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CONTENTS

NOTES

BOOK REVIEW

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Species inventory and conservation status of chelonians in Natma Taung National Park, Myanmar

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ABSTRACT.– **We conducted a baseline species inventory and assessed the conservation status of chelonians inhabiting Natma Taung National Park (NTNP) and surrounding areas of the southern Chin Hills, Myanmar during May–June 2011. We verified the occurrence of *Indotestudo elongata*, *Cyclemys fusca*, and *Amyda cartilaginea* in the park. Shells of *Heosemys depressa* confiscated from wildlife traders near NTNP are thought to have originated from northern Rakhine State, but contrary to our earlier predictions we found nothing to indicate this species occurs in the southern Chin Hills. *Indotestudo elongata* and *C. fusca* are subject to widespread subsistence harvest at levels that are probably unsustainable, at least in populated areas. However, there seems to be little commercial harvest of either species, possibly due to the high cost of transporting turtles to distant markets and the fact that agriculture yields a much greater financial return. In contrast, *Amyda cartilaginea* populations in the southern Chin Hills have been decimated by a continuing commercial harvest.**

KEY WORDS.– ***Amyda cartilaginea*, Chin Hills, *Cyclemys fusca*, *Heosemys depressa*, *Indotestudo elongata*, Myanmar, Natma Taung National Park, species inventory, turtles, wildlife trade.**

Introduction

The conservation status of most species of chelonians in Myanmar is tenuous owing to widespread subsistence harvesting, and export to food, medicinal, and pet markets in southern China (Platt *et al*. 2000). Fieldwork indicates that many populations are severely depleted and some species are nearing extinction in the wild (Thorbjarnarson *et al*. 2000b; Platt *et al*. 2000 2003b). This situation is particularly alarming given that Myanmar is recognized as a global center of chelonian biodiversity with 27 species occurring in the country, of which at least seven are endemic (van Dijk 1997; Platt *et al*. 2000). Because of its high level of endemism and the serious, on-going threats faced by wild populations, Stuart and Thorbjarnarson (2003) ranked Myanmar among the top four Asian countries with priority for turtle conservation efforts. Unless appropriate conservation action is rapidly implemented, chelonian populations will no doubt continue to decline (Platt *et al*. 2000).

National parks, wildlife sanctuaries, and other protected areas can figure prominently in successful species conservation strategies (Stohlgren *et al*. 1994), and base-line species inventories are essential data sets for effective conservation planning (Oliver & Beattie 1993; Castellano *et al*. 2003; Tuberville *et al*. 2005). Furthermore, knowledge of alpha-level diversity (MacArthur 1965) is fundamental for understanding community and ecosystem dynamics (McDiarmid 1994). Such data are generally lacking in Myanmar, where the chelonian fauna

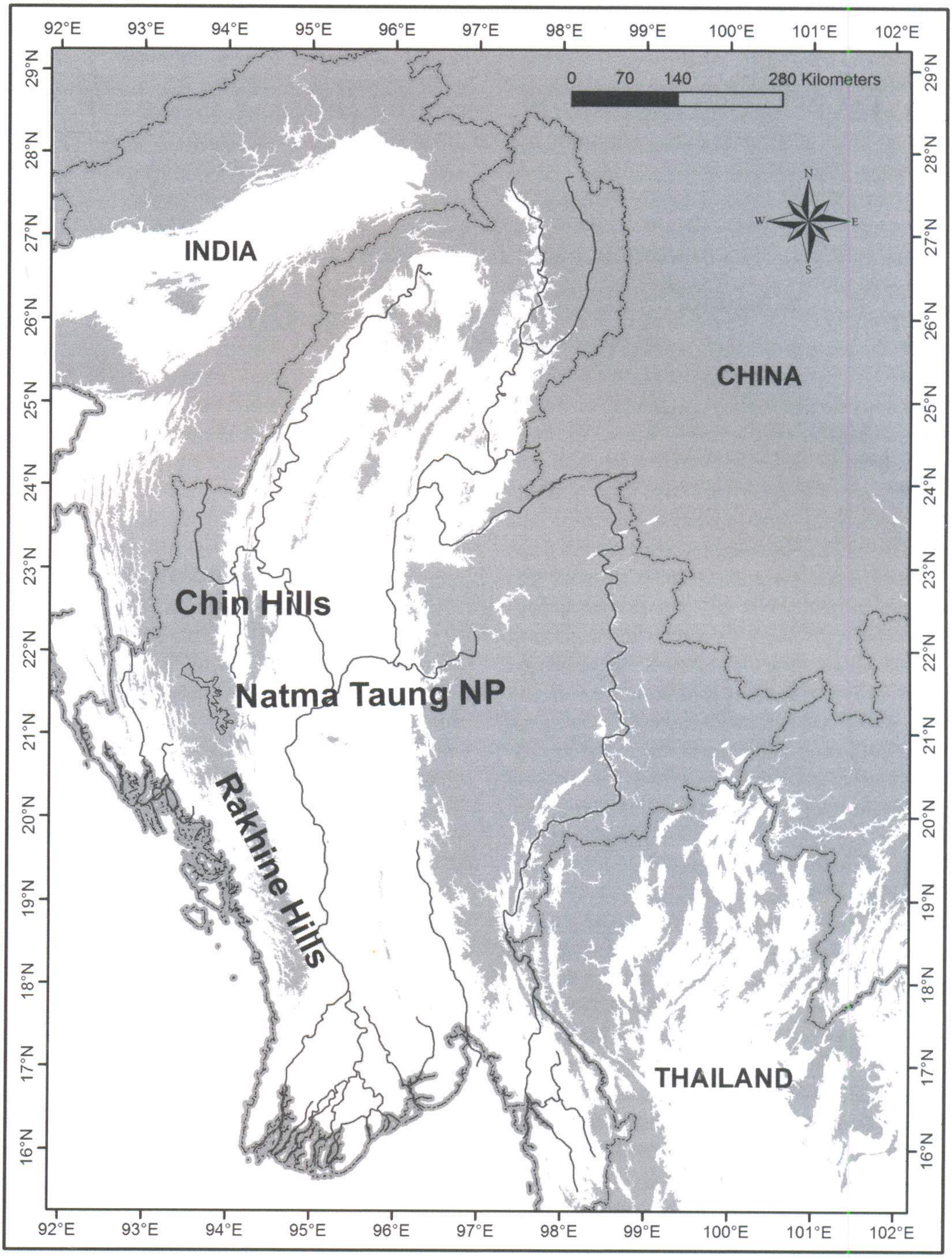

Figure 1. Map showing location of Chin Hills, Rakhine (=Arakan) Hills, and Natma Taung National Park in Myanmar.

remains among the least studied in Asia and even basic information on geographic distribution and natural history are unavailable for most species (van Dijk 1997; Platt *et al*. 2007).

Natma Taung National Park (NTNP) is an extensive protected area in the southern Chin Hills of western Myanmar. Owing to a lack of collecting effort and paucity of museum speci-

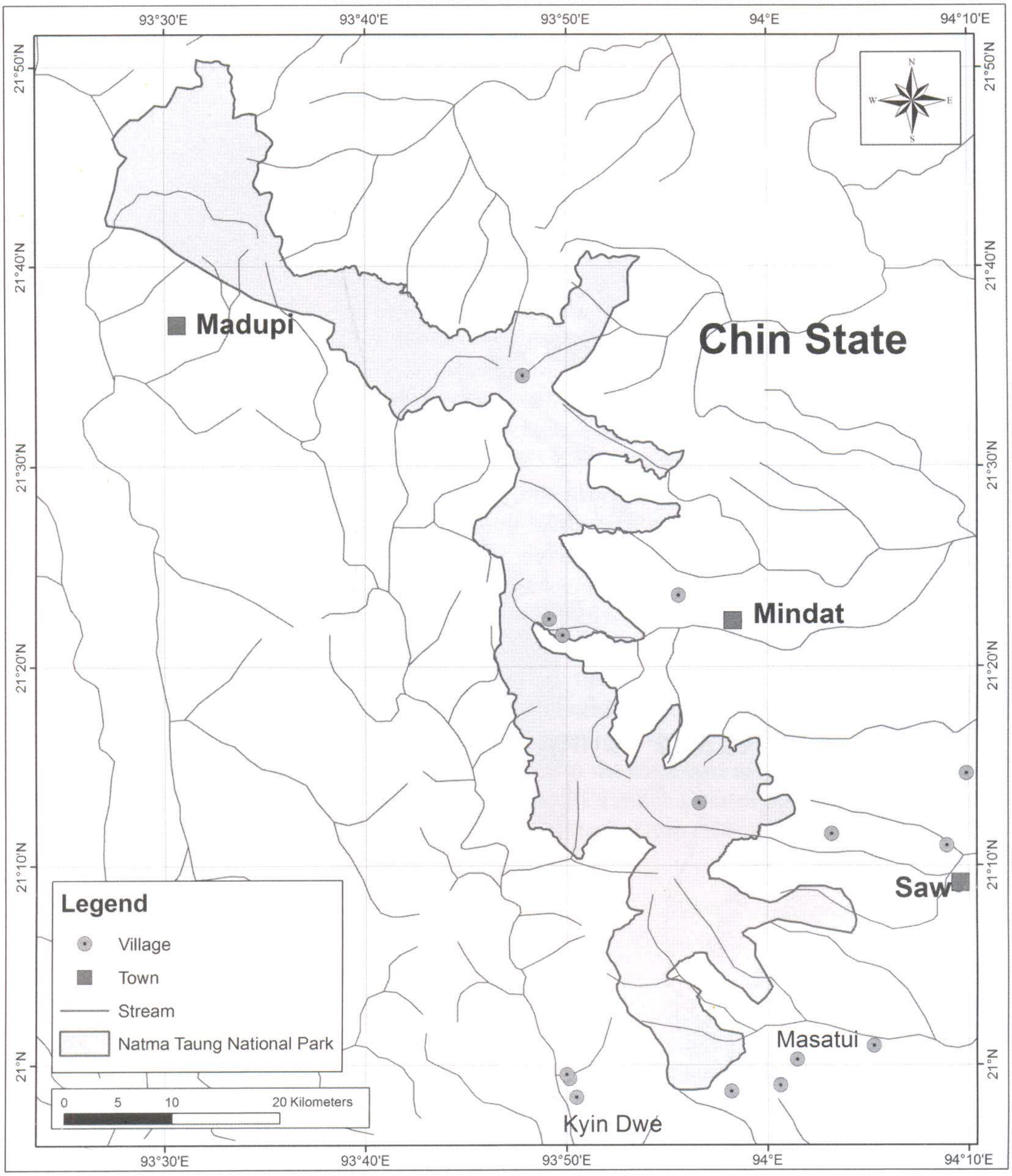

Figure 2. Map of Natma Taung National Park showing towns, villages, and waterways in relation to approximate park boundaries. Localities mentioned in text are labeled.

mens, virtually nothing is known regarding the chelonian fauna of the Chin Hills. Because the endemic and Critically Endangered *Heosemys depressa* (IUCN 2011) might occur in this region (Platt *et al*. 2003a) and efforts to identify populations in protected areas of Myanmar have been accorded high priority (Platt *et al*. 2010a), a survey of NTNP was warranted. Additionally, a chelonian inventory of NTNP was urgently needed by park authorities to facilitate informed conservation planning. To these ends, we conducted a baseline inventory of chelonians in NTNP and the surrounding area, investigated levels of subsistence and commercial exploitation, and made conservation recommendations based on our findings.

Materials and Methods

Natma Taung National Park is located in the southern Chin Hills, part of an unbroken chain of mountains linking the Himalayas to the north with the Rakhine Hills (formerly known as Arakan Hills) in southwestern Myanmar (Fig. 1). Natma Taung National Park (Fig. 2) encompasses 722 km^2 centered on Natma Taung (formerly known as Mount Victoria; 21°13'N; 93°55'E), which at 3,095 m is the highest peak in central Myanmar (Sayer 1983). These mountains are characterized by extremely rugged topography consisting of steep ridges separated by narrow stream valleys (Sayer 1983). High gradient, swift-flowing streams and rivers in rocky, boulder-strewn and often braided channels are typical of the southern Chin Hills. The region experiences a tropical monsoonal climate with a wet season extending from early June into October followed by a dry season from late October to late May (Terra 1944). Temperatures at higher elevations commonly drop below freezing during December–February (Sayer 1983).

Given the rugged topography, a wide range of slope, aspect, and elevational combinations often exist within a limited area, which in turn determine the vegetation at a particular site (Kingdon-Ward 1958; Sayer 1983). Although the flora of the Chin Hills remains poorly described, vegetative associations generally correspond to an elevational gradient (Platt *et al.* 2011). Low elevations are characterized by dry deciduous forest, followed by pine (*Pinus* spp.), oak (*Quercus* spp.), and evergreen forest associations at increasingly greater elevation; the highest elevations are dominated by open meadows and stunted oak-rhododendron forest (Kingdon-Ward 1958; Sayer 1983; Robson *et al.* 1999). Meadows and forests are regularly burned during the dry season to provide grazing for semi-feral mithan (*Bos frontalis*). Additionally, much of the natural forest below 2200 m has been impacted by the shifting agricultural practices of ethnic Chin farmers, and consists of seral vegetation in various stages of re-growth (Sayer 1983). Springs are uncommon on higher slopes and the availability of water is thought to determine the upper limits of shifting cultivation (Kingdon-Ward 1958; Sayer 1983). Our observations indicate that rice (*Oryza* spp.) is typically cultivated in valley floors and lower slopes, while corn (*Zea mays*) is grown at higher elevations (Platt *et al.* 2011). Attempts, albeit only partly successful, have been made by the Forest Department to settle shifting cultivators living within the boundaries of NTNP onto permanent plots of land. A number of small settlements exist within or immediately adjacent to the poorly defined boundaries of NTNP (Platt *et al.* 2011).

We conducted fieldwork in NTNP and surrounding areas from 24 May to 14 June 2011, a period coinciding with the beginning of the annual wet season. During this period we visited villages in the park and around its southern periphery where we conducted open-ended interviews (*sensu* Martin 1995) of farmers, hunters, and other knowledgeable individuals regarding the local occurrence of turtles, hunting and collecting methods, and levels of harvest. Such individuals are recognized as an excellent source of information on local chelonians (Thirakhupt & van Dijk 1994; Platt *et al.* 2004). In accordance with the format of an open-ended interview, we asked each informant a series of questions that included standard questions prepared in advance and others that arose during the course of conversation (Martin 1995). We also asked to examine any shells and living turtles that might be available in villages. On several occasions we met with large groups of villagers simultaneously and it was not possible to conduct standard open-ended interviews. In such cases we used a semi-directive method (Gilchrist *et al.* 2005), in which information was recorded as questions were asked and discussed more informally. Transcripts and summaries of interviews are contained in field notes archived in the Campbell Museum, Clemson University, Clemson, South Carolina, USA.

In addition to conducting interviews, we searched for tortoises using a team of four people accompanied by two local hunting dogs. Our previous work indicates that dogs are more effective at locating concealed turtles than humans, particularly in areas where chelonian population densities are low (Platt *et al.* 2003b). We also accompanied hunters to search for aquatic turtles along rivers and streams using local techniques. Terrestrial and aquatic searches began in the morning (07h00–08h00) and continued throughout most of the day. Captured turtles were measured, photographed, and released at the site of capture within 15 minutes. Geographic coordinates and elevation were determined with a Garmin® GPS 12. Straight-line carapace length (CL) and plastron length (PL; measured from base of anal notch) are presented as mean ± 1 standard deviation (SD). We sexed *Indotestudo elongata* based on tail and plastral morphology; males exhibit large tails and concave plastrons, whereas females have relatively small tails and plastral concavities are absent (Platt *et al.* 2001). In many cases only the carapace of tortoise shells could be obtained from villagers, making determination of sex impossible. Similarly, we were unable to determine the sex of *Cyclemys* sp. when only shells were available; however, living turtles were readily sexed by differences in tail morphology.

Results and Discussion

We verified the occurrence of three species of chelonians (*Indotestudo elongata*, *Cyclemys fusca,* and *Amyda cartilaginea*) in NTNP, but found nothing to indicate that *H. depressa* occurs in the southern Chin Hills. An account for each species is presented below.

Testudinidae

***Indotestudo elongata* (Blyth, 1853).–** We examined 22 *Indotestudo elongata* during this survey; our sample included three living tortoises, eight complete shells (carapace with accompanying plastron), four specimens consisting only of a carapace, and seven plastrons without a carapace. For the latter, we used PL (in mm) to estimate CL with the equation CL = 1.37PL – 16.6 ($r^2 = 0.97$; $p<0.001$; Platt *et al.* 2007). The mean CL of our sample was 196 ± 34 mm (range = 132–247 mm). Our sample was dominated by intermediate-sized tortoises; small juveniles and large adults were lacking (Fig. 3). We were able to determine the sex of 16 specimens; females (CL = 215 ± 29 mm; range = 154–239 mm; n = 8) were larger than males (CL = 193 ± 19 mm; range = 165–214 mm; n = 8), although our small sample size precluded meaningful statistical comparisons.

We were unable to determine the specific provenance of most *I. elongata* examined during the survey. However, a specimen obtained at a temporary agricultural encampment (21°00.48′N; 94°03.59′E; elevation = 770 m) was captured in second-growth forest nearby. Using dogs we found a tortoise among dense undergrowth beneath large widely scattered trees on a steep hillside (21°00.89′N; 94°03.29′E; elevation = 795 m; slope ca. 55°). Based on our interviews, most *I. elongata* are captured in secondary forests and abandoned swidden fields, which is not unexpected given the amount of time villagers spend in these habitats. *Indotestudo elongata* appears restricted to relatively low elevations (<1000 m) in the southern Chin Hills. We examined the shell of a tortoise in Hman Taung (21°56.49′N; 94°03.29′E; elevation ca. 1370 m) reportedly captured about 200 m below the village; no evidence was found of tortoises at higher elevations.

Local perceptions of abundance vary; most villagers stated that *I. elongata* remains common, although some thought tortoises are now more difficult to find than in the past. Subsistence harvesting of *I. elongata* is ubiquitous throughout the area we surveyed; however, we found no evidence of commercial trade. Based on our interviews, it appears most tortoises are captured when opportunistically encountered by villagers engaged in land clearing and other agricultural pursuits, or traveling to and from swidden fields. Villagers attribute most captures to the dogs, which seem to accompany them everywhere. The rank growth that rapidly becomes established in swidden fields after abandonment affords concealment and probably some degree of protection for tortoises. While no market for living tortoises or meat exists in remote areas, hunters retain plastrons, which are sold to itinerant merchants who regularly visit villages to purchase recyclables, such as metal and plastic.

The long-term impact of subsistence harvesting on populations is evident in the size-class distribution of *I. elongata* from NTNP (Fig. 3). In comparison to an unexploited population of *I. elongata* from Rakhine Yoma Wildlife Sanctuary (Platt & Khin Myo Myo 2009), tortoises from NTNP are smaller and the largest size-class is absent. We attribute this distribution to chronic exploitation that results in very few tortoises surviving long enough to reach a large body size. Additionally, large adult tortoises are

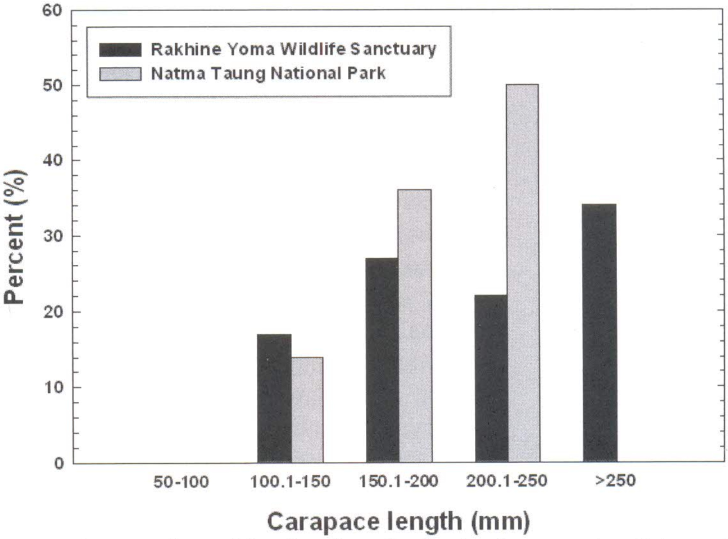

Figure 3. A comparison of the size-class distribution (carapace length in mm) of *Indotestudo elongata* from an exploited population in the southern Chin Hills ($n = 22$) and an unexploited population in the Rakhine Yoma Wildlife Sanctuary ($n = 18$). Rakhine Yoma Wildlife Sanctuary data from Platt & Khin Myo Myo (2009).

probably easier for humans to find than smaller tortoises (Aponte *et al.* 2003). Because humans selectively target larger individuals, over-harvested populations generally contain few larger, and hence older tortoises, resulting in a higher proportional representation of juveniles and small adults (Robinson & Redford 1994; Stiner *et al.* 2000; Aponte *et al.* 2003). Similar to our findings, the CL of *I. elongata* in an exploited population near Mandalay never exceeded 250 mm (van Dijk 1993), and the mean CL of *Trachemys scripta* (Schoepf, 1792) in harvested populations was significantly smaller than in a protected population (Close & Seigel 1997). A reduction in CL over time in archaeological profiles is generally considered to indicate long-term over-exploitation by foraging humans (Klein 1999; Stiner *et al.* 1999).

