

SHORT COMMUNICATION

Notes on the reproduction of *Kentropyx altamazonica* (Squamata: Teiidae) and *Imantodes lentiferus* (Serpentes: Dipsadidae) from southeast Peru

Shirley Jennifer Serrano Rojas^{1,2}, Jaime Villacampa¹, and Andrew Whitworth³

¹ The Crees Foundation, Mariscal Gamarra, B-5, Zona-1, 2^{da} Etapa, Cusco, Peru. E-mail: shirley.serrano25@gmail.com

² Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Peru. E-mail: 070901@unsaac.edu.pe

³ Institute of Biodiversity, Animal Health and Comparative Medicine, College of Medical, Veterinary and Life Sciences, University of Glasgow, G12 8QQ, Glasgow, United Kingdom.

Keywords: Amazonia, clutch size, communal nesting, hatching, incubation, Manu Biosphere Reserve, oviposition.

Palavras-chave: Amazônia, eclosão, nidificação comunal, ovipostura, incubação, Reserva da Biosfera Manu, tamanho da ninhada.

Field observations on the reproductive biology of squamate reptiles are important to understanding the life history, ecology, and evolution of this diverse group (Vitt 1991, Ramírez-Bautista *et al.* 2000, Vitt *et al.* 2001, Werneck *et al.* 2009); however, these data remain sparse for many tropical species (Figueroa *et al.* 2013, Sousa *et al.* 2014). Seasonality, clutch frequency, clutch size, egg size, and body size are important factors related to the life history of oviparous squamates (King 2000, Nelson *et al.* 2004, Kratochvíl and Frynta 2006a,b, Wang *et al.* 2011). Here, we present important information on the reproductive cycles of two, little-known Amazonian reptiles, *Kentropyx altamazonica* (Cope, 1876) and *Imantodes*

lentiferus (Cope, 1894). Neither species has been assessed by the International Union for Conservation of Nature (IUCN) Red List.

Imantodes lentiferus, the Amazon Basin tree snake, is an arboreal and nocturnal dipsadid. It occurs in lowland rainforest of the Amazon Basin and Guiana region, having been reported from French Guiana, Suriname, Guyana, Venezuela, Colombia, Ecuador, Peru, Bolivia, and Brazil (Frota *et al.* 2015, Uetz and Hošek 2015). The snake produces clutches of two or three eggs (Duellman 1978, Myers 1982). *Kentropyx altamazonica* is an active-foraging, heliothermic teiid lizard that is associated with water edges (Vitt *et al.* 2001). It is distributed throughout Venezuela, Colombia, Ecuador, Peru, Bolivia, and Brazil (Duellman 2005, Uetz and Hošek 2015). The species is reported to have a clutch size of three to nine eggs (Duellman 2005, Werneck *et al.* 2009).

Received 13 November 2015.

Accepted 9 March 2016.

Distributed June 2016.

The study area is in the Crees Foundation's Mascoitania Reserve (643 ha; 12°47'21" S, 71°23'28" W; 460 m a.s.l.), Madre de Dios, Amazonian southeast Peru. The reserve is situated on the banks of the Alto Madre de Dios River, in the cultural zone of the Manu Biosphere Reserve and is the site of a research station, the Manu Learning Centre (MLC). The reserve has a highly diverse reptile assemblage (Whitworth *et al.* 2016). *Imantodes lentiferus* and *K. altamazonica* have been recorded at numerous sites in the Manu Biosphere Reserve (Catenazzi *et al.* 2013).

On 27 September 2012 at 21:40 h, we encountered an adult female *Imantodes lentiferus* 190 cm above ground on a branch in a secondary regenerating forest. The snake was gravid and while being housed overnight in a container it laid two elliptical eggs (Figure 1A). The snake was 820 mm SVL, 380 mm in tail length, and weighed 32 g prior to oviposition. The next day we released the adult female in the same location it was found. We placed the eggs into a plastic tub with leaf litter substrate, and maintained at ambient temperature and humidity. Incubation lasted 125 days. Neonates emerged along the sidewalls of the egg (Figure 1B). One week later, we released the neonates at the site where the mother was found.

Oviposition occurred at the end of the dry season (September) and hatching in the wet season (January). This concurs with Duellman's (1978) report of one female that deposited three eggs on 14 August (dry season), with two of these hatching on 25/26 November (wet season). Similar clutch sizes for *I. lentiferus* also were reported by Duellman (1978) and Myers (1982) as well as for other species of *Imantodes* (e.g., *I. cenchoa*; Duellman 2005).

