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Notes on Reproduction in *Oxybelis fulgidus* from Costa Rica

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The green vine snake, *Oxybelis fulgidus* (Daudin, 1803), is an arboreal and diurnal snake with a distribution ranging from southern Mexico to northeastern Argentina (Savage, 2002; Köhler, 2008; McCranie, 2011). Snakes of the genus *Oxybelis* are characterised by a slender body, large eyes with binocular vision, elongated snout, and cryptic coloration; features all associated with their arboreal lifestyle (Henderson and Binder, 1980; Henderson, 1982). Vine snakes are ambush foragers feeding predominately on lizards but they also take other prey (Scartozzoni et al., 2009; Figueroa and Valerio, 2011; Santos Jr. et al., 2011). Despite some data on the ecology of wild specimens, knowledge regarding reproduction is limited (Scartozzoni et al., 2009). Herein we present data on clutch size from a live specimen, egg incubation period and neonate size.

On 26 March 2011 at 14:00 h we captured an adult female *O. fulgidus* near human settlement at the base of Cerro Tortuguero (N 103508.0 /W 833146.4; elevation), Limón Province, Costa Rica (8 km north of Tortuguero National Park). Cerro Tortuguero lies within the Barra del Colorado Refuge (92,000 ha) and is Atlantic lowland tropical wet forest on top of a volcanic uplift (Lewis et al., 2010). Its vegetation comprises 21 families of plants with dominant stands of *Pentaclethra macroloba*, *Prioria copaifera*, and *Spondias mombin* that create a high over storey and light understory on a steep, well drained slope. This region is characterised by an annual average temperature of 26˚C and receives approximately 5000 mm of annual rainfall. The majority of these rains fall between November and January, creating flash flooding. From February to September the climate is drier but rarely experiences more than two weeks without rain. Upon capture we perceived that the body of the snake was distended and confirmed the presence of eggs by palpation. We brought the snake back to Caño Palma Biological Station (N 103536.1/W 833139.4) to measure for part of an ongoing study on arboreal snakes. Since the snake was gravid, we kept it in captivity until oviposition in a plastic container (60 x 31 x 33 cm) at ambient temperature and humidity within the station's laboratory with leaf litter as substrate, no perches, and water provided ad libitum.

We measured snout-vent length (SVL) and tail length (TL) for the adult female and all the neonates to the nearest 0.1 mm by using dental floss to measure SVL along the snake's vertebrae from the cloaca to the tip of the snout, and from the cloaca to the tip of the tail for TL, and then measuring the dental floss along a meter stick. For each of the eggs, we measured length and width using Mitutoyo™ digital calipers to the nearest 0.1 mm. Mass of the snakes and of the eggs were measured using Pesola™ scales to the nearest 0.5 g.

The adult snake measured 1408 mm in SVL, 585 mm in TL, and weighed 289 g prior to oviposition. Three days after capture the snake oviposited seven eggs (Figure 1). We numerically marked each of the eggs 1-7 using a marker to record the measurements of the eggs and hatchlings. The eggs averaged 44.9 mm in length, 18.6 mm in width, and 11.6 g in mass (Table 1). One of the eggs (egg 7) was not viable as it was sunken in and varied greatly in size and mass from the other

Figure 1. Wild female *Oxybelis fulgidus* collected on 26 March 2011 with eggs oviposited between 03 July 2011 and 06 July 2011 at Caño Palma Biological Research Station, Costa Rica.

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Table 1. Morphometrics of seven *Oxybelis fulgidus* eggs laid on 29 July 2011. Length and width are in millimeters, and mass is in grams.

Egg Number	Egg Length	Egg Width	Egg Mass
1	50.8	18.5	13.5
2	48.4	19.4	13.5
3	46.2	19.0	12.5
4	43.7	19.3	11.5
5	48.0	19.0	12.5
6	41.6	20.6	11.5
7	36.0	14.3	6.5
Mean	44.9	18.6	11.6
SD	10.0	2.0	2.4

Table 2. Morphometrics of six *Oxybelis fulgidus* hatchlings. SVL = snout-vent length, TL = tail length. Incubation period is in days, SVL and TL are in millimeters, and mass is in grams.

