V-1926.

Typhlops polygrammicus brongersmai Mertens, 1930

Current status.- *Ramphotyphlops polygrammicus brongersmai* (Mertens, 1930)

(Holotype.- ZMA 11179 from Mao Maru, Kananggar, Sumba Island, by K.W. Dammerman).

Paratype.- MZB Oph. 251, 1 ex, sub-adult, Kananggar, South-east Sumba, at 700 m. asl., by K.W. Dammerman.

Note.- Daan and Hillenius (1966) note that this paratype was probably deposited in SMF.

Genus: *Typhlops* Oppel, 1811

Typhlops schmutzi Auffenberg, 1980

(Holotype.- UF 29507, Loho Lavi, Komodo Island. 12 m asl., by W. Auffenberg & colls., I-1970).

Paratypes.- MZB Oph. 1750, 6 ex. (ex. UF 29502, 29503, 29505, 29509, 29510, 29511), same data as for the holotype, except collected between 1970-1973.

Typhlops soensis de Jong, 1930

Current status.- *Ramphotyphlops polygrammicus soensis* (de Jong, 1930).

Paratypes.- MZB Oph. 264, 6 ex. adults and subadults, Soe, south-central Timor, at 880 m asl., Mrs. Walsch.

Note.- Described from nine specimens, consisting of the holotype, six paratypes in MZB plus two in ZMA. The holotype was deposited in MZB, but we were unable to trace it. This form may be synonymous with *R. polygrammicus*, but such decision needs to be based on further study.

Family: Cylindrophiidae
Genus: *Cylindrophis* Wagler, 1863

Cylindrophis yamdena Smith & Sidik, 1998

Holotype.- MZB (WAM R112252) from Latdalam (7º 59' S, 131º 09'E), Yamdena, Tanimbar Islands, Indonesia, by R.E. Johnstone, D.J. Kitchener & R.A. How on 23-IV-1993

Paratypes.- MZB (WAM) 2 ex, same data as for the holotype.

Note.- These specimens are still in WAM on long-term loan, and have not been catalogued.

Family: Colubridae
Subfamily: Natricinae
Genus: *Tropidonophis* Jan, 1863

Natrix mairii multiscutellata Brongersma, 1948

Current status.- *Tropidonophis multiscutellatus* (Brongersma, 1948)

(Holotype.- RMNH 8669, Alkmaar, Lorentz river, by W.C. van Heurn).

Paratypes.- MZB Oph. 045, 2 ex. Prauwen bivak, Mamberamo river, north-western Irian Jaya, by W.C. van Heurn on 11-VII-1920 (noted as 18-IX-1920 in the original description).

Note.- The original description indicated that MZB has five specimens, but only two are traceable. Those from Manokwari and Albatros river, Batavia Rapid are probably lost. Unfortunately these two remaining specimens are now completely destroyed. The generic allocation follows Malnate and Underwood (1989)

Subfamily: Colubrinae
Genus: *Boiga* Fitzinger, 1826

Boiga dendrophila atra Kopstein, 1936

Current status.- *Boiga dendrophila gemmicincta* (Duméril & Bibron, 1854)

Holotype.- MZB Oph. 813, 1 ex, sex undetermined, Ba Ebunta, Masamba, Central Sulawesi, by M. Mansjur, on 27-VII1934.

Paratypes.- MZB Oph. 806 1 ex, male from Kolaka, South East Sulawesi, by Indonesian surgeon, on VI-1935. MZB Oph. 811, 1 ex., female from Palopo, Central Sulawesi, by an Indonesian veterinarian, on 15-XII-1934. MZB Oph. 815. 1 ex, Ba Ebunta, Masamba, central Sulawesi, by M. Mansjur, on 27-VII-1934.

Note.- This taxon is a melanistic form of the Sulawesian subspecies. However Kopstein is not the first one who described a black Sulawesian *Boiga*. *Naja celebensis* (Ahl 1933) may have priority, as Mertens (1961) examined the type of *Naja celebensis* and found that it to be a *Boiga dendrophila*. All old individuals became black, and colour variation is merely ontogenetic characteristics and not a case of melanism.

Genus: *Dendrelaphis* Boulenger, 1890

Ahaetulla boiga intermedia Mertens, 1927

(Holotype.- SMF 22093, Sumbawa Besar, Sumbawa Island., by Sunda Expedition Rensch).

Current status.- *Dendrelaphis inornatus* Boulenger, 1897

Paratypes.- MZB Oph. 195, 196, 784, 784a, 785, 792, 794, (ex 101), 7 ex, all from Sumbawa Besar, by Sunda Expedition Rensch, on 25-IV-1927.

MZB Oph. 1177, 1211 (ex. 010), 2 ex, Dompu, Sumbawa Island, by Sunda Expedition Rensch, on 24-V-1927.

Note.- According to How et al. (1996), this form could not be distinguished from *D. inornatus* based on multivariate analysis.

Genus: *Oligodon* Boie, 1827

Oligodon purpurascens kangeanicus Mertens, 1959

(Holotype: SMF 55144, Kalisanga, near Ardjasa, Kangean Isl., by A. Hoogerwerf).

Paratype.- MZB Oph. 1086. 1 ex, male, Kalisanga, near Ardjasa, north-west Kangean Island, at sea level, by A. Hoogerwerf, on 2-X-1954.

Note.- The original description gives the museum number as 1066 in error.

Family: Elapidae
Genus: *Bungarus* Daudin, 1803

Maticora intermedia Westermann, 1942

Current status.- *Bungarus flaviceps flaviceps* Reinhardt, 1843

Syntype.- MZB Oph. 466, 1 ex, sex undetermined, North Kalimantan, by Mohari - Grens Expedition, in 1912 (not found).

Note.- The original description noted that this species was described based on two specimens, neither of which were chosen as the holotype. However, it was noted that the other specimen is badly damaged at the head. The second (damaged) specimen is now in RMNH (Brongersma, 1948).

Bungarus javanicus Kopstein, 1932

Current status.- *Bungarus candidus* (Linn. 1754)

Note.- The holotype (and other Kopstein's specimens collected after the description of this form) are now in RMNH, bearing the number RMNH 9007 (and 9008) from Matanghaji, Cirebon. The species was synonymized to *B. candidus* by Slowinski (1994), and recently supported by molecular studies (U. Kuch, pers. comm., 2002).

Family: Viperidae
Genus: *Vipera* Laurenti, 1768

Vipera russelii sublimitis Kopstein, 1936

Current status.- *Daboia russelii siamensis* (Smith, 1917)

Syntype.- MZB Oph. 472, 1 ex, male, Klumprik, Sepanjang, near Kembang Kuning cementary, Surabaya, East Java, by H. Neuhaus, on 16-XII-1933.

Note.- Originally described on the basis of three specimens in the MZB collection, the syntype is the first as well as the largest specimen compared to two others, although none was designated as the holotype. Brongersma (1958) designated one of the cotypes from RMNH as a lectotype. We have no information of the whereabouts of the third specimen. The status of the MZB type specimen is rather doubtful, because the original description stated that "having only a single specimen is not enough...., ... fortunately we have collected two additional specimens" is the only indication that Kopstein did have access to this specimen when he described this form as a new subspecies. By the designation of the RMNH specimen as the lectotype, this specimen is, by implication, a paralectotype.

ORDER: CHELONII

Family: Chelidae
Genus: *Elseya* Gray, 1867.

Emydura branderhorsti Ouwens, 1914

Current status.- *Elseya branderhosti* (Ouwens, 1914)

Holotype.- lost, not in the records.

Note.- The holotype was kept as living specimen at the time of description, and cannot be traced in the MZB archive at present.

Family: Geoemydidae
Genus: *Leucocephalon* McCord, W. P. J. B. Iverson, P. Q. Spinks & H. B. Shaffer. 2000.

Geoemyda yuwonoi McCord, Iverson & Boeadi, 1995

Current status.- *Leucocephalon yuwonoi* (McCord, Iverson & Boeadi, 1995)

Holotype.- MZB 10295? from Marisa, North Sulawesi, by F. B. Yuwono, in 1993.

This holotype did not reach the MZB collection, and was presumably destroyed during the flooding of Jakarta.

Family: Trionychidae
Genus: *Chitra* Gray, 1844

Chitra chitra javanica McCord & Pritchard, 2002

Holotype.- MZB Test 199, 57.0 cm male, from Pasuruan River, near Pasuruan, East Java, Indonesia by local turtle hunters. Donated by F. Yuwono.

Paratypes.- MZB. 264, a 34.2 cm subadult and MZB 265, a 15.5 cm juvenile; MZB 266 and 267, both subadult skeletons.

Note.- in addition, MZB have two other giant (skeletonized) specimens, but are not included in the types.

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LITERATURE CITED

AHL, E. 1933. Ergebnisse der Celebes und Halmahera Expedition Heinrich 1930-1932. 1. Reptilien und Amphibien. *Mitt. Zool. Mus. Berlin*. 19: 577-583.

APLIN, K. P., R. A. HOW & BOEADI. 1993. A new species of the *Glaphyromorphus isolepsis* species group from Sumba Islands, Indonesia. *Rec. Western Australian Mus*. 16 (2): 235-242.

AUFFENBERG, W. 1980. The herpetofauna of Komodo, with notes on adjacent areas. *Bull. Florida St. Mus. Biol Sci***.** 25: 39-156.

BLUM, J. P. & J. I. MENZIES. 1988. Notes on *Xenobatrachus* and *Xenorhina* (Amphibia: Microhylidae) from New Guinea with description of nine new species. *Alytes* 7: 125-163.

BROWN, R. M., J. SUPRIATNA & H. OTA. 2000. Discovery of a new species of *Luperosaurus* from Sulawesi, with a phylogenetic analysis of the genus and comments on the status of *Luperosaurus serraticaudus*. *Copeia* 2000: 191-209.

BROWN, W. C. 1953. Results of the Archbold Expeditions. No 69. A review of New Guinea lizards allied to *Emoia baudini* and *Emoia physicae* (Scincidae). *American Mus. Novit*. 1627: 1-25.

________. 1991. Lizards of the genus *Emoia* (Scincidae) with observations on their evolution and biogeography. *Mem. California Acad. Sci*. 15: 1-94.

BRONGERSMA, L.D. 1948. A new subspecies of *Natrix mairii* (Gray) from Dutch New Guinea. *Proc. Kon. Acad. Wet. Amsterdam* 51: 372-381.

________. 1948. Notes on *Maticora bivirgata* (Boie) and *Bungarus flaviceps* Reinh. *Zool. Med. Leiden* 30: 1-29.

________. 1958. Note on *Vipera russellii* (Shaw). *Zool. Med. Leiden*, 36: 55-76.

COGGER, H.C., E. E. CAMERON & H. M. COGGER, 1983. Zoological catalogue of Australia. I. Amphibia and Reptilia. Australian Government Publ. Service, Canberra. 313 pp.

DAAN, S. & D. HILLENIUS. 1966. Catalogue of the type specimens of amphibians and reptiles in the Zoological Museum, Amsterdam. *Beaufortia* 13: 117-144.

DAREVSKY, I. S., 1964. New scincid lizards from the Lesser Sunda Archipelago (East Indonesia). *Zool. Zh.*, *Moskow* 43: 80-88. (in Russian.)

________. 1964. Two new species of gekkonid lizards from the Lesser Sunda- Archipelago. *Zool. Anz*. 172: 402-406.

DAS, I. & K. K. P. LIM. 2001. A new *Bufo* (Anura, Bufonidae) from the peat swamps of Selangor, West Malaysia. *Raffles Bull. Zool*. 49: 1-6.

DUNN, E. R. 1927. Results of the Douglas Burden expedition to the island of Komodo. III. Lizards from the East Indies. *American Mus. Novit*. 288:1-13.

________. 1928. Results of the Douglas Burden expedition to the island of Komodo. IV. Frogs of the East Indies. *American Mus. Novit*. 315:1-9.

GÜNTHER, R. 2001. The papuan frog genus *Hylophorbus* (Anura: Microhylidae) is not monospecific: description of six new species. *Russian J. Herpet*. 8 (2): 81-104.

________. & S. J. RICHARDS. 2000. A new species of the *Litoria gracilenta* group from Irian jaya (Anura: Hylidae) *Herpetozoa* 13: 27-43.

________,________ & D. T. ISKANDAR. 2001. Two new species of the genus *Oreophryne* from Irian Jaya, Indonesia. *Spixiana* 24 (3): 257-274.

HANITSCH, R., 1900. An expedition to Mount Kina Balu, British North Borneo. *J. Br. Royal Asiatic Soc*. 34: 48-88.

HOW, R. A., B. DURRANT, L. A. SMITH & N. SALEH. 1998. *Emoia* (Reptilia: Scincidae) from the Banda Arc islands of eastern Indonesia: variation in morphology and description of a new species. *Rec. Western Australian Mus*. 19: 131-139.

________, L. H. SCHMITT & MAHARADATUNKAMSI. 1996. Geographical variation in the genus *Dendrelaphis* within the islands of south-eastern Indonesia. *J. Zool. Lond*. 238: 351-363.

INGER, R. F., BOEADI & A. TAUFIK. 1996. New species of ranid frogs from Central Kalimantan. *Raffles Bul. Zool*. 44 (2): 363-369.

ISKANDAR, D. T. 1978. A new species of *Barbourula*: first record of a discoglossid anuran in Borneo. *Copeia* 1978: 564-566.

________. 1995. Note on the second specimen of *Barbourula kalimantanensis* (Amphibia, Anura, Discoglossidae). *Raffles Bull. Zool*. 43: 309-311.

________. 1996. A new lizard species of the genus *Sphenomorphus* from central Java. *Treubia* 30: 25-30.

________. 1998. The amphibians of Java and Bali. LIPI Field Guide. Yayasan Hayati, Bogor. 147 pp + 52 col. pl.

________, BOEADI & M. SANCOYO. 1996. *Limnonectes kadarsani* (Amphibia, Anura, Ranidae), a new frog from the Nusa Tenggara Islands. *Raffles Bull. Zool*. 44: 1-7.

________& E. COLIJN. 2000. Checklist of Southeast Asian and New Guinean herpetofauna I. Amphibians. *Treubia* 31 part 3 (Supplement) 1-133.

________&________ . 2000. A checklist of southeast Asian and New Guinean reptiles I. Serpentes. Biodiversity Conservation Project, Institut Teknologi Bandung and Gibbon Foundation. Jakarta, Binamitra. 195 pp.