We discovered two egg clutches of *Kentropyx altamazonica* on the grounds of the MLC (Figure 2A)—one on 8 April 2014 and the other on 13 November 2014. The elliptical, shelled eggs were buried 10 cm deep in a sandy substrate beneath one of the buildings. We placed the eggs into a plastic tub (30 × 10 × 10 cm) with a sandy substrate and leaf litter on top. The tub was maintained at ambient temperature and humidity, and checked daily. Eggs that were easily accessible without separating the entire clutch ($N = 10$) were measured to the nearest 0.1 mm; 17.3 ± 0.8 mm mean length and 10.5 ± 0.8 mm mean width (Table 1). Incubation of the April clutch took an average of 142.5 ± 1.1 days, with the first hatching on 23 August 2014 and the last on 1 September 2014. Incubation of the November clutch took an average of 110.3 ± 0.2 days, with all eggs hatching 9–10 March 2015.

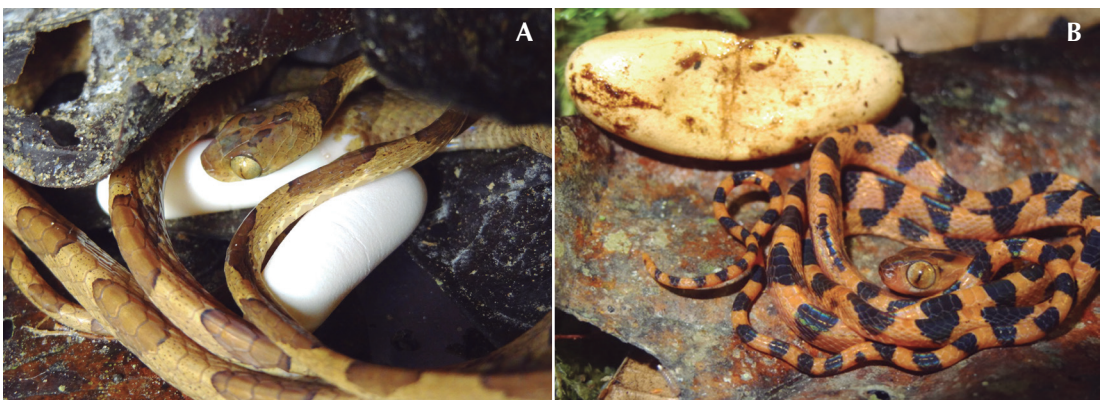


Figure 1. (A) *Imantodes lentiferus* adult female after depositing the eggs. (B) Newly hatched *I. lentiferus* and an empty egg showing sidewall as exit point of neonates.

All neonates emerged from the distal end of the egg (Figure 2B). Hatching success was 100% for both clutches (Figure 2C, D). We measured SVL and tail lengths to the nearest 0.1 mm and weighed to the nearest 0.1 g. The average SVL of neonates ($N = 19$) was 33.7 ± 0.0 mm; the average tail length was 59.7 ± 0.5 mm and the weight 0.8 ± 0.0 g (Table 1). We released the hatchlings near the egg deposition site. Incubation times differed between the two clutches; however, we do not know when the eggs were laid.

Oviposition and hatching in *Kentropyx altamazonica* occurs in both dry (e.g., April) and wet (e.g., November) seasons. Likewise, hatching also occurs in wet and dry seasons (March and August, respectively). Duellman (2005) reported a female containing three oviductal eggs in December (wet season) and another female with four well-developed eggs in February (wet season). This variety of oviposition dates may suggest aseasonal reproductive cycles in *K. altamazonica*. Duellman (2005) reported a small clutch size of two or three eggs for *K. altamazonica*, whereas Werneck *et al.* (2009) reported larger clutch size of three to nine eggs (mean 5.45 ± 1.11 , $N = 38$). This latter value is more similar to the clutch we found in November ($N = 6$). A possible explanation for the 13 eggs found in April might be communal nesting. Communal nesting is a reproductive strategy