Geoemydidae

***Cyclemys fusca* Fritz, Guicking, Auer, Sommer, Wink, and Hundsdörfer, 2008.–** We examined five *Cyclemys* spp., including one complete shell (carapace with accompanying plastron), two specimens consisting only of a carapace, and two living turtles. The mean CL of this sample was 185 ± 13 mm (range = 143–215 mm); all specimens originated from the vicinity of Kyin Dwe Village (20°58.35′N; 93°50.23′E; elevation = 535 m). We accompanied two local hunters to search for turtles along a tributary of the Mon River, about 4 km upstream from Kyin Dwe Village. Hunters searched for turtles in backwater pools adjacent to the main channel of the river by probing long sticks under boulders, into crevices, and beneath tree roots and woody flotsam. Two *Cyclemys* spp. were found concealed among rocks after approximately 1.0 man-hours of search effort (21°00.50′N; 93°49.01′E; elevation = 518 m; Fig. 4a, b, and c). Both turtles emitted a strong, foul-smelling odor upon capture.

Two species of dark-bellied *Cyclemys* reportedly occur in Myanmar (Fritz *et al.* 2008), although few museum specimens are available and the geographic distribution of each is poorly understood and remains to be fully resolved. *Cyclemys oldhamii* Gray, 1863 is found in central and southern Myanmar, and eastwards into Thailand, while *C. fusca* inhabits northern and central Myanmar, and perhaps adjacent parts of India and Bangladesh (Fritz *et al.* 2008). A putative *C. fusca* × *C. oldhamii* hybrid from south central Myanmar possibly represents a zone of introgression between the two species (Fritz *et al.* 2008).

Because *C. oldhamii* and *C. fusca* are morphologically similar, field identification is challenging; however, the crown of the head is speckled in *C. oldhamii*, and uniformly greenish yellow to light brown in *C. fusca* (Fritz *et al.* 2008). Based on the uniform brown coloration of the head and absence of speckling (Fig. 4c), we provisionally identified the living turtles collected from the Mon River as *C. fusca*. Moreover, the southern Chin Hills are within the distribution of *C. fusca* proposed by Fritz *et al.* (2008). Identification of the *Cyclemys* shells

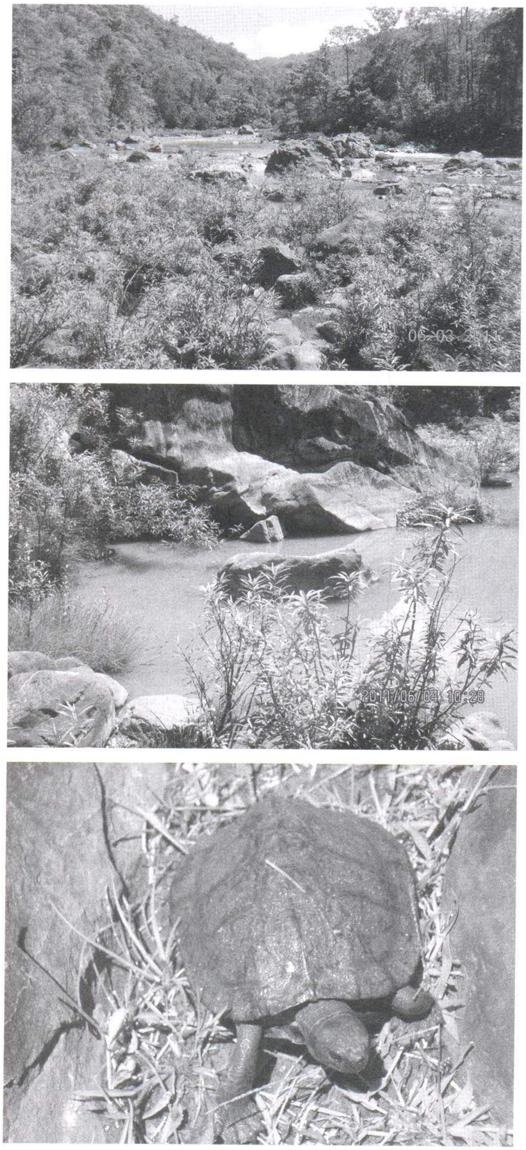

Figure 4. A tributary of the Mon River near Kyin Dwe Village in the southern Chin Hills (top). *Cyclemys fusca* were found in small pools along the margins of the river, while *Amyda cartilaginea* inhabits the main channel. Small pool (middle) where *Cyclemys fusca* (bottom) was captured. Note the absence of speckling on the head of this specimen.

we examined in Kyin Dwe Village is problematic as *C. oldhamii* and *C. fusca* cannot be distinguished solely on the basis of shell attributes. Because the shells originated from the same area as the two living turtles, it is likely these specimens are assignable to *C. fusca* as well.

According to villagers, *Cyclemys fusca* are common in suitable habitat at lower elevations in the southern Chin Hills, and the minimal search effort required to find two turtles along the Mon River seems consistent with local perceptions of abundance. Villagers reported that *C. fusca* are often found in buffalo wallows during the wet season and feeding on fallen fruit beneath riverside *thepan* trees (*Ficus glomerata*). There appears to be little market demand for *C. fusca* owing to the strong odor emitted by the turtles when handled. Fishermen opportunistically take *C. fusca* captured in nets for consumption, but otherwise this species seems to be experiencing minimal harvest pressure at the moment. These observations contrast markedly with other regions in western Burma, where *Cyclemys* spp. are heavily exploited for local consumption (Platt *et al*. 2007).

***Heosemys depressa* (Anderson, 1875).–** The geographic distribution of this endemic and poorly known species remains ill-defined (Iverson & McCord 1997; Platt *et al*. 2001, 2003a, 2010a). We examined six *H. depressa* plastrons (PL = 188 ± 28 mm; range = 132–207 mm) at NTNP Headquarters. Based on plastral morphology, we determined this sample consisted of two males, three females, and a single juvenile that could not be reliably sexed. These plastrons were among a large number of shells confiscated by Forest Department officials from illegal wildlife traders operating in Saw (21°09′0.0″N; 94°09′31″E; elevation = 365 m), and consequently their specific provenance could not be determined. The only currently known populations of *H. depressa* occur in the Rakhine Hills to the south of our study area (Platt *et al*. 2001, 2003a, 2010a). Given the contiguous nature of the mountain ranges in western Myanmar and the absence of any obvious geographic barriers to dispersal, Platt *et al*. (2003a, 2010a) speculated the distribution of *H. depressa* might extend northwards from Rakhine State into the Chin Hills. However, we found nothing to indicate *H. depressa* occurs in the Chin Hills; no shells or living turtles were forthcoming and villagers were unfamiliar with the species. Furthermore, the bamboo (*Melocanna baccifera*) habitat preferred by *H. depressa* in Rakhine State (Platt *et al*. 2010a and b) appears absent from NTNP. The plastrons we examined at NTNP headquarters almost certainly originated in Rakhine State, and were likely transported north over a trail network linking this region with southern Chin State, ultimately destined for Mandalay.

Trionychidae

Amyda cartilaginea (Boddaert, 1770).– We examined a single juvenile *Amyda cartilaginea* (CL = 121 mm) during this survey. The turtle was captured in fishing gear set in a tributary of the Mon River about 1 km upstream from Kyin Dwe Village. Despite its small body size, the turtle was being kept for eventual sale to a wildlife trader. Few specimen-based records of *A. cartilaginea* are available from anywhere in western Myanmar (Iverson 1992), and this record provides continuity with earlier records from the Rakhine Hills to the south (Platt *et al*. 2007) and northeastern India to the west (Pawar & Choudhury 2000).

According to villagers *A. cartilaginea* occurs at low elevations in most rivers of the southern Chin Hills. Until recently *A. cartilaginea* was apparently quite common, and one resident of Kyin Dwe stated that 5 years ago up to 10 softshell turtles could be captured in a single day from the Mon River tributary. Without exception, our informants maintained that *A. cartilaginea* is now very difficult to capture, and few if any large individuals remain in local rivers. Consequently, fishermen no longer devote effort to capturing *A. cartilaginea*, although opportunistic harvesting continues. Softshell turtles are in great demand for export markets (Platt *et al*. 2000) and command a high price (>US$200 for large adults) from traders.

Conclusions

The results of our survey suggest that a relatively depauperate chelonian assemblage is present in low elevation (<1300 m) habitats of NTNP. Because NTNP largely consists of high elevation ridges and mountains, most of the park does not constitute suitable chelonian habitat. Local knowledge reinforces this conclusion, as according to our informants, chelonians are only present at elevations suitable for rice cultivation. However, areas of low elevation habitat are present in southern regions of the park and appear to harbor significant populations of *I. elongata* and *C. fusca*. Given that both species are intensively exploited and populations are declining or extirpated in many areas of Myanmar (Platt *et al*. 2000 2007), NTNP is important for the conservation of these turtles.

Commercial harvesting of *I. elongata* and *C. fusca* is apparently not occurring in NTNP or adjacent areas. Our interview data suggest this is because 1) NTNP is distant from trade centers such as Mandalay, and 2) transportation costs are such that harvested turtles cannot be moved to markets and still yield a profit. Most importantly, harvesting and selling turtles would yield far less income than farming, the principal economic endeavor of most people living in the region. Several villagers told us that it would be nonsensical to devote time to hunting turtles instead of tending their fields.

In contrast to commercial exploitation, opportunistic subsistence harvesting of turtles is ubiquitous in anthropogenic landscapes of the southern Chin Hills. The sustainability of this harvest is questionable; like most long-lived vertebrates, the life history traits of chelonians severely constrain the ability of populations to respond to chronic mortality (Congdon *et al*. 1993), and even low intensity subsistence harvesting has the potential to decimate turtle populations inhabiting areas accessible to humans (Thirakhupt & van Dijk 1994). Indeed, it is doubtful whether any harvest of chelonians can be regarded as truly sustainable (Thorbjarnarson *et al*. 2000a). We posit that chelonian populations in NTNP and surrounding areas of the southern Chin Hills function as a source-sink system (Hanski & Simberloff 1997); turtles from unpeopled habitat (source) disperse into the areas near villages where harvesting is likely to occur (sink). Because human population density is low, villages are widely scattered, and there is no compelling economic reason to deliberately seek out turtles, we consider populations of *I. elongata* and *C. fusca* in areas removed from villages relatively secure, at least for the moment. Given the manpower and fiscal resources available to park authorities, attempting to halt the subsistence harvest of chelonians is in no way feasible at present.

Unlike *I. elongata* and *C. fusca*, *Amyda cartilaginea* is being heavily exploited to meet commercial demand. Large adults are apparently no longer to be found, and populations appear to be at critically low levels in rivers of the southern

Chin Hills. This intensive level of harvest is undoubtedly driven by the high price traders are willing to pay for *A. cartilaginea*, which for a particularly large turtle may equal or surpass the annual income of many villagers. This lucrative trade is no doubt fueling the continuing, rapid decimation of wild populations throughout Myanmar (Platt *et al.* 2004 2005 2007). Halting the harvest of *A. cartilaginea* is probably impossible given its opportunistic and diffuse nature, and lack of law enforcement resources available to park authorities. Forest Department officials should instead target illicit wildlife traders, often based in distant urban centers, who drive the demand for these turtles. Without a concerted effort on the part of Forest Department officials it is likely that populations of most trionychids will disappear from all but the most remote regions of Myanmar within the next 10 years.

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Comments on the distribution and external morphology of *Typhlops vermicularis* (Ophidia: Typhlopidae) in Iran

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ABSTRACT.– New records of *Typhlops vermicularis* are presented and the distributional range of this species is extended towards eastern and western Iran. Morphological data of collected specimens are presented.

KEY WORDS.– *Typhlops vermicularis,* Iran, new records, distribution, morphology.

Introduction

The family Typhlopidae Merrem, 1820 encompasses 12 genera and more than 300 species (McDiarmid *et al.* 1999; V. Wallach, pers. comm.). *Typhlops* Schneider and Oppel, 1811 is the most speciose genus of the family. The members of this genus are distributed all over the world. One of the well-known species of this genus is *Typhlops vermicularis* Merrem, 1820, widely distributed from throughout the Middle East and as far west as Albania (McDiarmid *et al.* 1999; Wallach 2002).

Two species of the genus *Typhlops* are presently documented from Iran: *Typhlops vermicularis* Merrem, 1820; and *Typhlops wilsoni* Wall, 1908 (Leviton *et al.* 1992; McDiarmid 1999; Rastegar-Pouyani *et al.* 2008).

The last published records of *Typhlops vermicularis* from Iran were those of Latifi (1991). Based on the previous records, *T. vermicularis* is mostly distributed in southern and northern regions of Iran.

Althought some studies have been done on internal characters of *Typhlops vermicularis* (Wallach 1998), there is almost no comprehensive study regarding distinguishing external characters and their taxonomic implication for this species. Some distingushing characters of *Typhlops vermicularis* are: supralabial imbrication pattern T-III, inferior nasal suture touching the second supralabial, nasal incompletely divided, midbody scale rows 20–24, subcaudals 7–13 and presence of two postoculars (Grillitsch & Grillitsch 1993).

In this paper, an identification key based on new data is provided. In addition, new records of *T. vermicularis* from Iran are given (Table 1 and Fig. 1).

Material and Methods

During field work in various regions of Iran (2008–2009), 10 specimens of *Typhlops vermicularis* were collected from western and central regions of the country. Whilst most were collected from under rocks on mountainsides, a few were seen above ground on rainy days.

In addition, other material was borrowed and examined from: Iran National Natural History Museum (Tehran) (INNHM), Razi University Zoological Museum (RUZM) (Kermanshah), Zoology Museum of Gorgan University (ZMGU) (Gorgan), and Göteborgs Naturhistoriska Museum (GNM) (Göteborg-Sweden) (see Appendix). Overall, 41 specimens from Golestan, 18 from Kermanshah, five from Markazi, three from Lorestan, four from Razavi Khorasan, three from Mazandaran, two from West Azerbaijan, two from Ilam, one from Khuzestan, two from Kerman, one from Fars, and one from Tehran Province were examined.

Prior to this study, only a few records of *Typhlops vermicularis* from Iran were documented

(Latifi 1991). Based on the previous records, *T. vermicularis* was distributed in East Azerbaijan, Markazi, Tehran, Fars, Mazandaran, Kerman, Khuzestan and Gilan provinces. In this study new specimens were collected from: Eslamabad-e-Gharb, (34º 06’N; 46º 31’E), Guilan-e-Gharb, (34º 08’N; 45º 55’E), Kermanshah (34º 18’N; 47º 04’E), Ravansar (34º 43’N; 46º 40’E), Gorgan (36º 50’N; 54º 26’E), Sirjan (29º 27’N; 55º 40’E), Neishabour (36º 12’N; 58º 47’E), Chenaran (36º 38’N; 59º 07’E), Mashhad (36º 17’N; 59º 36’E), Khoramabad (33º 29’N; 48º 21’E), Kaboudan Island (37º 22’N; 45º 28’E), and Shirvan Chardavul (33º 46’N; 46º 32’E).

The following measurements, counts and character states were taken: LOA – total length in mm, TL – tail length in mm, MTD – midtail diameter in mm, ABD – anterior body diameter in mm, MBD – midbody diameter in mm, PBD – posterior body diameter in mm, HW – head width in mm, HL – head length in mm, HW/HL – head width/ head length, TL/LOA – tail length/ total length, LOA/MBD – total length/midbody diameter, TL/MTD – tail length/ midtail diameter, TSR – total scale rows, SC – number of subcaudals, ASR – anterior scale rows; number of scales around the body at 20th scale after the mental, MSR – midbody scale rows; number of scales around the body at midbody (LOA/2), PSR – posterior scale rows; number of scales around the body at 10th scale before the ventral, MPSR – midbody plus posterior scale row (MSR + PSR), AMPSR – anterior - plus mid - plus posterior-body scale rows (ASR+MSR+PSR), SL – number of supralabials, IL – number of infralabials, INS – inferior nasal suture; contact of inferior nasal suture with supralabial, SIP – supralabial imbrication pattern, Po – number of postoculars, Pari – number of parietals, RW – rostral width in mm, RL – rostral length in mm, VL – ventral-rostral length, DOR – dorsal pattern (Afroosheh 2009).

Results

The coloration and color pattern of the studied specimens of *Typhlops vermicularis* are as follows: light to dark yellowish, brownish or grayish (Fig. 2A–B), juveniles bearing a darker coloration. The tail is very short, as wide as long, terminating in a small conical spine-like scale. Body cylindrical, rather thick, covered with

Table 1. Descriptive statistics of morphological characters of the adult *Typhlops vermicularis* specimens used in this study (n = sample size). Abbreviations: LOA = total length in mm, TL = tail length in mm, MTD = midtail diameter in mm, ABD = anterior body diameter in mm, MBD = midbody diameter in mm, PBD = posterior body diameter in mm, HW = head width in mm, HL = head length in mm, HW/HL = head width/ head length, TL/ LOA = tail length/ total length, LOA/MBD = total length/midnody diameter, TL/MTD = tail length/ midtail diameter, TSR = total scale rows, SC = number of subcaudals, ASR = anterior scale rows, MSR = midbody scale rows, (LOA/2), PSR = posterior scale rows, MPSR = midbody plus posterior scale row (MSR+PSR), AMPSR = anterior- plus mid- plus posterior-body scale rows (ASR+MSR+PSR), SL = number of supralabials, IL = number of infralabials, INS = inferior nasal suture; contact of inferior nasal suture with supralabial, SIP = supralabial imbrication pattern, Po = number of postoculars, Pari = number of parietals, RW = rostral width in mm, RL = rostral length in mm, VL = ventral-rostral length, DOR = dorsal pattern (Afroosheh 2009).

Characters	n	Minimum	Maximum	Mean
LOA	83	90.94	277.88	178.31
TL	83	0.60	5.75	3.01
MTD	83	0.83	5.21	2.67
ABD	83	1.39	4.75	2.89
MBD	83	1.76	7.22	3.69
PBD	83	1.19	5.51	3.01
HW	83	1.73	4.13	2.73
HL	83	1.58	4.21	2.97
TSR	83	340.00	438.00	389.18
SC	83	7.00	12.00	9.01
ASR	83	22.00	24.00	23.28
MSR	83	21.00	24.00	22.86
PSR	83	20.00	24.00	21.75
RW	77	0.78	1.79	1.14
RL	77	1.25	2.42	1.83
LS	77	0.68	1.80	1.19
HW/HL	83	0.77	1.58	0.92
TL/LOA	83	0.01	0.03	0.01
LOA/MBD	83	32.77	85.14	49.40
TL/MTD	83	0.50	2.15	1.18
MPSR	83	41.00	48.00	44.62
AMPSR	83	63.00	72.00	67.91
RL/RW	77	0.02	1.96	1.58
LS/HW	77	0.33	0.64	0.44
RW/HW	77	0.27	0.57	0.42

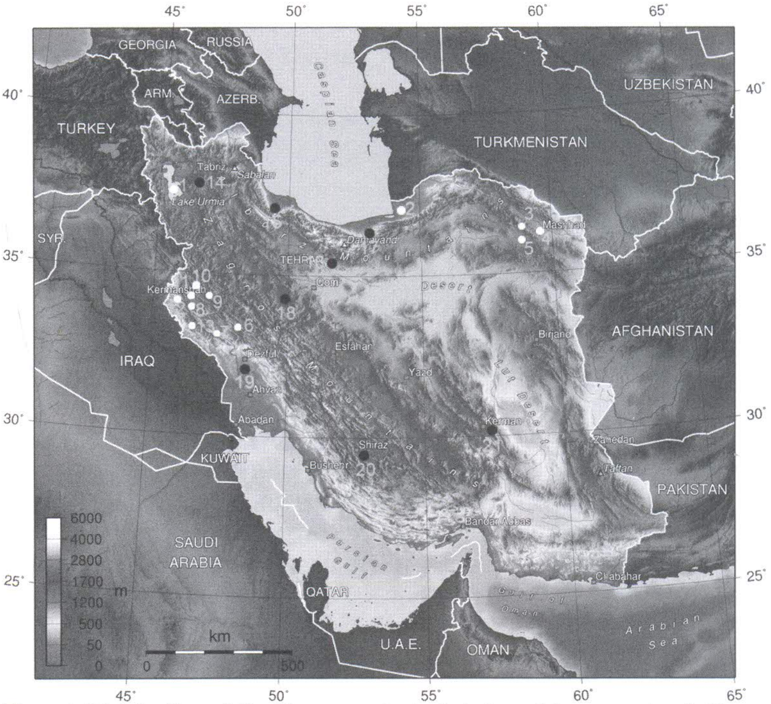

Figure 1. Distribution of *Typhlops vermicularis* in Iran. New records of *Typhlops vermicularis* (▣): 1, Kabudan Island (West Azerbaijan Province); 2, Gorgan (Golestan Province); 3, Chenaran (Razavi Khorasan Province); 4, Mashhad (Razavi Khorasan Province); 5, Neishabur (Razavi Khorasan Province); 6, Khoram Abad (Lorestan Province); 7, Shirvan- Chardavul (Ilam Province); 8, Eslam- Abad Gharb (Kermanshah Province); 9, Kermanshah (Kermanshah Province); 10, Ravansar (Kermanshah Province); 11, Gahvareh (Kermanshah Province); 12, Guilan-Gharb (Kermanshah Province); 13, Ilam (Ilam Province). Distribution of *T. vermicularis* based on Latifi (2001) (●): 14, East Azerbaijan Province; 15, Guilan Province; 16, Tehran Province; 17, Mazandaran Province; 18, Markazi Province; 19, Khozestan Province; 20, Fars Province; 21, Kerman Province

smooth scales of uniform size, eyes are vestigial, visible as small dark dots below the large ocular scale. Snout is rounded, rostral is narrow, about one-third of head width; nasal is incompletely divided, slightly lighter on the ventral side. There are four supra- and five infralabials, inferior nasal suture touches SL2, supralabial imbrication pattern is T-III (Wallach 1993) (Table 1). They live in burrows in regions with relatively high humidity, in the banks of seasonal rivers or in hillsides (Fig. 3), and they feed on termites, ants, eggs of ants, small insects, and decayed materials (Wallach 1998).

Discussion

Based on the statistics, color pattern, and other pertinent characters and in comparison with the key identification characters of *Typhlops vermicularis* specimens studied by Wallach (pers. comm.), all the newly collected specimens belong to *Typhlops vermicularis*.

