Hamadryad Vol. 36, No. 1, pp. 42 – 44, 2012.

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.

Acknowledgements

I thank Alan Resetar (FMNH) for allowing me to examine *C. baluensis*.

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Received: 8 December 2010.
Accepted: 31 July 2011.

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.

Hamadryad Vol. 36, No. 1, pp. 44 – 46, 2012.

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

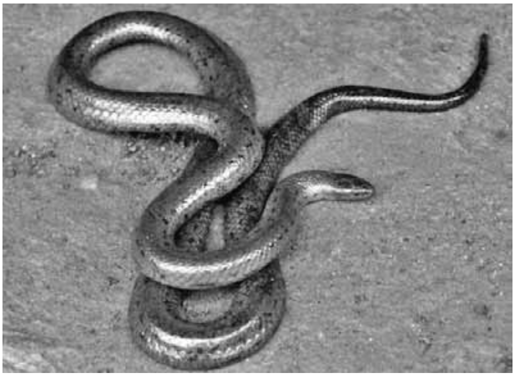

Figure 1. Live uncollected *Rhabdops olivaceus*.

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).

Acknowledgements

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.

for logistics; Madras Crocodile Bank for access to library; Romulus Whitaker and David Gower for confirming our species identification; Ashok Captain and an anonymous reviewer for their insightful comments.

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Received: 4 November 2009.
Accepted: 31 July 2011:

Hamadryad Vol. 36, No. 1, pp. 46 – 51, 2012.

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-

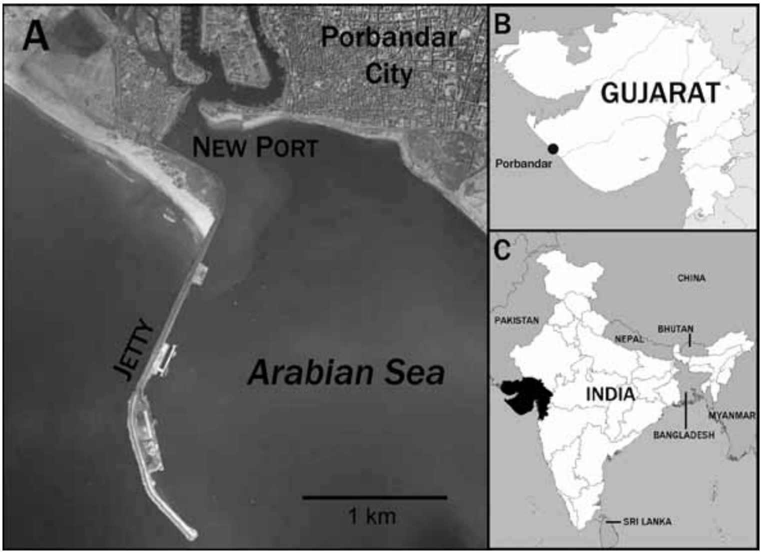

Figure 1. A) GoogleEarth image of the port area of Porbandar, Gujarat. The known distribution of *Hemidactylus porbandarensis* is limited to the port area and jetty. B) Map of Gujarat showing the position of Porbandar. C) Map of India showing Gujarat in black.

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).

Acknowledgements

Raju Vyas is especially thankful to Dilip Vyas, Porbandar for hospitality and support during the field portion of the study. We would like to thank Praveen Karanth for his help and suggestions with the molecular work, Aniruddha Datta-Roy for his help with the lab work, and B. H. C. Murthy for consultation regarding ZSI type material. Gaurav Sharma (ZSI Jodhpur) kindly provided images of the types of *H. porbandarensis*. We thank Asad Rahmani, Director, BNHS for his support of this research. This research was supported by grant DEB 0844523 from the National Science Foundation of the United States to AMB and TRJ.

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Received: 15 July 2011.
Accepted: 4 September 2011.
Acting Editor: Indraneil Das.

Hamadryad Vol. 36, No. 1, pp. 51 – 53, 2012.

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

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.

Acknowledgements

I thank Alan Resetar (FMNH) for allowing me to examine *D. vittata.*

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Received: 15 July 2011.
Accepted: 4 September 2011:

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.

Hamadryad Vol. 36, No. 1, pp. 53 – 56, 2012.

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 Waynad. 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-

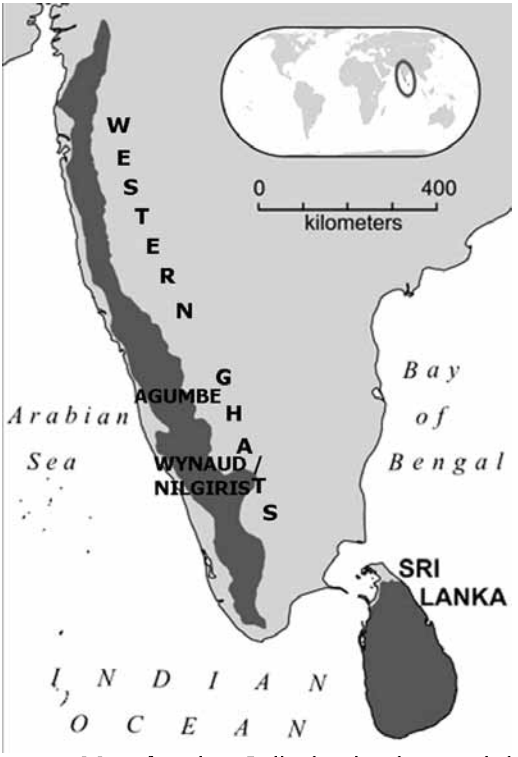

Figure 1. Map of southern India showing the extended distribution of *Melanophidium wynaudense*.

