

Notes on reproduction of the adorned graceful brown snake, *Rhadinea decorata* (Serpentes, Colubridae), from Costa Rica

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The Adorned Graceful Brown Snake *Rhadinea decorata* (Colubridae) is known from humid broadleaf evergreen forests from southern Mexico to Ecuador; it is active in the daytime and eats mainly *Eleutherodactylus* frogs and their terrestrial eggs (Savage 2002). Solórzano (2004) reported *R. decorata* clutch sizes of up to four eggs. The purpose of this paper is to present new information on the reproductive cycle of *R. decorata* from Costa Rica based on a histological examination of gonadal material from museum specimens. The first information on the timing of the testicular cycle is also presented. Comparisons are made with the timing of testicular cycles of other snakes from Costa Rica as part of an ongoing series of studies on the reproductive biology of snakes from this area.

A sample of 22 specimens of *R. decorata* from Costa Rica (collected 1959-1985) was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM) Los Angeles, California, USA (Appendix I). Counts were made of enlarged ovarian follicles (> 8 mm length) or oviductal

eggs. The left testis and vas deferens were removed from males and the left ovary was removed from females for histological examination. Tissues were embedded in paraffin, sectioned at 5 μ m and stained with hematoxylin followed by eosin counterstain. Testis slides were examined to determine the stage of the testicular cycle and ovary slides were examined for the presence of yolk deposition (secondary vitellogenesis *sensu* Aldridge 1979). Follicles in advanced stages of yolk deposition or oviductal eggs were not examined histologically. An unpaired *t* test was used to compare male and female mean body sizes (SVL) (Instat vers. 3.0b, Graphpad Software, San Diego, CA).

Seven females (mean snout-vent length [SVL] = 229 mm \pm 23 SD, range: 208-250 mm); 13 males (SVL = 190 mm \pm 29 SD, range: 172-207 mm) and 2 neonates SVL 90 and 98 mm were examined.

All testes examined exhibited spermiogenesis with metamorphosing spermatids and sperm present. Vasa deferentia also contained sperm. The following monthly numbers of *R. decorata* males were undergoing spermiogenesis: February (1), March (3), May (2), July (2), August (2), September (2), October (1). The smallest spermiogenic male measured 120 mm SVL (LACM 131127).

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Females were larger than males (unpaired *t*-test, 18 *df*, $t = 3.07$, $P = 0.007$). Three females with oviductal eggs were observed, one (1 egg) collected in January (LACM 154320), one (2 eggs) collected 19 July-2 August (LACM 154313) and one (3 eggs) collected in August (LACM 154317). The smallest reproductively active *R. decorata* female (1 oviductal egg) measured 203 mm SVL (LACM 154320). Three females were undergoing yolk deposition = secondary vitellogenesis; one each from July, August and December. One female (SVL = 202 mm) from February was reproductively inactive (no yolk deposition). Most of the females (86.7%) were reproductively active. There was no evidence that *R. decorata* from Costa Rica produce more than one clutch of eggs per year (oviductal eggs and yolk deposition in the same female) although the existence of reproductively active females in different parts of the year: January, July, August, December suggests that this might be possible. Solórzano (2004) previously reported clutches of up to four eggs for *R. decorata* but did not give a mean clutch size. Two (presumably) neonates of *R. decorata* were collected, one each in September and November.

Results obtained in the present study suggest that *R. decorata* males produce sperm throughout the year. Extended testicular cycles have also been reported in other snakes from Costa Rica: *Drymobius margaritiferus* (Goldberg 2003a), *Dendrophidion* sp. (Goldberg 2003b), *Ninia maculata* (Goldberg 2004a), *Erythrolamprus bizona* and *E. mimus* (Goldberg 2004b), *Micrurus nigrocinctus* (Goldberg 2004c), *Hydromorphus concolor* (Goldberg 2006a), *Mastigodryas melanolomus* (Goldberg 2006b), and *Geophis godmani* (Goldberg 2007). Whether this is typical of snakes from Costa Rica must await histological examination of testes from additional species of Costa Rican snakes.

The preceding observations on the reproductive cycle of males and females indicates that *R. decorata* has a prolonged

reproductive cycle in Costa Rica in which both sexes are in reproductive condition, at least, through most of the year. This fits into the “polyestrous with continuous reproduction” of Saint Girons (1982). Fitch (1982) reported year-round breeding in snakes from some aseasonal equatorial regions. Zug *et al.* (1979) reported continuous or aseasonal reproduction for the colubrid snakes, *Dipsas catesbyi* in Peru and *Imantodes cenchoa* from Peru/Ecuador. In contrast the congener *Rhadinea flavilata* which occurs in the southeastern United States follows a seasonal reproductive cycle in which breeding occurs in the spring and eggs are laid from late May to mid-August (Ernst and Ernst 2004). The timing of this reproductive cycle is similar to those of other colubrid snakes from north temperate areas of North America (e.g., Goldberg and Parker 1975) and fits into the “aestival spermatogenesis” of Saint Girons (1982). Subsequent investigations are needed to ascertain how widespread extended reproductive cycles are in the snakes of Costa Rica.

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Appendix I – Specimens Examined

COSTA RICA – Alajuela, 131127; Cartago 154326, 154329, 154334; Limón 154311, 154316; Heredia 154306, 154307, 154313, 154312, 154323, 154333; Puntarenas 154308, 154315, 154317, 154320, 154322, 154324, 154310, 154314, 154319, 154321.