Since the latest reliable records (Latifi 1991), so far, there is no report of the occurrence of *T. vermicularis* from western regions of Iran. Based on this study, the distribution range of this snake extends toward eastern and western Iran. According to the new distribution map, it can be assumed that *T. vermicularis* is distributed all over Iran (Fig. 1). It seems that the distribution range of this species extends continuously from North Africa, southeastern Europe to northern Afghanistan (Wallach 2002), a wide area with homogeneous populations (the relevant morphological and molecular data are under preparation and will be published in a forthcoming paper).

After examination of specimens treated in this paper, now we may present a more reliable identification data for *Typhlops vermicularis* in Iran (Table 1).

In 1908, Wall reported *Typhlops wilsoni* from Iran. The type locality of *T. wilsoni* is given as southwestern Iran without further details. Some key characters of *T. wilsoni* are as follows: MSR are 24, PSR are 22; rostral is about one-third the breadth of the head, not reaching as far back as the eyes, in contact with the internasal, nasals are just failed to meet behind the rostral. The nostril is lateral; an upper suture passes towards but fails to meet the rostral, the lower suture passes to the 2nd labial. Preocular touches the 2nd and 3rd labials, and the supraocular. The eyes are distinct, and their diameter about half the ocular shield. Supraoculars fail

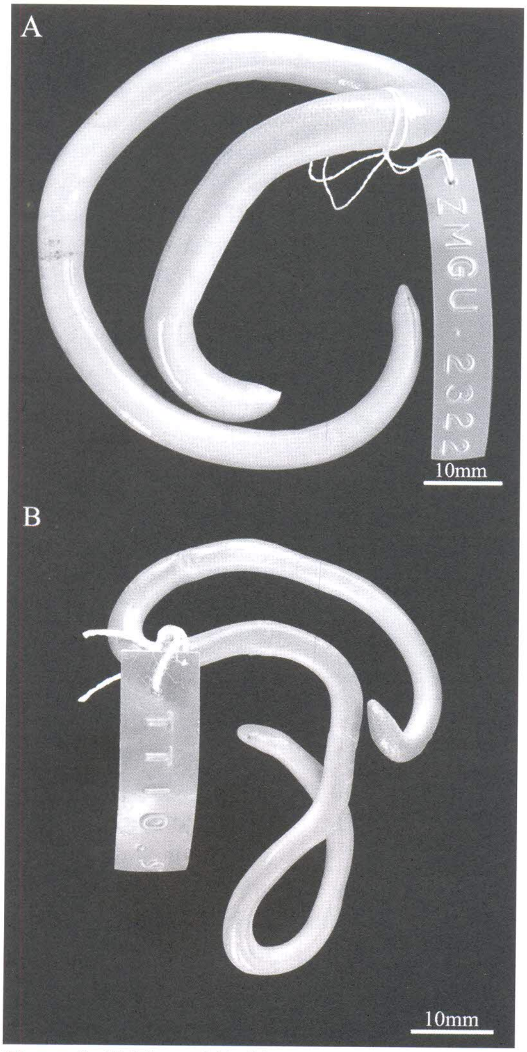

Figure 3. Habitat of *Typhlops vermicularis* in Shirvan Chardavol, Ilam Province, western Iran.

to meet. The internasal, frontal, and supraocular shields subequal and are smaller than the occipital, and parietals which are subequal. Four labials. Snout rounded. Tail with a single small spine directed downwards, and slightly backwards. Color is uniformly dirty brown (Wall 1908). It seems that the only distinguishing character which separates *T. vermicularis* from *T. wilsoni* is that in *T. wilsoni* the ocular is separated from labials by the subocular, whereas in *T. vermicularis* the ocular is in contact with labials (Afroosheh 2009).

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Figure 2. Two specimens of *Typhlops vermicularis* studied here (A. ZMGU-2322. B. RUZM-TT 10.9).

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Appendix

Material examined:
Typhlops vermicularis (n= 83)

GNM- Re. 4420 (n=2): Golestan Province, Gorgan; GNM- Re. 5741, 5751, 5776, 6618: Kermanshah Province, Kermanshah; GNM- Re. 5750: Kermanshah Province, Eslamabad-e-Gharb; GNM- Re. 6631 (n=2): Lorestan Prov,. Khoramabad; INNHM 16: Tehran Province, Kan; INNHM 1449: Lorestan Province; INNHM 120, 113: West Azerbaijan Province, Kaboudan Island; RUZM-TT10-5–10-7, 10-9–10-11, 10-16, 10-31: Kermanshah Province, Kermanshah; RUZM-TT10-21–10-22: Kermanshah Province, Ravansar; RUZM-TT10-17, 10-20: Kermanshah Province, Gahvareh; RUZM-TT10-25–10-28, 10 -30: Markazi Province, Arak; RUZM-TT10-14: Khuzestan Province, Dezful; RUZM-TT10-24: Fars Province, Shiraz; RUZM-TT10-23, 10-29: Ilam Province, Shirvan Chardavoul; ZMGU 1179: Kermanshah Province, Guilan-e-Gharb; ZMGU 29, 127, 266, 346, 348–349, 355, 460–463, 465–466, 470, 490, 552, 676, 679–684, 687– 689, 885, 1023, 1085, 1277, 1519, 1593, 1604, 1606–1608, 1621–1622, 1625: Golestan Province, Gorgan; ZMGU 1245: Razavi Khorasan Province, Neishabour; ZMGU 2082, 2163: Razavi Khorasan Province, Chenaran; ZMGU 38: Razavi Khorasan Province, Mashhad; ZMGU 1270–1271, 1623: Mazanderan Province, Sari; ZMGU 1997–1998: Kerman Province, Sirjan.

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Rediscovery of *Geckoella jeyporensis* (Squamata: Gekkonidae), with notes on morphology, coloration and habitat

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ABSTRACT.– ***Geckoella jeyporensis*** **(Beddome, 1877) was described based on a single male specimen from "Patinghe Hill", and in the 135 years since the original description, there have been no further reports of the species. We recently collected two additional specimens of this poorly known species from close to the type locality. In this paper, we present a detailed morphological description of *G. jeyporensis*, as well as details of life coloration and notes on its habitat, based on the new specimens and published morphological data of the holotype.**

KEYWORDS.– ***Geckoella jeyporensis*, rediscovery, Eastern Ghats, India.**

Introduction

The genus *Geckoella* Gray, 1867 is endemic to peninsular India (five species) and Sri Lanka (two species). The phylogenetic relationships of this genus remain unresolved; while Bauer (2002) considered *Geckoella* a subgenus of *Cyrtodactylus* based on morphology, the only molecular phylogenetic study which used these genera recovered them as sister taxa (Feng *et al.* 2007), albeit with extremely poor taxon sampling. More recent phylogenetic data support the monophyly of *Geckoella* (Agarwal & Karanth unpublished data), although it appears to be embedded within *Cyrtodactylus* (Wood, Heinicke, Bauer, Greenbaum & Jackman, submitted). Dorsal scalation divides the species into two broad groups – one with smooth granular dorsal scales, with or without small rounded tubercles (*collegalensis, nebulosa, yakhuna*), the other with plate-like dorsals or irregular small scales intermixed with larger tubercles (*albofasciata, deccanensis, jeyporensis, triedra*) (modified after Smith 1935).

These terrestrial geckos are widely distributed across peninsular India and Sri Lanka – with *Geckoella yakhuna* and *G. triedra* known from the dry and wet zone of Sri Lanka, respectively (Somaweera & Somaweera 2009); *G. albofasciata* and *G.deccanensis* from the central and northern Western Ghats respectively (Giri & Bauer 2004); *G. collegalensis* from drier hills in southern Gujarat, the Western Ghats and southern India, with unconfirmed reports from Sri Lanka (Somaweera & Somaweera 2009; Mirza *et al.* 2010); *G. nebulosus* from across the Eastern Ghats, also extending west into the Satpuras (Agarwal 2007) and *G. jeyporensis* known from a single locality in the Eastern Ghats of Odisha (Smith 1935).

Geckoella jeyporensis was described in 1877, based on a single male specimen from "Patinghe Hill", in the Jeypore Hills, India (Beddome 1877; now in Koraput district, Odisha State). Since then, no additional specimens of this species have been reported. A popular article that declared the rediscovery of this species (Dutta *et al.* 2005) was erroneous and referred to a specimen of *G.* cf. *nebulosa* (based on the photograph presented in Dutta *et al.* 2005; S. K. Dutta pers. comm.).

We conducted fieldwork specifically targeting *Geckoella jeyporensis* in high elevation areas of the Eastern Ghats in south Odisha and northern Andhra Pradesh in September 2010 and November 2011. We provide a detailed morphological description of the species based on the two specimens that were collected, details of life coloration, and notes on habitat.

Methods

The recently collected specimens of *Geckoella jeyporensis* were deposited in the collection of the Centre for Ecological Sciences (CES), Bangalore and the Bombay Natural History Society (BNHS), Mumbai. Data on the holotype (The Natural History Museum, London: BMNH 82.5.22.37) were taken from the literature (Beddome 1877; Boulenger 1885; Smith 1935). In case of discrepancies between authors, we present the range. The following measurements were taken with a Mitutoyo dial vernier caliper (to the nearest 0.1 mm): snout-vent length (SVL; from tip of snout to vent), trunk length (TRL; distance from axilla to groin measured from posterior edge of forelimb insertion to anterior edge of hindlimb insertion), body width (BW; maximum width of body), crus length (CL; from base of heel to knee); tail length (TL; from vent to tip of tail), tail width (TW; measured at widest point of tail), head length (HL; distance between retroarticular process of jaw and snout-tip), head width (HW; maximum width of head), head height (HH; maximum height of head, from occiput to underside of jaws), forearm length (FL; from base of palm to elbow); orbital diameter (OD; greatest diameter of orbit), nares to eye distance (NE; distance between anteriormost point of eye and nostril), snout to eye distance (SE; distance between anteriormost point of eye and tip of snout), eye to ear distance (EE; distance from anterior edge of ear opening to posterior corner of eye), internarial distance (IN; distance between nares) and interorbital distance (IO; shortest distance between left and right supraciliary scale rows). Scale counts and external observations of morphology were made using a Wild M5 dissecting microscope. In the description, details for the larger, adult specimen CES09/1356 are listed first, followed by characters for BNHS 2274, or, in some cases, the range of values across both specimens is provided.

Geckoella jeyporensis
(Fig. 1)

Gymnodactylus jeyporensis Beddome, 1877; Proceedings of the Zoological Society of London: 685.

Holotype.– The Natural History Museum, London: BMNH 82.5.22.37, adult male, collected from "a wood on the top of Patinghe Hill, 4200 feet [1273 m] elevation", Jeypore Hills, Koraput District, Odisha, India [collection date not listed in original description or BMNH register]. Collected by Col. R. H. Beddome.

Additional Specimens.– CES09/1356, adult male (Fig. 1A), collected from Galikonda, Visakhapatnam District, Andhra Pradesh, India (18° N, 82° E; 1234 m asl) on 9th October, 2011. Collected by A. D. Roy, P. Raj, P. Karanth, V. Deepak and I. Agarwal. BNHS 2274, subadult male (Fig. 1B), collected from Deomali, Koraput District, Odisha, India (18° N, 83° E; 1,240 m asl) on 20 September, 2010. Collected by A. D. Roy, T. Khichi and I. Agarwal. Precise latitude and longitude are not listed here in order to provide some protection from commercial collecting for this attractive species.

Description of CES09/1356 and BNHS 2274.– Adult male. SVL 60.2 mm (subadult male, 33.2 mm); TL 40.5 mm (8.5 mm, tail tip missing. Original length ~ 24.2 mm, tail tip stored for subsequent DNA sequence analysis in the collection of the Centre for Ecological Sciences, Bangalore CES10/1206). Head relatively short (HL/SVL ratio 0.29, 0.31), wide (HW/HL ratio 0.76, 0.74), not depressed (HH/HL ratio 0.45, 0.49), distinct from slender neck. Loreal region weakly inflated, canthus rostralis not prominent. Snout elongate (SE/HL ratio 0.42, 0.41), rounded; not much longer than eye diameter (OD/SE ratio 0.50, 0.52); scales on snout enlarged, roughly 5–6 sided, flattened, largely homogeneous, similar in size to those on crown and interorbital regions, scales on occipital region slightly larger and flattened, scales on temporal region similar in size and bead-like. Eye moderately large (OD/HL ratio 0.21, 0.22); pupil vertical with crenelated margins; supraciliaries short, those at posterior of orbit bearing small conical spines. Ear opening vertically elliptical; eye to ear distance greater than diameter of eyes (EE/OD ratio 1.39, 1.45). Rostral much wider than deep. Two enlarged supranasals separated from one another by a small internasal (in broad contact with one another, no internasal). Rostral in contact with first supralabials, nostrils, supranasals and internasal (rostral in contact with first supralabials, nostrils, and supranasals). Nostrils oval, more-or-less laterally directed, each surrounded by supranasal, rostral, first supralabial and three enlarged postnasals. A single row of small scales separates orbit from supralabials. Mental triangular, wider than deep. A single pair of enlarged postmentals in broad contact behind mental, each postmental bordered anteromedially by mental, anterolaterally by first infralabial and anterior portion of second infralabial, posterolaterally by an enlarged lateral chinshield (or second postmental), and posteriorly by three granules, the medialmost of which also contacts the other postmental. Supralabials to midorbital position 8/8 (8/8), enlarged supralabials to angle of jaws 12/11 (11/10); infralabials 10/10 (10/9). Interorbital scale rows between centre of eyes 19 (21).

Body slender, elongate (TRL/SVL ratio 0.41, 0.45), ventrolateral folds indistinct. Dorsal pholidosis weakly heterogeneous, composed of enlarged, hexagonal, plate-like dorsal scales in 21–22 rows, weakly imbricate across most of dorsum, smaller and more granular toward the flanks (Fig. 1C). Ventral scales much smaller than dorsals, smooth and subimbricate, largest in precloacal region. Midbody scale rows across belly to lowest rows of enlarged dorsals 25–27. Gular region with homogeneous, smooth, juxtaposed granular scales. No precloacal or femoral pores. Three postcloacal spurs on each side, dorsolateralmost largest. Scales on palm and sole smooth, rounded to oval or hexagonal, slightly domed. Scalation on dorsal surfaces of limbs consisting of juxtaposed granular to conical domed scales, much smaller than dorsals. Fore and hindlimbs moderately long, slender (ForeaL/SVL ratio 0.17, 0.16; CrusL/SVL ratio 0.17, 0.16). Digits long for *Geckoella*, short in comparison with typical *Cyrtodactylus*, slender, inflected at interphalangeal joints, all bearing robust, slightly recurved claws. Basal subdigital lamellae ovoid to rectangular, broad, without scansorial surfaces, lamellae distal to digital inflection smaller; 8-11-11-13-11 (10-12-12-12-12) subdigital lamellae one left manus and 7-11-14-15-16 (9-13-13-13-12) on left pes; very weakly developed interdigital webbing between digits (except IV and V). Relative length of digits: IV~III>V>II>I, IV>III>II>V>I (left manus); IV>V>III>II>I, V>IV~III>II>I (left pes). Original tail thick, cylindrical, circular in transverse section, distinctly constricted at base; scales on the tail similar to dorsals of body, slightly smaller, less regular, tail ending in a single pointed scale; shorter than SVL (unregenerated tail in CES09/1356: TL/SVL ratio 0.67). Tail beneath with imbricate, semicircular scales, much larger than body ventrals, no enlarged subcaudal plates.

Morphometric and meristic data: SVL 60.5, 33.4; TRL 24.8, 15.0; BW 13.6, 2.3; CL 10.0, 5.5; TL 40.5, 8.5*; TW 8.6, 3.2; HL 17.3, 10.2; HW 13.2, 7.5; HH 7.8, 5.0; FL 10.0, 5.2; OD 3.6, 2.2; NE 5.0, 2.8; SE 7.2, 4.2; EE 5.0, 3.2; IN 2.4, 1.5; IO 5.2, 3.3; Supralabials (L/R) 12(8)/11(8), 11(8)/ 10(8); Infralabials (L/R) 10/10, 10/9; Dorsal Scale Rows 21–22; Ventral Scale Rows 25–27; Lamellae (Manus L/R; Pes L/R) 8-11-11-13-11/8-12-12-13-11, 10-12-12-12-12/10-12-12-12-12; 7-11-14-15-16/6-11-12-+-15, 9-13-13-12-13/9-13-13-13-12/ [* = tail incomplete, + = digit missing].

Coloration in life.– Adult specimen with body dorsum orangey-brown with a series of large, almost black, chocolate brown dorsal blotches (Fig. 1A). Blotches oblong, arranged in four relatively symmetrical pairs between shoulder and sacrum, with a broad fused blotch across neck and a similar dark marking on the occiput. Flanks with an additional series of 4–5 dark blotches between fore and hind limb insertions. Tail dorsum with six dark blotches, distal three forming bands that alternate with the orangey-brown background colour. Small scattered dark markings between the larger dark blotches, similar such markings on proximal half of tail. Flank blotches continue along ventrolateral margin of anterior two thirds of tail. Limbs somewhat lighter in color than trunk with a series of brown bands (fore limbs) or blotches (hind limbs). Crown less orangey than body dorsum, bearing roughly symmetrical dark markings. Labial scales and sides of neck white with scattered dark markings. Venter white with dark mark-

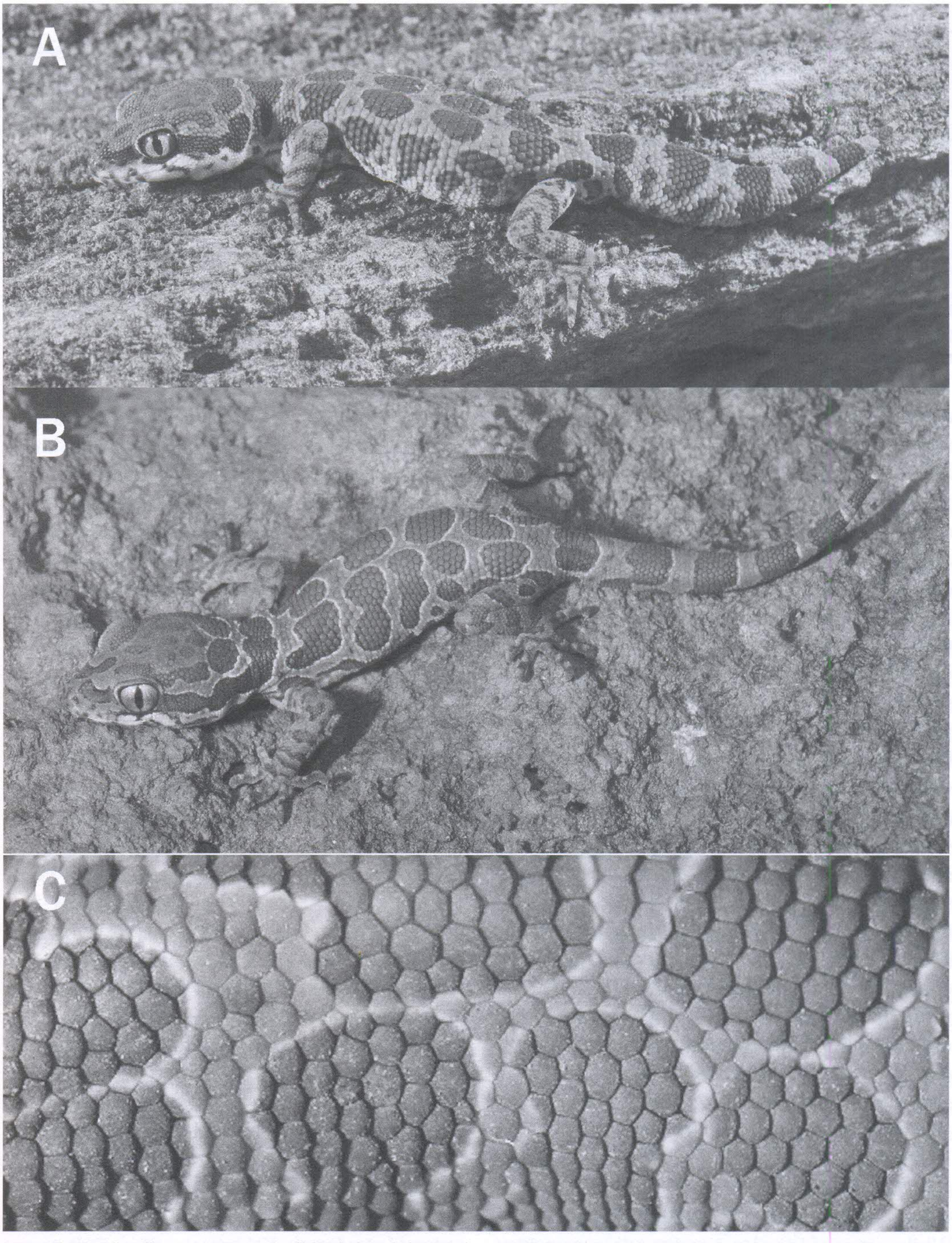

Figure 1. *Geckoella jeyporensis* in life. (A) Adult specimen CES09/1356. (B) Subadult specimen BNHS 2274. (C) Close up of dorsal scalation of BNHS 2274 showing the distinctive enlarged, flattened, hexagonal dorsal scales of this species.

ings under the chin and jaws, across neck, and along edges of flanks; remainder of venter immaculate. Tail venter pale dull yellow with five narrow incomplete brown bands proximally and five darker, more complete bands distally. Iris brass colored.

