

Notes on the breeding habits and new distribution records of seven species of snakes from southwest Costa Rica

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The reproductive cycles of tropical snakes vary from highly seasonal to continuous throughout the year (Fitch, 1970; Shine, 2003) depending on climatic complexity (Greene, 1997) and food availability (Seigel et al., 1987; Santos et al., 2005). However, the reproductive timing of most Central American snakes is not well understood (Seigel, et al., 1987; Green, 1997) partially due to their secretive nature and infrequent encounter rates (Henderson et al., 1978). Much of the information on snake reproductive activity has come from casual observation on the presence of gravid females, oviposition, or observation of hatchlings (Fitch, 1970). These casual observations have been important to broadening our understanding of snake breeding biology, especially rarely encountered species.

Costa Rica harbors a rich snake fauna of 139 species (Bolaños, et al. 2011), most of which have poorly known reproductive biology and phenology (Wilson and Meyer, 1985; Savage, 2002). The country is bisected by four mountain ranges that form distinct physiographic barriers separating the Caribbean and Pacific versants, with profound effects on the seasonality of both versants (Savage, 2002). The Pacific versant has a distinct dry season between December and April, while the Caribbean versant does not have a well-defined dry season but experiences a period

of lower precipitation between February and April (Janzen, 1983). In spite of this, many snake species have geographic ranges that encompass both the aseasonal environments of the Caribbean versant and the strongly seasonal environments on the Pacific versant (Wilson and Meyer, 1985; Savage, 2002). There is a general consensus that seasonal rainfall differences influence snake reproduction so that young are born towards the end of the dry season and start of the wet season (Henderson and Hoevers, 1977; Seigel et al., 1987; Greene, 1997).

Much of what is known about the reproductive ecology of Costa Rican snakes comes from La Selva Field Station in the Caribbean lowlands (Guyer and Donnelly, 2005). At La Selva many snakes breed year-round, some species breed seasonally, or their breeding cycles remain unknown (Guyer and Donnelly, 2005). Many of the species that occur at La Selva also occur on the Pacific versant of Costa Rica, and little is known of the reproductive ecology of snake species on the drier, seasonal Pacific versant (Savage, 2002).

Variation in the length and intensity of seasonality within the geographic range of a species can result in variable breeding phenology across its range (Greene 1997). For example, the wide-ranging species, *Bothrops asper* occurs in habitats that are both highly aseasonal and seasonal (Savage, 2002). On the seasonal Pacific versant *B. asper* breeds between September and November and gives birth between April and June, while on the aseasonal Atlantic this species breeds in March and gives birth in September and November (Solórzano and Cerdas, 1989). Thus, it should be expected that other snake species that occur in both seasonal and aseasonal environments would exhibit similar differences in breeding timing (Fitch, 1970).

Herein we report on the timing of the reproduction and clutch size for seven snake species from SW Costa Rica (Pacific versant) based on the presence of oviductal eggs

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Table 1. Summary of collection localities, body size, and clutch size for seven snake species from southwestern Costa Rica.

Specimen	Locality	Locality Coordinates	Elevation (m a.s.l.)	Total length (mm)	Clutch Size (# eggs)	Date	Significance
<i>Tantilla supracincta</i> (UCR 14800)	Tres Piedras	9° 19' 39.72"; -84° 51' 12.23"	100	325	3	9 August 2000	First recorded clutch size and reproductive phenology.
<i>Dipsas tenuissima</i> (UCR 21077)	Rincon de Osa, Puntarenas Province	8° 44' 39.40"; -83° 24' 37.40"	49	633	4	12 January 2009	First recorded clutch size and reproductive phenology.
<i>Dipsas tenuissima</i> (MSB 79910)	Las Cruces Biological Station, San Vito, Puntarenas Province	8° 47' 32.42"; -82° 58' 5.95"	1127	446	N/A	18 March 2010	Range extension and elevational record.
<i>Enulius sclateri</i> (UCR 21075)	Rincon de Osa, Puntarenas Province	8° 44' 39.40"; -83° 24' 37.33"	49	245	2	11 January 2009	Pacific coast clutch size and reproductive phenology.
<i>Imantodes cenchoa</i> (UCR 21078)	Hatillo, Puntarenas Province	9° 17' 50.13"; -83° 54' 9.58"	52	104	N/A	9 January 2009	Pacific coast reproductive phenology.
<i>Imantodes inornatus</i> (MSB 79932)	San Vito, Puntarenas Province	8° 47' 35.16"; -82° 57' 26.99"	1,200	960	5	23 March 2009	First recorded montane clutch size.
<i>Leptodeira rubricata</i> (UCR 21076)	Dominical, Puntarenas Province	9° 2' 17.68"; -83° 36' 9.39"	27	540	3	7 January 2009	Additional clutch record for uncommonly encountered species
<i>Rhadinea decorata</i> (MSB 79928)	San Vito, Puntarenas Province	8° 47' 35.16"; -82° 57' 26.99"	1,200	378	3	18 March 2010	Range extension and reproductive phenology.

or neonates. We provide the first records of clutch size for two species in Costa Rica. Additionally, we provide new elevational and distribution records for two species and note details of collection for each species.