De JONG, J. K. 1927. Reptiles from Dutch New Guinea. *Nova Guinea* 15: 296-318.

________. 1930a. Notes on some reptiles from the Dutch-East Indies. *Treubia* 12: 115-119.

________. 1930b. List of reptiles collected by Prof. W. Docteurs VAN Leeuwen during the North New Guinea Expedition, 1926. *Nova Guinea* 15: 405-408.

Van KAMPEN, P. N. 1909. Die Amphibienfauna von Neu-Guinea; nach der Ausbeute der Niederlandischen Sud-Neu-Guinea Expedition. *Nova Guinea* 9: 36.

KLUGE, A. G. 2001. Gekkotan lizards taxonomy. *Hamadryad* 26: 1-209.

KOPSTEIN, F. 1927. Die Reptilienfauna der Sula-inseln. *Treubia* 9: 437-446.

________. 1932. *Bungarus javanicus*, Eine neue Giftschlange von Java. *Treubia* 14: 73-77.

________. 1936a. Herpetologische Notizen XII. Ein Beitrag zur herpetofauna von Celebes. *Treubia* 15: 257-258.

________. 1936b. Herpetologische Notizen XIII. Ueber *Vipera russellii* von Java. *Treubia* 15: 259-264.

MALNATE, E. V. & G. UNDERWOOD. 1989. Australasian natricine snakes of the genus *Trophidonophis*. *Proc. Acad. Sci. Philadelphia* 140: 59-201.

MATSUI, M. 1986. Three new species of *Amolops* from Borneo (Amphibia, Anura, Ranidae). *Copeia* 1986: 625-630.

McCORD, W. P., J. B. IVERSON & BOEADI. 1995. A new batagurid turtle from northern Sulawesi, Indonesia. *Chelonian Conserv. & Biol.* 1 (4): 311-316.

________,_________ , P. Q. SPINKS & H. B. SHAFFER. 2000. A new genus of geoemydid turtle from Asia *Hamadryad* 25(2): 86-90.

________& P. C. H. PRITCHARD. 2002. A review of the softshell turtles of the genus *Chitra*, with the description of new taxa from Myanmar and Indonesia (Java). *Hamadryad* 27(1): 11-56.

MENZIES, J. I. 1982. Systematics of *Platymantis papuensis* and related species of the New Guinean region. *British J. Herpetol.* 6: 241-245.

MERTENS, R. 1927a. Herpetologische Mitteilungen XVII. *Mabuya multifasciata* Kuhl auf Bali. *Senckenbergiana Biologica* 9: 181-182.

________. 1927b. Neue Amphibien und Reptilien aus dem Indo-Australischen Archipel. *Senckenbergiana Biologica* 9: 234-242.

________. 1928. Neue inselrassen von *Cryptoblepharus boutonii* (Desjardin). *Zool. Anz*. 78: 85-86.

________. 1929. Herpetologische Mitteilungen XXV. Zür kenntnis der *Rana microdisca* Boettger und ihrer rassen. *Zool Anz*. 86: 66-68.

________. 1930. Bemerkungen uber *Typhlops florensis*. *Treubia* 11: 294-295.

________. 1934. Die Schlangengattung *Dendrelaphis* in systematischer und zoogeographischer Beziehung. *Arch. Naturgesch. Berlin* 3 (2): 187-204.

________. 1956. Eidechsen (Reptilia) von Karimundjawa Archipel. *Treubia* 23: 253-257.

________. 1961. Was is "*Naja celebensis* Ahl" in Wirklichheit? *Senckenbergiana Biologica* 42: 419-420.

________. 1959. Amphibien und reptilien von Karimundjawa, Bawean und den Kangean inseln. *Treubia* 25: 13-15.

________. 1965. Eine neue Art der Froschgattung *Oreophryne* von der Insel Rintja. *Senckenbergiana Biologica* 46: 189-91.

________. 1967. Die herpetologische Sektion des Natur-Museums und Forschungs-Institutes Senckenberg in Frankfurt a. M. nebst einem Verzeichnis ihrer Typen. *Senckenbergiana Biologica* 48:1-106.

OUWENS, P. A. 1912. On a large *Varanus* species from the island of Komodo. *Bull. Jard. Bot. Buitenzorg*. 2: 1-3.

________. 1914. List of Dutch East Indian chelonians in the Buitenzorg Zoological Museum. *Contributions a la Faune des Indes Neerlandaises* 1: 31-38

PHILIPP, K. M., W. BÖHME & T. ZIEGLER. 1999. The identity of *Varanus indicus*: redefinition and description of a sibling species coexisting at the type locality. *Spixiana* 22: 273-287.

RICHARDS, S. J. & D. T. ISKANDAR. 2000. A new tiny species of frog of the genus *Oreophryne* (Anura, Microhylidae) from the mountains of Irian Jaya, Indonesia. *Raffles Bull. Zool.* 48 (2): 257-262.

________&________ . 2001. A new species of treefrog (Anura, Hylidae, *Litoria*) from the mountains of Irian Jaya, Indonesia. *Alytes* 18: 141-152.

SLOWINSKI, J. B. 1994. A phylogenetic analysis of *Bungarus* (Elapidae) based on morphological characters. *J. Herpetol*. 28: 440-446.

SMITH, L. A. & I. SIDIK. 1998. Description of a new species of *Cylindrophis* (Serpentes: Cylindrophiidae) from Yamdena Island, Tanimbar Archipelago, Indonesia. *Raffles Bull. Zool*. 46: 419-424.

SOMADIKARTA, S., S. KADARSAN & M. DJAJASASMITA. 1964. Primary type specimens of the Museum Zoologicum Bogoriense (I). *Treubia* 26: 179-205.

________,________&________ . 1965. Primary type specimens of the Museum Zoologicum Bogoriense (II). *Treubia* 26: 293-308.

________,________&________ . 1966. Primary type specimens of the Museum Zoologicum Bogoriense (III). *Treubia* 27: 33-44.

________,________&________ . 1968. Primary type specimens of the Museum Zoologicum Bogoriense (IV). *Treubia* 27: 165-173.

________,________&________ . 1970. Primary type specimens of the Museum Zoologicum Bogoriense (V). *Treubia* 27: 417-431.

WESTERMANN, J. H. 1942. Snakes from Bangka and Billiton. *Treubia 18: 611-619.*

ZWEIFEL, R. G. 1969. Frogs of the genus *Platymantis* (Ranidae) in New Guinea, with the description of a new species. *American Mus. Novit*. 2374: 1-19.

________. 2000. Partition of the Australopapuan microhylid frog genus *Sphenophryne* with descriptions of new species. *Bull. American Mus. nat. Hist.* 253: 1-130.

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ETHNOZOOLOGY OF THE *DIBOMINA* (SERPENTES: COLUBRIDAE: *GRAYIA ORNATA*) IN THE MASSIF DU CHAILLU, GABON

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ABSTRACT.– **Interviews with local people and direct observations in seven villages in the Massif du Chaillu, central-southern Gabon, revealed various uses of *Grayia ornata,* including: food consumption; medicinal use for delivery problems, preventive care for newborn babies, treatment of sprains and magic “vaccinations” to improve swimming or fishing abilities. The treatment of bites and various other beliefs, and observations by local people on the natural history of *G. ornata* were also recorded.**

KEY WORDS.– **Colubridae, *Grayia ornata*, Massif du Chaillu, Gabon, ethnozoology, traditional medicine.**

INTRODUCTION

During the course of conservation-oriented herpetological surveys conducted jointly by the Direction de la Faune et de la Chasse (DFC, Libreville), the World Wildlife Fund - Central African Regional Program Office (WWF-CARPO, Libreville) and the Wildlife Conservation Society (WCS) in Gabon during May-November 2001 (see Bauer and Pauwels, 2002; Pauwels and Kamdem Toham, 2002; Pauwels et al., 2002a-c), an impressive amount of ethnoherpetological data were gathered. An assessment of traditional use and importance in local folklore of a target species’ is critical for effective regional protection programmes. Here, we report on the relationships between several ethnic groups of the Massif du Chaillu in central-southern Gabon and the ornate water snake *Grayia ornata* (Barboza du Bocage, 1866), an aquatic colubrid snake which can be found in streams and rivers in forested areas of Cameroon, Central African Republic, Equatorial Guinea, Gabon, Democratic Republic of Congo, Republic of Congo and northern Angola (Chippaux, 1999; Pauwels, 1995).

MATERIALS AND METHODS

We interviewed local people about *Grayia ornata* in seven localities within the Massif du Chaillu. All information was recorded in the presence of voucher specimens to avoid misunderstandings by informants regarding the identity of *G. ornata*. Voucher specimens were deposited at the Institut Royal des Sciences naturelles de Belgique (IRSNB, Brussels) and the Musée Royal de l’Afrique Centrale (MRAC, Tervuren). In each locality, two groups of people were independently interviewed. Care was taken to ensure that no contact between the groups occurred between interview sessions and only consensual data are presented here. The list of localities is given hereafter, with the names of the main informants.

Localities visited- Boussimbi (11°49’16’’E, 1°10’32’’S; Offoué-Onoy Dpt, Ogooué-Lolo Province): Massango village; visited in September and November 2001; informant: Chief Jean-Claude Ndzohou;

- Diangui (11º49’23”E, 1º13’22”S; Offoué-Onoy Dpt, Ogooué-Lolo Province): village whose inhabitants are mainly Massango, with some Nzebi and Pouvi; visited in September and November 2001; informants: Mrs Marianne Moussounda, Chief Maurice Boussengui, Mr Marcel Loundou, Mr Benjamin Moukambi, Mr Théophile Yamouna;

- Dikinga (11°42'43"E, 1°32'45"S; Ogoulou Dpt, Ngounié Province): Babongo pygmy village near Diyanga; visited in July 2001; informant: Mr Patrice Mouélé;

- Diyanga (11°43'45"E, 1°30'56"S; Ogoulou Dpt, Ngounié Province): village whose half is occupied by Babongo pygmies and the other half by Massango; visited in July (7-14), September and November 2001; informants: Mr Antoine Dingoudi and Mr Syriaque Moulengui;

- Iboundji (11°49'24"E, 1°13'14"S; Offoué-Onoy Dpt, Ogooué-Lolo Province): a small town whose inhabitants are mainly Massango; visited in September and November 2001; informants: Mr Louis-Charles (Yala) Makaho-Ipoungat, Lieut. Major Mathurin Oyandji;

- Itsiba (11°58'41"E, 1°46'55"S; Boumi-Louétsi Dpt, Ngounié Province): village whose inhabitants are all Nzebi; visited in July (15-23), September and November 2001; informants: Mr Jean-Marie Ndongo, chief Ferdinand Pandja, and Mr Jean-Euloge Pandja;

- Moudouma (12°03'12"E, 1°44'06"S; Boumi-Louétsi Dpt, Ngounié Province): Nzebi village; visited in September 2001; informant: Chief Daniel Mouélé.

Voucher specimens

IRSNB 16242 (field nr P626): Itsiba, Matombo River, 9 Sept. 2001.

MRAC 2001-102-R-6 (field nr P562): Diyanga, 11 July 2001.

RESULTS

Vernacular names.- In Gabon, *Grayia ornata* has been given a single common name, *dibomina* (plurial: *mabomina*), by the Loumbou, Massango, Pounou and Nzebi people, and is called *mouboyi* by the Pouvi, *otoubou* by the Obamba, and *moléngué* by the Babongo pygmies. The species is called *ghébomina* in Mitsogho at Mokabo (Douya-Onoy Dpt, Ngounié Province) (Yoga, pers. comm.). *Dibomina* is also the name given to this species by the Pounou, Vili and Yombe in the Kouilou Region in the Republic of Congo. South of the southern end of the Massif du Chaillu in the Republic of Congo, *G. ornata* is called *munsioka* by the Badondo, and *bonongo* by the Kongo in the vicinity of Brazzaville (V.M., pers. obs.). Nutritional uses.- All interviewed villagers regarded *G. ornata* as an excellent food, especially during the dry season "when it is the fattest" (particularly around July). The smallest specimens are usually disregarded by the adults, but are always killed and eaten by the children. Specific hunting outings for this snake are never organised, but efforts are made to capture all specimens that are casually encountered. Most specimens are actually found trapped in fishing nets or hoop nets (*bidoubou* in Nzebi), to which these piscivorous snakes are attracted when they contain a number of entrapped fishes. Specimens are also encountered and killed by women when they explore holes in the river banks with their hands in search of silurids. This snake is thus also called *nioga baguetu* ('women's snake') by the Pounou in the Moabi area (Douigni Dpt, Nyanga Province) (Koumba, Makaya, pers. comm., June 2002).

The snakes are prepared as follows: after being killed with a stick or a machete, the snake is beheaded and its body placed on a fire in order to burn off its scales. The snake is then eviscerated, the digestive tract discarded, and the body cut into sections a few centimeters in length. These are placed in a bush leaf ("*feuille de brousse*", i.e., any large leaf found in the forest, often Marantaceae) with salt, chopped onions and chillis. The leaf is closed to form a bag ("*paquet*") which is then placed in a cooking-pot with a small amount of water, or placed directly on the embers. In the Congolese part of the Massif du Chaillu, as well as in the Brazzaville area, the meat of *G. ornata* is hung for a few days before being prepared in this way, in order to make it more tasty (V.M., pers. obs.).