Subadult reddish medium brown with a series of large dark chocolate brown dorsal blotch-

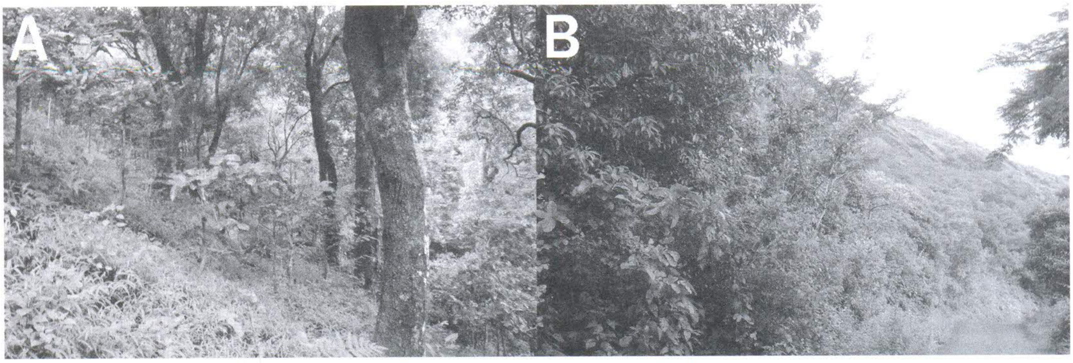

Figure 2. Semi-evergreen forest habitat of *Geckoella jeyporensis.* (A) Coffee plantation at Galikonda, Visakhapatnam District, Andhra Pradesh, India. Photo courtesy of V. Deepak. (B) Deomali, Koraput District, Odisha, India.

es, each outlined by a very thin light goldenrod to orange border. Blotches arranged in pairs, although these are asymmetrical and may be fragmented: one pair on occiput, one fused pair on the nape, confluent with a broad ventral postocular streak, 4 (right)–5 (left) pairs from shoulders to sacrum, and 6 blotches on tail, alternating with narrower medium brown interspaces; tail blotches with goldenrod border only on posterior margins (Fig. 1B). Limbs with much smaller, less distinct blotches that form bands; goldenrod borders only on larger blotches of hindlimb. Antorbital markings a deep brick red with dark brown margins. Dark supraocular and crown markings, as well as a dorsal postocular streak, present; colour of head markings grading from brick to chocolate brown from anterior to posterior. Labial scales whitish with scattered fine black dots, light orange-brown blotches and incomplete black crossbars; markings more prominent on anterior labials and left side more strongly pigmented than right. Throat white with black reticulations, underside of tail, margins of limbs, and flanks dirty, pale ochre with darker blotches thickly bordered by black; belly uniform off-white to grey. Iris bronze.

Distribution.– *Geckoella jeyporensis* was described from "Patinghe Hill", in the "Jeypore Hills", at an altitude of 4,200 ft. (1273 m). While we could locate Jeypore, a town in Koraput District of Odisha, we were unable to trace "Patinghe" on any available maps. About 50 km from Jeypore and 10 km from Deomali is Pottangi, a small town, around which the hills rise up to above 1,200 m. Based on elevation and location it is likely that the hill referred to as "Patinghe Hill" by Beddome (1877) is in the hill range around Pottangi. CES09/1356 was collected from Galikonda, near Arakku, Visakhapatnam District, Andhra Pradesh, India, which is within about 40 km of the type locality. BNHS 2274 was collected within about 10 km of the type locality, on the ascent to Deomali peak, near Jeypore, in Koraput District, Odisha. There are a few other high peaks (> 1,200 m asl) in this hill range where it is possible this species may occur.

Natural History.– CES09/1356 was collected from Galikonda which rises to about 1430 m asl, while the mountain on which BNHS 2274 was collected, Deomali, is the highest peak in Odisha, with a maximum elevation of 1672 m asl. CES09/1356 was collected from a coffee plantation that has mainly natural shade trees at an altitude of 1234 m asl (Fig. 2A) and BNHS 2274 was found in a patch of semi-evergreen forest habitat (Fig. 2B) at an altitude of 1240 m asl, while the holotype was collected in a "wood" at ~1273 m, suggesting that *G. jeyporensis* is a high elevation forest specialist. The high elevation forests at Galikonda are highly degraded and have been extensively converted to coffee plantations, only some of which have native shade trees. The plantations do not seem well maintained and there are small patches of native vegetation toward the fringes and near streams. At Deomali high elevation forests are restricted to pockets in depressions and sheltered areas, and have stunted trees, rich leaf litter and epiphytic growth. In both areas, the forests open into grasslands with *Pheonix* on the mountain-top (1300–1600 m asl). The average annual rainfall in Visakhapatnam District is about 1100 mm and 1255 mm in Koraput District (data from 1901–2002, http://indiawaterportal.org/met_data/).

CES09/1356 was spotted about 1.5 m above the ground on the trunk of a large tree at ~21h00 in the course of an hour-long search by five team members. The same area was searched for about 8–10 hours by three team members during the day and night in 2010, during which no specimens of *Geckoella jeyporensis* were observed, though a few specimens of *G. nebulosa* were located. BNHS 2274 was found during the day under a rock in a small patch of forest in the course of about three hours of searching by four team members, during which time two specimens of *Geckoella nebulosa* were also found. The same area was searched at night for about two hours by the same team and no specimens of *G. jeyporensis* were observed, although an additional specimen of *G. nebulosa* was spotted. *Sepsophis punctatus* and *Eutropis macularia* were also found at Galikonda and *Lygosoma punctata* at Deomali.

Comparison with published information on the holotype.– Though the original description of *Geckoella jeyporensis* (Beddome 1877) as well as two subsequent descriptions of the same specimen (Boulenger 1885; Smith 1935) are all brief, a fairly specific type locality is given, and a number of diagnostic characters are provided that allow us to confidently assign both CES09/1356 and BNHS 2274 to this species. Both specimens are from fairly close to the type locality and were collected from forest habitat above 1200 m (Beddome 1877). The distinctive dorsal pholidosis seen in the new specimens and described by Beddome (1877) is unlike that of any other Indian gecko, and is diagnostic of *G. jeyporensis*. Additional characters listed by Beddome (1877), Boulenger (1885), and Smith (1935) that CES09/1356 and BNHS 2274 share (holotype characters followed by variation seen in CES09/1356, BNHS 2274 in parantheses) include the lack of pores in males, subcaudals larger then belly scales, 18 dorsal scale rows (21–22, 21–22), 27–30 ventral scale rows (27–30, 25–27). CES09/1356 and BNHS 2274 differ from the holotype in the following characters (CES09/1356, BNHS 2274 vs. holotype): dorsal scale rows (21–22 vs. 18; possibly reflecting a difference in rows included in the count), number of supralabials (12/11, 11/10 vs. 10), number of infralabials (10/10, 10/9 vs.7). At 60.2 mm SVL the newly collected adult is about 11% larger than the holotype (54 mm SVL).

Discussion

The phylogenetic affinities of *Geckoella jeyporensis* are difficult to comment upon. There are two broad groups of *Geckoella* based on dorsal scalation, however, a close examination of CES09/1356 and BNHS 2274 reveals that the dorsal scalation of this species (Fig. 1C) is unlike any other *Geckoella* species and is, in fact, unique among Indian geckos. *Geckoella jeyporensis* is distributed in high elevation, semi-evergreen moist forests within the arid Eastern Ghats, which are a broken chain of mountains across the east coast of India with predominantly scrub or deciduous forests. Two other species of *Geckoella* are distributed in the Eastern Ghats. *G. collegalensis* is found in deciduous and scrub forests across mainly western and southern Peninsular India (Mirza *et al*. 2010), extending into the southern part of the Eastern Ghats in Andhra Pradesh and Tamil Nadu. *G. nebulosa* is widely distributed across the Eastern Ghats from about 17.6° N to 22.3° N (Agarwal 2007) and occurs in a variety of habitats. *Geckoella jeyporensis* is sympatric with *G. nebulosa* at both Galikonda and Deomali, and is nested within the range of this species, and thus may represent a case of peripatric speciation (Coyne & Orr 2004). Additionally, the enlarged dorsal scales are relatively homogenous, and could conceivably be derived from or related to the homogenous granular scales of *G. nebulosa*. Alternatively, *G. jeyporensis* could be a wet zone relict, persisting in its moist high elevation habitat through the aridification of peninsular India (Karanth 2003), and may have affinities to the wet zone species. However such conclusions are highly speculative, and molecular phylogenetic data as well as more accurate distributional data are needed for a true understanding of the relationships among members of the genus *Geckoella*.

In some ways, the rediscovery of *Geckoella jeyporensis* is symptomatic of herpetological research in India. There are a number of species that have not been recorded since their original descriptions or are known from few localities around the type locality (2011 IUCN Western Ghats reptile assessment, unpublished data), while the recent past has seen rediscoveries and new descriptions of many reptiles and amphibians (Gower *et al.* 2004; Mistry *et al.* 2007; Giri 2008; Mahony 2009; Seetharamaraju *et al.* 2009; Agarwal *et al.* 2010; Scheffers *et al.* 2011; Vogel & Rooijen 2011). While some of these species may be intrinsically rare, range-restricted or infrequently encountered due to ecological traits such as seasonality, fossoriality or arboreality (high canopy species); many so-called lost species have simply not been searched for by trained field biologists. This underscores the need for basic biodiversity inventory across India, especially in areas that have been relatively less studied such as the Eastern Ghats. This rediscovery was after a few hours of intensive fieldwork by a team with considerable field experience, though similar searches by other competent teams have not been successful (P. Mohapatra pers. comm.), and we also failed to locate *G. jeyporensis* at Galikonda in 2010.

The forest habitats in which *Geckoella jeyporensis* was found are under extreme anthropogenic pressures. Neither area in which the new material was collected is formally protected and both have been severely deforested. Galikonda and the surrounding hills have also been extensively converted to coffee plantations, while Deomali faces grazing and fuel wood collection pressures. More broadly, the hills in Koraput District face pressures from mining as well as social forestry activities (P. Mohapatra pers. comm.). Even if it is widely distributed in the region, the potential habitat available to *G. jeyporensis* may be restricted by its presumed habitat preference (semi-evergreen forests >1200 m asl). Many of these areas have been converted to plantations, agriculture or grazing lands, further reducing the potential habitat for this species. Deomali and Galikonda, the only localities from where *Geckoella jeyporensis* is definitely known, require immediate protection and surveys in the region are needed to determine where else *G. jeyporensis* occurs.

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New records of snakes and lizards from Bhutan

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ABSTRACT.– Ten snake species (*Ramphotyphlops braminus, Python bivittatus, Lycodon fasciatus, Lycodon aulicus, Lycodon jara, Rhabdophis subminiatus, Chrysopelea ornata, Dendrelaphis tristis, Naja naja, Trimeresurus albolabris*) and two lizards (*Gekko gecko* and *Sphenomorphus maculatus*) are reported for the first time from Bhutan. With the exception of a few species, most are from the Sarpang District. Data were collected opportunistically and georeferenced.

KEYWORDS.– Snakes, lizards, distributional records, Bhutan

Introduction

Bhutan is a landlocked Himalayan country, lying between two Asian giants, China and India. A large part of the country is comprised of mountains and valleys, located on the southern slopes of the Eastern Himalayas. A majority of the Bhutanese are Buddhists and consider reptiles (especially snakes) as animals that represent anger and jealousy. They also believe that snakes represent deities which live underground, and prefer not to disturb them. Therefore, most people choose to keep away from reptiles, and it has generally been presumed locally that the country does not require separate measures for reptile conservation. Conservation is further hindered by a lack of resources, inclusive of personnel (Das 1998; Das & Palden 2000; Das & Palden 2001; Wangyal 2011). Consequently, information relevant to reptiles continues to be inadequate for conservation and management. Recent studies in Bumdeling Wildlife Sanctuary (BWS) have revealed a number of new records for Bhutan (Wangyal 2011). Past research on reptiles of Bhutan include those of Bustard (1979 1980a 1980b) who reported on status of crocodiles, a report of a new species of agamid, *Calotes bhutanensis* (Biswas 1976), a report on the herpetofauna based on an old collection (Bauer & Günther 1992), a report on a collection of reptiles and amphibians from southern Bhutan (Das & Palden 2000), and two studies of reptile diversity at BWS (Wangyal & Tenzin 2009; Wangyal 2011). In this paper, I report the occurrence of 10 snake species and one lizard from the Himalayan Kingdom of Bhutan (Fig. 1). For each of these records, I provide a digital photograph, georeferenced locality data and details of pholidosis, using the Dowling system, when relevant. I also provide information on where some of the collected materials are archived.

Materials and Methods

After the publication of a regional reptile report (Wangyal & Tenzin 2009) of Bumdeling Wildlife Sanctuary (BWS), Trashiyangtse, collection of information on the reptiles found in Bhutan was continued by the field staff of the Department of Forests and Park Services, who were encouraged to gather data whenever they came across reptiles. Photographs and data reported here, therefore, are derived from opportunistic encounters of reptiles by several different individuals, and the quality of data collection varies considerably. For the identification of species, references used include Das (2002), Smith (1935 1943), Whitaker and Captain (2004) and Ahmed *et al.* (2009). Digital images of species reported are archived at the College of Natural Resources, Royal University of Bhutan. For lack of a standardized system to allocate e-voucher numbers, digital copies of the images are maintained by the author and the Department of Forestry, Faculty of Forestry at the College under the Royal University. GPS datum used is WGS 84.

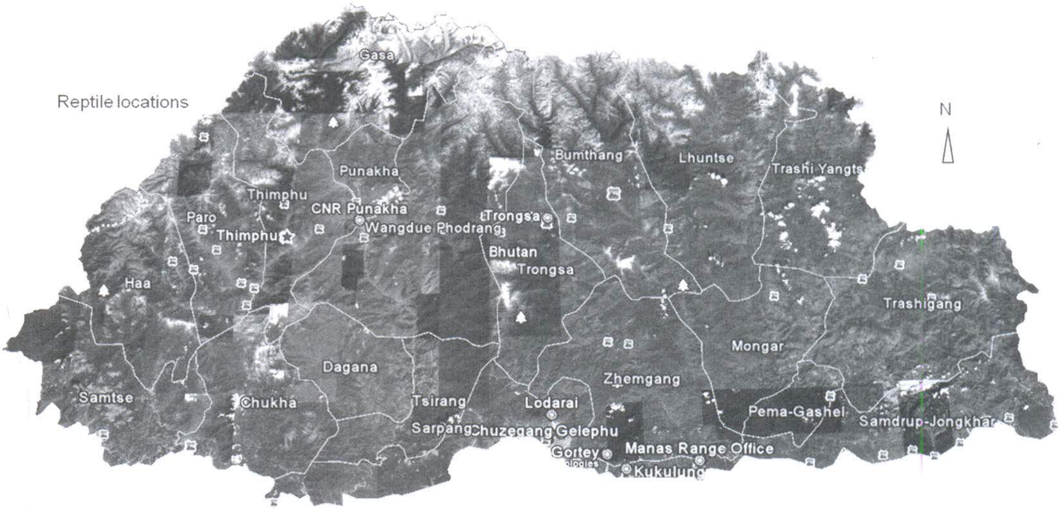

Figure 1. Political map of Bhutan, showing localities mentioned in text. Image from Google Earth prepared by author.

Results

Information on 10 species of snakes and two lizards was collected from different parts of the country (Fig. 1), the details of which are given below.

Typhlopidae

Ramphotyphlops braminus **(Daudin, 1803), Brahminy worm snake.–** A dead snake (Fig. 2) was observed at the College complex (27°30’13.17”N, 89°52’41.26”E) at 13h46 on 27 March 2009 at an altitude of 1406 m asl, Punakha District. Specimen maintained at the College laboratory. The species can be found on the campus any time between March and June in the flower gardens, kitchen gardens, and elsewhere. Introduced worldwide, it is known from the whole of the subtropical and tropical parts of Asia (Das 2002; Whitaker & Captain 2004; Ahmed *et al.* 2009).

Pythonidae

Python bivittatus **Kuhl, 1820, Burmese rock python.–** An individual (Fig. 3) was found by a staff member of Royal Manas National Park from an unspecified locality in 2006. Subsequently, two individuals were spotted in the Sarpang District, one at Gortey (26°48’47.09”N, 90°40’28.72”E) on 29 March 2011, and one at Kanamakura (26° 48’51.65”N, 90°40’18.16”E), at an altitude of 245 m asl on 15 February 2011. This species is reported from India from the Terai and eastern India (Das 2002), as well as from Nepal, Bangladesh, China and Southeast Asia (Whitaker & Captain 2004). It was previously reported from

Figure 2. *Ramphotyphlops braminus*, College of Natural Resources compound 1406 m asl Photograph by D. B. Gurung, Faculty of Forestry.

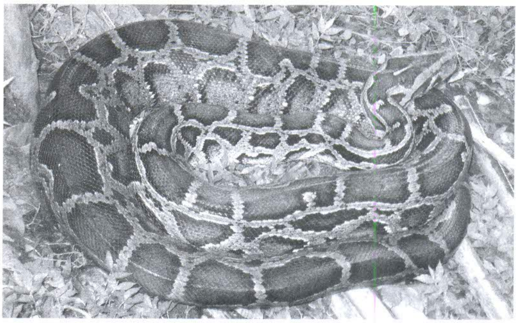

Figure 3. *Python morulus bivittatus*, Kanamakura, Sarpang District, South Bhutan, 245 m asl. Photograph by Sonam Wangdi.

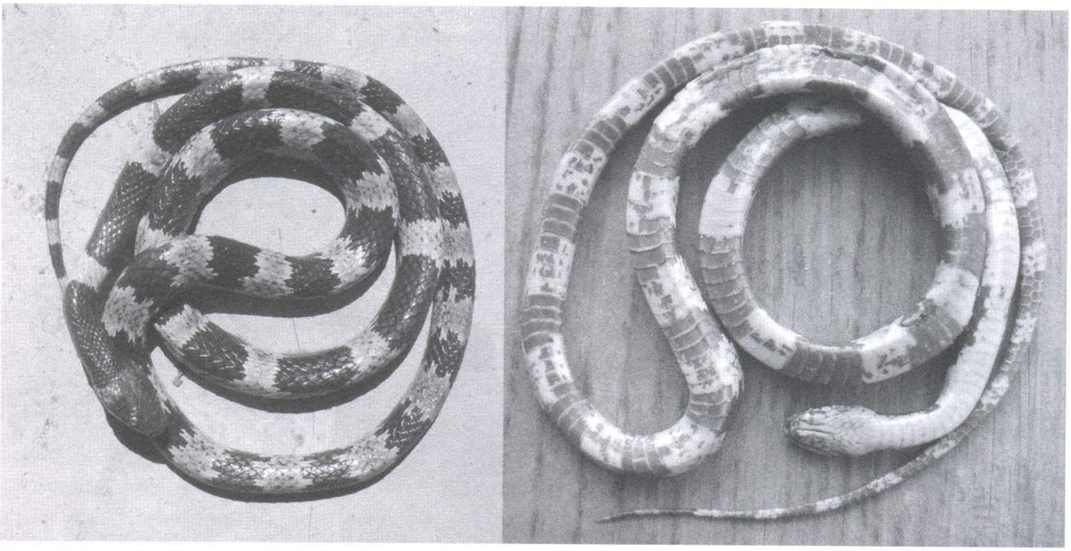

Figure 4. *Lycodon fasciatus* (dorsal and ventral views), Trongsa, Trongsa District, Central Bhutan, 2073 m asl. Photograph by author.

an unspecified location from Bhutan (Ahmed *et al.* 2009). This report authenticates their claim of its presence in Bhutan.

Colubridae

Lycodon fasciatus (Anderson, 1879), Banded wolf snake.– A road-killed specimen (Fig. 4) was collected by Tashi Wangchuk, a Bhutanese naturalist in the monsoon of 2005 from Trongsa (27°30'02.99"N, 90°30'18.36"E), at an altitude of 2073 m asl and was deposited at the headquarters of Jigme Singye Wangchuck National Park, Tshangkha, Trongsa District. The specimen has 37 white bands including the white tail part until the tip. The loreal touches the eye. The measurements of the specimen are SVL 560 mm, TL 142+ mm. Pholidosis. Body scales smooth, in 17:17:15, rows; ventrals 208; subcaudals 67+, paired; anal undivided. The specimen is preserved in the laboratory of Bumdeling Wildlife Sanctuary. This species has been reported from India (Assam), Myanmar, Thailand, Laos, Vietnam, China (Boulenger 1890), and southwest Cambodia (Daltry & Wüster 2002). This is the first record for Bhutan.

Figure 5. *Lycodon aulicus*, College of Natural Resources compound 1406 m asl. Photograph by D. B. Gurung

Lycodon aulicus (Linnaeus, 1758), Common wolf snake.– This is one of the most common snakes on the College of Natural Resources campus, and is seen frequently from March until September. The location of collection is as reported for *Ramphotyphlops braminus* above. It has been recorded from throughout Pakistan, India, Bangladesh, Nepal, Sri Lanka, Myanmar (Das 2002; Whitaker & Captain 2004). The specimen photographed (Fig. 5) was found on the college campus at 21h30 on 16 September 2008. A specimen is preserved at the College of Natural Resources laboratory.

Lycodon jara (Shaw, 1802), Yellow-speckled wolf snake.– An individual (Fig. 6) was seen in Gelephu town, Sarpang District (26°52'28.08"N, 90°29'43.09"E) at 17h50 on 16 April 2011, at an altitude of 255 m asl. The species is reported from the states of Orissa, West Bengal, Arunachal Pradesh and Uttarkhand of the Indian Union, and is also known from Nepal and Bangladesh (Whitaker & Captain 2004).

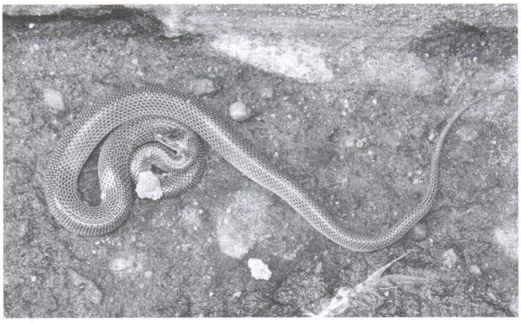

Figure 6. *Lycodon jara*, Gelephu town, 255 m asl. Photograph by Dorji Wangchuk.