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

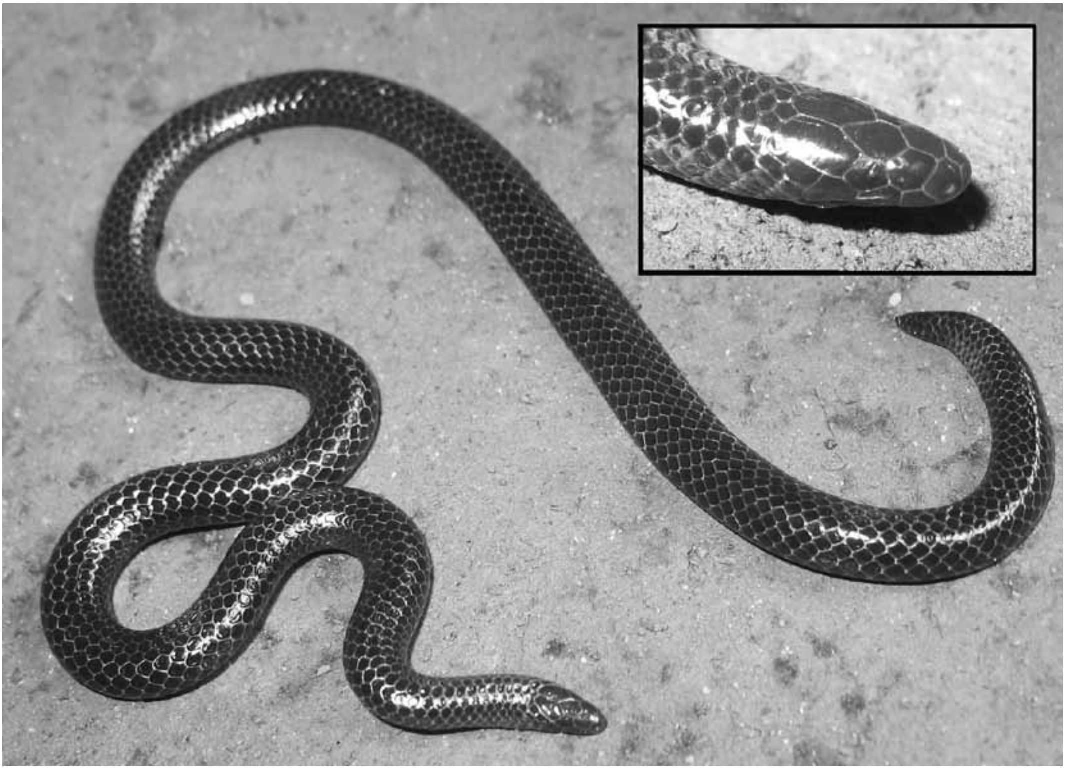

Figure 2. Live uncollected *Melanophidium wynaudense*, entire profile. Inset: close up for head showing diagnostic characters.

the sole exception had a few white patches near the anal shield.

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.

Acknowledgements

We thank our respective organizations—Romulus Whitaker, founder, Agumbe Rainforest Research Station and B. Vijayaraghavan, Chairman, Chennai Snake Park, for supporting our researches; Karnataka Forest Department for permission; Mittal Gala for her kind help with scale counting and photography; Ashok Captain for confirming our identification; India's Centre for Herpetology / Madras Crocodile Bank for extending their library facilities; an anonymous referee for his critical comments that greatly improved this manuscript.

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Received: 29 October 2011.
Accepted: 1 April 2012:

Hamadryad Vol. 36, No. 1, pp. 56 – 58, 2012.

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

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

Acknowledgements

We would like to thank Kunal Ullalkar, N. S. Achyuthan and Sushant Gavas for help with field work. Ishan Agarwal is thanked for sharing information about the species and his observation from Dorle. Special thanks to Aaron Bauer and Stephen Mahony for the valuable comments from which the manuscript benefited.

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Received: 26 February 2011.
Accepted: 26 October, 2011.

Hamadryad Vol. 36, No. 1, pp. 58 – 60, 2012.

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 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

Acknowledgements

I thank Alan Resetar (FMNH) for allowing me to examine *C. intermedius*.

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Received: 15 November 2011.
Accepted: 8 February 2012:

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.

REVIEWERS FOR *HAMADRYAD* 36(1)

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.