Natural history.- All our informants refuted Chippaux's (1999: 83) report that *G. ornata* can hunt from branches overhanging streams, although these snakes were considered to be excellent climbers and liked to bask on branches overhanging water, sometimes two to three meters high. When alerted, they fall into the water (as already reported by Perret and Mertens, 1957: 593) and quickly disappear into holes in the banks. They are said to be solitary and to hunt underwater at night, during which they actively explore every nook and crevice for prey items. It is believed in the Lunda area of north-eastern Angola that *G. ornata* live in pairs (Laurent, 1964: 102), but this is not held in our study area. The stomach contents are often revealed when the viscera are removed during preparation for food. The most common prey noted by informants were fish (especially silurids), but frogs, shrimps and small rodents were also sometimes encountered in the stomachs. At Boussimbi, Diangui and Iboundji we were told that fish are strongly attracted by the smell of *dibomina*, and so the fisherwomen search the places where this snake lives as they think there will be many fishes there. Perhaps in support of this belief, one of us (V.M.) observed during the day in October 1991 cyprinid fishes (genus *Barbus* Cuvier and Cloquet, 1816) rushing and feeding on excrement defecated by *G. ornata* in Loeme River, Kouilou Region, Republic of Congo. Itsiba inhabitants reported that the two species of otters they know (a large species called *loubangha* and a small one called *ngoundou*) often destroy hoop nets in order to eat the entrapped fish and *dibomina*. The same observation was reported in Moudouma, where these otters are called *nioundou* and *nyongo*. These observations probably involve the large Congo clawless otter (*Aonyx congica* Lönnberg, 1910) and the small Spotted-necked Otter (*Lutra maculicollis* Lichtenstein, 1835), to date the only two recorded otter species in Gabon (Kingdon, 1997). It was also reported that when the *dibomina* are already drowned in the nets, crabs sometimes eat them. Several fishermen of Diangui told us that they sometimes find *dibomina* in the stomachs of the *ngandou* (the Massango name for *Crocodylus cataphractus* Cuvier, 1824) and *moungoundou* (*Osteolaemus tetraspis* Cope, 1861) caught in the nearby Onoy River.

Medicinal uses.- In Itsiba and Moudouma, *G. ornata* comprises the basic component of a remedy for delivery problems during childbirth. When a *dibomina* is killed and beheaded, the head is placed in the smokehouse ("*fumoir*") where, once smoked, it is carefully kept in a bush leaf and usually hung by string from the roof in order to protect it from rats and ants. If, after a woman's water has broken, she remains in labour for too long the medicine man ("*charlatan*") employs the following procedure. (Although for instance in France or Belgium, the word *charlatan* is the equivalent of the English word quack (or bogus doctor), in Gabonese French this word is not pejorative and corresponds to the word *tradipraticien*). At Itsiba, the snake's head is removed from the smokehouse and pierced with a metal needle. The impaled head is put in a bush leaf folded to form a funnel. Water poured through the funnel is drunk by the mother. At Moudouma, the dried head is simply put in a cup of water for about ten minutes, and then the water is drunk. The head is then returned to the smokehouse for storage and future use. The folk logic behind this remedy is that, as the *dibomina* is famous for letting itself fall into the water head first when disturbed, the head of the baby is supposed to hurry to get back to the water the mother lost. At Diangui, as well as in Boussimbi and Iboundji, the use of *G. ornata* for delivery problems is unknown. However, it is used in another medicinal application. As a preventive measure a few days after a baby is born, some people take the viscera of *dibomina* (first dried in the smokehouse) and use it as a bangle around the ankle of the baby. This bangle is believed to suck out sickness: "like the *dibomina* can go out of the water, the sicknesses can go out of the body". We were also informed in Diangui that the fat of *dibomina* (as well as that of other snake species, mainly *Python sebae* Gmelin, 1788), collected in the course of cooking can be used to treat sprains by direct application on the skin. This latter use is also current by the Pounou at least in the area of Mouila (Bignoumba, pers. comm., Oct. 2001). In southern Republic of Congo, the fat of *G. ornata* is applied on the skin in order to facilitate the removing of a thorn or a splinter (V.M., pers. obs.).Magic uses.- At Boussimbi, Diangui and Iboundji, *dibomina* is used by fishermen for two kinds of "vaccinations", one securing excellence in swimming ability, the other securing high fishing success. The head of a *dibomina* is burnt and its ashes sprinkled on incisions made with a razor blade on the wrists for "fishing vaccination", and on the wrists and the upper parts of the feet for "swimming vaccination". Vaccinated people are believed to never drown and/or catch more fish than unvaccinated fishermen. In Diangui, some Massango use the *dibomina* as a totem. This totem is hereditary and is transmitted to a chosen member of the next generation through the father, the mother, the grandmother or the maternal uncle. The transmission is accompanied by the divulgence of a secret ritual to the designated heir. This consists in taking the head and heart of a *dibomina* killed the same day, mixing it raw with the fresh leaves of a small shrub called *ikalou* in Massango, and putting this mixture in a black loincloth. (The word *ikalou* also means acrobatics, due to the fact that this plant is also used in magic to reverse undesired situations). This small bag is deposited in the house beneath the place where the nets are stored and in contact with the nets. The smell produced by the rotting pieces of *dibomina* mixed with *ikalou* is supposed to be very attractive for the fish. Being impregnated with this smell the nets are believed to be more efficient. The fishermen also put this small black bag into their gamebag when they go to fish. If they use a net they rub the black bag against the net before putting it into the water; if they use a hook they simply keep the black bag in their hand. It is forbidden for a person whose totem is the *dibomina* to eat this snake species.Bite cases and treatment.- *Grayia ornata* is reputedly non-aggressive in all villages visited. It bites so rarely that in Diyanga a special meaning is even attributed to a bite case: the bitten person is accused of incest with a sibling of the opposite sex. In all local villages, although it is known that the bite is not life-threatening, all cases have to be treated and the same remedy is applied everywhere. It consists of taking a handful of rotten wood found in the river, chewing it and spitting it at the place on the body where one has been bitten. By the Nzebi of Itsiba, being bitten by the *dibomina* is not regarded as an unfortunate event. On the contrary, it is believed that the bitten person will be protected for life against bites by other snakes, for *G. ornata* is regarded as the "grandfather of all the other snakes". Indeed, "snakes feel that [if] a person has already been bitten by the *dibomina* – why should they bite somebody who has already been bitten by their grandfather?" and "if today all snake species are able to swim, it is thanks to their grandfather *dibomina* which was the first to do it." A Massango proverb, current in the area of Iboundji, says "*Gnogh a se fou ghou mambe dibomina reghile*" (*gnogh* = snake; *a se* = not; *fou* = to die; *ghou* = in; *mambe* = water; *reghile* = to precede), and literally means "Snakes can not die in the water, since the *dibomina* preceded them there". It refers to the fact that one must always take notice of the experience of the elders. An old man of Diangui explained to us that when snakes enter the water they have to consult the *dibomina* in order to know the life in the water and its dangers; "*de même tous les hommes qui vont en forêt devraient consulter les Pygmées Babongo qui étaient là les premiers; le dibomina est le pygmée de l'eau*" ["in the same way all men going in the forest should consult the pygmies who were there the first; the *dibomina* is the pygmy of the water"].

DISCUSSION

Grayia ornata shows two distinct colour patterns: the common crossbarred colour phase and the rare longitudinally striped phase, the latter phase having not been encountered in the course of our study. Among others, Spawls and Branch (1995: 56) have noted the extreme similarity between the crossbarred colour phase of *G. ornata* and the sympatric aquatic cobra *Boulengerina annulata* (Buchholz and Peters, 1876). Since we did not collect the latter species in the investigated localities, and were therefore unable to show vouchers to the locals, the possibility of confusion between the two species cannot be ruled out. It is also possible that the two species receive distinct names among the Babongo, Massango, and Nzebi ethnic groups. At Doumvou (Basse-Banio Dpt, Nyanga Province) the Loumbou villagers give *B. annulata* and *G.*

ornata distinct names (V.M., pers. obs., July 2001). Knoepffler (1966: 9) noted that both species were systematically confused by local people in Ogooué-Ivindo and Woleu Ntem. At Boussimbi, Diangui and Iboundji, the *dibomina* is distinguished from the *nguéné*, a species we unfortunately did not collect at those localities, but which seems likely to be *B. annulata*. In those places it is said that the *nguéné* (*nguénié* in Pouvi) is highly venomous, and a belief exists concerning bite cases: when one has been bitten, one should stay at the same place without moving as the snake will come and bite a second time; it is then still forbidden to move as the snake will come a third time and bite again, but this time in order to get its venom back since it should think that it has needlessly bitten a piece of deadwood. We were told the subtle differences between the *dibomina* and the *nguéné*. 1.) a head not distinct from the neck versus a diamond-shaped head, 2) black rings interrupted on the belly versus rings completely encircling the body, 3) black rings indistinct on the tail versus distinct tail rings, 4) numerous small squares on the head versus only five squares, and 5) remaining slim as adults versus growing thick-bodied. Syntopy of both species does not seem to occur very often. *B. annulata* seems to be found mainly in large and medium rivers (Trape and Roux-Estève, 1995: 43), although Knoepffler (1965: 244) recorded that the species is found in forest stream bank holes where the silurids, frogs and crabs stay. This latter place is also typical for *G. ornata*, according to the villagers and our own observations, although large rivers are also sometimes occupied by *G. ornata*. For instance we examined a large beheaded female which was sold at Kango (Komo Dpt, Estuaire Province) on 30 Oct. 2001; it had been caught by net in the Komo River and the fisherman said that it was very common in this large river.

Since all the *dibomina* brought by villagers to us were *G. ornata*, all the food, medicinal and magic uses cited above concern this species. Where *G. ornata* and *B. annulata* are confused in some of the visited localities, observations of locals on natural history could be based on both species. Pauwels et al. (2000) made a compilation of the known prey of *G. ornata*, which appears to be strictly piscivorous. *B. annulata* is also known to feed only on fish (Chippaux, 1999: 204; Spawls and Branch, 1995: 56). Records of prey such as frogs, shrimps and small rodents have been documented for neither species. It would be very interesting to verify that one or both can indeed feed on such a wide variety of prey types. The closest species to *G. ornata*, *G. smithii*, is known to prey on frogs and fishes (Pauwels et al., 2000).

CONCLUSION

The present report highlights the significance of *Grayia ornata* in local food habits, traditional medicine and folklore of the Babongo, Massango, and Nzebi ethnic groups in the Massif du Chaillu. Interesting observations by locals on the natural history of the *dibomina* suggest a complex involvement of this snake in the trophic chain as predator and as prey, and should be confirmed by future field studies. The distribution of *G. ornata* is closely associated with that of the Central African rain forest. Protection of this rain forest will help not only to save this snake and many other species, but also to preserve those unique, most often neglected and unrecorded, ethnozoological links which are an integral part of the culture and traditions of the forest peoples.

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LITERATURE CITED

BAUER, A. M. & O. S. G. Pauwels. 2002. A new forest-dwelling *Hemidactylus* from Gabon, West Africa (Squamata: Gekkonidae). *African J. Herpet.* (in press).

CHIPPAUX, J.-P. 1999. Les serpents d'Afrique occidentale et centrale. Editions de l'IRD, Collection Faune et Flore tropicales 35, Paris. 278 pp.

KINGDON, J. 1997. The Kingdon field guide to African mammals. Natural World, Academic Press, San Diego: i-xviii + 1-464 pp + map.

KNOEPFFLER, L.-P. 1965. Le comportement fouisseur de *Conraua crassipes* (Amphibien anoure) et son mode de chasse. *Biologia Gabonica* 1 (3): 239-245.

________. 1966. Faune du Gabon (Amphibiens et Reptiles). I. Ophidiens de l'Ogooué-Ivindo et du Woleu N'tem. *Biologia Gabonica* 2 (1): 3-23.

LAURENT, R. F. 1964. Reptiles et Amphibiens de l'Angola (Troisième contribution). *Publ. Cult. Companhia de Diamantes de Angola* 67: 1-165.

PAUWELS, O. S. G 1995. Etude biométrique des couleuvres aquatiques africaines du genre *Grayia* Günther (Serpentes: Colubridae). Master Degree Thesis in Zoology, Faculty of Sciences, Université Libre de Bruxelles, Brussels. 146 pp.

________& A. KAMDEM TOHAM. 2002. *Pseudohaje goldii* (Boulenger, 1895). Goldie's Tree Cobra. Habitat. *African Herp News* (in press).

________,________ & C. CHIMSUNCHART. 2002. Recherches sur l'herpétofaune des Monts de Cristal, Gabon. *Bull. l'Institut Royal Sci. nat. Belgique*, 72 (in press).

________,________&________ . 2002. Recherches sur l'herpétofaune du Massif du Chaillu, Gabon. *Bull. l'Institut Royal des Sci. nat. Belgique*, 72 (in press).

________,________ & G. LENGLET. 2000. *Grayia ornata* (Bocage, 1866), Ornate Water Snake: Diet. *African Herp News*, 31: 9-10.

________,________ , J. MAYOMBO & R. MIKALA-MUSSAVU. 2002. Geographical distribution. *Pelusios marani* Bour, 2000. Maran's mud turtle. *African Herp News* (in press).

________, G. LENGLET, J. F. TRAPE & A. DUBOIS. 2000. *Grayia smithii* (Leach, 1818), Smith's African water snake: diet. *African Herp News*, 31: 7-9.

PERRET, J.-L. & R. MERTENS. 1957. Etude d'une collection herpétologique faite au Cameroun de 1952 à 1955. *Bull. I.F.A.N.*, 19, ser. A, 2: 548-601.

SPAWLS, S. & B. BRANCH. 1995. The dangerous snakes of Africa. Natural history. species directory. venoms and snakebite. Blandford, London: 192 pp.

TRAPE, J.F. & R. ROUX-ESTÈVE. 1995. Les Serpents du Congo: Liste commentée et clé de détermination. *J. African Zool.* 109 (1): 31-50.

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A trap designed for capturing *Python reticulatus* (Serpentes: Pythonidae) in the wild

(with one text-figure)

Until recently, field studies of boids and pythons have been rare even though they have wide geographic distributions. For some species, this may be due in part to the inaccessibility of their habitats. For example, *Python reticulatus* favours densely vegetated tropical habitats characterised by landscapes replete with bodies of water.

Life history studies of large snakes, *Eunectes murinus*, *Python reticulatus*, *P. molurus* and *P. sebae*, are especially uncommon (for recent publications, see Bhupathy and Vijayan, 1988; Starin and Burghardt, 1992; Strimple, 1993; Calle et al., 1994; Kemper, 1996; Strussmann, 1997; Erdelen et al., 1997; Shine et al., 1998; Auliya and Abel, 2000).

Methods for trapping snakes have been reported by Fitch (1951) and Rodda et al. (1992; 1999). Fitch described a trap consisting of a wire-mesh cylinder with funnel entrances, at each end. Traps for snakes and larger lizards were at least 38 cm in length and 15 cm in diameter. The snakes captured comprised colubrids and pit vipers. Rodda et al. (1982) trapped the arboreal snake *Boiga irregularis* with funnel traps, some of which were baited with live geckos.