Number of Individual	Date of Hatching	Incubation Period	SVL	TL	Mass
1	05 July 2011	98.0	268.0	146.0	8.0
2	06 July 2011	99.0	258.0	131.0	6.5
3	05 July 2011	98.0	392.0	141.0	5.5
4	03 July 2011	96.0	449.0	143.0	7.5
5	04 July 2011	97.0	395.0	151.0	6.5
6	04 July 2011	97.0	378.0	140.0	6.5
Mean	--	98.6	356.7	142.0	6.8
SD	--	1.1	76.5	6.7	0.9

eggs; therefore it was dispatched. The remaining six eggs were placed in a container (30 x 17 x 10 cm) with moist substrate and kept at ambient temperature and humidity at the station's laboratory. All six eggs hatched successfully, with hatching commencing on 3 July 2011 and ending on 6 July 2011 (Figures 2 and 3). All the snakes hatched at the distal end of the egg and this could be due to the elongate head shape of the species. The head, when inside the egg, was likely laterally aligned with its length and too long to be used to puncture the side walls of the egg (Figure 2). Eggs incubated for an average of 98.6 days (Table 2). Neonates averaged 356.7 mm SVL, 142.0 mm TL and weighed 6.8 g (Table 2). One day after ovipositing, the adult female was released into lowland tropical rainforest close to the site of capture, and all the neonates were released at the same location after they all shed.

Our observation alludes to oviposition and hatching in *O. fulgidus* in the Tortuguero region occurring outside the wet season with oviposition in March and hatching in July. This observation is in accordance with Solórzano (2004) who reported a female from Costa Rica that oviposited 14 eggs in March. In contrast, populations in northern Brazil have oviposition and hatching that coincides with the rainy season, with oviposition occurring from September to December and hatching from January to April (Scartozzoni et al., 2009). This region of Brazil receives a mean monthly temperature of 24-28˚ C with most rainfall occurring in December to April. Based on the literature, fecundity in *O. fulgidus* ranged from six to 10, with incubation lasting up to 149 d (Table 3). Neonate size appears to vary drastically, with

Figure 2. Recently hatched *Oxybelis fulgidus* eggs showing distal exit points. Eggs oviposited in captivity by wild *Oxybelis fulgidus* collected on 26 March 2011 at Caño Palma Biological Research Station, Costa Rica. Eggs hatched between 03 July 2011 and 06 July 2011.

Figure 3. Recently hatched *Oxybelis fulgidus* at Caño Palma Biological Research Station, Costa Rica.

Table 3. Morphometrics of six *Oxybelis fulgidus* hatchlings. SVL = snout-vent length, TL = tail length. Incubation period is in days, SVL and TL are in millimeters, and mass is in grams.

Clutch Size	Month of Oviposition	Size of Eggs (l x w x mass)	Incubation Period	# of Hatchlings	Size of Hatchlings (SVL, TL*, Mass)	Month of Hatching	Country	Reference
6	--	--	--	--	--	--	Venezuela	Beebe, 1946
10	--	Clutch Mass 53.2	105-106 d	4	231, 129, 3.3 217, 118, 3.7 256, 101, 4.3 228, 82, 3.4	--	Not reported	Conners, 1989
10	October	32-38 x 15-18	78-81 d	6	--	January	Brazil	Martins & Oliveira, 1998
8-12*	September & December	41.1, 24.9, 15.1***	117-149 d	--	280.9, 125.0, 6.2***	March & April	Brazil	Scartozzoni et al., 2005
7	March	44.9, 18.6, 11.6	98.6**	6	356.7, 142.0, 6.8***	July	Costa Rica	This Study

neonates ranging in size from 217 mm SVL to 449 mm SVL, and mass ranging from 3.3 g to 8.0 g (Tables 2 & 3). Unfortunately, the role of temperature on *O. fulgidus* reproduction remains unknown as no study reports at what temperature eggs were incubated at.

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