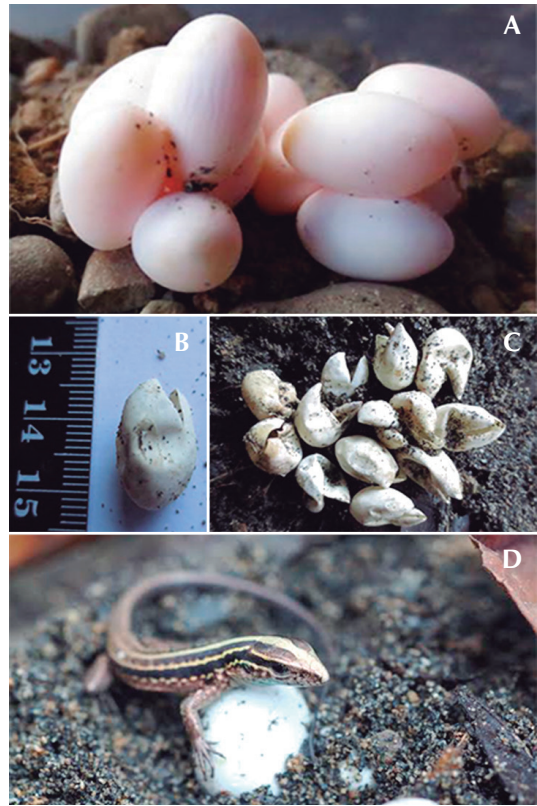


Figure 2. (A) Clutch of 13 eggs of *Kentropyx altamazonica* found at the MLC research station on 8 April 2014. (B) An empty egg of *K. altamazonica*, showing the distal exit point. (C) *K. altamazonica* hatchling success was 100%. (D) Newly hatched *K. altamazonica*.

Table 1. Morphometrics of *Kentropyx altamazonica* eggs and hatchlings.

Clutch	Eggs			Hatchlings			
	<i>N</i>	Length (mm)	Width (mm)	<i>N</i>	SVL (mm)	Tail Length (mm)	Weight (g)
April 2014	4	18.1	11.4	13	33.8	59.6	0.8
November 2014	6	16.4	9.7	6	33.7	58.5	0.8
Mean	–	17.3	10.5	–	33.7	59.1	0.8
SD	–	1.2	1.1	–	0.0	0.7	0.0
SE	–	0.8	0.8	–	0.0	0.5	0.0

common among reptiles, often in response to environmental constraints (Rand 1967, Swain and Smith 1978) or adaptations (Blouin-Demers *et al.* 2004, James and Henderson 2004, Zbinden *et al.* 2006). A congener, *K. calcaratus*, displays communal-nesting behavior (Magnusson and Lima 1984, Filadelfo *et al.* 2013). Nevertheless, additional field data are needed to verify the possibility of communal nesting in *K. altamazonica*.

Although much remains to be learned about the ecology of tropical forest reptiles (Böhm *et al.* 2013), these observations contribute important information about two poorly known Amazonian species.

Acknowledgments.—Thanks to the Crees Foundation and its director Quinn Meyer for supporting herpetological research at the MLC. We are grateful for the financial support and encouragement of the TJMF Foundation, which provided crucial support for this work through their Amazon Research Programme grant to the University of Glasgow, and the Darwin Initiative for financial support of the Sustainable Manu project. Thanks to the Ministerio de Agricultura de Peru for providing the permit to conduct research (Permit number: 25397; Authorisation number 2904-2012-AG-DGFFS-DGEFFS). We thank Chicago Herpetological Society, the Louise Hiom Fund and Glasgow Natural History Society for funding herpetological fieldwork. Finally, we thank Rudolf von May, Ross MacCulloch, and an anonymous reviewer for helpful comments to improve this manuscript. 🐸