In South Kalimantan, trapping methods for *Python reticulatus* have involved nets stretched over slow-flowing creeks (Saputra, pers. comm., 1996). Other python traps used in swamp forests have been constructed with a snare mechanism. These are baited with week-old carcasses of monitor lizards, snakes and birds, but most commonly with monkeys as baits (Chairuddin et al., 1990). With these traps, snakes are killed imme-

FIGURE 1: A trap baited with live chicken to capture *Python reticulatus*. The funnel entrance (20 x 30 cm, length up to 40 cm), which enable the python to enter the trap, but not permit its escape, is visible.

TABLE 1: Captures of *Python reticulatus* related to the number of traps in West Kalimantan in 1996. The number of traps is proportionate to trap sites. SVL = snout-vent length; TOL = total length; measurements in cm. * = specimens recaptured.

Month	JULY	AUG	SEPT	OCT	NOV	DEC
No. traps	2	2	4	5	6	7
No. captures	1	3	5	4	4	2
TOL /SVL	238/ 204	226/199 252/209 264/228	215/185 258/228* 299/265 380/326 277/242	249/214* 428/377 306/267 245/211	293/260 307/274* 239/211 346/302	344/296 256/221

diately. In northern Sumatra, professional hunters construct various snare traps which are positioned in the middle of a narrow creek, forcing the python to swim through a fixed noose.

In the following section, the author refers to his experiences gained in a field study conducted during 1996/1997 in Indonesia. The purpose of the project was to assess the impact of widespread harvesting on local populations of the water monitor (*Varanus salvator*), the reticulated python (*Python reticulatus*), and the blood python (*P. curtus*). Sumatra and Kalimantan are the main source for reptile skins in Indonesia, especially skins of the three taxa mentioned. Densities were estimated on the basis of the mark-recapture method.

The author's study site in West Kalimantan was a river-fed swamp forest. The approximately 6.5 km^2 study area is anthropogically influenced by the existence of scattered harvest plantations (e.g., *Hevea brasiliensis* and *Musa* spp.), by local fishermen checking their nets on the main river, and by the river itself being used as a thoroughfare by the villagers. Along the river dense, isolated, and dark microhabitats are found.

Preliminary trials were conducted in order to determine the accessibility of these reptiles in the dense tropical forest. Initially, transects with fishing-nets were constructed in ponds with the upper lines of the nets set at least 30 cm above the water level, and anchoring weights attached to the lower edges of the nets. The netting had a mesh size of approximately 4 cm. However, this net capture method did have serious problems, which included rapidly rising water levels, driftwood accumulation, occasional theft of the nets, and otters (*Lutra* spp.) tearing up the nets to seize captured fish. In addition, other species of snakes were caught including *Acrochordus javanicus*, *Boiga dendrophila, Elaphe flavolineata, Homalopsis buccata* and *Ophiophagus hannah.* Based on the python's presence of a infrared sensory system used in conjunction with olfaction, another method of capturing reticulated pythons was developed.

Six box traps consisting of wire netting were constructed. Sizes ranged from 1.46 - 1.90 m in length, 0.80 - 1.50 m in width, and 0.46 - 0.65 m in height. Funnel entrances constructed of flexible sliced rattan canes were positioned on all four sides (Fig. 1). A lid was built into the trap roof in order to be able to grasp and remove the snake. The entire trap was set on a bamboo raft so that it can easily adapt to the floods of water originating from the northern mountain regions (Gunung Lawit, 1,767 m), where annual rainfall of 2,000 - 4,000 mm are recorded (MacKinnon et al., 1996). Traps were then baited with live "village chickens" (chickens bred commercially could not withstand the hot moist microclimate) with a feeding and drinking corner inside (Fig. 1).The trap sites chosen were located in dark, dense forest swamps and pools. The traps were checked daily. After examination of any snakes captured (e.g., size, weight, scalation), the animals were released adjacent to the trap sites. In total, 19 pythons were captured in these traps, including three recaptures, over a period of six months (see Table 1). The trap size did not influence the capturing rate**.** Microclimate changes (heavy rainfalls in December) might have affected capture rates. Aside from seven *Varanus salvator* captured with this trap, no other species were recorded.

Near the end of the study period, the structural integrity of the funnel entrances began to weaken, so that more than one python managed to escape, as evinced by regurgitated chickens. Viverrids (e.g., *Arctogalida trivirgata*) were also able to get hold of the chickens more easily due to entrance degradation. The weathered funnel entrances, thus, were either closed or replaced by a funnel made of wire netting (Riquier, 1998). In summary, this large floating trap, baited with live chicken, has proven to be effective in capturing wild *Python reticulatus*.

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LITERATURE CITED

AULIYA, M. & F. ABEL 2000. Zur Taxonomie, geographischen Verbreitung und Nahrungsökologie des Netzpythons (*Python reticulatus*). Teil 2: Nahrungsökologie, Danksagung und Literatur. *Herpetofauna* 22: 19-28.

BHUPATHY, S. & V. S. VIJAYAN. 1988. Status, distribution and general ecology of the Indian python *Python molurus molurus* Linn. in Keoladeo National Park, Bharatpur, Rajasthan. *J. Bombay nat. Hist. Soc*. 86: 381-387.

CALLE, P. P., J. RIVAS, M. MUÑOZ, J. THORBJARNARSON, E. S. DIERENFELD, W. HOLMSTROM, W. E. BRASELTON & W. B. KARESH. 1994. Health assessment of free-ranging anacondas (*Eunectes murinus*) in Venezuela. *J. Zoo. & Wildl. Med*. 25: 53-62.

CHAIRUDDIN, RUSMAYADI & H. DJASMANI. 1990. Populasi dan perdagangan kulit ular python di Kalimantan Selatan - A report to WCMC and CITES. Universitas Lambung Mangkurat, Banjarbaru. 33 pp.

ERDELEN, W., M. RIQUIER & F. ABEL. 1997. Status, population biology and conservation of the water monitor (*Varanus salvator*), the reticulated python (*Python reticulatus*) and the blood python (*Python curtus*) in Sumatra and Kalimantan, Indonesia. Unpublished Project Report - Federal Agency for Nature Conservation, Bonn, Germany. 158 pp.

FITCH, H. S. 1951. A simplified type of funnel trap for reptiles. *Herpetologica* 2: 77-80.

KEMPER, S. 1996. "Slogging through the haunts of the anaconda". *Smithsonian Features* 6: 43-50.

MACKINNON, K., G. HATTA, H. HALIM, & A. MANGALIK. 1996. The ecology of Kalimantan - The Ecology of Indonesia Series, Vol. III. Periplus Ed. (HK) Ltd., Singapore. 802 pp.

RIQUIER, M. A. 1998. Status, population biology and conservation of the water monitor (*Varanus salvator*), the reticulated python (*Python reticulatus*) and the blood python (*Python curtus*) in Sumatra and Kalimantan, Indonesia, Project Report Kalimantan. *Mertensiella* 9: 119-129.

RODDA, G. H., R. J. RONDEAU, T. H. FRITTS & O. E. MAUGHAN. 1992. Trapping the arboreal snake *Boiga irregularis*. *Amphibia - Reptilia* 13: 47-56.

________, R. H. FRITTS, C. S. CLARK, S. W. GOTTE & D. CHISZAR. 1999. A state-of-the-art trap for the brown treesnake. *In*: Problem snake management. The Habu and the brown treesnake. pp: 268-305. G. H. Rodda, Y.

Sawai, D. Chiszar & H. Tanaka (Eds). Comstock Publishing Associates/Cornell University Press, Ithaca and London.

SHINE, R., P. S. HARLOW, J. S. KEOGH & BOEADI 1998. The allometry of life-history traits: insights from a study of giant snakes (*Python reticulatus*). *J. Zool*. 244: 405-414.

STARIN, E. D. & G. M. BURGHARDT. 1992. African rock pythons (*Python sebae*) in the Gambia: observations on natural history and interactions with primates. *The Snake*. 24: 50-62.

STRIMPLE, P. D. 1993. Overview of the natural history of the green anaconda (*Eunectes murinus*). *Herp. Nat. Hist*. 1**:** 25-35.

STRUSSMANN, C. 1997. Hábitos alimentares da sucuri-amarela, *Eunectes notaeus* cope, 1862, no Pantanal Matogrossense. *Biociências*, *Porto Alegre* 5**:** 35-52.

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First report of *Micrixalus nudis* (Amphibia: Ranidae) from Karnataka, India

The Western Ghats is one of the "hotspots" of biological diversity with high endemicity (Myers, et. al., 2000). About 123 species of amphibians (60% of the total species count for India) are found in the Western Ghats of which 93 species are endemic (Daniels, 1992; 1997a; Molur and Walker, 1998). During the course of amphibian sampling as a part of ongoing research project to assess of lesser known and functionally important taxa of Rajiv Gandhi (Nagarahole) National Park (11 45' -12 15' N; 76 5' - 76 25' E), Karnataka State, south-western India, I encountered *Micrixalus nudis* on 21 April 2001 near the Nagarahole stream, flowing through moist deciduous forest, close to the forest dormitory. The species was identified using Pillai (1978) and Daniels (1997b). The specimen collected measures 15 mm from snout to vent; its dorsum brownish with chocolate band from eye to shoulder and dark bands along the sides of the body; venter white, throat and the breast is mottled with brown and white; limbs with dark cross bands; tympanum indistinct and fingers and toes have enlarged discs; toe webbing partial. The specimen is currently deposited at the ATREE Museum (ATREE A06).

Micrixalus nudis frequents small streams with shallow bottom in wet evergreen and moist deciduous forest between 200 to 1,000 m elevations (Pillai, 1978; Inger et. al., 1982). It is one of the endemic and threatened frogs found in the Western Ghats (Anon., 1998) even though it is widely distributed (Inger, et. al., 1982). The main threats to this species are habitat loss and fragmentation (Vasudevan, et. al., 2001).

Micrixalus nudis was described by Pillai (1978) from Wynad. It has been reported from five localities from the southern Western Ghats-Silent Valley, Siruvani, Kottagiri, (Pillai, 1978, 1989) and Ponmudi (Inger, 1982), in Kerala State and Kalakkad in Tamil Nadu State (K. Vasudevan pers. comm.). This is the first report from Karnataka. This report extends the range of *M. nudis* 60 km north-west of Chedleth, the type locality of this species.

I thank Karthikeyan Vasudevan of Wildlife Institute of India for identifying the specimen collected. I also thank K. V. Gururaja, T. Ganesh and Soubadra Devy for suggestions and comments. This work was funded by the Karnataka Forest Department. This is the publication number 01 from the project "Assessment of lesser known and functionally important taxa of Rajiv Gandhi (Nagarhole) National Park".

LITERATURE CITED

ANONYMOUS, 1997. Amphibian CAMP handbook. Zoo Outreach Organization, Coimbatore. 84 pp.

Sawai, D. Chiszar & H. Tanaka (Eds). Comstock Publishing Associates/Cornell University Press, Ithaca and London.

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LITERATURE CITED

ANONYMOUS, 1997. Amphibian CAMP handbook. Zoo Outreach Organization, Coimbatore. 84 pp.

DANIELS, R. J. R. 1992. Geographical distribution patterns of amphibians in the Western Ghats, India. *J. Biogeogr*. 19: 521-529

________. 1997a. A field guide to the frogs and toads of the Western Ghats, India: Part I. *Cobra* 27:1-25.

________. 1997b. A field guide to the frogs and toads of the Western Ghats, India: Part II. *Cobra* 28:1-24.

INGER, R. F., H. B. SHAFFER, M. KOSHY & R. BAKDE. 1984. A report on a collection of amphibians and reptiles from the Ponnmudi, Kerala, south India. *J. Bombay nat. Hist. Soc.* 81: 406-427.

MOLUR, S. & S. WALKER. 1998. Conservation assessment of the herpetofauna of India: an overview. *Hamadryad* 23: 169-178

MYERS, N., R. A. MITTERMEIER, C. A. MITTERMEIER, G. A. B. DA FONSECA & J. KENT. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

PILLAI, R. S. 1978. A new frog of the genus *Micrixalus* (Boulenger) from Wynad, South India. *Proc. Indian Acad. Sci. (Anim. Sci)* 87B: 173-177.

VASUDEVAN, K., A. KUMAR & R. CHELLAM. 2001. Structure and composition of rainforest floor amphibian communities in Kalakad-Mundhanthurai Tiger Reserve. *Curr. Sci.* 80: 406-412.

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Record of *Kaloula pulchra* (Gray, 1831) (Anura: Microhylidae) from Cherrapunjee, East Khasi Hills District, Meghalaya, north-eastern India

(with one text figure)

Kaloula pulchra was first reported from India by Romer (1949) from Nagaland State, north-eastern India. It was subsequently reported from Tinsukia and Cachar Districts, Assam State, north-eastern India (Dutta, 1997; Dey et al., 2000). This note reports the occurrence of *Kaloula pulchra* from a forest in the East Khasi Hills District, Meghalaya State, north-eastern India, located 5 km south of Cherrapunjee.

Three adults (two males and one female) of *Kaloula pulchra* were collected from a dense forest area near a pond located at Cherrapunjee (25° 5’N; 91° 43’E; ca. 950 m above msl). The climate

TABLE 1: Morphometric measurements (in mm) of adult *Kaloula pulchra* collected from East Khasi Hills, Meghalaya State, north-eastern India.

	adult female	adult male
Snout-vent length	58	55
Head length	12	12
Head width	18.5	18
Snout length	6	6
Eye diameter	5	5
Interorbital width	10	8
Internarial width	4	4
Length of forelimb	44	44
Length of first finger	10	10
Length of second finger	12	12
Length of third finger	19	19
Length of fourth finger	15	15
Length of hindlimb	62	66
Length of first toe	9	9
Length of second toe	11	11
Length of third toe	16	16
Length of fourth toe	23	25
Length of fifth toe	14	14
Length of tibia	21	25

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________. 1997a. A field guide to the frogs and toads of the Western Ghats, India: Part I. *Cobra* 27:1-25.