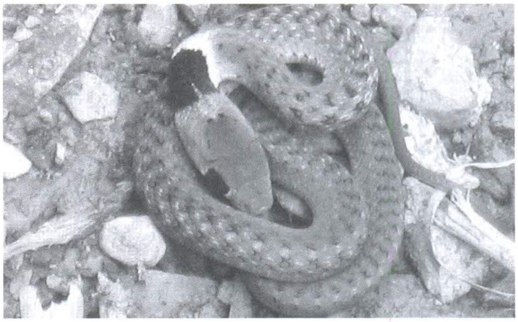

Figure 7. *Rhabdophis subminiatus*, Kanamakura, 271 m asl. Photograph by D. S. Rai.

Rhabdophis subminiatus **(Schlegel, 1837), Red-necked keelback.–** An individual (Fig. 7) was found resting on the river bed, with fallen leaves, at Kukulung within the Kanamakura Range, Royal Manas National Park, Sarpang District (26°46'22.09"N, 90°43'58.01"E) at an altitude of 271 m asl at 15h00, on 11 April 2006. Field staff of the Royal Manas National Park report the species as encountered occasionally. In India, it has been reported from Sikkim, Assam and Arunachal Pradesh. The species is also found in Nepal, China, Thailand, Cambodia, Laos, Peninsular Malaysia, Indonesia and Vietnam (Whitaker & Captain 2004).

Chrysopelea ornata **(Shaw, 1902), Ornate flying snake.–** There are many undocumented reports of this species (Fig. 8) from Royal Manas National Park, Sarpang District, 124 m asl. An individual was found trying to enter the elephant shed at the Range office (26°47'32.04"N, 90°57'39.33"E) on 20 October 2006, at 13h47. This species has been reported from the foothills of Himalayas, Uttar Pradesh, south Gujarat, Western Ghats and northeast India. It is also found in Nepal, China, Sri Lanka, Bangladesh, and mainland Southeast Asia (Schleich & Kästle 2002).

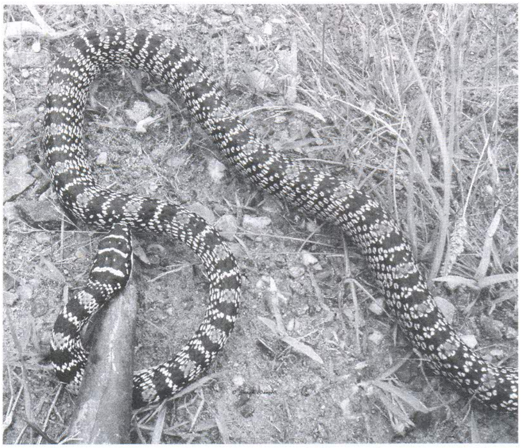

Figure 8. *Chrysopelea ornata*, Manas Range Office, 124 m asl. Photograph by Sonam Wangdi.

Dendrelaphis tristis **(Daudin, 1803), Common bronzeback tree snake.–** An individual (Fig. 9) was found dead below the road in Gelephu, Sarpang District (26°52'45.8"N, 90°29'22.5"E), at an altitude of 258 m asl on 20 September 2011. The species was identified by the two parietal spots, a vertebral stripe on the anterior part of the body and ventrolateral stripes. Outside of Bhutan, the species is found in neighbouring Nepal, India, Pakistan, Bangladesh and Sri Lanka (Das 2002).

Elapidae

Naja naja **(Linnaeus, 1758), Spectacled cobra.–** An individual (Fig. 10) was found in the irrigation channel at Chuzegang, Sarpang District (26°52'26.4"N, 90°31'59.6"E), at an altitude of 238 m asl on 18 January 2011 at 14h42. The species is found throughout mainland In-

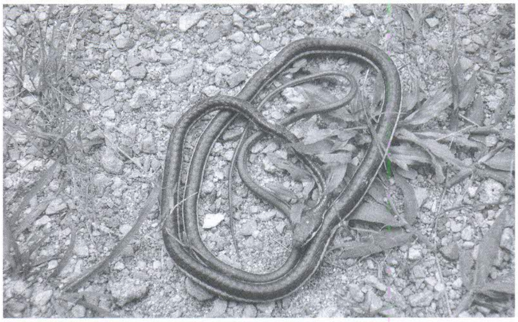

Figure 9. *Dendrelaphis tristis*, Gelephu 258 m asl. Photograph by Dorji Wangchuk.

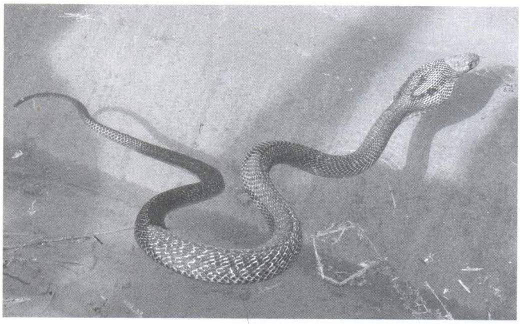

Figure 10. *Naja naja naja*, Chuzegang 238 m asl. Photograph by Dorji Wangchuk.

dia, Pakistan, Sri Lanka, Bangladesh and Nepal (Whitaker & Captain 2004).

Viperidae

Trimeresurus albolabris **Gray, 1842, White-lipped pit viper.–** Two individuals of this species were observed chasing each other by a staff member near Manas Range on 27 September 2006 at 07h55 , whereas a road-kill was found at Lodari, Sarpang District (26°55'29.6"N, 90°30'19.10"E), on 16 March 2010. A third specimen (Fig. 11) was observed on 7 October 2010 at 07h31 in Gelephu, Sarpang District. In India it has been reported from West Bengal and Assam states (Whitaker & Captain 2004). It is also found in China, Bangladesh, Myanmar, Laos, Cambodia, Thailand, Vietnam and Indonesia (Whitaker & Captain 2004).

Figure 12. *Gekko gecko*, near Manas Range 180 m asl. Photograph by D. B. Gurung

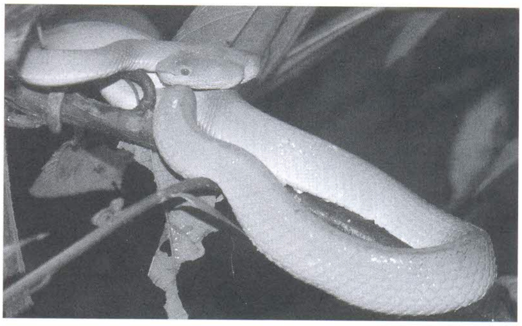

Figure 11. *Trimeresurus albolabris*, near Manas Range 148 m asl. Photograph by Dorji Wangchuk.

Gekkonidae

Gekko gecko **(Linnaeus, 1758), Tokay gecko.–** This species (Fig. 12) is known from Bihar, West Bengal, Assam and Tripura in India and also Nepal, Bangladesh, China, Southeast Asia (Das 2002). It was found in Manas (26°47'35.55"N, 90°57'42.91"E) at an altitude of 180 m asl on 28 April 2008 at 12h00.

Scincidae

Sphenomorphus maculatus **(Blyth, 1853), Spotted litter skink.–** This species is fairly common in Manas close to the Forest Range Office complex. Of many observations, one individual (Fig. 13) was seen in the forest, not far from the office (26°47'40.45"N, 90°57'27.59"E) at an altitude of 150 m asl on 17 August, 2010 at 08h30. The literature mentions its presence in Bhutan (Ahmed *et al.* 2009), without specific location besides Northeast and north India including the Andaman and Nicobar Islands (Das 2002). The species is also found in Southern China, Nepal and Southeast Asia (Das 2002).

Figure 13. *Sphenomorphus maculatus*, near Manas Range 150 m asl. Photograph by Dorji Wangchuk

Discussion

Amphibians and reptiles are among the least studied faunal groups in Bhutan, and there are no specific conservation programmes. Even *Calotes bhutanensis* (Biswas 1976), an endemic species, is not included in the list of protected plants and animals in the Forest and Nature Conservation Act of Bhutan, 1995. However, all wildlife species of the Kingdom are deemed safe owing to the overall commitment in the nature conservation acts and rules of Bhutan which give protection to wildlife as a whole. *Ramphotyphlops braminus*, a cosmopolitan species, is reported here for the first time from Western Bhutan. The records of *Lycodon aulicus* and *L. jara* from southern Bhutan are expected, as they are also found in the adjacent Indian state of Assam. However, the presence of *Lycodon fasciatus*, a Chinese element from Central Bhutan, is significant in the sense that it occurs relatively far from the international boundaries with India and China. Other snakes, such as *Rhabdophis subminiatus*, *Chrysopelea ornata* and *Dendrelaphis tristis,* are also expected in Bhutan, as they are reported from northeast Indian states. *Cryptelytrops albolabris*, which is found in West Bengal, is also a new record for Bhutan, and *Gekko gecko*, an element of eastern and northeast India, is also formally reported for the first time. With the exception of *Ramphotyphlops braminus* and *Sphenomorphus maculatus* reported from southern Bhutan (Bauer & Günther 1992), and *Naja naja* (Das & Palden) also from southern Bhutan, I consider all species reported in this paper as new records for Bhutan since there are no formal papers or voucher specimens to reliably document their past occurrences in the Kingdom. Further, this report authenticates the presence of *Python bivittatus* (fide Whitaker & Captain 2004) in Bhutan, which was otherwise recorded without any specific locations.

Although the study of the herpetofauna of Bhutan has received no focused attention until now, with young foresters taking up the subject, it is expected that the group will receive a research boost in the near future.

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Insight into hemipenial morphology of five species of *Hemidactylus* Oken, 1817 (Reptilia: Gekkonidae) of Guwahati, Assam, India

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ABSTRACT.– **In this paper we present comparative hemipenial morphology of five Hemidactylus species, namely *Hemidactylus aquilonius, H. brookii, H. frenatus, H. flaviviridis* and *H. platyurus* of Guwahati city of Assam, India**

KEYWORDS.– ***Hemidactylus*, Hemipenis, Assam, India**

Introduction

The morphology of the copulatory organ in the reptiles is of great interest both taxonomically as well as in reproductive biology (Dowling 1967; Arnold 1986a; Zhang 1986; Malnate 1990). Male squamates have a pair of such intromittant copulatory organs, the hemipenes (Eberhard 1985; Arnold 1986a; Arnold 1986b). These are pocket like structures that are stored retracted in an inside out position at the base of the tail. When everted, a groove on one of its surface, the sulcus spermaticus, can be observed. This groove transports sperm from the cloaca of the male to the female. The hemipenis also shows different ornamentation in different species. In retracted state, the sulcus spermaticus and the ornamentation of the hemipenis is in the inner side of the blind tube (Cope 1896).

Hemipenis structures serve as indicator of taxonomic identity of squamate reptiles (Keogh 1999). As hemipenis morphology has no correlation with diet, ecology, etc. (Dowling 1967; Böhme 1971; Arnold 1986b; Branch 1986; Klaver & Böhme 1986; Böhme 1988), it is believed to be an excellent tool for studying phylogenetic relationships.

Earlier work on hemipenis morphology was carried out for several families of lizards (e.g. Cope 1896; Rosenberg 1967; Böhme 1971; Presch 1978; Branch 1982; Klaver & Böhme 1986; Böhme 1988; Card & Kluge 1995; Glaw et al. 2006; Rösler & Böhme 2006; Maduwage et al., 2008) and snakes (e.g. Pope & Pope 1933; Pope 1935; Smith 1943; Mao et al. 1984; Guo et al. 1999; Keogh 1999; Guo 2000; Guo & Zhang 2001).

Hemipenis morphology of gekkonids in general is characterized as having a more or less club-shaped trunk, a pedicel, and a voluminous apex. In several geckos the apex has two lobes (Böhme 1988; Rösler 1998). Although previous work on the hemipenis morphology of several gekkonid genera has been carried out (Glaw *et al.* 2006; Rösler & Böhme 2006), there are relatively few studies focused on the hemipenial morphology of the genus *Hemidactylus* Oken, 1817. In India, prior to this study, the courtship, mating behaviour, and hemipenis structure of *Hemidactylus flaviviridis* has been investigated (Mahendra 1953).

The genus *Hemidactylus* is represented by five species in Assam: *H. frenatus* Schlegel, 1836; *H. aquilonius* McMahon and Zug, 2007; *H. flaviviridis* Rüppell, 1835; *H. brookii* Gray, 1845 and *H. platyurus* (Schneider, 1792). Although they are one of the most common types of lizards found in the region, this genus has been little studied. In this paper we present a preliminary comparative study of the hemipenis morphology of species in the genus *Hemidactylus* found in Assam.

Materials and Methods

This study was conducted in Guwahati (26°11'9"N, 91°44'51"E), Assam, India. The adult male specimens of *Hemidactylus* were collected for this study. The lizards were euthanized and their hemipenes fully everted by injecting water through the tail, eight subcaudals away from the base. The measurements on the everted hemipenis were taken immediately, prior to fixing the specimen. The specimen were fixed and stored in 10% formaldehyde. Measurements of different parameters (in mm) were taken using Mitutoyo dial calliper (0.02mm precision). The fully everted hemipenis, the asulcal surface, and sulcal surface were photographed. The following morphometric measurements were taken for comparison: HPL= hemipenis length, HPW= hemipenis width, LL= lobe length, LW= lobe width, ROB= region of bifurcation, SVL= snout to vent length of the specimen, TL= tail length. The characteristic features and classification of the hemipenes were done as per Dowling and Savage (1960).

Results

The structure of the hemipenis in the genus *Hemidactylus* is bilobed and cylindrical. The organ is stout, and is comprised of a base, pedicel (stalk), and head. Bilobed organs are formed when the hemipenis is divided, at the apex only, and for a distance which is lesser than the undivided basal segment. The lobes are, in most cases, a distinguished portion of the trunk which is more swollen. Presence of ornamentation at the apex is limited to *H. aquilonius* and *H. brookii*. In most cases the entire organ is also devoid of any ornamentation. The sulcus spermaticus is a longitudinal groove, present on the outer surface of the hemipenis. The sulcus spermaticus bifurcates in all the five species we examined. However, the route of entry of the sulcus to the lobe head shows some variation in these five species.

A summary of hemipenial morphology of five species of *Hemidactylus* of the study area

1)– *Hemidactylus aquilonius* McMahan and Zug, 2007

The hemipenis of *H. aquilonius* is bilobed, elongated, and almost bow shaped. Its trunk or pedicel is long and ends in a voluminous bilobed head covered with numerous small papillae. The width of the lobe is more than half of its length. The sulcus spermaticus is bifurcated and passes around to the asulcal surface before entering the head of the lobes. The region of bifurcation of the sulcus spermaticus is almost one third of the total length of the hemipenis, the width is more than half of its length. The sulcus spermaticus also shows a branching pattern at the lobe head. An unusual feature observed in case of *H. aquilonius* is the presence of a tissue joint in between the two lobe heads. In a fully everted hemipenis this tissue joint assumes a conical shape. The organ is totally devoid of any other ornamentation on its trunk or pedicel (see Table 1, Fig. 1 [IA, IB, IC]).

2)– *Hemidactylus brookii* Gray, 1845

The hemipenis of *H. brookii* is fleshy and bilobed. The lobes are almost round in shape and clearly distinct from the pedicel. The pedicel is stout with very few transverse ridges. The

Table 1. A table showing comparative morphometry of hemipenis to the corresponding body size of five species of *Hemidactylus* of Assam.

Specimen	HPL	HPW	LL	LW	ROB	SVL	TL
H. aquilonius	5.24	3.52	2.66	1.72	2.46	48.14	52.72
H. brookii	7.1	3.64	2.56	2.92	2.34	56.72	73.14
H. frenatus	6.6	4.92	2.52	1.9	2.26	56.94	61.24
H. flaviviridis	7.18	4.6	4.46	3.44	0.26	75.82	93.54
H. platyurus	8.12	3.7	2.14	1.72	1.72	55.18	58.52

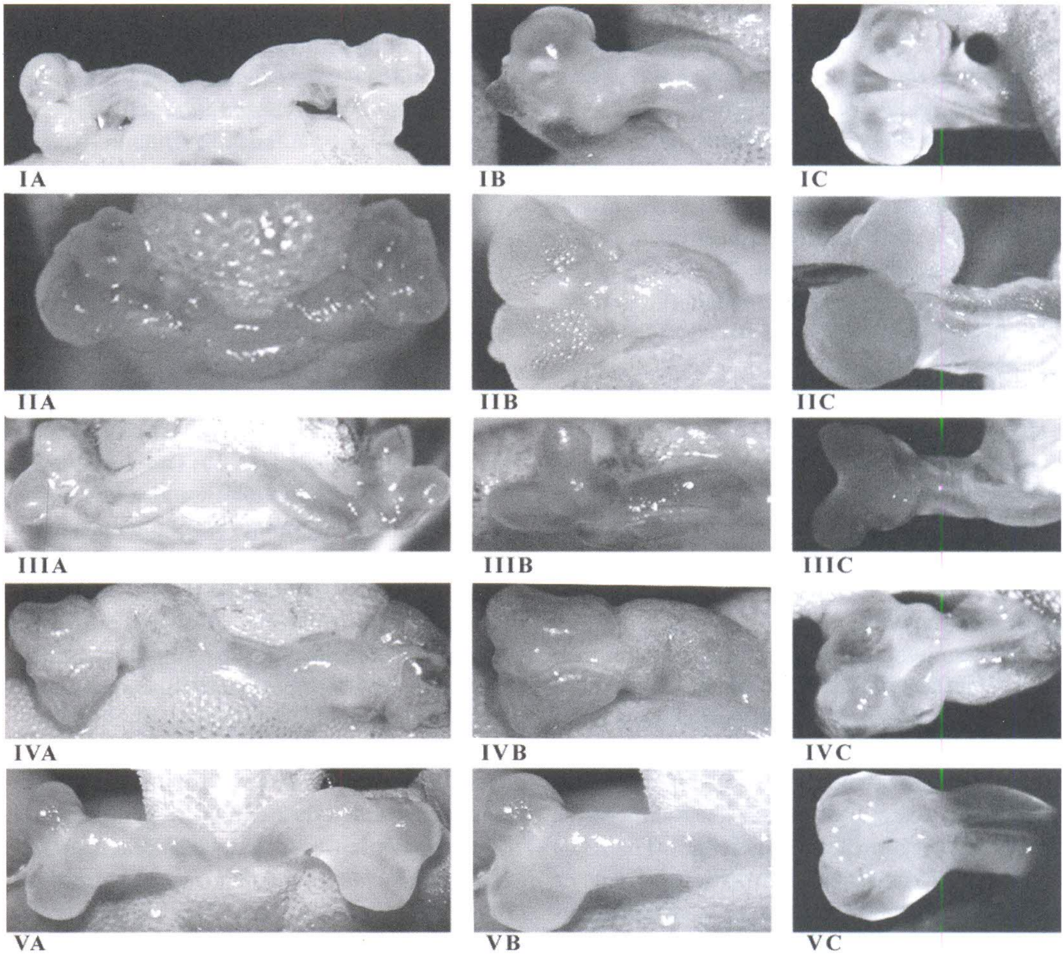

Figure 1. A figure showing hemipenial morphology (A: Fully everted hemipenis, B: asulcal view and C: sulcal view) of five species of *Hemidactylus* geckos (I: *Hemidactylus aquilonius*, II: *H. brookii*, III: *H. frenatus*, IV: *H. flaviviridis* and V: *H. platyurus*) of Guwahati, Assam, India.

length of the organ is greater than its width. The sulcus spermaticus starts from the base of the pedicel at a median point and traverses the entire length of the organ upto the region of bifurcation (ROB). It bifurcates from the ROB and enters the lobe head. The sulcus spermaticus does not coil as it enters the lobe head, but enters the lobe head laterally dividing each lobe into equal halves. The lobe is wider than long and spinose. Spines are present on the lobe head. The asulcal surface also displays spines and these are greater in number than on the sulcal surface (see Table 1, Fig.1 [IIA, IIB, IIC]).

3)– *Hemidactylus frenatus* Schlegel, 1836

The hemipenis in *H. frenatus* is bilobed and the apex of the lobes is symmetrically divided and fleshy. The apex is almost smooth with little to no spines, which become more sparse towards the base. The head of the lobe is nude (devoid of any ornamentation). The pedicel is stout and without embellishments. There are no calyces or cardioid structures present. The length of the entire organ is greater than its width and the lobe is longer than wide, though not elongated. There are no hooks or other accessory structures towards the base. The sulcus spermaticus is bifurcated, traverses the entire length from the base, and stops a little way below the region of bifurcation. The sulcus spermaticus enters the lobe head laterally up to its tip (see Table 1, Fig.1 [IIIA, IIIB, IIIC]).

4)– *Hemidactylus flaviviridis* Rüppell, 1835

The hemipenis of *H. flaviviridis* is short and stout. The organ is almost a whole organ with a stout pedicel. The lobe length is very short with an extremely small region of bifurcation, making the lobe quite undefined. The lobe is wide and fleshy. The entire organ is smooth and devoid of any kind of ornamentation. The sulcus spermaticus bifurcates at the base of the lobe and takes an almost ninety degree turn before rising up to the lobe head. The head of the lobe is nude .The sulcus spermaticus also longitudinally splits the lobe head while passing through it, thereby dividing each lobe into two equal halves (see Table 1, Fig.1 [IVA, IVB, IVC]).

5)– *Hemidactylus platyurus* (Schneider, 1792)

The hemipenis of *H. platyurus* is longer than other *Hemidactylus* species of the region, despite its size. The organ is bilobed and the lobes are very distinct. The trunk is smooth and devoid of any ornamentation. The lobe head is almost round, nude, and smooth. The width of the lobe is almost one third of its length. The ROB is adequate. The sulcus spermaticus bifurcates from the ROB and assumes a "V" shaped pattern to enter the lobe head almost directly (see Table 1, Fig. 1 [VA, VB, and VC]).