References

- Blouin-Demers, G., P. J. Weatherhead, and J. R. Row. 2004. Phenotypic consequences of nest-site selection in black rat snakes (*Elaphe obsoleta*). *Canadian Journal of Zoology* 82: 449–456.
- Böhm, M. *et al.* (more 243 authors). 2013. The conservation status of the World's reptiles. *Biological Conservation* 157: 372–385.
- Catenazzi, A., E. Lehr, and R. von May. 2013. The amphibians and reptiles of Manu National Park and its buffer zone, Amazon basin and eastern slopes of the Andes, Peru. *Biota Neotropica* 13: 269–283.
- Duellman, W. E. 1978. The Biology of an Equatorial Herpetofauna in Amazonian Ecuador. *Miscellaneous Publications of the Museum of Natural History of the University of Kansas* 65: 1–352.
- Duellman, W. E. 2005. *Cusco Amazónico. The Lives of Amphibians and Reptiles in an Amazonian Rainforest*. Ithaca. Comstock Publishing Associates, Cornell University Press. 472 pp.
- Figueroa, A., T. R. Lewis, and P. Mooney. 2013. Notes on reproduction in *Oxybelis fulgidus* from Costa Rica. *Herpetology Notes* 6: 29–31.
- Filadelfo, T., P. T. Danta, and R. M. D. Ledo. 2013. Evidence of a communal nest of *Kentropyx calcarata* (Squamata: Telidae) in the Atlantic Forest of northeastern Brazil. *Phyllomedusa* 12: 143–146.
- Frota, J. G., A. F. R. Missassi, M. C. Santos-Costa, and A. L. C. Prudente. 2015. New records of *Imantodes lentiferus* (Cope, 1894) (Squamata: Dipsadidae) from the states of Pará and Mato Grosso, Brazil. *Check List* 11: 1–4 (article 1686).
- James, A. and R. W. Henderson. 2004. Communal nesting site in the snake *Liophis juliae* in Dominica, West Indies. *Caribbean Journal of Science* 40: 263–265.
- King, R. B. 2000. Analyzing the relationship between clutch size and female body size in reptiles. *Journal of Herpetology* 34: 148–150.
- Kratochvíl, L. and D. Frynta. 2006a. Body-size effect on egg size in eublepharid geckos (Squamata: Eublepharidae), lizards with invariant clutch size: negative allometry for egg size in ectotherms is not universal. *Biological Journal of the Linnean Society* 88: 527–532.
- Kratochvíl, L. and D. Frynta. 2006b. Egg shape and size allometry in geckos (Squamata: Gekkota), lizards with contrasting eggshell structure: why lay spherical eggs? *Journal of Zoological Systematics and Evolutionary Research* 44: 217–222.
- Magnusson, W. E. and A. P. Lima. 1984. Perennial communal nesting by *Kentropyx calcaratus*. *Journal of Herpetology* 18: 73–75.
- Myers, C. W. 1982. Blunt-headed vine snakes (*Imantodes*) in Panama, including a new species and other revisionary notes. *American Museum Novitates* 2738: 1–50.
- Nelson, N. J., M. B. Thompson, S. Pledger, S. N. Keall, and C. H. Daugherty. 2004. Egg mass determines hatchling

- size, and incubation temperature influences post-hatching growth, of tuatara *Sphenodon punctatus*. *Journal of Zoology* 263: 77–87.
- Ramírez-Bautista, A., C. Balderas-Valdivia, and L. J. Vitt. 2000. Reproductive ecology of the whiptail lizard *Cnemidophorus lineatissimus* (Squamata:Teiidae) in a tropical dry forest. *Copeia* 2000: 712–722.
- Rand, A. S. 1967. Communal egg laying in anoline lizards. *Herpetologica* 23: 227–230.
- Sousa, K. R. M., A. L. C. Prudente, and G. F. Maschio. 2014. Reproduction and diet of *Imantodes cenchoa* (Dipsadidae: Dipsadinae) from the Brazilian Amazon. *Zoologia* 31: 8–19.
- Swain, T. A. and H. M. Smith. 1978. Communal nesting in *Coluber constrictor* in Colorado (Reptilia: Serpentes). *Herpetologica* 34: 175–177.
- Uetz, P. and J. Hošek (eds.). 2015. The Reptile Database: an Online Reference. Electronic Database accesible at <http://www.reptile-database.org>. Captured on 29 March 2016.
- Vitt, L. J. 1991. Ecology and life history of the wide-foraging lizard *Kentropyx calcarata* (Teiidae) in Amazonian Brazil. *Canadian Journal of Zoology* 69: 2791–2799.
- Vitt, L. J., S. S. Sartorius, T. C. S. Ávila-Pires, and M. C. Espósito. 2001. Life at the river's edge: ecology of *Kentropyx altamazonica* in Brazilian Amazonia. *Canadian Journal of Zoology* 79: 1855–1865.
- Wang, Z., Y. Xia, and X. Ji. 2011. Clutch frequency affects the offspring size-number trade-off in lizards. *PLoS One* 6: e16585.
- Werneck, F. P., L. G. Giugliano, R. G. Collevatti, and G. R. Colli. 2009. Phylogeny, biogeography and evolution of clutch size in South American lizards on the genus *Kentropyx* (Squamata: Teiidae). *Molecular Ecology* 18: 262–278.
- Whitworth, A., R. Downie, R. von May, J. Villacampa, and R. MacLeod. 2016. How much potential biodiversity and conservation value can a regenerating rainforest provide? A 'best-case scenario' approach from the Peruvian Amazon. *Tropical Conservation Science* 9: 224–245.
- Zbinden, J. A., D. Margaritoulis, and R. Arlettaz. 2006. Metabolic heating in Mediterranean loggerhead sea turtle clutches. *Journal of Experimental Marine Biology and Ecology* 334: 151–157.

Editor: Ross D. MacCulloch