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Length of fourth finger	15	15
Length of hindlimb	62	66
Length of first toe	9	9
Length of second toe	11	11
Length of third toe	16	16
Length of fourth toe	23	25
Length of fifth toe	14	14
Length of tibia	21	25

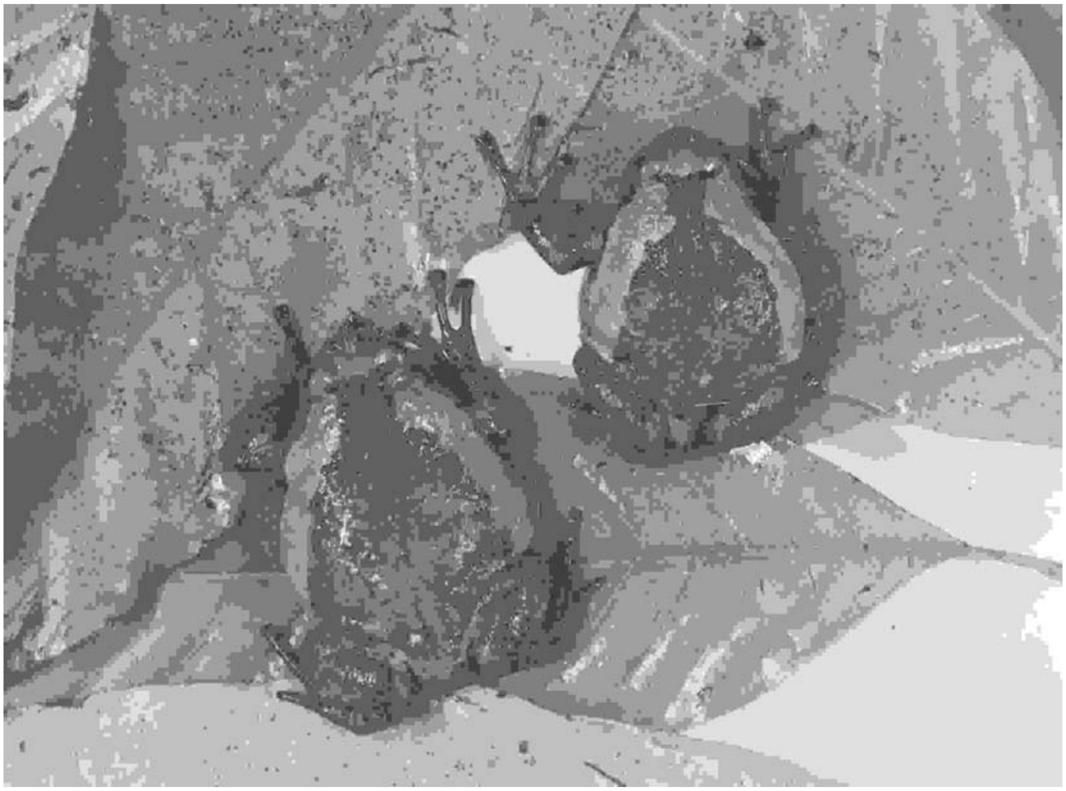

FIGURE 1: *Kaloula pulchra* from East Khasi Hills, Meghalaya State, north-eastern India.

of the area is highly variable: summer is hot and wet, winter is cold and dry. The average air and water temperatures during the time of collection in the month of May were 27°C and 17°C, respectively. One of the specimens was deposited with Zoological Survey of India, Eastern Regional Station, Shillong (ZSI V/A/ERS/ZSI/322). Measurements were made with vernier calliper and mm ruler (Table 1).

All three specimens show a dark brown dorsum with a bright orange patch extending from tip of snout between eyes on either side of body up to trunk; ventral surface uniformly coloured except throat region, which is darker and minutely granulated; venter with small white spots; skin smooth, with small tubercles; head wider than long, snout obtusely pointed, nostrils closer to tip of snout than to eyes, tympanum indistinct; interorbital space greater than internarial width. In general, the body is balloon shaped (Fig. 1).

Forelimbs slender, fingers free, tips of fingers dilated. First finger shorter than second, third finger longest, longer than snout, subarticular tubercles small and moderately prominent.Hindlimbs long, tibiotarsal articulation reaching shoulder, heels do not overlap when hindlimbs folded at right angle to the body. Tibia three and a half times as long as broad, toes with rudimentary webbing, tips of toes dilated; subarticular tubercles small; both inner and outer metatarsal tubercles present.

The authors are thankful to S. K Chanda, Zoological Survey of India, Kolkata, for his help in identification of the specimen as well as for his constructive comments on the manuscript.

LITERATURE CITED

DEY, M & A. GUPTA. 2000. Record of *Kaloula pulchra* from Cachar district, Assam, north-eastern India. *Hamadryad* 25(2): 214-215.

DUTTA, S. K. 1997. Amphibians of India and Sri Lanka (checklist and bibliography). Odyssey Publishing House, Bhubaneswar. xiii + 342 + xxii pp.

ROMER, J. D. 1949. Herpetological observations in Assam and Bengal (1944). *J. Bombay nat. Hist. Soc*. 48: 376-387.

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Hamadryad Vol. 27, No. 1, pp. 148 – 149, 2002

First report of the herpetofauna of Pulau Pemanggil, Johor, West Malaysia

Pulau Pemanggil is a small island (5 x 2 km), lying off the south-eastern coast of peninsular Malaysia, between Pulau Aur and Pulau Tioman in the Seibuat Archipelago at the southern end of the South China Sea. The steep, interior of the island consists of large granitic boulder outcrops, which form numerous caves. The island's coastline is rocky and only a few isolated sandy beaches exist. There is one small, freshwater stream on the north-eastern side of the island and only a small patch of primary forest exists on the island's summit, while the rest of the island consists of highly degraded secondary forest.

The herpetofauna of the adjacent islands, Aur and Tioman have been well documented (Grismer et al., 2001 a, b; Grismer et al. 2002; Hein et al. 2001; Hendrickson, 1966 a,b; Lim and Lim, 1999). However, only an unpublished report (Day, 1990) exists for Pulau Pemanggil which lists the frog, *Limnonectes blythii* and the gecko, *Gekko monarchus* as being present.

On 27 March 2002, we visited Pulau Pemangill to observe its herpetofauna. Observations were made from 0900-0100 h behind Kampung (Kg.) Pasar Sempit and along the coast 5 km north and south of Kg. Pasar Sempit from 0300-0500 h. Additional observations were made along the north-eastern side of the island along the freshwater stream from 0500-0630 h, and during the evening from 0930-1300 h behind Kg. Pasar Sempit. All observations were made in highly degraded secondary forest. Representatives of each species observed were photographed and released. Voucher photographs are deposited in the 35 mm colour transparency collection of La Sierra University Collection (LSUPC).

Anura (Frogs)

Limnonectes blythii.- This species was reported by Day (1990). Locals report seeing frogs in the freshwater stream on the northern side of the island at night.

Squamata (lizards)

Bronchocela cristatella (LSUPC L5945).- One individual was observed in a cleared coconut plantation behind Kg. Pasar Sempit on top of a small coconut tree, 1 m above the ground. Another was observed on the northern side of the island near the freshwater stream on top of an isolated bush in the middle of a field of tall grass.

Cnemaspis sp. (LSUPC L7495-7505).- Lizards were observed in nearly all caves explored. A few individuals were seen during the day, but in general, activity was greatest at night. Individuals were never found in caves with the larger *Gekko monarchus*. This population has unique features not seen in any other species of *Cnemaspis* and its description as a new species will be investigated further.

Gekko monarchus (LSUPC L7487-7481).- Many individuals were seen during the day and night on boulders in and about the caves. Thousands of egg scars were found on the cave ceilings. Several developing clutches were also observed. This species was also observed in the cracks of large boulders along the beach.

Lygosoma bowringii (LSUPC L4023).- One individual was observed in the leaf litter of a banana grove behind Kg. Pasar Sempit, running across the ground into the base of a small palm tree.

Mabuya multifasciata (LSUPC L3079).- Many large adults were observed on the forest floor in the secondary forest, and also near the town. Most of the larger individuals had reddish flanks.

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Sphenomorphus scotophilus (LSUPC L3301).- This skink was observed in and around the caves near the crest of the island and on rocks at the entrances of the caves.

Varanus salvator (LSUPC L7069).- One individual was observed in brackish water scavenging in garbage behind Kg. Pasar Sempit. Another was seen on the large boulders in the intertidal zone. Tracks were also observed on the beach near intertidal rocks and housing.

Unidentified snake.- A portion of the vertebral column of a colubrid snake was found 4 km north of Kg. Pasar Sempit.

We are most grateful to Sahir bin Othman of the Department of Wildlife, Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) for permission to conduct field work in the Seributat Archipelago. This research was supported in part by a Rychman Research grant awarded to Timothy M. Youmans, Jesse L. Grismer, and Ricardo Escobar III.

LITERATURE CITED

DAY, M., 1900. Zoological research. *In*: University of Bristol Tioman Archipelago Expedition, Peninsular Malaysia, 1988, Final report. pp: 25-43. M. Day & T. Mowbray (Eds). Unpublished Report.

GRISMER, L. L., N. S. YAAKOB, L.-B. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAS, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, J. TRUJILLO & H. KAISER. 2001a. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

_____, _____, _____, _____, _____, ______, ______, _____, _____, _____, _____, _____, _____, ______, ______, _____, _____, ______ & _____. 2001b. Report on the herpetofauna of Pulau Tulai, West Malaysia. *Hamadryad* 26(2): 369-371.

_____, J. A. McGUIRE, R. A. SOSA & H. KAISER.2002. Revised checklist and comments on the terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Herpetol. Rev*. 33(1): 26-29.

HIEN, P., W. GROSSMANN & C. SCHAFER. 2001. Beitrag zur Kenntnis der landbewohnenden Reptilienfauna von Pulau Tioman, West-Malaysia. *Sauria, Berlin* 23: 11-28.

HENDRICKSON, J. R., 1966a. Observations on the fauna of Pulau Tioman and Pulau Tulai. 5. The Reptiles. *Bull. Nat. Mus Singapore* 34: 53-71.

_____, 1966b. Observations on the fauna of Pulau Tioman and Pulau Tulai. 6. *Bull. Nat. Mus Singapore* 34: 72-84.

LIM, K. K. P. & L. J. LIM. 1999. The terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Raffles Bull. Zool*. Suppl. (6): 131-155.

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A note on the distribution of *Amyda cartilaginea* (Boddaert, 1770) in Vietnam

(with three text figures)

The Asiatic softshell turtle, *Amyda cartilaginea* (Boddaert, 1770) is a widely distributed species occurring in aquatic habitats from southern and eastern Myanmar, possibly to extreme south-western China, Thailand and Cambodia, the Mekong drainage area of Laos, central and southern Vietnam, the Malay Peninsula and the continental shelf islands of Sumatra, Bangka, Belitung, Java, Bali, Lombok and Borneo (e.g., Iverson, 1992, Jenkins, 1995). It was recently re-

Sphenomorphus scotophilus (LSUPC L3301).- This skink was observed in and around the caves near the crest of the island and on rocks at the entrances of the caves.

Varanus salvator (LSUPC L7069).- One individual was observed in brackish water scavenging in garbage behind Kg. Pasar Sempit. Another was seen on the large boulders in the intertidal zone. Tracks were also observed on the beach near intertidal rocks and housing.

Unidentified snake.- A portion of the vertebral column of a colubrid snake was found 4 km north of Kg. Pasar Sempit.

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LITERATURE CITED

DAY, M., 1900. Zoological research. *In*: University of Bristol Tioman Archipelago Expedition, Peninsular Malaysia, 1988, Final report. pp: 25-43. M. Day & T. Mowbray (Eds). Unpublished Report.

GRISMER, L. L., N. S. YAAKOB, L.-B. LIM, T.-M. LEONG, I. DAS, R. A. SOSA, J. L. GRISMER, K. M. CRANE, R. E. DIAS, S. V. FIGUEROA, C. A. LEDBETTER, S. C. NEWBOLD, S. R. NEWBOLD, C. P. PATEL, J. CASTRO, R. A. ESCOBAR, III, S. GUERRERO, J. W. PINEDO, J. TRUJILLO & H. KAISER. 2001a. First report on the herpetofauna of Pulau Aur, Johor, West Malaysia. *Hamadryad* 26(2): 350-353.

_____, _____, _____, _____, _____, ______, ______, _____, _____, _____, _____, _____, _____, ______, ______, _____, _____, ______ & _____. 2001b. Report on the herpetofauna of Pulau Tulai, West Malaysia. *Hamadryad* 26(2): 369-371.

_____, J. A. McGUIRE, R. A. SOSA & H. KAISER.2002. Revised checklist and comments on the terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Herpetol. Rev*. 33(1): 26-29.

HIEN, P., W. GROSSMANN & C. SCHAFER. 2001. Beitrag zur Kenntnis der landbewohnenden Reptilienfauna von Pulau Tioman, West-Malaysia. *Sauria, Berlin* 23: 11-28.

HENDRICKSON, J. R., 1966a. Observations on the fauna of Pulau Tioman and Pulau Tulai. 5. The Reptiles. *Bull. Nat. Mus Singapore* 34: 53-71.

_____, 1966b. Observations on the fauna of Pulau Tioman and Pulau Tulai. 6. *Bull. Nat. Mus Singapore* 34: 72-84.

LIM, K. K. P. & L. J. LIM. 1999. The terrestrial herpetofauna of Pulau Tioman, Peninsular Malaysia. *Raffles Bull. Zool*. Suppl. (6): 131-155.

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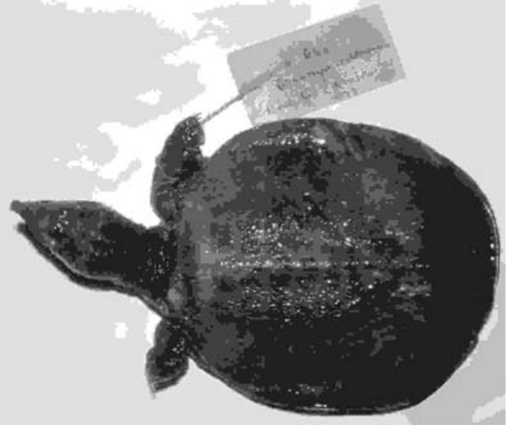

FIGURE 1: Dorsal (a) and ventral aspect (b) of the juvenile specimen of *Amyda cartilaginea* located in the collections of Hanoi National University; from the hand-written label it is evident, that it is indeed Bourret's (1939) specimen T.48 from Nha Trang. Photo: T. Ziegler.

