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Successful Repair of an Emerald Tree Monitor (*Varanus prasinus* Schlegel, 1839) Egg at Bristol Zoo Gardens

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Abstract: During the artificial incubation of a clutch of *Varanus prasinus* eggs, one egg ruptured. This article describes the successful repair of this egg, alongside reproductive data pertaining to the egg clutch and resulting hatchlings.

During artificial incubation, reptile eggs can be subjected to hazards resulting from human error or equipment malfunction. Two of the most important factors influencing the hatching success and viability of reptile eggs are the thermal and hydric conditions present during incubation (Booth, 2004). If these conditions fall outside the optimal incubation ranges for the species, or if a sudden fluctuation in these environmental variables occurs, eggs can become damaged - sometimes resulting in rupture of the eggshell.

Accounts describing the repair of ruptured reptile eggs are relatively uncommon in the literature, with few examples from the genus *Varanus* (Adragna & Madden, 2009; Fischer, 2012). An attempt to repair a ruptured tree monitor egg (*V. beccarii*) used hot wax to seal the perforataion (Fischer, 2012). This repair occurred fairly late into the egg's incubation (day 136) and while the embryo developed fully, it failed to hatch and died in the egg. A single instance of successful monitor lizard egg repair was documented by Adragna & Madden (2009), after a *V. acanthurus brachyurus* egg was found ruptured 81 days into incubation. This egg went on to hatch (day 106) after it was patched with a piece of eggshell from a hatched *V. tristis tristis* egg. The following article details the successful repair of a damaged *V. prasinus* egg that had ruptured approximately half way through its incubation, and provides morphometric data on the egg clutch and resulting hatchlings.

Oviposition and Incubation of Eggs

A five year old, second generation (F2) captive-bred *V. prasinus* female was introduced to a six year old wild-caught male's enclosure on 28 December 2012. Courtship began immediately, and the first observed copulation took place within an hour. Thirty four days after this first mating, the female laid five eggs in a horizontally-dug nest chamber 17 cm in depth, inside a nest box. The nest box, a plastic bucket measuring 30 cm high and 25 cm in diameter, was filled with a 1:2 mix by volume of dampened sand and coir and heated from beneath to provide a vertical temperature gradient ranging from 29 to 32° C. The surface temperature of the eggs and surrounding nesting medium in which the eggs were deposited was 31.1° C. One egg (egg # 5) was deflated and non-viable, and subsequently discarded.

Table 1. Clutch data.

Egg No.	Mass (g)	Length (mm)	Width (mm)
1	10.84	43	21
2	10.28	42	21
3	10.74	44	21
4	10.74	42	21
5*	6.8	40	21

*Egg was deflated and nonviable, and subsequently discarded

After the eggs were retrieved from the nest site, they were weighed and measured (Table 1), and set up for artificial incubation inside a sealed, transparent plastic storage container. Vermiculite was used as an incubation substrate, and was hydrated with reverse-osmosis (RO) water to a 1:1 ratio by weight. The clutch was then placed in an incubator (Vickers Medical Neocare Baby-controlled Incubator, Model # 142; Vickers Medical, Ltd., London, UK) set to a constant temperature of 31.0° C. The lid of the container was initially removed weekly for aeration of the incubation environment and daily during the latter stages of development.

Repair of Ruptured Egg

Egg number two ruptured 77 days into incubation, and lost approximately 0.2 ml of albumen from the opening (Fig. 1). The likely cause of the rupture was the sudden rehydration of the eggs after they had begun to dehydrate and deflate several days earlier due to humidity levels inside the egg container dropping to 67%. The egg was repaired by applying tissue adhesive (3M™ Vetbond™ Tissue adhesive; 3M, St. Paul, Minnesota, USA) to the surface of the damaged shell using a small gauge needle syringe. The albumen was wiped away, and the tissue adhesive was applied quickly before much more albumen could escape (Figs. 2 & 3). Including the initial seepage, approximately 0.4 ml of albumen was lost in total before the egg could be completely sealed.