Discussion

The hemipenis morphologies exhibited by the five species of *Hemidactylus* of Assam are similar in their basic structure. All are bilobed andpossess a trunk, pedicel, and voluminous apex. The apex is bilobed and the lobe heads in all the examined species are nude. However, the head displays spines, particularly in case of *H. brookii* and *H. aquilonius*, although in *H. aquilonius* the head is more papillate. *H. flaviviridis*, despite being the largest *Hemidactylus* of the region, has an organ proportionately smaller than the others. In *H. flaviviridis* HPL/SVL is 0.0946, whereas it is 0.1088 in *H. aquilonius*, 0.1159 in *H. frenatus*, 0.1251 in *H. brookii*, and 0.1471 in *H. platyurus*. There is little to no ornamentation in all the species, though if present it is typically restricted to spines and papillae. The lobe head of *H. flaviviridis* does display a curve, though they cannot be attributed to flounces.

The sulcus spermaticus shows interesting routes to the lobe head and its tip. In *H. platyurus* it is almost a "V" shaped structure from the ROB, whereas in *H. flaviviridis* an almost ninety degree turn occurs at the entrance the lobe head. In *H. aquilonius* the sulcus spermaticus takes a deviated path around to the asulcal surface before entering the head of the lobes. We have not observed coiling of the sulcus in the lobe head in any other species examined so far. The hemipenis of *H. aquilonius* also exhibits a cone shaped structure at the junction of the two lobe heads (see Fig.1 IB, IC). This structure has not been observed in the other species, in fully everted condition, though a rudimentary tissue patch may be seen in case of *H. brookii.* Based on hemipenial observations of these species we conclude that *H. frenatus, H. aquilonius* and *H. platyurus* have the most similar hemipenis morphology, which consists of the shape of the organ being elongated with a comperatively longer pedicel. *H. brookii* and *H. flaviviridis* have somewhat shorter, fleshier, and stouter hemipenes with a shorter relative pedicel length. The hemipenis of *H. brookii* differs from that of *H. flaviviridis* by having a spinose head (see Fig. 1). These results are somewhat consistent with recent phylogenetic findings for tropical Asian *Hemidactylus* (Bauer *et al.* 2010), which suggest that *H. platyurus* and *H. aquilonius,* which share similar hemipenis morphology, are indeed closely related. However, there is not a direct correlation between genetic relatedness and genital morphology for the other congeners studied.

Several authors have debated whether the copulatory organs like hemipenes differ from other organ systems in an evolutionary context. These organs seem to retain their structure through the course of evolution and thus are deemed more stable (Arnold 1986b).This may be due to the fact that these organs are located internally and are less likely to be affected by external morphological changes. Additionally, it is likely that these structures are unaffected by changes in niche (Arnold 1986b). Seasonal hemipenial variation is common among lizards, but has not yet been demonstrated for geckos;

seasonal hemipenial variation is known from many lacertids, some iguanids, and some species of chameleon (Böhme 1988). Overall, hemipenial structures have proved to be an excellent indicator of relationships between various taxa (Arnold 1986a; Arnold 1986b) making detailed hemipenial studies all the more imperative and valuable.

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Varanus salvator swallowing a catfish – another facet of the life-dinner principle?

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ABSTRACT.– Recurrent laborious attempts by *Varanus salvator* to swallow a walking catfish (*Clarias* sp.) posterio-anteriorly are described. This feeding behaviour is interpreted as a trade-off between immediate gains, i.e. a presumably easy and quick anterior-posterior swallowing and a laborious and lengthy posterior-anterior swallowing, but more secure in the long-run, i.e. in cases of emergency, an anterio-posteriorly swallowed catfish may not be ejected or regurgitated quickly enough (or not at all) due to the backwards pointing spines of the pectoral fins. This trade-off is interpreted as another facet of the life-dinner principle unrelated to its original implication in predator-prey coevolution.

KEYWORDS.– coevolution, feeding behaviour, ecology, prey handling, Thailand.

The term "life-dinner principle" was coined by Dawkins and Krebs (1979) who related it to predator-prey coevolution. In this context, a more efficient predator is likely to leave more descendants to subsequent generations. Hence, it is probably continuously selected to become more efficient. Likewise, a prey that is more efficient in evading predation is also likely to leave more descendants to subsequent generations. Hence, it is also continuously selected to become more efficient. These conflicting goals are commonly referred to as the arms race in predator-prey coevolution (Dawkins & Krebs 1979; Krebs 1994). Dawkins and Krebs (1979) argue that these selection-forces are asymmetrical and are probably stronger on the prey than on the predator because a prey individual that loses the race loses its life, while the unsuccessful predator loses merely a meal. Based on one observation on the feeding behaviour of the water monitor *Varanus salvator* endeavoring to swallow a catfish in the Lumpini Park in Bangkok, Thailand, I postulate herein another facet of the life-dinner principle unrelated to the arms race in predator-prey coevolution.

Lumpini Park is a 58 ha public park located in the heart of Bangkok, surrounded by a hyper-urban environment and heavily trafficked roads. The park includes several ponds, water canals and various sporting and recreational facilities. The park is open to the public during daytime hours and is usually teeming with people engaged in jogging and other sporting and recreational activities. Lumpini Park includes a notable (and probably dense) population of water monitors. I have seen monitors of all size-classes – from small juveniles (ca. 30 cm in total length [TL]) to very large adults of 2.5 m TL or more (estimated from a distance). The monitors are easily spotted, either swimming in the ponds or canals or on the shores, usually within 10 m from the water's edge. Less frequently they may move away from the water – 50 m or more from the water's edge. Contrary to most other places in Thailand, in Lumpini Park people refrain from fishing. Hence, the ponds seem to hold sizable populations of fish, turtles and other aquatic animals. The water monitors of Lumpini Park are habituated to humans and seem to be indifferent to their presence at distances of 2–3 m or more. Below 2–3 m they flee (usually into the water) or display various threatening postures. Further details on Lumpini Park are given by Stanner (2010).

At 1643 h on 21st April 2008, I spotted a ca. 1.3 m (estimated from a distance) water monitor grabbing a ca. 40 cm TL walking catfish (*Clarias* sp.) on a pond's shore ca. 5 m from the water's edge. Other onlookers claimed that the scene had started at least ten minutes prior to my arrival. The monitor tried to swallow the fish posterio-anteriorly but the spines of the pectoral fins got stuck at both corners of the monitor's mouth and hampered swallowing. The monitor ejected the fish, grabbed its mid-body transversally and rubbed the front half of the fish's body sideways and backwards against the ground and a tree stump, obviously trying to break or invert the pectoral fins from pointing backwards to forwards. It then tried again to swallow the fish posterio-anteriorly but the spines got stuck again at both corners of the mouth and hampered swallowing. It ejected the fish again, and rubbed the fish again against the ground and the tree stump as aforementioned. This procedure was repeated two more times - altogether five swallowing attempts. As time passed more people gathered and the crowd of onlookers got closer to the monitor, all of which created a disturbance. At 1720 h the monitor grabbed the fish and retreated into a nearby thicket and disappeared. Hence, the final outcome of the swallowing attempts is unknown.

In all five swallowing attempts, the monitor tried to swallow the fish posterio-anteriorly, and the backwards-protruding spines of the pectoral fins hampered each swallowing attempt. Presumably, had the monitor tried to swallow the fish anterio-posteriorly, the backwards pointing spines of the pectoral fins would not have stuck at the mouth corners and the swallowing could have been completed successfully and quickly, but the monitor insisted on a posterior-anterior swallowing. It is unknown whether this behaviour was individual or typical, but since the probability of observing a typical phenomenon is much higher, I tentatively analyze the monitor's insistence on a posterior-anterior swallowing as another facet of the life-dinner principle as follows:

1. If a predator approached the monitor during an anterior-posterior swallowing, the catfish could not be ejected quickly enough (or not at all) because the backwards pointing spines of the pectoral fins would probably pierce and penetrate the throat wall and thus prevent the monitor from escaping swiftly or defending itself (see below).
2. Likewise, in case of digestion-problems due to low ambient temperatures during abrupt cold-spells that may occur in many places in the distribution area of *V. salvator* (though only rarely in Bangkok), poisonous materials or other digestion problems, the catfish could not be regurgitated and the monitor would probably be doomed.

Presumably, the monitor may be advantaged by trading-off immediate gains i.e. easy and quick swallowing process for long-run advantages - securing its life in either or both of the two aforementioned potentially life-threatening circumstances.

I have observed water monitors in Lumpini Park swallowing other species of fish (*Fluta alba* and *Puntius* sp.) anterio-posteriorly. The fins of most fresh-water fish point backwards and their distal tips might be spiny and sharp, but they are usually not as long, thick and strong as the spines of the pectoral fins of walking catfish. The spines of catfish are located ventrally and can rotate back and forth. Moreover, when the spines are fully abducted they can be locked by skeletal specializations and held rigidly perpendicular to the fish; even when they are partially abducted they may still be bound by applying muscle force to friction-locking mechanisms, and each spine has a series of dentations along the postaxial margin (Fine *et al.* 1997). Hence, they pose a greater risk of piercing the throat inner wall while being regurgitated or ejected after an anterior-posterior swallowing. The hazards of catfish spines to piscivorous vertebrates have been documented in many cases. Even when the catfish is swallowed anterio-posteriorly, the spines may pierce the walls of the mouth and throat and cause serious injuries or even death; e.g. catfish spines of various species were implicated in wounds or death in largemouth bass (*Micropterus salmoides*, Krummrich 1969, in Bosher *et al.* 2006), great blue herons (*Ardea herodias*, Line 1993), brown pelicans (*Pelecanus occidentalis*, Bunkley-Williams *et al.* 1994, in Bosher *et al.* 2006), brown water snakes (*Nerodia taxispilota*, Vigil 2006), and midland water snakes (*Nerodia sipedon*, Burr & Stoeckel 1999; B. Burr pers. comm.). Strangely, in the latter two cases the pectoral spines protruded from the skin of the snake. Brooks Burr (pers. comm.) assumes that the body of the catfish is eventually digested and the spines fall off the skin of the snake - an assumption supported also by Vigil (2006). The hazards of the spines are probably exacerbated when the catfish is slidden in the throat counter the direction of the spines – either down the throat during a posterior-anterior swallowing, or up the throat during regurgitation or ejection of an anterio-posteriorly swallowed catfish. In that respect, King (1997) reports that channel catfish (*Ictalurus punctatus*) up to 34 cm long were found in stomachs of American white pelicans (*Pelecanus erythrorhynchos*), but several catfish longer than 53 cm were found stuck in throats of pelicans. In the latter cases, the pelicans apparently tried to swallow the larger catfish posterio-anteriorly and the pectoral spines of the catfish pierced the pelican's throat, preventing swallowing. Compared to *V. salvator,* the advantage of a posterior-anterior swallowing of large catfish by pelicans is less clear. Being endothermic, birds are less likely to have thermally-related digestion problems that necessitate regurgitation. Pelicans are also swifter in evading predation by hovering away from an approaching predator, thus lessening the need to eject prey quickly. However, poisonous materials and other digestion problems may still necessitate regurgitation.

Suranjan Karunarathna *et al.* (2008) observed a 2 m *V. salvator* swallowing a 50 cm suckermouth catfish (*Hypostomus plecostomus*) anterio-posteriorly in the Bellanawila-Attidiya Sanctuary in Sri Lanka. Like walking catfish, suckermouth catfish are also equipped with backwards-pointing spines at the pectoral fins. Thus in a case of emergency an anterior-posterior swallowed suckermouth catfish could not be ejected or regurgitated, as aforementioned, but the monitor in Bellanawila-Attidaya was 2 m long (vs. 1.3 m in Lumpini Park) and the fish was 50 cm (vs. 40 cm in Lumpini Park), i.e. predator/prey length-ratio in Bellanawila-Attidaya was 4, vs. 3.25 in Lumpini Park.

In summary, by trading-off immediate gains i.e. easy and quick anterior-posterior swallowing of fish for long and laborious (but more secure in the long run) posterior-anterior swallowing, I assume that the monitor weighs the potential risks of the anterior-posterior swallowing by considering either one or all of the following factors: the species of the fish, its morphology and the monitor/fish size-ratio. If the predator/prey size ratio is very large, the risks are very low and the monitor will swallow the fish the easiest way, i.e. anterio-posteriorly. If the predator/prey size ratio is not so large, by trying to swallow the fish posterio-anteriorly the monitor might evaluate the risks as follows:

1. If swallowing is easy, it will swallow the fish as it is (posterio-anteriorly).
2. If swallowing is hard, it will try to break or invert the spines of the pectoral fins.
3. If (2) cannot be accomplished, it will either discard the fish, because the risks are too high, or switch to an even more laborious and long prey handling technique - rip the prey apart with its jaws and forefeet (Stanner 2010).

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Notes on Reproduction of the Kinabalu bow-fingered gecko, *Cyrtodactylus baluensis* (Squamata: Gekkonidae), from Sabah, Malaysia

Cyrtodactylus baluensis (Mocquard, 1890) is endemic to Borneo (Sabah, Brunei) (Malkmus *et al*. 2002). It is restricted to low hills, 500–1000 m in dipterocarp forest (Das 2007). There are reports from field guides that *C. baluensis* produces two eggs at a time (Manthey & Grossman 1997; Das 2004 2007 2011). The purpose of this paper is to add information on the reproduction of *C. baluensis* from a histological examination of gonads from museum specimens as part of ongoing studies on the reproductive cycles of lizards from tropical Asia, see for example (Goldberg 2008 2009).

A total of 84 *C. baluensis* from Sipitang District, Sabah, Malaysia (5.083056°N, 115.549722°E) including 41 males (mean snout vent length, SVL = 80.02 mm ± 7.6 SD, range = 64–95 mm), 31 females (mean SVL = 85.9 mm ± 5.1 SD, range = 78–98 mm) and 12 juveniles (mean SVL = 61.2 mm ± 7. 4 SD, range = 48–72 mm) sampled July to December were examined from the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois (Appendix). Geckos were collected 1987, 1989, 1990.

For histological examination, the left testis was removed from males and the left ovary was removed from females. Enlarged follicles (> 4 mm length) or oviductal eggs were counted. Tissues were embedded in paraffin and cut into sections of 5 µm. Slides were stained with Harris hematoxylin followed by eosin counterstain (Presnell & Schreibman 1997). Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition or corpora lutea. Histology slides were deposited in the Field Museum of Natural History (FMNH) herpetology collection. An unpaired t-test was used to compare *C. baluensis* male and female mean body sizes (SVL) using Instat (vers. 3.0b, Graphpad Software, San Diego, CA).

The only stage of the testicular cycle observed was spermiogenesis (sperm formation) in which the lumina of the seminiferous tubules are lined by sperm and/or clusters of metamorphosing spermatids (Table 1). The smallest reproductively active male (spermiogenesis in progress) measured 64 mm SVL (FMNH 235081) and was from November. All males larger than 64 mm SVL from the months sampled were undergoing spermiogenesis (Table 1). Epididymides were not histologically examined but all were enlarged and swollen indicating they contained sperm.

Table 1. Monthly distribution of 41 *C. baluensis* males exhibiting spermiogenesis in the seminiferous tubules.

Month	n	Spermiogenesis
July	6	6
August	13	13
September	2	2
November	17	17
December	3	3

Mean SVL of females was significantly larger than that of males (unpaired t-test, $t = 3.7$, $df = 70$, $P = 0.0004$). Monthly stages in the ovarian cycle of *C. baluensis* are in Table 2. There was reproductive activity in all months sampled. Mean clutch size for 19 females was 2.1± 0.23, range = 2–3 eggs. A clutch of two eggs is typical for gekkonids (Vitt 1986) and has been reported by Das (2011) from other species of *Cyrtodactylus* from Borneo (*C. consobrinus, C. ingeri*, *C. pubisulcus* and *C. quadrivirgatus*). The smallest reproductively active female (FMNH 235064) measured 78 mm SVL (3 enlarged follicles > 4 mm) and was from November. As no evidence of production of multiple egg clutches was found, it is not possible to ascertain whether *C. baluensis* produces multiple egg clutches in the same year although this has been shown to occur in *Dixonius siamensis* from Thailand (Goldberg 2008).

Based on available samples, the reproductive cycle of *C. baluensis* appears similar to that of other tropical lizards that also exhibit

Table 2. Monthly distribution of stages in the ovarian cycle of 31 *C. baluensis* females.

Month	n	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs	Corpus luteum
July	4	0	0	2	2	0
August	12	4	2	4	1	1
November	13	1	2	6	4	0
December	2	1	1	0	0	0

an extended period of sperm formation and egg production (Fitch 1982). This pattern has been reported for other tropical gekkonid lizards such as *Cosymbotus platyurus* (currently *Hemidactylus platyurus*), *Hemidactylus frenatus* and *Peropus mutilatus* (currently *Gehyra mutilata*) from West Java, Indonesia (Church 1962). Moreover, two other congeneric species, *Cyrtodactylus malayanus* and *C. pubisulcus* from Borneo appeared to breed continuously through the year; males produce sperm at all times and production of eggs by females showed no seasonal pattern (Inger & Greenberg 1966). This synchronous reproductive pattern with both sexes reproductively active at the same time also occurs in *D. siamensis* from Thailand (Goldberg 2008) and *Gekko smithi* from Borneo, Indonesia and Malaysia (Goldberg 2009). In contrast, gekkonids from temperate areas exhibit a seasonal cycle with most reproduction occurring in spring, see for example, (Flemming & Bates 1995; Goldberg 2006).

Kluge (1967) categorized gecko reproductive cycles as: (1) no definite seasonal reproductive cycle with mating occurring throughout the year, and (2) breeding is cyclic and restricted to a short period during the year. *Cyrtodactylus baluensis* clearly fits into the former category. With 28 other species of geckos known from Borneo (Das 2011) subsequent studies are needed before the variations in their reproductive cycles can be ascertained.

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Appendix

The following specimens of *C. baluensis* from Borneo comprise the basis for this study: FMNH 235058–235064, 235069–235076, 235080–235084, 235090–235097, 235099, 235101, 235106–235116, 239437, 239439, 239440, 239443, 239459–239465, 239466, 239469, 239473–239475, 239477, 239478, 239487, 239489, 239490, 239493, 239494, 239497–239500, 239526–239528, 243705, 243707, 243708, 243714–243719, 243724–243729.

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Record lengths of two endemic caenophidian snakes from the Western Ghats Mountains, India

The Western Ghats mountain range of southwestern India is a global biodiversity hotspot (Myers *et al*. 2000) and is rich in endemic herpetofauna (Daniel 2002; Das 2002). Much still remains to be discovered about these poorly known endemic reptiles. In this note, we report on the longest specimens of two endemic species of snakes, *Rhabdops olivaceus* and *Xylophis captaini*, based on live and preserved examples. *Rhabdops* Boulenger, 1893 and *Xylophis* Beddome, 1878, are two enigmatic genera of colubrid snakes, most of which are endemic to the Western Ghats. The former has one representative species, *R. olivaceus* (Beddome, 1863), distributed in the Western Ghats (Wynaad, north to Koyna), and another, *R. bicolor* (Blyth, 1854), in northeastern India (Khasi and Mishmi Hills), Myanmar (Kachin Hills), and China (Yunnan) (Smith 1943; Whitaker & Captain 2004). *Xylophis* is restricted to the southern Western Ghats, from the Nilgiri hills further south, with three currently recognized species: *X. perroteti* (Duméril, Bibron & Duméril, 1854), *X. stenorhynchus* (Günther, 1875), and *X. captaini* Gower & Winkler, 2007. The taxonomic status of a possible fourth taxon, *X. indicus* Beddome, 1878, is in need of reassessment (Gower & Winkler 2007). These snakes were grouped together under the "Group VII" of the family Colubridae by Smith (1943).

We examined four live *Rhabdops olivaceus* from Tirthahalli and Suralihalla in and around Agumbe (13°N 76°E; 550–600 m asl), located in Shimoga district of Karnataka state, and two preserved *Xylophis captaini* collected from Ambadi estate, Kanyakumari district, Tamil Nadu state, housed in the Chennai Snake Park Museum. Measurements were recorded using vernier calipers, except snout-vent and total lengths, which were measured with a standard measuring tape, to the nearest millimeter. Live snakes were gently restrained by hand for measurements and scale counts. Scalation terminologies follow Smith (1943), except infralabials, which we recognised as the scales bordering the lower margin of the mouth on each side immediately after the mental, up to and including the final scale bordering lower jaw angle; those touching the genials are in parenthesis. Ventral counts follow Dowling (1951) for *Rhabdops* and Gower & Winkler (2007) for *Xylophis*. Subcaudal counts exclude the terminal scale. When different, symmetrical head scalation character values are mentioned in left, right order.

Rhabdops olivaceus (Beddome, 1863)

(n = 4; Fig. 1)

First specimen sighted by S.R.C and S.R.G on 9th June 2006, at 08h05, swimming in ankle-deep water in a slow watercourse flowing past a country road bordered by human settlements, areca nut trees and paddy fields in Tirthahalli near Agumbe; second specimen sighted by P.G.S on 7th July 2008, at 13h05, swimming in ankle-deep water, within a patch of evergreen rainforest; third specimen found by P.G.S on 14th April 2009, at 14h15 near a log close to some small

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Appendix

The following specimens of *C. baluensis* from Borneo comprise the basis for this study: FMNH 235058–235064, 235069–235076, 235080–235084, 235090–235097, 235099, 235101, 235106–235116, 239437, 239439, 239440, 239443, 239459–239465, 239466, 239469, 239473–239475, 239477, 239478, 239487, 239489, 239490, 239493, 239494, 239497–239500, 239526–239528, 243705, 243707, 243708, 243714–243719, 243724–243729.