FIGURE 2: Map of Vietnam showing capital (Hanoi), provincial borders (after Fig. 2 in Ziegler 2002) and known localities of *Amyda cartilaginea* according to Bourret (1939, 1941), Iverson (1992) and Nguyen Van Sang and Ho Thu Cuc (1996): 1- surroundings of "Sé Bang Hien, région de Tchépone, dans le centre de la châine annamitique" (approximate location according to Fritz et al. 1999); 2 - northernmost dot presented in Iverson (1992); 3- southernmost dot presented in Iverson (1992); 4- Nha Trang; 5- Bao Loc; 6- Ho Chi Minh City.

ported from north-eastern India (Choudhury et al., 2000), but a suggested occurrence in Bangladesh, the Moluccas or Timor remains unconfirmed (Meylan et al., in press).

For Vietnam, Ernst and Barbour (1989) give the distributional range of the species "from the Gulf of Tonkin in Vietnam westward...". Hendrie (2000) states that it is found in "most water bodies including marshes, estuaries, streams, rivers, ponds and canals" in central and southern Vietnam, but provides no locality details. From the trade, the species is known from the south, the centre as well as from the north of Vietnam, although being relatively rarely seen or uncommon in seizures (Jenkins, 1995, Le Dien Duc and Broad, 1995, Lehr, 1997, Hendrie, 2000). Touch Seang Tana et al. (2000) believe that the Vietnamese population of *Amyda cartilaginea* is "probably very low".

For confirmed Vietnamese collection or observation localities, Iverson (1992) displays two localities (only one was dotted in his earlier checklist, see Iverson, 1986), relatively far from

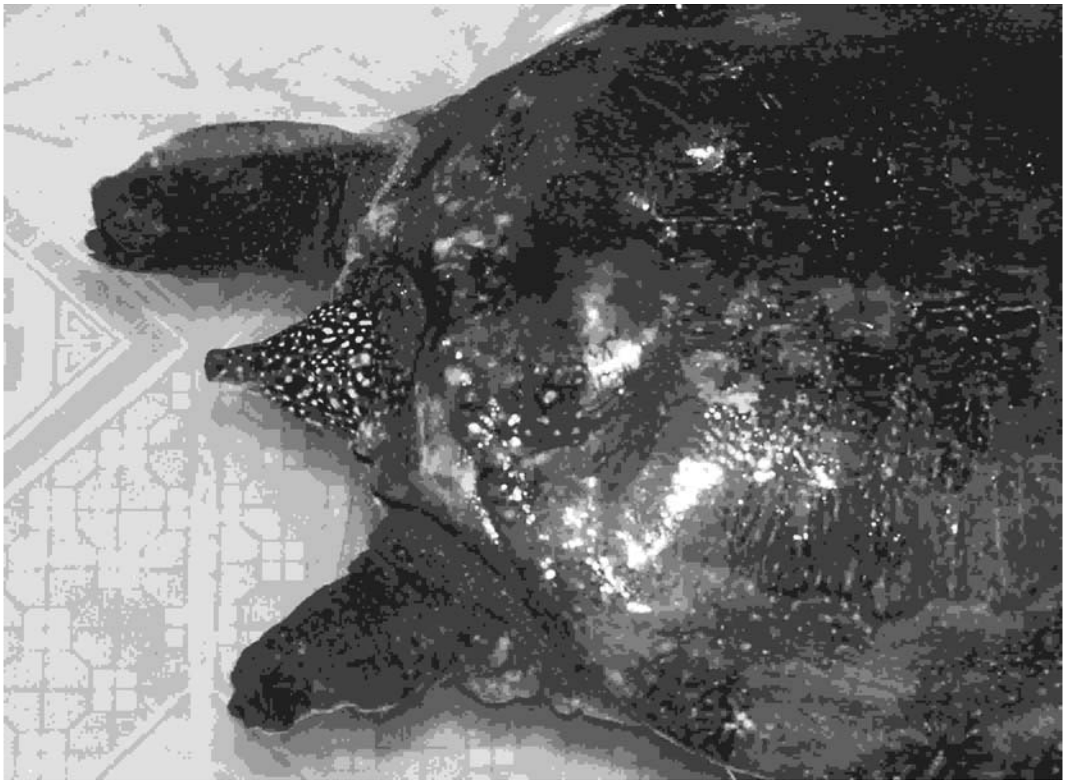

FIGURE 3: Asiatic softshell turtle photographed in a restaurant 2.5 hours by car southwards of Hanoi, North Vietnam. Photo: H.-W. Herrmann.

his nearest documented records in Thailand and Laos. The source of the southernmost record of *Amyda cartilaginea* is a “posthatchling” specimen originating from Kon Tum province, deposited in the Natural History Museum, London (BMNH 1929.5.20.46, leg. Delacour and Lowe). The other dot is the approximate equivalent of Phuoc Son (Kham Duc) in Quang Nam province, but its basis remains obscure to us. According to P. P. van Dijk (in litt. 2002), the “well-documented Kon Tum record provides the currently-known northernmost record in Vietnam”.

The northernmost record of this species ever is Petzold’s (1963) from Hoan Kiem Lake in the center of Hanoi. Originally identified as *Trionyx cartilagineus*, this population of gigantic softshell turtles was subsequently assigned to *Pelochelys bibroni* Owen, 1853 (e.g., Pritchard, 1979, Constable, 1982, Peter, 1994, and Rudolphi and Weser, 1998) and later to the genus *Rafetus* (Niekisch et al., 1997, Hendrie 2000). Most recently, Ha Dinh Duc (2000) introduced the name *Rafetus leloii* for the gigantic Hoan Kiem Lake softshells. However, the specific status of *R. leloii* as opposed to *R. swinhoei* (Gray, 1873) seems unjustified (Pritchard, 2001).

In the monograph of the turtles of “Indochina”, Bourret (1941) states “*T. cartilagineus* ne paraît pas exister au Tonkin, ni dans le Nord-Annam” and being “commune dans les cours d’eaux du Sud à basse et moyenne altitude”. But as sole locality he gives Saigon (Ho Chi Minh City) in South Vietnam, the respective specimen (T.78, a male “conservé au Laboratoire des Sciences Naturelles”) being depicted on his plate XLII. However, in one of his earlier, but scarcely known publications (Bourret, 1939), he mentions four specimens of the species deposited in the “collections du Laboratoire”: T.48 from the surroundings of Nha Trang (“S. Annam”), T.27, a female, obtained from the director of the botanical gardens in Ho Chi Minh City, and two further specimens from "Sé Bang Hien, région de Tchépone, dans le centre de la châine annamitique" (Se Bang Hien is a river in the central border area of Laos and Vietnam, compare Fritz et al., 1999). Nha Trang (Khanh Hoa province) also is one of both distributional dots provided by Nguyen Van Sang and Ho Thu Cuc (1996) for *A. cartilaginea*; the other dot is Bao Loc in Lam Dong province, South Vietnam.

Hydrologically, both Kon Tum (i.e., the Dac Ba Lu river) as the Se Bang Hien river are part of the Mekong tributary, while Nha Trang confirms the occurrence of this species in one of the minor coastal drainages presently not in direct connection with the Mekong; that would, however, have been connected to the river's delta at any time that sea level would have dropped by 10-15 meters (P. P. van Dijk in litt. 2002).

During recent herpetodiversity studies in northern Vietnam (see Ziegler, 2002) the junior author was able to investigate a scarcely known herpetological collection in October 1998 in the Center for Natural Resources Management and Environmental Studies (CRES), Hanoi National University. Among the formalin preserved specimens of this collection, in which also the holotypes of *Dendrophis pictus ngansonensis* Bourret, 1935 and of *Geoemyda tcheponensis* Bourret, 1939 were rediscovered (Fritz et al., 1999, Ziegler and Vogel, 1999), a juvenile *Amyda cartilaginea* was detected (Fig. 1). According to the hand-written label ("No T 48 *Trionyx cartilagineus* Binh-tân [Nhatrang] 1938") it is evident, that it is the same specimen presented in Bourret (1939).

Besides the confirmation of *Amyda cartilaginea* occurring or at least having occurred around Nha Trang, which lies approximately 260 km air distance SE of Kon Tum, from where another of the rare preserved Vietnamese Asiatic softshell turtles originate (Fig. 2), we were able to locate three further specimens in Hanoi: there are two mounted specimens of unknown source in the same institution (compare also Petzold, 1963). Another individual, apparently dry mounted, but in a poor state of preservation, is deposited at the Institute of Ecology and Biological Resources, National Center of Scientific Research of Vietnam, Nghia Do, Tu Liem, Hanoi. While the origin of this specimen is equally unknown to us, all these dry mounted specimens are with most certainty from Vietnam. Additionally, a shell of an *Amyda cartilaginea* collected in "Cochinchina" is kept at the Naturhistorisches Museum Wien (NMW 1301) (Grillitsch et al., 1996). No details are available about its collector or its source.

Even though current knowledge suggests that most *Amyda* available on Vietnamese markets (Fig. 3) are actually of Cambodian or Laotian origin (P. P. van Dijk, pers. comm.), genuine locality data are scarce. A list of both village and trade records as well as some field observations in the north, the centre (including limestone region and Annamite foothills) and in the south of Laos is provided in Stuart (1999). One of the exceptions with respect to collected material is a head preserved in alcohol obtained by M. A. Smith at Pak Lay, Upper Mekong (BMNH 29.10.17.3). Although recent reports on the Asian turtle crisis (e.g., Stuart & Timmins, 2000, Stuart et al., 2000, Touch Seang Tana et al., 2000) state that the Lao population of *A. cartilaginea* is widespread and still numerous, detailed distribution details are largely lacking. As concerns Cambodia, there is no dot in Iverson's (1992) map, probably because the exact origins of Mouhot's specimens, two hatchlings collected in 1859 or 1860 (BMNH 1860.11.14.1, re-registered 1946.1.22.6–7; the types of *Trionyx ornatus* Gray, 1860) are unknown. Finally, Daltry and Chheang Dany (2000) state in their report on the Cardamom Mountains herpetodiversity survey (being also the most detailed herpetological survey conducted anywhere in Cambodia to date), that they observed *A. cartilagina* in the wild in the Central Cardamom Mountains as well as in markets in Phnom Penh; they further refer to Baird (1993) who reported large collections of softshell turtles along the Selampao river on the Cambodian-Laotian border.

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LITERATURE CITED

BAIRD, I. G. 1993. Wildlife trade in the southern Lao PDR. Provinces of Champasak, Sekong and Attapeu, and Thailand, Cambodia and Vietnam. TRAFFIC Southeast Asia, Field Report 3, Kuala Lumpur.

BOURRET, R. 1939. Notes herpétologiques sur l'Indochine française. XVI. Tortues de la collection du Laboratoire des Sciences Naturelles de l'Université. Description d'une espèce nouvelle. *Ann. Bull. Inst. Publ.* 6: 5-12. [In French].

________. 1941. Les tortues de l'Indochine. Inst. Océanogr. de l'Indochine, Nhatrang. 1-235. [In French.]

CHOUDHURY, B. C., S. BHUPATHY & F. HANFEE. 2000. Status information on the tortoises and freshwater turtles of India. *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 86–94. P. P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds). *Chelonian Res. Monogr.* No. 2.

CONSTABLE, J. D. 1982. A visit to Vietnam. *Oryx* 16(3): 249-254.

DALTRY, J. C. & CHHEANG DANY. 2000. Reptiles. *In*: Cardamom Mountains biodiversity survey 2000. pp. 99-110. J. C. Daltry & F. Momberg (Eds). Fauna & Flora International, Cambridge. 254 pp.

ERNST, C. H. & R. W. BARBOUR. 1989. Turtles of the world. Smithsonian Institution Press, Washington D. C. and London. 313 pp.

FRITZ, U., NIEKISCH, M. & T. ZIEGLER. 1999. Rediscovery of the holotype of *Geoemyda tcheponensis* Bourret, 1939 (Reptilia: Testudines: Bataguridae). *Zool. Abh. Staatliches Mus. für Tierkunde, Dresden* 50(2): 243-247.

GRILLITSCH, H., E. SCHLEIFFER & F. TIEDEMANN. 1996. [Catalogue of dry preserved specimens in the herpetological collection of the natural history collections of the Natural History Museum in Vienna, as of 31 December 1995]. Kataloge der wissenschaftlichen Sammlungen des Naturhistorischen Museums in Wien, 11, Vertebrata Heft 5, xii + 137 pp. [In German.]

HA DINH DUC. 2000. Rua Ho Guom Loai Rua Moicho Khoa Hoc. Khao co Hoc 4: 104-111. [In Vietnamese.]

HENDRIE, D. B. 2000. Status and conservation of tortoises and freshwater turtles in Vietnam. *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 63–73. P. P. van Dijk, Stuart, B. L. & A. G. J. Rhodin (Eds). *Chelonian Res. Monogr.* No. 2.

IVERSON, J. B. 1986. A checklist with distribution maps of the turtles of the world. Privately printed, Richmond, Indiana. viii + 282 pp.

________. 1992. A revised checklist with distribution maps of the turtles of the world. Privately printed, Richmond, Indiana. xiii + 363 pp.

JENKINS, M. D. 1995. Tortoises and freshwater turtles: the trade in southeast Asia. Traffic International, Cambridge.

LE DIEN DUC & S. BROAD. 1995. Investigations into tortoises and freshwater turtle trade in Vietnam. IUCN Species Survival Commission. IUCN, Gland and Cambridge.

LEHR, E. 1997. [Investigations into the turtle trade in Vietnam between 1993 and 1996]. *Mitt. Zool. Ges. f. Arten- und Populationsschutz e.V.* 13(2): 12-19. [In German.]

MEYLAN, P. A., E. O. MOLL & P. P. VAN DIJK. In press. *Amyda cartilaginea.* In: Conservation biology of freshwater turtles. *Chelonian Res. Monogr.*

NGUYEN VAN SANG & HO THU CUC 1996: Danh luc bo sat va ech nhai Viet Nam. Nha xuat ban khoa hoc va ky thuat, Hanoi. 264 pp. [In Vietnamese.]

NIEKISCH, M., FARKAS, B., FRITZ, U. & HA DIN DUC. 1997. [Record sizes in softshell turtles in the center of Hanoi, Vietnam]. *Herpetofauna* 19(107): 28-34. [In German.]

PETER, W. P. 1994. [Huge softshelled turtles in the Hoan Kiem Lake in Hanoi, Vietnam]. *DATZ* 2: 75. [In German.]

PETZOLD, H.-G. 1963. [On some turtles from North Vietnam in the Berlin zoo]. - *Senckenb. Biol.* 44(1): 1-20. [In German.]