Fig. 1. Egg number two had a small fissure where albumen began to seep out.

Figs. 2 & 3. Egg number two wiped free of albumen with clean tissue paper before appllying tissue glue to the damaged section of the egg.

Hatching

Sixty days after the repair (137 days total incubation), egg numbers one, two (the repaired egg) and three hatched on 16 June 2013. This incubation period falls within the known range of 123-215 days for this species (Baldwin, 2006; Biebl, 1993; Bosch, 1999; Dedlmar, 1994; Gorman, 2000; Horn & Visser, 1991; Jacobs, 2002; Kok, 2000; Mendyk, 2008, 2012; Pfaff & Sprackland, 1996; Polleck, 2004). The hatchling from egg number one had emerged by 1600 h, but the yolk sack had not internalized and a herniation at the umbilicus was present. It was left overnight in the incubator, but was found dead the next morning. Egg number four hatched two days later, after 139 days of incubation.

Hatchling number four had also pipped on 16 June, but did not fully emerge until two days later. It was inspected within the egg on 17 June, where the yolk sac was found to be ruptured. This is possibly the result of the yolk sac adhering to the eggshell and being pulled against the amniotic contraction, causing a tear (Perazo *et al*., 2013). This failure to internalize residual yolk seems likely to have contributed to the remarkably small size of the hatchling. At just 4.8 grams, this

Fig. 4. Hatchling *Varanus prasinus* pipping from the repaired egg.

Fig. 5. Juvenile *V. prasinus* that hatched from the repaired egg.

hatchling falls outside of the known 5.7-11.0 g range for *V. prasinus* (Mendyk, 2012). All hatchling data for this clutch are summarized in Table 2. Each hatchling fed on pieces of chopped pinkie mouse parts three days after hatching, and then moved on to a diet of almost entirely invertebrates (crickets and cockroaches). All three offspring continue to grow and do well at the time of writing (Fig. 6).

Table 2. Summary of hatchling measurements. Abbreviations used: SVL = Snout to vent length; TL = Total length ; TaL:SVL = Tail length to snout to vent length ratio.

Egg No.	Hatchling Mass	SVL (mm)	TL (mm)	TaL:SVL
1*	8.1	n/a	n/a	n/a
2**	7.9	86	214	1.5
3	8.2	88	218	1.5
4	4.8	68	177	1.6

*Hatchling died within 15 hours of hatching; measurements from necropsy. ** Hatched from the repaired egg.

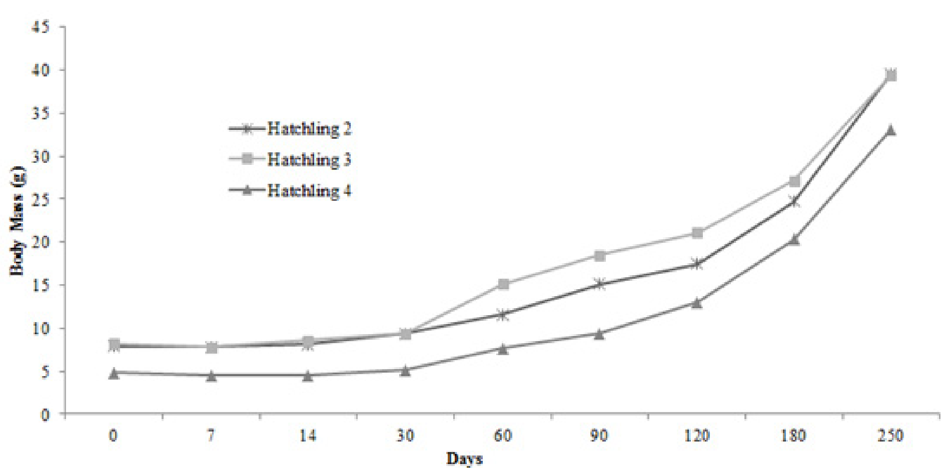

Fig. 6. Body mass growth of three captive-bred *V. prasinus* at Bristol Zoo Gardens.

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