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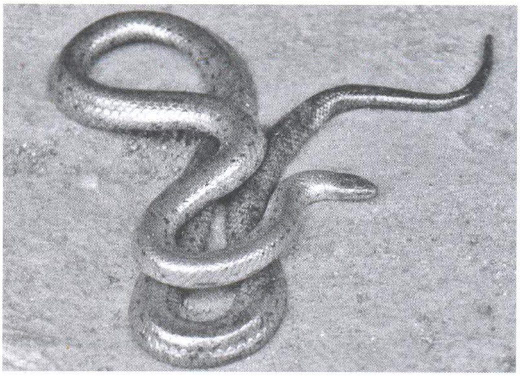

Figure 1. Live uncollected *Rhabdops olivaceus*.

intermittent puddles of a drying stream, within a patch of evergreen rainforest, fourth specimen (by P.G.S) on 2nd August 2009, at 12h25 from a slow moving stream within mild canopy cover, all in Suralihalla, near Agumbe.

Rostral scale broader than long; dorsal scale rows 17:17:17 smooth, slightly glossy; supralabials 5 (3 touching eye); infralabials 4–5, preoculars 2, postoculars 2, loreal 1, temporals 1+1, ventrals 215–230 not angulate laterally, anal scales 2, subcaudals 52–68 pairs excluding terminal scale, total length 365–985 mm, tail length 55–155 mm.

Total length of one of our specimens was 985 mm vs. a previously reported maximum of 780 mm (Smith 1943; Whitaker & Captain 2004) i.e., 205 mm longer. Ventral counts of two of our specimens were 223 and 230 vs. 206–215 (Smith 1943) and 202–215 (Whitaker & Captain 2004). Subcaudals (in perfectly intact tail) were 52 vs. 62–74 (Smith 1943; Whitaker & Captain 2004). Whitaker & Captain (2004) consider the Olive forest snake to be nocturnal. Our three sightings of this species (seen actively moving about during daytime between 08h05–14h15 of rainy months) indicate *R. olivaceus* is not exclusively nocturnal.

Xylophis captaini Gower & Winkler, 2007

(n = 2; Fig. 2)

Two preserved specimens, CSPT/S 77 a & b, collector unknown, collected from Ambadi estate, Kanyakumari district, Tamil Nadu state (Ganesh 2010).

Scale rows 15:15:15; supralabials 5 (2, 3 touching eye); infralabials 5, the last two much larger than the preceding ones; no preocular; postocular 1; loreal 1; temporal 1+2; ventrals 117–118; anals 1; subcaudals 13–18; total length 176–199; tail length 10.0–16.0; relative tail length 0.05–0.09; midbody girth 4.62–4.70; head length 4.75–4.93; head width (max.) 4.27–4.55; frontal-snout distance 1.87–1.99; prefrontal length at midline suture 0.51–0.65; internasal length at midline suture 0.48–0.61; (frontal–snout/prefrontal) length 3.06–3.66; frontal length 2.51–2.55; frontal width 2.23–2.33; parietal length 2.47–2.62

Morphology of our specimens are in accordance with Gower & Winkler's (2007) account on this species, except that both of our specimens clearly surpass the 145 mm maximum length reported by Gower & Winkler (2007), despite their description being based on a commendably strong type series of 26 specimens. Our male (CSPT/S 77a) was 176 mm and female (CSPT/S 77b) 199 mm long, which is nearly the size reported for *X. stenorhynchus* (see Gower & Winkler 2007).

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We thank our respective institutions for support and logistics provided; Karnataka Forest Department; Mr. Muralidhar, plantation owner

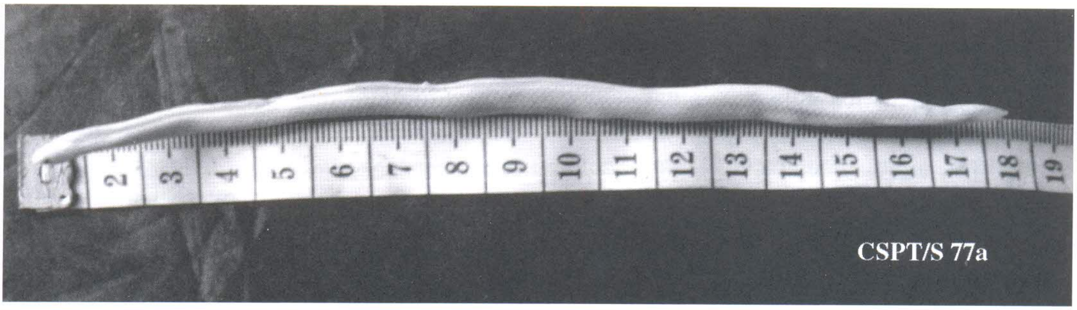

Figure 2. *Xylophis captaini*, Chennai Snake Park Trust CSPT / S-77a with a scale, showing its record size.

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Hemidactylus porbandarensis Sharma, 1981 is a synonym of *Hemidactylus robustus* Heyden, 1827

The genus *Hemidactylus* is the second most species-rich genus of gekkonid lizards in the world (Kluge 2001; Carranza & Arnold 2006; Bauer *et al*. 2007; Giri & Bauer 2008), and is represented by over 100 species, including approximately 30 in south Asia (Giri & Bauer 2008; Bauer *et al*. 2008, 2010; Bansal & Karanth 2010). Although new species are regularly described, increased taxonomic and faunistic research has resulted in the removal of several *Hemidactylus* from the Indian herpetofaunal list. For example, the validity of *H. subtriedrus* Jerdon and *H. mahendrai* Shukla, has recently been questioned (Zug *et al*. 2007; Venugopal 2010a,b; Mahony 2011; but see Giri & Bauer 2008; Bauer *et al*. 2010; Mirza 2010), *Hemidactylus karenorum* (Theobald) has been demonstrated to be extralimital (Zug *et al*. 2007; Mahony & Zug 2008), and Indian *H. bowringii* have been shown to be referrable to *H. aquilonius* (Purkayastha *et al*. 2010).

Another member of the genus that has been problematic is *H. porbandarensis*. This species was described by Sharma (1981) from the seaport of Porbandar City, Junagadh District, Gujarat (Fig. 1). The apparent restriction of the species to this highly disturbed manmade locality is suspect, but the existence of several endemic taxa from other areas of Gujarat (Giri *et al*. 2009) suggest at least the possibility that the species could be regionally restricted and incidentally only collected from this one locality thus far. The specific identity of this species has been a matter of question, largely because the illustrations accompanying the description (Sharma 1981) do not resemble any species of *Hemidactylus*, or any other gecko, showing long-clawed, strongly fused digits that lack any trace of subdigital lamellae (although this is not consistent with the short description).

Since its description, *H. porbandarensis* has appeared in a number of lists of gecko species of the world (Kluge 1991 1993 2001; Rösler 2000; Uetz 2011) and has been treated in works deal-

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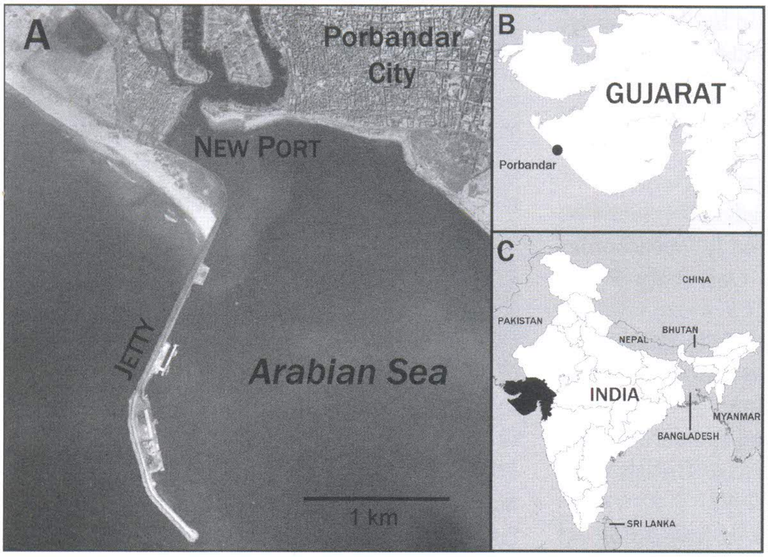

Figure 1. A) GoogleEarth image of the port area of Porbandar, Gujarat. The known distribution of *Hemidactylus porbandarensis* is limited to the port area and jetty. B) Map of Gujarat showing the position of Porbandar. C) Map of India showing Gujarat in black.

ing with the lizards of India (Murthy 1990 2010; Tikader & Sharma 1992; Das 1994 1996 1997; Das & Andrews 1997; Sharma 2002), the reptile fauna of Gujarat (Vyas 1998 2000a 2000b 2007; Gayen 1999; Sharma 2000), and the type collection of the Zoological Survey of India (Das *et al.* 1998), but in every case, the information on the species merely repeated information from the type description. Only Vyas (2001 2006 2008), who studied a population at the type locality, has added any new biological data. He considered the range as restricted to the New Sea Port area of Porbandar City in Gujarat. Within this area, he found them to be common, particularly in areas of anthropogenic activity (Fig. 2). He did not believe that the species was actually restricted to this area, but that it had been imported, perhaps in association with the materials used to build the port or with goods transferred through the port.

We collected fresh material of *Hemidactylus porbandarensis* from the type and only known locality at Porbandar Port (Fig. 3). Specimens were identical with those described and illustrated by Vyas (2001 2006 2008) and fully consistent with the holotype (Fig. 4) and paratypes of *H. porbandarensis* housed in the Zoological Survey of India, Jodhpur, and with Sharma's (1981) original description, although not with his figures (see comments above). We sequenced 294 bp of the mitochondrial gene cytochrome *b* (cyt *b*) from a representative specimen using the laboratory protocols of Bansal & Karanth (2010). This was compared with 481 *Hemidactylus* cyt *b* sequences obtained from GenBank and deriving primarily from the papers of Carranza & Arnold (2005), Bauer *et al.* (2007 2010a 2010b) and Bansal and Karanth (2010). Comparison of sequences revealed that this sample was identical to a specimen of *Hemidactylus robustus* Heyden from Abu Dhabi, United Arab Emirates (Genbank number DQ120175), and highly similar, but not identical to, the other *H. robustus* in Genbank.

The specific identity of *H. robustus* and other Middle Eastern and North African *Hemidactylus* has long been problematic due to a combination of broad distribution, morphological conservatism across taxa, and extensive geographic and ecotypic variation within individual species. *Hemidactylus robustus* was long synonymized with *H. turcicus* (e.g., Kluge

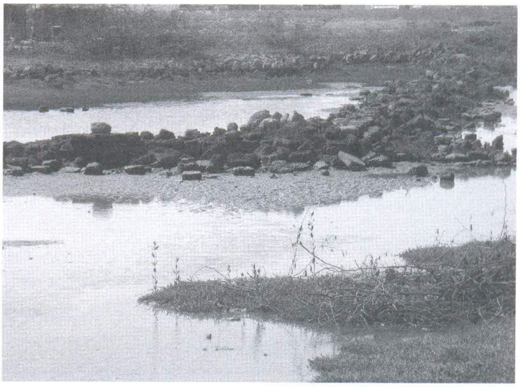

Figure 2. Habitat of *Hemidactylus porbandarensis* at the New Port of Porbandar. The gecko uses crevices between the artificially piled stones as retreat sites. Photo R. Vyas.

Figure 3. Juvenile specimen of *Hemidactylus robustus* from Porbandar in life. Photo R. Vyas.

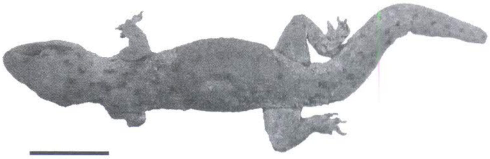

Figure 4. Holotype (ZSI-Jodhpur V/2152) of *Hemidactylus porbandarensis* Sharma. Scale bar = 10 mm. Photo courtesy of Gaurav Sharma.

1991 1993 2001; Anderson 1999; Rösler 2000). Lanza (1990) and Moravec and Böhme (1997), however, treated *H. robustus* as a full species and this was confirmed by Baha el Din (2005) who documented *H. robustus* and *H. turcicus* in sympatry on the Red Sea coast of Egypt and by Carranza and Arnold (2006) who found a 14% genetic divergence between the two taxa. However, even within *H. robustus* it is clear that there are highly divergent cryptic taxa that await description (Busais & Joger 2011).

Bauer *et al.* (2007) recently confirmed the presence of *H. robustus* in both Lorestan, Iran and Sind, Pakistan, but showed that populations in both of these countries were identical to each other and to specimens from Jebel Dhanna, near Ruweis, Abu Dhabi, with respect to cyt *b*. A specimen from Balochistan, Pakistan was nearly identical and also similar to other specimens from Abu Dhabi. The great genetic similarity across the region confirms that the current distribution of *H. robustus* is the result of very recent events and, as suggested by Baha El Din (2005), that it was highly influenced by human activity. Both Anderson (1999) and Bauer *et al.* (2007) suggested that ancient caravan routes might have provided the means by which *Hemidactylus* were distributed to isolated localities in Iran and Pakistan. Porbandar is an ancient port city and it is conceivable that similar trade routes might have resulted in the establishment of *H. robustus*. However, the fact that the gecko appears limited to an area of new land created between 1975 and 1978 during the construction of the new port and jetty, and is absent from the adjacent city, and that it was not known until 1975 (Vyas 2001, 2006, 2008), strongly suggests that it may have arrived only in the late 20th century.

Regardless of the time of origin of the Porbandar gecko population, it is clear that the population is referrable to *Hemidactylus robustus* and that it was introduced, probably from Abu Dhabi and probably within historical times — possibly as recently as 30–40 years ago. The name *Hemidactylus porbandarensis* is thus synonymized with *H. robustus* and deleted from the national species list, whereas the latter species, which has not previously been recorded from the Republic of India, should be added to the national faunal list and that of Gujarat.

The recognition of *Hemidactylus robustus* as an introduced member of the Indian herpetofauna follows closely on the recent discovery of another foreign congener, *H. persicus*, in and around anthropogenic habitats in Jassore Wildlife Sanctuary in the Banaskantha District, Gujarat (Vyas *et al.* 2006). Both *H. persicus* and *H. robustus* are members of the "Arid Clade" of *Hemidactylus* (Carranza & Arnold 2006), a relatively large and diverse group of geckos mostly occurring in the Middle East and the Horn of Africa, but with at least one apparently native undescribed species in Rajasthan (Bauer *et al.* 2010). Another member of this clade, *H. turcicus*, is well-known for being invasive and has established itself in many areas of the United States and other countries in the Americas (Kraus 2009). Other *Hemidactylus* species are even more invasive and have spread throughout the tropics and subtropics globally (Lever 2003; Kraus 2009). Although virtually all of India except the highest elevations is inhabited by native species of *Hemidactylus*, the invasive qualities of some members of the genus can result in their establishment even in the face of autochthonous *Hemidactylus* communities. This has occurred recently in Guwahati, Assam with the establishment of *H. flaviviridis*, a species native to more western areas of north and central India, but only recently established in the northeast, probably as a result of accidental transport with food products (Das *et al.* 2011).

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Notes on Reproduction of the Borneo skink, *Dasia vittata* (Squamata: Scincidae) from Borneo

Dasia vittata (Edeling, 1865) is a primarily ant-feeding skink that is endemic to Borneo (Malkmus *et al.* 2002). All species of *Dasia* are arboreal to semiarboreal (Greer 1970). Mori *et al.* (1995) reported *D. vittata* (as *Apterygodon vittatum*) produced clutch sizes of 2–4 eggs. The purpose of this note is to add information on the reproductive biology of *D. vittata* as part of ongoing studies on the reproductive cycles of lizards from tropical Asia. The first information on the testicular cycle of *D. vittata* is presented and reproductive periodicity is discussed for this species.

A total of 44 *D. vittata* including 21 males (mean snout vent length, SVL = 68.3 mm ± 3.8 SD, range = 63–74 mm) and 23 females (mean SVL = 68.4 mm ± 3.9 SD, range = 63-74 mm) from Sabah, Borneo (n = 4) 5.98305°N, 116.06638°E and Sarawak, Borneo (n = 40) 4.38327°N, 113.98277°E were examined from the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois (Appendix). *Dasia vittata* were collected during the following years from Sabah (1929, 1950, 1956, 1959) and Sarawak (1960, 1962–1964, 1984).

For histological examination, the left testis was removed from males and the left ovary was removed from females. Oviductal eggs were counted. Tissues were embedded in paraffin and 5 µm sections cut. Slides were stained with Harris hematoxylin followed by eosin counterstain (Presnell & Schreibman 1997). Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition or corpora lutea. Histology slides were deposited in the FMNH herpetology collection. An unpaired *t*-test was used to compare *D. vittata* male and female mean body sizes (SVL) and linear regression analysis was used to examine the relationship between female SVL and clutch size using Instat (vers 3.0b, Graphpad Software, San Diego, CA).

There was no significant size difference in mean SVL between males and females (unpaired *t*–test, $t = 0.09$, $df = 42$, $P = 0.9305$). In contrast, Mori *et al.* (1995) recorded a significant difference with females attaining larger sizes than males. The only stage of the testicular cycle observed was the last stage of spermatogenesis, spermiogenesis (sperm formation) in which the lumina of the seminiferous tubules were lined by sperm and/or clusters of metamorphosing spermatids. Males undergoing spermiogenesis (sample size in parentheses) were collected during the following months: January (1), February (1), March (1), April (3), May (1), June (3), August (9), September (1), November (1). The smallest reproductively active males each measured 63 mm SVL (FMNH 120350, 129520, 150764) and were collected in August, June and February, respectively. The epididymides were not histologically examined but were enlarged, convoluted and swollen in my entire male sample indicating they contained sperm. My data

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Table 1. Monthly distribution of stages in the ovarian cycle of 23 *Dasia vittata* females.

Month	n	Quiescent	Early yolk deposition	Oviductal eggs	Corpus luteum only
January	3	2	0	1	0
February	1	0	1	0	0
April	2	0	2	0	0
May	3	2	1	0	0
July	1	0	0	0	1
August	11	3	3	5	0
October	1	0	0	1	0
December	1	1	0	0	0

indicate year-round production of sperm in *D. vittata.*

Female *D. vittata* were reproductively active in all months sampled except for December when only one female was examined (Table 1). Mean clutch size for the 7 gravid *D. vittata* in this sample was 2.8 ± 0.98 SD, range = 1–4 eggs. This is the first report of a single-egg clutch for *D. vittata*. The smallest reproductively active females (both from August) measured 63 mm SVL (oviductal eggs, FMNH 120343) and SVL measurement? (early yolk deposition, FMNH 63697). No females with enlarged pre-ovulatory follicles were found which likely reflects my small sample sizes. There is no evidence that *D. vittata* females may produce multiple clutches in the same year (e.g. oviductal eggs and concomitant yolk deposition for a subsequent clutch in the same female), although Malkmus *et al.* (2002) reported eggs are laid several times per year. Mori *et al.* (1995) reported a mean clutch size of 3.3 eggs for 10 *D. vittata* females collected in December, January, July and August from Sarawak, Borneo and found a significant relationship between clutch size and SVL ($r = 0.66$, $P < 0.01$). In my samples, there was no positive relationship between *D. vittata* female SVL and clutch size (linear regression analysis, $r^2 = 0.09$, $P = 0.50$), which may reflect my small sample size ($n = 7$), having specimens from widely differing years or a smaller range of females (63–74 mm) versus (65–84 mm) in Mori *et al.* (1995). Moreover, the mean SVL for females of *D. vittata* of Mori *et al.* (1995) (76.3 ± 4.3 SD) is larger than my largest female (SVL = 74 mm), which may also reflect my small sample size. The minimum SVL of 63 mm for reproductive maturity in males and females in my study is only an approximation, as smaller *D. vittata* were not examined. However, given Mori *et al.* (1995) reported *D. vittata* < 60 mm SVL as juveniles, it likely approximates the size at which reproductive maturity is reached.

The reproductive cycle of *D. vittata* appears similar to that of other tropical skinks which exhibit prolonged or continuous reproductive cycles including, for example, *Tropidophorus brookei* from Borneo (Inger & Greenberg 1966; Goldberg 2010). Borneo has a tropical rain forest climate to altitudes above 1000 meters with yearly precipitation greater than 2000 m and is subject to the north-east monsoon (November through March) and the southwest monsoon (June through September) (Malkmus *et al.* 2002). I was unable to correlate reproduction with precipitation for *D.* vittata, as my samples were too small to ascertain a peak in breeding activity, if one exists. With 24 species of skinks known to inhabit Borneo (Das 2011), additional studies are needed before the variations in reproductive cycles of these lizards can be ascertained.

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Appendix

The following specimens of *Dasia vittata* from Borneo comprise the basis for this study (Sabah): FMNH 14309, 14872, 63697, 76228; (Sarawak) FMNH 120324, 120326, 120328, 120332, 120335, 120337–120344, 120350, 120351, 120353–120355, 129516, 128518–129520, 138549, 138550, 145670, 149035, 149040, 149043, 150754, 150756, 150757, 150762–150764, 221610, 221612, 221614, 221616, 221617, 221618.

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First record of Wayanad shieldtail *Melanophidium wynaudense* (Beddome, 1863) from the Central Western Ghats, India

The Wayanad shieldtail snake was originally described by Beddome (1863) as *Plectrurus wynaudensis* from "Cherambady, in the Wynaud" (now Waynad district in Kerala state, India). Günther (1864) recognized its unique character among uropeltids, the presence of a mental groove, and erected the genus *Melanophidium* giving it the presently accepted generic allocation. Furthermore, he emended the specific epithet into *wynandense*. Smith (1943) incorrectly stated the type locality as "nr. Manantoddy" whereas Beddome (1863) in his original description mentioned it as "Cherambady in the Wynaud". Beddome (1886) gave further data on five more specimens from Nilgiris and Wayanad. Boulenger (1890 1893) gave the same variation based on Beddome's specimens. Wall (1919) collected 26 more specimens, again from the Nilgiri-Waynad and gave good accounts on morphology and natural history. Even Wall's record has now become nearly a century old and there are no recent sightings of this species, even after more than 150 years since description. Constable (1949) mentioned one more material, also from the same hill range, in the Museum of Comparative Zoology, USA, given by the British Museum (Natural History). More recent works on Indian snakes (Whitaker 1978; Daniel 2002; Das 2002; Whitaker & Captain 2004) have not shed light on this species.