PRITCHARD, P. C. H. 1979. Encyclopedia of turtles. T. F. H. Publications, Neptune City, NJ. 895 pp.

________. 2001. Observations on body size, sympatry, and niche divergence in softshell turtles (Trionychidae). *Chelonian Conserv. & Biol.* 4(1): 5-27.

RUDOLPHI, M. & R. WESER. 1998. [The softshelled turtles of North Vietnam with particular consideration of the Wattle-necked softshell turtle, *Palea steindachneri* (Siebenrock, 1906)]. *Sauria, Berlin* 20(1): 3-14. [In German.]

STUART, B. L. 1999. Amphibians and reptiles. *In*: Wildlife in Lao PDR: 1999 status report. pp. 43-67. J. W. Duckworth, R. E. Salter & K. Khounboline (Eds). IUCN, WCS & CPAWM.

________& R. J. TIMMINS. 2000. Conservation status and trade of turtles in Laos. *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 58–62. P. P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds). *Chelonian Res. Monogr.* No. 2.

________, R. J. TIMMINS, D. B. HENDRIE, LIENG SOPHA, CHUN SOPHAT, HOUT PISETH, HENG KIMCHAY, TOUCH SEANG TANA, PRAK LEANG HOUR, CHUL THACH, J. COMPTON & R. HOLLOWAY. 2000. Turtle trade in Indochina: Regional summary (Cambodia, Laos, and Vietnam). *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 74–76. P. P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds). *Chelonian Res. Monogr.* No. 2.

TOUCH SEANG TANA, PRAK LEANG HOUR, CHUL THACH & LIENG SOPHA. 2000. Overview of turtle trade in Cambodia. *In*: Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia. pp: 55–57. P. P. van Dijk, B. L. Stuart & A. G. J. Rhodin (Eds). *Chelonian Res. Monogr.* No. 2.

ZIEGLER, T. 2002. Die Amphibien und Reptilien eines Tieflandfeuchtwald-Schutzgebietes in Vietnam [In German]. Natur & Tier Verlag, Münster. 342 pp.

________& G. VOGEL. 2000. On the knowledge and specific status of *Dendrelaphis ngansonensis* (Bourret, 1935) (Reptilia: Serpentes: Colubridae). *Russian J. Herpetol.* 6(3): 199-208.

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A note on *Ambylomma clypeolatum* Neumann, 1899 (Acari: Ixodidae) on the star tortoise *Geochelone elegans* (Schoepff, 1792)

Tick infestations on chelonians are poorly known (Frazier & Keirans, 1990). We have been monitoring the Indian star tortoise, *Geochelone elegans* (Schoepff, 1793) from the Telengana region (16º 00'–18º 05'N; 78º 00'–79º 00'E) on the Deccan plateau in Andhra Pradesh between Godavari and Krishna rivers in India, for tick infestations.

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PETZOLD, H.-G. 1963. [On some turtles from North Vietnam in the Berlin zoo]. - *Senckenb. Biol.* 44(1): 1-20. [In German.]

PRITCHARD, P. C. H. 1979. Encyclopedia of turtles. T. F. H. Publications, Neptune City, NJ. 895 pp.

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RUDOLPHI, M. & R. WESER. 1998. [The softshelled turtles of North Vietnam with particular consideration of the Wattle-necked softshell turtle, *Palea steindachneri* (Siebenrock, 1906)]. *Sauria, Berlin* 20(1): 3-14. [In German.]

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TABLE 1: Details of *Ambylomma clypeolatum* Neumann, 1899, collected from *Geochelone elegans* (Schoepff, 1792), from Andhra Pradesh, India. Specimens retained in the National Zoological Collection, Zoological Survey of India (ZSI) and the Natural History Museum, Osmania University (NHM.OU).

Sl. No.	Sex	Year	Site of attachment	Repository
1.	M	2000	Left hindlimb	ZSI, Kolkata
2.	M	2000	Left forelimb	NHM.OU Acar.1
3.	F	2000	Right forelimb	NHM.OU Acar. 2
4.	F	2000	Near base of neck	NHM.OU Acar.3
5.	F	2000	Right forelimb	NHM.OU Acar.4
6	F	2000	Right forelimb	NHM.OU Acar.5
7.	M	2001	Mid-plastral suture	Specimen misplaced

Between March 1998 and February 2002, a total of the 19 individuals of the host were screened, of which two individuals (11%) were observed to be infested with *Ambylomma clypeolatum* Neumann, 1899. Among the infected, one host was infested with six parasites, while the second had a single tick (Table 1). Both hosts were males. On the heavily infested host, the ticks were obtained from the right side base of the right forelimb (three female ticks), near elbow of the left forelimb (one male tick), left side of the neck (one female tick), and base of the left hindlimb (one male tick). On the host with single male tick, it was found attached at the midplastral suture.

Ambylomma clypeolatum is a specific ectoparasite of *Geochelone elegans* in India and Sri Lanka, and has been reported from Rajasthan and Gujarat in western India and Andhra Pradesh in southern India (Frazier and Keirans, 1990; Robinson, 1925; Seneviratna, 1965; Sharif, 1928; Sharma, 2001; Warburton, 1925). Frazier and Keirans (1990) reported heavy parasitization of hosts by the ticks from Andhra Pradesh (56%, or five out of nine) over those recorded from Rajasthan and Gujarat (2%, or two ot of 90). However, the low levels of parasitization of host as indicated from the present study reveals that this trend may be locally varying and is much dependent on the area specific population trends of the ticks, albeit, no concrete evidence exists, to support this hypothesis.

The present observations, contrary to earlier studies that report the occurrence of one tick per host (Frazier and Keirans, 1990; Sharma, 2001) shows that occurrence of more number of ticks per host could also be a tick density-dependent phenomenon. Further observations on *Ambylomma clypeolatum* on *Geochelone elegans* from other parts of India will be helpful.

We acknowledge a research grant from CSIR, New Delhi and thank A. K. Sanyal, Scientist ‘E’ and Officer-in-Charge, Acarology Section, ZSI Kolkata for identification and Sanjay Molur, Zoo Outreach Organization, Coimbatore for his comments.

LITERATURE CITED

FRAZIER, J. G. & J. E. KEIRANS 1990. Ticks (Acari: Ixodidae) collected on chelonians (Reptilia) from India and Burma. *J. Bombay nat. Hist Soc.* 87(2): 247-249.

ROBINSON, L. E. 1926. A monograph of the Ixodoidea. Part IV. The genus *Amblyomma.* Cambridge University Press, Cambridge. 302 pp.

SENEVIRATNA, P. 1965. The Ixodoidea (Ticks) of Ceylon. Parts II & III. *Ceylon Vet. J.* 13: 28-54.

SHARIF, M. 1928. A revision of the Indian Ixodidae with species reference to the collection in the Indian Museum. *Rec. Indian Mus*. 30(3): 217-344.

SHARMA, S. K. 2001. A note on the ectoparasitic ticks of reptiles from southern Rajasthan. *J. Bombay nat. Hist Soc.* 98(3): 455-456.

WARBURTON, C. 1925. Report on Ixodidae of the Colombo Museum. *Spolia Zeylanica* 13: 255-256.

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GYMNOPHIONA (AMPHIBIA) OF INDIA: A TAXONOMIC STUDY

by R. S. Pillai and M. S. Ravichandran. 1999.

Records of the Zoological Survey of India, Occasional Paper No. 172. ISBN 81-85874-13-1.
Available from: The Publication Division, Zoological Survey of India, 234/4, A. J. C. Bose Road, 2nd MSO Building, 13th Floor, Nizam Palace, Kolkata 700 020, West Bengal, India.
Price Rs. 300 or US$ 20.

The Monograph starts with a preface that contains a brief historical background about caecilian taxonomy, but a strange statement about the publication of the Monograph has been mentioned in the last paragraph: the Monograph has been printed five years after submission of the manuscript and this gestation period of publication is too long in terms of advances in taxonomy. Though nothing of great systematic consequence on Indian caecilians has been published between 1994 to 1999, herpetologists will benefit if attempts are made by those in charge of ZSI publications to reduce the time lag between submission and publication. This is particularly true for names being proposed. In the present work, the authors have described four new species of caecilians (*Ichthyophis garoensis, Ichthyophis husaini, Uraeotyphlus interruptus* and *Gegeneophis krishni*), the types of which are deposited in the Zoological Survey of India, Kolkata. Publication delays, therefore, has the potential to allow the descriptions of the same species to appear before their formal description, in publications by the same author, or under different names (senior synonyms) in works of others. Fortunately, this has not happened in the present case.

However, there is evidence of serious taxonomic errors, due to the long gestation period of ZSI publications. For instance, the Memoirs of the Zoological Survey of India, Vol. 18, Number 3, 1999 (Ray, 1999), that carried description of new species, were described validly in another journal (refer to Ray, 1992).

To return to the contents of Monograph under review, the introductory section ("The Indian Perspective"; pp. 3-4) analyzes previous studies in a chronological order starting with Linnaeus's (1758) description of *Ichthyophis glutinosus* and culminating with Nussbaum and Wilkinson's (1989) paper on caecilian classification. Further, as a convenience to readers, the authors have provided about 10 pages on the general biology of caecilians. The distribution of *Ichthyophis sikkimensis* in Kerala is questionable, although one of the authors (RSP) mentioned that the identity of the specimen was determined by R. A. Nussbaum. However, I suspect the identification of the specimen of *I. sikkimensis* from Kerala, because the key character (caudal folds) used for separation of the specimen (p. 21) from other unstriped species of *Ichthyophis* from southern India, is not available for counting, due to the damaged tail (p. 51). In addition, six other characters conventionally used by the authors for description of all the *Ichthyophis* species of India are also missing in the mutilated specimen from Injiparai, Kerala. I suspect that, either the specimen belongs to one of the four unstriped *Ichthyophis* species found in peninsular India or represents an undescribed species. The other unstriped *Ichthyophis* found in the north-eastern India (*I. husaini*) is closely related to *I. sikkimensis*.

The authors have raised an old story regarding the distribution of *Ichthyophis glutinosus* in India (pp. 32-36). In fact, prior to Nussbaum and Gans' (1980) publication, there were several publications on Indian amphibians dealing with reports on *I. glutinosus* from India. However, Nussbaum and Gans (1980) restricted this species to Sri Lanka. Hence, Pillai and Ravichandran's report on *I. glutinosus* (ZSI 10402) from Assam, India is probably based on an erroneous identification. Excluding this record, four new species of caecilians (two *Ichthyophis*, one *Uraeotyphlus* and one *Gegeneophis* species) have also been described in the Monograph. In fact, both the *Ichthyophis* species (*I. garoensis* and *I. husaini)* have been described from north-eastern India (Meghalaya). The only known record of *Ichthyophis* species from north-east India was *I.*

sikkimensis (distribution: Sikkim and West Bengal) and reports on the occurrence of a second species (*I. beddomei)* were based on erroneous identification (Dutta, 1997). In all likelihood, *I. garoensis* (a striped form) has been confused with *I. beddomei* and the present publication confirms the doubt raised by Dutta (1997: 21). In addition to the present distribution record of *I. garoensis*, Md. F. Ahmed and S. Sengupta have also obtained several specimens from various localities in Assam. Similarly, *I. husaini* also described from Meghalaya seems to be closely related to *I. sikkimensis*, but the only type of *I. husaini* collected during 1983 needs to be reexamined osteologically. Also, fresh collections of both *I. sikkimensis* and *I. husaini* are needed for evaluation of their systematic status.

As for *Uraeotyphlus interruptus* described from Kerala, I have some reservations about the character sets used by the authors for separation of the species from *U. menoni* and *U. narayani*. I would prefer to see a comparative assessment of the number of annuli or body folds and the vertebrae of all the above three species. However, there is no doubt about the species status of *U. interruptus*, on account of the interrupted annuli and colour. The fourth species described from Karnataka is *Gegeneophis krishni*, which also needs osteological comparison with the other three known *Gegeneophis*, though one of them (*G. fulleri*) is known only from the type and also from the north-east India (Assam). The record of *I. bombayensis* from Karnataka (a single example) is an interesting inclusion in the present monograph. Previous records of the species from Karnataka (Balakrishna et al., 1982; Bhatta, 1998) are based on authentic specimen, but voucher specimens are not available to other workers. However, a recent report of the species from Karnataka by Ravichandran and Krishnamurthy (2001) is based on specimen available for examination in the ZSI, Chennai and Kuvempu University, Karnataka. To summarize my critical observations of data available on all the known species, I would recommend an additional and more elaborate taxonomic evaluation, which should include osteological data and also colour photographs of the Indian species of caecilians.

LITERATURE CITED

BALAKRISHNA, T. A., S. KATRE & K. R. GUNDAPPA. 1982. Taxonomy and myogen patterns of some caecilians of the Indian subcontinent. *Curr. Sci.* 51: 848-849.

BHATTA, G. 1998. A field guide to the caecilians of the Western Ghats, India. *J. BioSci.* 23(1): 73-85.

DUTTA, S. K. 1997. Amphibians of India and Sri Lanka (checklist and bibliography). Odyssey Publ. House, Bhubaneswar. i-xiii + 342 + i-xxii pp.

NUSSBAUM, R. A. & C. GANS. 1980. On the *Ichthyophis* (Amphibia: Gymnophiona) of Sri Lanka. *Spolia Zeylanica* 35(1-2): 137-154.

________& M. WILKINSON. 1989. On the classification and phylogeny of caecilians (Amphibia: Gymnophiona), a critical review. *Herpetol. Monogr.* 3: 1-42.

RAVICHANDRAN, M. S. & S. V. KRISHNAMURTHY. 2001. On the distribution of *Ichthyophis bombayensis* Taylor, 1960 (Family: Ichthyophiidae) in central Western Ghats. *J. Bombay nat. Hist. Soc*. 98(1): 121-123.

RAY, P. 1992. Two new hill-stream frogs of the genus *Amolops* Cope (Amphibia: Anura: Ranidae) from Uttar Pradesh (India). *Indian J. Forestry* 15(4): 346-350.

________. 1999. Systematic studies on the amphibian fauna of the District Dehradun, Uttar Pradesh, India. *Mem. Zool. Surv. India* 18(3): 1-102.

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INDIA’S WILDLIFE HISTORY

by Mahesh Rangarajan. 2001.