Snakes were encountered during general herpetological surveys of southwestern Costa Rica between 2000–2010 and included visual encounters along roads and forest trails. Southwestern Costa Rica receives between 2,500–4,000 mm of rainfall annually with a pronounced dry season from late December through April (Ryan *et al.*, 2014). All individuals reported here are deposited as vouchers at the University of Costa Rica (UCR) or the Museum of Southwestern Biology at the University of New Mexico (MSB).

We collected a *Tantilla supracincta* (UCR 14800) with three eggs on 9 August 2000 at Tres Piedras, Puntarenas Province. This is the first known record of clutch size and reproductive phenology for the species (Solórzano, 2004; Guyer and Donnelly, 2005).

We collected, dead on road (DOR), a gravid female *Dipsas tenuissima* (UCR 21077) with four eggs on 12 January 2009 near Rincon de Osa, Puntarenas Province. This is the first report of clutch size and reproductive phenology for this secretive species (Savage 2002; Solórzano, 2004).

On 18 March 2010 we collected a DOR male *D. tenuissima* (MSB 79910) at Las Cruces Biological Station, San Vito at 1127 m a.s.l. This is the first record of this species from the San Vito region and represents

a new elevation record (Savage, 2002). The species was previously known to reach an elevation of 970 m a.s.l. (Savage, 2002).

We collected a DOR gravid female *Enulius sclateri* (UCR 21075) with two oviductal eggs on 11 January 2009 from the Osa Peninsula, Puntarenas. Egg clutches have been recorded from March through May and mating has been observed in May on the Atlantic lowlands (Solórzano, 2004). This is the first report of clutch size for *E. sclateri* for the Pacific lowlands and suggests that this species begins breeding early in the dry season along the central Pacific coast.

We collected one egg containing an almost completely developed *Imantodes cenchoa* (UCR 21078) on 9 January 2009 from Hatillo, Puntarenas Province. The egg was ripped open by a Great Tailed Grackle (*Quiscalus mexicanus*), but was inexplicably dropped. The bird was observed foraging in along a branch covered with large tank bromeliads in a tree approximately 20 meters high. The snake survived only for a few minutes outside of the egg. On the Caribbean versant of Costa Rica female *I. cenchoa* have been found with eggs in April to July and neonates have been observed from July to October (Fitch, 1970; Zug *et al.*, 1979; Guyer and Donnelly, 2005). This is the first record of an egg found in January at the start of the dry season on the Pacific coast of Costa Rica and supports the notion that this species has a reproductive pattern similar to that of *Bothrops asper* cited above (Zug *et al.*, 1979).

We collected a gravid female *Imantodes inornatus* (MSB 79932) (960 mm TL, 700 mm SVL) with five oviductal eggs on 23 March 2009 near San Vito, Puntarenas Province. Myers (1982) collected a 846 mm TL female from the lowlands of central Panama in late June, that contained 4 eggs. This is the first record of clutch size for *I. inornatus* from a montane locality in Costa Rica or Panama.

We collected a DOR gravid female *Leptodeira rubricata* (UCR 21076) with three oviductal eggs on 7 January 2009 from Dominical, Puntarenas Province. Clutch size for this species can be up to six eggs and oviductal eggs have been recorded in November, January, and February (Solórzano, 2004). This is a rarely encountered species and little information is known about its biology. Our observation is consistent with previously published accounts (Solórzano, 2004).

We collected a DOR *Rhadinea decorata* (MSB 79928) with three oviductal eggs on 18 March 2010 at Las Cruces Biological Station (LCBS), San Vito, Puntarenas Province. Solórzano (2004) reported clutches up to four eggs in this species. Goldberg (2007) found that Costa Rican *R. decorata* had a prolonged reproductive cycle based on oviductal eggs present in January, July and August, but he did not detail geographic variation. Furthermore, this is the first record of *R. decorata* from Las Cruces Biological Station and the San Vito region (Savage, 2002).

Our observations on the reproductive timing and egg clutch size for SW Costa Rica add to the growing knowledge on snake breeding ecology from a poorly known region of Costa Rica (Savage, 2002; Solórzano, 2004). Our observations suggest that *Dipsas tenuissima*, *Enulius sclateri*, *Imantodes cenchoa*, and *Leptodeira rubricata* breed at the start of the dry season in SW Costa Rica. Understanding the reproductive timing of snakes can lead to better understanding of the importance of seasonality on reproduction and snake natural history.

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