In this note, we report on our recent finding of *Melanophidium wynaudense* from Agumbe (13°50'N 75°09'E; 586 m asl), a Reserve Forest situated in Shimoga district in the Malnad region of Karnataka state; covered mainly by tropical rainforests, apart from Areca, Vanilla and paddy cultivations; has chiefly red laterite soil and is the wettest place in south India, with an annual rainfall of > 10,000 mm, during the southwest monsoon season, i.e., June to September. Fifteen live individuals were found during the southwest monsoon (July through September), the predominant wet season in this ecoregion. Five specimens were observed in July 2008 on the same day and ten more were sighted during July–August 2010. Individuals were seen under rotten logs and among boulders strewn by stream-sides within primary rainforests, inside heaps of fallen leaves in *Areca catechu* plantations, and under the top soil of abandoned paddy fields. In most cases, we saw these snakes in sheltered conditions during daytime, but one was seen out at daylight (11h20) within a patch of rainforest. All snakes were swift movers and burrowed well in loose soil. The exact places where these snakes were found were mostly with deep (ca. 10 cm) humus-rich top soil, well aerated, and watered. Other uropeltid species like *Melanophidium punctatum* Beddome, 1870, *Uropeltis ceylanica* Cuvier, 1829 and *Rhinophis sanguineus* Beddome, 1863 as well as the caecilian amphibian *Ichthyophis beddomei* Peters, 1879 were observed syntopic with *M. wynaudense* in Agumbe. On one occasion, a green vine snake (Colubridae: *Ahaetulla nasuta* (Bonnatere, 1790)) was observed predat-

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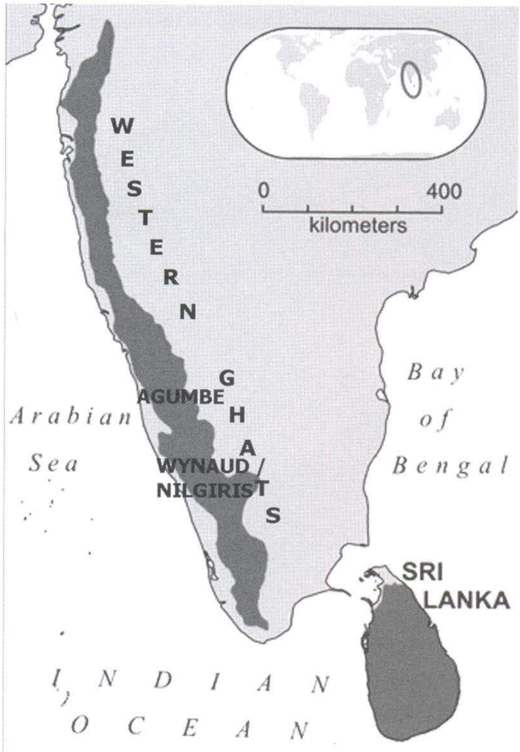

Figure 1. Map of southern India showing the extended distribution of *Melanophidium wynaudense*.

ing on one individual and on another occasion, a domestic chicken. As per our observations, it is the most common uropeltid species in Agumbe, as we got only one sighting each of the other species.

The morphology of Agumbe specimens is as follows: rostral scale visible from above, slightly dividing nasals; nasal scale pierced by nostril; no internasals; nasals smaller than prefrontals; suture between ocular and frontal greater than one third the length of frontal scale; frontal larger than ocular scale, tapering posteriorly; parietals large, in contact with supralabial; supralabials 4, last one the largest; infralabials 4; no temporals; mental grove present, dividing the first infralabial; anterior genials larger; midbody scalerows 15, scales smooth, imbricate, with white outline; ventrals (counted on complete ventral profile photos of restrained live snakes printed on 420 x 297 mm A3 sheets) 180–198, thrice as wide as adjacent scale; anal scale bifid; subcaudals 10–12 pairs excluding terminal scale; body small (snout-vent length 275–392 mm; total length 284–402 mm) and slender; head not distinct from neck; small and tapering when viewed laterally; overall dorsally bluish to shimmering black, with iridescent sheen allover; venter similarly coloured and in one specimen, with a few white patches posteriorly; tail bilaterally compressed, tapering to a striated and pointed end.

Our ventral scale count of 180–198 appears higher than counts of 170–185 previously reported (Boulenger 1890; Wall 1919; Smith 1943) because of varied conception of ventral scales, as we followed Gower & Ablett (2006), while previous authors would have quite naturally, owing to the presence of mental groove, followed Dowling (1951) or the "wider than long" system as in Peters (1964). Our subcaudal count range was 10–12, which is within the range of 10–18 reported by Smith (1943). Wall (1919), based on 26 specimens, gave a subcaudal count of 10–13, and Boulenger (1890) mentioned it as 10–15. Smith (1943) reported a considerable advancement in the range. In Beddome's (1863) original description, data on name-bearing type(s) and ventral scale count were absent. Subcaudal scale count was given as 11 pairs. Günther (1864) stated "a specimen, 9 inches long (tail half an inch) was found at Wynand, at an elevation 3500 feet." Günther (1864) gave the ventral count as 180, but mentioned that subcaudal scales are in 12 pairs (vs. 11 in Beddome 1863), so the correct subcaudal count of that specimen is unclear. Whether the terminal subcaudal scale was included in their counts is also not known. Constable (1949) wrote the scale row count of this species as 17. To the best of our knowledge, the midbody scale row count of this species, both in literature (Boulenger 1890 1893; Wall 1919; Smith 1943) and this work is at least 15. Its life colouration has been described as iridescent black with or without yellow or white spots on the venter (Murthy 1981; Sharma 2003; Smith 1943). Murthy (1982) remarked "body entirely black without any ventral spots," while Günther (1864) stated "black; posterior two thirds of belly irregularly black and white," and Wall (1919) remarked "the irregularly distributed ventral patches were quite white and not yellow as supposed by Boulenger." All but one of our live individuals were completely black ventrally and the sole exception had a few white patches near the anal shield.

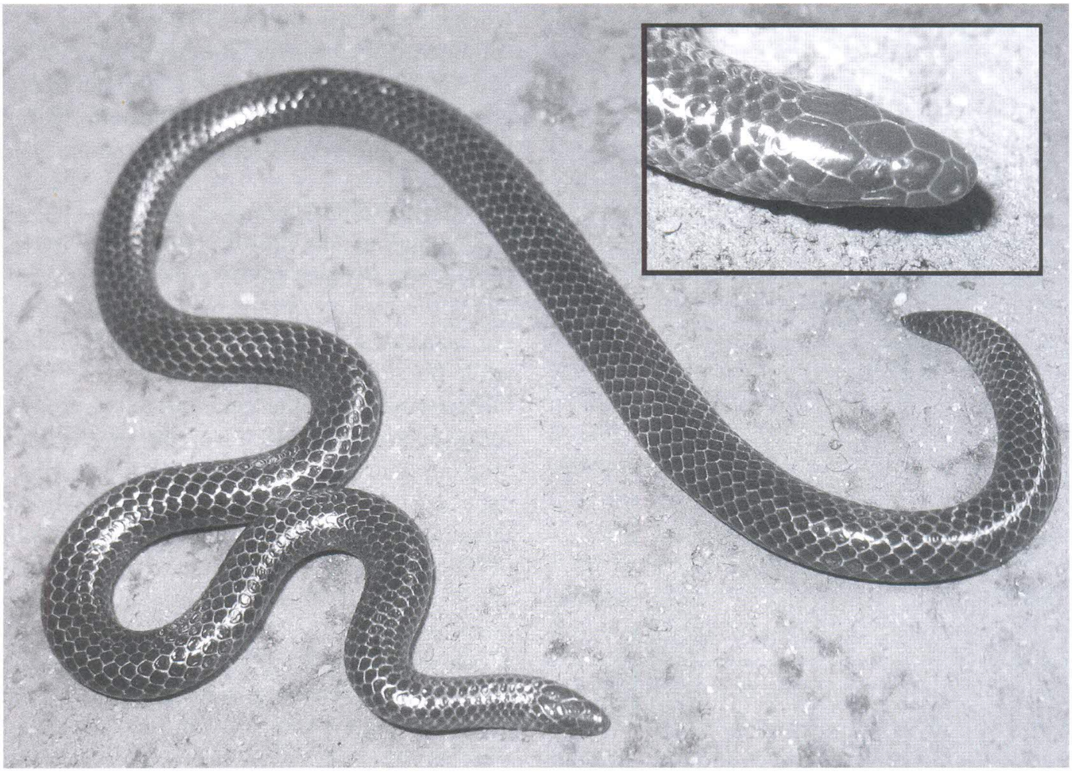

Figure 2. Live uncollected *Melanophidium wynaudense*, entire profile. Inset: close up for head showing diagnostic characters.

The Waynad shieldtail was known only from high elevations (900–2121 m asl) of Nilgiri-Waynad sensu Wall (1919) (see Beddome 1863 1886; Günther 1864; Boulenger 1890; Wall 1919; Smith 1943; Murthy 1982; Anonymous 2001) and so our sightings from Agumbe, which is ca. 250 airline km north and ca. 300 m asl lower, is the first record of *M. wynaudense* from outside its known geographic range. We believe that further fieldwork in other suitable areas may prove the existence of this species in wet hill forest belts of the Western Ghats between the Palghat and the Goa gaps.

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Notes on the natural history of *Hemidactylus albofasciatus* Grandison and Soman, 1963 (Reptilia: Gekkonidae)

The White-striped Viper Gecko *Hemidactylus albofasciatus* Grandison & Soman, 1963 is an endemic gecko found in the Western Ghats mountain range which runs parallel to the western coast of India. Grandison & Soman (1963) described the species from the open plateau region of Dorle in Ratnagiri district of Maharashtra and subsequently it was reported to occur at Malvan and Kunakeshwar in Sindhudurg district southern Maharashtra by Gaikwad *et al.* (2009). Until recently, the species was considered to be a member of the genus *Teratolepis* but recent phylogenetic analysis clearly shows that the genus *Teratolepis* is embedded within the Tropical Asian clade of *Hemidactylus* (Bauer *et al.* 2008). The gecko remained poorly known until the recent valuable addition by Gaikwad *et al.* (2009) on its morphological variations, distribution and basic natural history. However, the present knowledge of its breeding biology is meager.

In the course of a herpetological investigation, we visited Tarkarli (Malvan) in Sindhudurg district of southern Maharashtra from the 9th to 11th December, 2010. On a visit to one of the plateaus on 10th December, we encountered seven individuals (three males and four females) of *H. albofasciatus*. Of the four females, one was gravid with two well-developed eggs visible in the body cavity, and two eggs were found in a small depression under a boulder glued to the substratum. The gravid female, three males, and two other females and the eggs were collected for further observation. The geckos were housed in a glass tank (30x20x20 cm) with loose soil as the substrate. The geckos would hide under pieces of bark during the day and would emerge to forage at dusk. The geckos were fed on termites and small moths. While foraging, the male geckos would raise their bodies and tails well above the substrate and sway their tails from left to right during social encounters. The dominant

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Figure 1. Dorsolateral aspect of an adult *Hemidactylus albofasciatus* from Tarkarli, Malvan in Sindhudurg district of southern Maharashtra. Photo by Zeeshan A. Mirza

male rose higher and maintained its position, whereas its opponent retreated backward. This behaviour further supports their solitary nature as not more than one gecko was found under a single rock (Gaikwad *et al.* 2009, Mirza & Sanap pers. obs.). The gravid female laid eggs on 11th December and these eggs along with those collected from the plateau were kept for incubation in a small plastic container insulated with a layer of dry cotton at 30–32°C. The eggs measured 7x6 mm. Those that were collected from under the stone hatched on 2nd February, 2011 (53 days after collection). The eggs laid in captivity hatched on the 22nd February, 2011 (73 days after laying). The hatchlings measured 13.1–14.2 mm from snout to vent length and had a bright orangish red tail (Figure 2). Gaikwad *et al.* (2009) report encountering juveniles from June to August and considering our observation, it is likely that this species breeds during the summer and post monsoons.

Our preliminary observations show that this species is highly territorial for shelter as well as food perhaps to avoid competition in a harsh habitat. The species is found under boulders on the plateau and their population is under threat at least at Malvan as the boulders are removed for the construction of bunds around paddy fields and an upcoming airport. It would be worth experimenting if the tail swaying behavior is exhibited only by this species or also by other ground dwelling species of the genus such as *H. sataraensis*. There are currently few reports of data on the natural history of *H. albofasciatus* and thus the present data is noteworthy.

Figure 2. Dorsolateral aspect of a hatchling animal. Photo by Zeeshan A. Mirza

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Notes on Reproduction of the Cardamon forest gecko, *Cyrtodactylus intermedius* (Squamata: Gekkonidae) from Cambodia and Thailand

Cyrtodactylus intermedius (Smith, 1917) is known from Cambodia, Thailand and VietNam (Nguyen *et al.* 2009). It is monotypic (Bourret 2009) and commonly occurs on logs and rocks near streams in evergreen forest, but is also found in leaf litter and tree trunks up to 2 m (Inger & Colwell 1977; Stuart & Emmett 2006; Grismer *et al.* 2007). To my knowledge, there is no information on the reproductive biology of *C. intermedius*. In this note I provide information on the reproductive cycle of *C. intermedius* gathered from a histological examination of gonadal materials. Characterization of the reproductive cycle including period of sperm production, timing of yolk deposition and numbers and sizes of clutches produced provides important information in formulating conservation policies for lizard populations. Due to difficulty in justifying collections of monthly lizard samples, utilization of museum collections for obtaining reproductive data has become increasingly important.

A total of 41 *C. intermedius* including 21 males (mean snout vent length, SVL = 73.3 mm ± 7.9 SD, range = 58–85 mm), 17 females (mean SVL = 81.6 mm ± 6.5 SD, range = 66–92 mm) and three juvenile females (mean SVL = 52.0 mm ± 8.5 SD, range = 43–60 mm) from Cambodia and Thailand were examined from the herpetology collection of the Field Museum of Natural History (FMNH), Chicago, Illinois (Appendix). *Cyrtodactylus intermedius* were collected 1969, 2000, 2004.

The snout-vent length (SVL) was measured to the nearest mm using a plastic ruler. For histological examination, the left testis was removed from males and the left ovary was removed from females. Enlarged ovarian follicles (> 4 mm) or oviductal eggs were counted. Tissues were embedded in paraffin and 5 µm sections cut. Slides were stained with Harris hematoxylin followed by eosin counterstain (Presnell & Schreibman 1997). Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition or corpora lutea. Histology slides were deposited in the FMNH herpetology collection. An unpaired *t*-test using Welch correction was used to compare male and female mean body sizes (SVL) using Instat (vers 3.0b, Graphpad Software, San Diego, CA).

The only stage of the testicular cycle observed was the last stage of spermatogenesis, spermiogenesis (sperm formation) in which the lumina of the seminiferous tubules were lined by sperm and/or clusters of metamorphosing spermatids. All males examined were undergoing spermiogenesis and were collected during the following months (sample size in parentheses): March (6), April (3), May (9), June (1), December (2). The epididymides were not histologically examined but were enlarged and convoluted in my entire male sample indicating they contained sperm. The smallest reproductively active male measured 58 mm SVL (FMNH 180758) and was collected in May. The minimum SVL of 58 mm for male reproductive maturity in my study is only an approximation, as smaller *C. intermedius* were not examined.

The mean SVL of females was significantly larger than that of males (unpaired *t*-test using

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The mean SVL of females was significantly larger than that of males (unpaired *t*-test using

Welch correction, $t = 3.6$, $df = 35$, $P = 0.001$). Four stages were observed in the ovarian cycle (Table 1): (1) Quiescent, no yolk deposition; (2) Early yolk deposition, basophilic yolk granules in the ooplasm; (3) Enlarged ovarian follicles (> 4 mm); (4) Oviductal eggs. Female *C. intermedius* were reproductively active in all months examined (Table 1). Mean clutch size (n = 11) was 1.91 ± 0.30, range: 1–2. There was no evidence that *C. intermedius* females produce multiple clutches in the same year (oviductal eggs and concomitant yolk deposition for a subsequent clutch in the same female). This may reflect my small female sample size (n = 17), as many species of geckos produce multiple clutches (Vitt 1986). The smallest reproductively active female measured 66 mm SVL, exhibited early yolk deposition (FMNH 180766) and was collected in August. Three smaller females (SVLs = 60, 53, 43 mm) were reproductively inactive and were considered as sub-adults.

My small samples and lack of data from all months prohibit a definitive analysis of the *C. intermedius* reproductive cycle. Still, reproductively active *C. intermedius* from opposite ends of the year indicate an extended period of reproduction as has been reported for other geckos from Southeast Asia: *Gehyra mutilata* (as *Peropus mutilatus*), *Hemidactylus frenatus*, *Hemidactylus* (as *Cosymbotus*) *platyurus* (Church 1962), *Cyrtodactylus malayanus, Cyrtodactylus pubisulcus* (Inger & Greenberg 1966), *Dixonius siamensis* (Goldberg 2008), *Gekko smithii* (Goldberg 2009). The almost invariant clutch size of 2 (1.9) is in keeping with Vitt (1986).

In conclusion, baseline reproductive data suggest *C. intermedius* has an extended reproductive cycle similar to other gekkonid species from Southeast Asia. With at least 40 other species of gekkonids known from Vietnam alone (Nguyen *et al.* 2009) analyses of gonads from numerous other species are needed before the reproductive strategies of Southeast Asian geckos can be ascertained.

Table 1. Monthly stages in the ovarian cycle of 17 *C. intermedius* females.

Month	n	Quiescent	Early yolk deposition	Enlarged follicles > 4 mm	Oviductal eggs
March	4	2	0	1	1
April	3	0	1	1	1
May	6	1	1	2	2
June	2	0	1	0	1
August	1	0	1	0	0
November	1	0	0	0	1

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Appendix

The following specimens of *C. intermedius* comprise the basis for this study: Thailand, Nakhon Ratchasima Province (13.1889°N, 99.9469°E) FMNH 180709, 180710, 180713–180716, 180721, 180722, 180724, 180727, 180729, 180733, 180734, 180736, 180745–180748, 180750, 180754, 180756, 180758, 180760, 180762, 180763, 180766, 180770, 180775, 180781; Cambodia, Kampot Province (10.6313°N, 104.0477°E) FMNH 263229, 263230, 263232–263236, Cambodia, Kampong Speu Province (11.3108°N, 104.0783°E) FMNH 263238–263240, 263242, Cambodia, Koh Kong Province (11.6833°N, 102.9666°E) FMNH 263345.

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Steven C. Anderson, Subramanian Bhupathy, Sathyabhama Das Biju, Wolfgang Böhme, Ashok Captain, Amanda Cottone, Indraneil Das, Harold De Lisle, Sushil K. Dutta, David Gower, Tsutomu Hikida, André Koch, Stephen Mahony, John Murphy, Annemarie Ohler, James Parham, Olivier S. G. Pauwels, Herbert Rösler, Saibal Sengupta, Glenn Shea, Bryan Stuart, Gernot Vogel, and George Zug.

A field guide to the reptiles of Southeast Asia

by Indraneil Das
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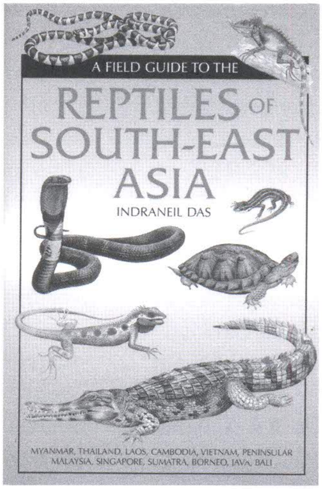

The task of putting together a book on the over 700 species of turtles, tortoises, lizards, snakes and crocs of this diverse chunk of the planet's real estate must have been truly daunting. My immediate impression, seeing a reptile book done in the format of a typical bird field guide, paintings of many species on each plate, was an 'ahah' moment: so this is how to cram a huge array of diversity into one field guide sized book!

Delving into the book, using it in the field on a recent visit to Arunachal Pradesh in Northeast India (where a fair chunk of S.E. Asia herpetofauna spills over into so-called South Asia), was a good chance to see the advantages and short-comings of this ambitious achievement.

First let's get into the problems of the book. On page 10 the 'Head scales of snakes' illustration is upside down which messes things up for the beginner. The dentition and tail diagrams on the same page are crude. Plate 38 on page 92 has confused the names of all the pythons. OK, so some of us are familiar with the python species, but what about some of the more obscure herps – how can we depend on the veracity of the illustrations? A minor point, the gharial is no longer found in Myanmar and its presence there was established by the finding of a couple of jaw bones. In general the illustrations are pleasing and accurate, but there is considerable disparity in the quality of the drawings, done by seven illustrators. Some are outstanding and they should have been given the job of doing the rest!

There is a problem with the use of *Broghammerus* as the genus name for the reticulated python and for the sake of argument it should remain *Python* for now.

On the positive side there is plenty to crow about, perhaps the best part is to have nearly 700 species of crocodilians, turtles, tortoises, lizards and snakes all wrapped up in one, easy to transport, 376 page book. Aside from the illustrations (over 70 pages of them), the information on each species is concise, but adequate with a short introductory paragraph for each of the families of reptiles. Here is a very important book for anyone interested in the reptiles of South-east Asia, particularly if you are going to be travelling there!

Romulus Whitaker

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