Permanent Black/Ranthambhore Foundation, Delhi. xv + 135 pp. ISBN 81-7824011-4.
Hardcover with dust jacket. Available from: Permanent Black, D-28 Oxford Apartments, 11, I.P. Extension, Delhi 110 092, India, and also, Vedams Books, www.vedamsbooks.com.
Price: Indian Rupees 250.

The decline of populations of large game in India that started from the days of the British Raj, through a combination of habitat destruction and hunting, for sport or simply out of fear, is now so well documented that most discussions on its history tend to be somewhat sterile.

Nonetheless, Mahesh Rangarajan, arguably India’s finest scholar in the history of conservation, presents the subject in a very readable style. Mahesh is no stranger to the subject, and has also authored works on the people – wildlife conflict (*Fencing the Forest* and *Towards Coexistence: People, Parks and Wildlife*) and compiled a series on the anthology of Indian wildlife (*Oxford Anthology of Indian Wildlife*). This particular work, published jointly by the Ranthambhor Foundation, which strives to save tigers and their habitats in Ranthambhor and elsewhere in India, opens with a Foreword by the Foundation’s own Valmik Thapar, tigerman extraordinaire and noted conservationist.

India’s Wildlife History includes chapters dedicated to descriptions of the forests and fields in ancient India, as depicted in literary works such as the *Ramayana* and *Arthashastra*, and goes on to describe the wildernesses maintained by the Mughals, primarily for supporting populations of game animals. To bring joy to herpetologists, part of a chapter is on venomous snakes (but clubbed with other ‘dangerous beasts’). To contrast these chapters are those on indigenous efforts to protect either individual species (e.g., storks and antelopes) or forests (as sacred groves), the transition from hunting to photography and on independent India’s new naturalists and writers (including Corbett, Champion, Ali, Gee and Krishnan). Project Tiger is dealt with in detail, as are events in its aftermath, and finally, the current crisis of both poaching for big bucks as well as human – large mammal conflict. A little bit here on the loss of biodiversity itself, its causes and presumed effects, as the country’s arable regions are brought under the plow, and encroachments eat into protected areas, would have been relevant, in my opinion. References to archaeological evidence for early faunal collapse, presumably a result of change of climate, makes for interesting reading, as do references to elephants (‘the most remarkable animal used in war’) and their acquisition by the Mauryas.

What makes the writing so refreshing is its scholarship and width of knowledge. Mahesh is equally likely to quote from ancient Indian texts and obscure Persian poetry, as he is from the pages of the ‘Big Game’ literature and from the pages of the hallowed Journal of the Bombay Natural History Society. And not to mention, the archives and other official records, from which Mahesh has the gift to ferret out pertinent information.

If Mahesh permits me to be a bit critical (surely, since we are friends from the Oxford days, discussing much wildlife and history while punting down the Isis, fellows of ill-repute, us), the title of the work is a bit confusing: it can equally well apply to a work on biogeography- the geographical distribution of plants and animals on earth, of which historical biogeography is an aspect of “wildlife history”. Or perhaps the work can even be mistaken for a historical account of studies of wildlife. I suppose ‘wildlife’ itself is a rather imprecise word whose usage is currently on the decline in favour of ‘biodiversity’, another new word for what old timers referred to as good old Mother Nature!

As the Foreword says, this volume had been missing from our shelves. I wish the author and publisher would now consider publishing a larger work, carrying profuse illustrations in colour, depicting both our rich history of big game hunting and conservation. And how about another on the history of biodiversity conservation itself, beyond cheetahs and tigers and lions and even snakes, gleaned from readings of ancient Indian texts? Conservation in the past has often entailed exclusion of local people, and for success has to look at more participation and resource sharing.

In summary, Mahesh, not a bad job for a historian!

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The contents of back issues of *Hamadryad* can be viewed at:
http://www.herplit.com/contents/hamadryad.html

EARLY CROC DAYS

In the late '60's, wildlife conservation was just starting to become a household word in India. Reptiles, though, were still second class citizens and the word from hunters and a few naturalists was that crocodiles were almost gone. That's when I started looking seriously at crocodiles- all the way from Himalayan rivers like the Karnali in western Nepal down to little Kedarhalla stream in the foothills of the Nilgiris. Magical days really- shoestring budgets, public transport and a hell of a lot of footwork. Some of those early croc trips were memorable.

TIGER TALE

Once back in May 1974, during a daytime survey along the Ramganga in Corbett National Park, I sat down near a pool to get a glimpse of the mugger who had left tracks and a big scat from the night before. Friend and Bengali babu croc surveyor, Dhruva Basu, walked upriver a little way and got comfortable on a sandbank under the shade of a sissoo tree. After a long, quiet and very still wait, when my mind was turning glassy like the water surface, my croc surfaced, an eight footer. I got a hasty picture and just then I heard a cough and not 20 meters from where I crouched half hidden, a large male tiger was walking up the dry river bed-TOWARD BASU! I got up in a hurry, yelled "BAAASSUUUU!" and took off after the big cat. The startled tiger gathered momentum - he'd probably never had a human chasing after him! With several big bounds, the cat disappeared.

When I reached Basu he was blissfully asleep and unaware of his close encounter. The tiger's deep pugmarks in the sand were just a few feet away.

BACK BITER

On another trip, this time on the Padma River near Rajshahi in Bangladesh, I was with Mohammed Ali Reza Khan, the compleat naturalist. We heard that a woman had been "attacked" by a gharial and we wondered why a fish-eater would do that. We met the lady; she was gingerly sitting on a cushion and shyly explained how she got bitten on her posterior. Squatting on the river's edge in the early morning, answering the call of nature, she heard a big splash. The next thing she knew, sharp teeth were biting into her and she was knocked over. She hastily scrambled up the riverbank, dignity damaged but luckily not too badly hurt. Looking down the bank, there was the adult gharial in the water with head out and mouth open. Reza and I both had the same hunch and later, when we visited the site of the "attack" we located the nest that the female gharial was defending. We even saw the gharial; she swam to the bottom of the river-bank, watching us from the river as we carefully covered her nest.

CLOSE CALLS

During all the years of croc work I never felt threatened by a crocodile. I had a bit of a rough time with some local bandits in 24-Parganas in West Bengal, cut my hand pretty badly on a catfish spine in the Sunderbans and learned how to pray on some of those harrowing highway drives up North—but no croc attacks. My near-death experience of those days was at Stanley Reservoir in southern Tamil Nadu. We were searching for mugger nests and assistant Solomon Pushparaj and I saw a man swimming across a neck of the huge lake. Rather than walk the several hot kilometers around the lake, we thought we'd swim too. Unbeknownst to us, the swimmer had waded much of the way on a thin, underwater strip of land that he knew about and only had to swim a hundred meters or so. To cut a long swim story short, Solomon and I swam the first couple of hundred meters and started getting very very tired. No buoyancy and our clothes were dragging us down – this wasn't at all like swimming in the sea, we thought. We kept putting our feet down—but no bottom! I was just about finished, ready to just sink down into the cool water and call it a life. I didn't have the strength to see how Solomon was doing and just then I heard his feeble shout - was he drowning? No, he'd found the bottom and was wading ashore. Phew! Two very tired individuals hauled themselves out on that lakeshore and just laid there like basking crocs for half an hour or so.

BABY CROCS

Not long after that, Solomon was with the late, great Irula snakeman, Chockalingam and I on a croc survey on the Lower Moyar River in the Nilgiris foothills. We located a whole gang of hatchling muggers in a deep stagnant pool. They were all grouped together but would disappear underwater as soon as we approached- so we waited till nightfall. Using small torches clamped precariously between our teeth (the forerunner of the headlamp), we slipped into the fetid water and swam towards the little group of tiny red eye shines. We had my *lungi* stretched between us like a fishing net and now we slipped it slowly and gently under the bobbing babies and simply scooped up all 16 of them. We got out of the water fast because even though we hadn't seen mamma croc, we knew she had a tunnel nearby. This little bunch of chirping babies grew into the Croc Bank's breeders who eventually produced thousands of offspring.

SCARY TIMES

Scary times with crocs? Yeah, well there have been a few. One late night, a bunch of us "nest robbers" were checking the crocs at Kilikudi, a pool near the Cauvery River not far from the bustling town of Tiruchirapalli. I made a few baby croc alarm squawks and we spotted two red eyes glowing in the water a few metres away. Just then we heard a pounding sound behind us as a big adult mugger came charging out of the bushes toward us. We didn't wait around but scattered like a bunch of scared mice as the heavy croc went right by, full tilt, and landed in the water with a mighty splash. Another time, a very dry and hot May at Hiran Lake in the Gir Lion Sanctuary in Gujarat, I was counting crocs and looking at all the tunnels they had made to survive the drought. One big tunnel was right at the top of a tall, steep embankment. Approaching from the top, I lay down on my belly and lowered myself over the edge. I peered into the tunnel and there, inches from my face was the toothy grin of a nice big mugger - SURPRISE!! The mugger let out a low, serious growl and I jumped up like a jack-rabbit. Jeevan Nana, my Maldhari guide muttered something that sounded like the Gujarati equivalent of "What a nutcase!"

TODAY

A lot of water under the boat as they say, and a lot of eggs and baby crocs resulting from these survey and egg collection trips went to the Croc Bank in those early days. Eventually close to a thousand of them went back to the wild.

So, after twenty-five years (actually more, since the croc work all started in 1970 at the Madras Snake Park) what is the present status of our crocs? Here it is in brief, the numbers are rough, more as indicators than census figures. Today gharial are pretty safe in two strongholds: the Chambal River (Rajasthan and Madhya Pradesh) and Girwa River (Uttar Pradesh). In these two places there are about 1,500 wild gharials. But there are no other places where more than tiny populations of gharial can survive. They are constrained by their need for deep flowing river habitat with plenty of fish– and no fishermen with nylon gillnets!

In India, the saltwater crocodile has only one stronghold: Bhitarkanika Sanctuary, Orissa, where there are close to a thousand. Scattered, small populations are reported from the Sunderbans (West Bengal and Bangladesh) which could recover and grow, parts of the Andamans and Nicobars and south-western Sri Lanka. The future for "salties" is not too good- they are limited by their bad reputation and need for undisturbed mangroves and freshwater marshes for nesting - prime paddy land already mostly used by humans.

Only the mugger, with its amazing adaptability has the chance to continue its eons old existence. It's a low profile croc, usually doesn't grow too big and can even live in sewage treatment ponds. In India we have close to six thousand mugger in captivity (with nowhere to release them) and perhaps two to three thousand in the wild. The Moyar River and the Amaravathi Reservoir in Tamil Nadu plus Hiran Lake in Gir Sanctuary, Gujarat are the mugger's last strongholds. There are also small but important populations in most other states. Sri Lanka still has thousands of mugger. Ah, what pleasure it is, shining a torch on a lake with a hundred or more glowing eyes beaming back at you!

It feels good to have been part of those early days of croc conservation. Reptiles had few friends then and it feels even better to see how many people are turned on by "herps" today in India. But no time for complacency! Threats to crocs and wild habitats in India and the rest of south Asia as a whole are very real. If a Government can coolly displace tens of thousands of people by building a dam how can we expect crocodiles to fare any better? There's still plenty to do, so hang in there!

Rom Whitaker
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INSTRUCTIONS TO CONTRIBUTORS

Hamadryad publishes original papers dealing with, but not necessarily restricted to, the herpetology of Asia. Reviews of books and major papers are also published.

Manuscripts should be only in English and submitted in triplicate (one original and two copies, along with three copies of all tables and figures), printed or typewritten on one side of the paper. Manuscripts can also be submitted as email file attachments. Papers previously published or submitted for publication elsewhere should not be submitted. Final submissions of accepted papers on disks (IBM-compatible only) are desirable. For general style, contributors are requested to examine the current issue of *Hamadryad.* Authors with access to publication funds are requested to pay US$ 5 or equivalent per printed page of their papers to help defray production costs. Reprints cost Rs. 2.00 or 10 US cents per page inclusive of postage charges, and should be ordered at the time the paper is accepted.

Major papers exceeding four pages (double spaced typescript) should contain the following headings: Title, name and address of author (but not titles and affiliations), Abstract, Key Words (five to 10 words), Introduction, Material and Methods, Results, Discussion, Acknowledgements, Literature Cited (only the references cited in the paper). Appendices follow the main paper. Descriptions of new taxa will be considered as major papers regardless of size. Abstracts (up to 150 words) should summarize the important findings of the paper and should avoid references. In case of descriptions of new taxa, diagnoses should be provided in the abstract. Special attention should be paid to accents and diacritical marks: if fonts are not available in the software or typewriter, these may be put directly on the hard copy of the manuscript by hand.

References should be in the following format:

Papers:
GAULKE, M. 1994. Notes on the herpetofauna of Panaon and Sámar, East Visayans, Philippines. *Hamadryad* 19:1-10.

Books:
RUSSELL, P. 1796. An account of Indian serpents collected on the coast of Coromandel; containing descriptions and drawings of each species; together with experiments and remarks on their several poisons. George Nicol, London. viii + 90 pp + Pl. I-XLVI.

Chapters in books:
KIEW, B. H. 1984. Terrestrial vertebrate fauna of Lambir Hills National Park. *In*: An ecological survey of Lambir Hills National Park, Sarawak. pp: 55-63. E. Soepadmo & K. I. Sudderuddin (Eds). University of Malaya, Kuala Lumpur.

Unpublished reports:
WILKINSON, J. W., J. W. ARNTZEN & R. S. THORPE. 1995. Amphibian populations on organic farms: their role in pest control. M.A.F.F. Report. iv + 48 pp.

Publications in languages other than English:
SZCZERBAK, N. N. & M. L. GOLUBEV. 1986. [The gekkonid fauna of the USSR and adjacent countries.] *Sci. Acad. Ukranian SSR Zool. Inst.* 1986: 1-232. [In Russian.]

Tables should be comprehensive without reference to the text. Tables should follow the main body of the paper, and their desired location within the text indicated on the manuscript. Footnotes are generally not allowed. Line art and half tones are preferred as electronic files saved on compact disks or attached to email files. Black and white photographic prints and slide transparencies are accepted if they are sharp and show good contrast. Black and white photos should be printed on glossy paper at least 152 x 204 mm after being trimmed at right angles and should carry the name of the author and of the manuscript at the back. Illustrations should be preferably done with Indian ink on good quality tracing paper. All lettering should be done using high quality computer printouts or transfers. Illustrations should be planned to fit either one column (6.5 mm) or one page (14 mm) width, after suitable reduction.

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