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Reproductive cycle of the salmon-bellied racer, *Mastigodryas melanolomus* (Serpentes, Colubridae), from Costa Rica

Stephen R. Goldberg

Department of Biology, Whittier College, Whittier, California 90608, USA. E-mail: sgoldberg@whittier.edu.

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The salmon-bellied racer, *Mastigodryas melanolomus* (Colubridae, Colubrinae), is known on the Atlantic versant from Tamaulipas, Mexico, to western Panama and on the Pacific slope from Nayarit, Mexico to western Guatemala (Savage 2002). In Costa Rica it is widely distributed in tropical and subtropical rainforest on both versants and in the Valle Central from sea level to 1,700 m (Solórzano 2004). This diurnal species is both terrestrial and arboreal (Solórzano 2004). It feeds mainly on lizards but also may eat frogs, snakes, reptile eggs and mammals (Seib 1984). Censky and McCoy (1988) reported on the female cycle of *M. melanolomus* (= *Dryadophis melanolomus*) from Yucatan, Mexico. Solórzano (2004) reported *M. melanolomus* clutch sizes and monthly occurrences of neonates from Costa Rica. The purpose of this paper is to present new information on the reproductive cycle of *M. melanolomus* from Costa Rica based on histological examination of gonadal material from museum specimens. The first information on the timing of the testicular cycle is also presented.

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A sample of 69 specimens of *M. melanolomus* from Costa Rica (collected 1959-1983) were 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 µm and stained with hematoxylin followed by eosin counterstain. Testes 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. Linear regression analysis was used to examine the relationship between female body size and clutch size using Instat (vers. 3.0b, Graphpad Software, San Diego, CA).

Twenty-nine females (mean snout-vent length [SVL] = 727 mm ± 66 SD, range: 621-904 mm); 26 males (SVL = 681 mm ± 144 SD, range: 422-941 mm) and 14 neonates, SVL = 254 mm ± 19 SD, range: 233-297 mm) from Costa Rica were examined.

All testes examined exhibited spermiogenesis with metamorphosing spermatids and sperm present. Vasa deferentia also contained sperm. The following monthly numbers of *M. melanolomus* males were undergoing spermiogenesis: January (1), February (1), March (6), April (1), May (1), June (2), July (4), August (3), September (4), October (2), December (1). The smallest spermiogenic male measured 422 mm SVL (LACM 153523).

Females with enlarged follicles (> 8 mm length) or oviductal eggs were observed in January and from March to November (Table 1). Most females reproduced as (86.2%) were reproductively active (Table 1). The smallest reproductively active *M. melanolomus* female (four enlarged follicles) measured 623 mm SVL (LACM 153429) (Table 2). Mean clutch size was 5.1 ± 1.1 SD, range 2-6. Linear regression analysis for 23 gravid females revealed that the relation between body size (SVL) and clutch size was not significant (r = 0.19, P = 0.39). Individual clutch sizes are given in Table 2. There was no evidence that *M. melanonomus* 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 during ten months of the year suggests this might be possible.

Neonates of *M. melanolomus* were collected in January (n = 1), March (3), May (1), June (1), July (1), August (1), September (1), October (1), November (2). For two neonates the collection date was given simply as "summer". Solórzano (2004) reported neonates of *M. melanonomus* from August to February.

Results obtained in the present study indicate that *M. melanolomus* males produce sperm thoughout the year. This characteristic has 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), and *Micrurus nigrocinctus* (Goldberg 2004c). Whether this is typical of snakes from this area must await histological examination of testes from additional species of Costa Rican snakes.

Solórzano (2004) previously reported clutches of up to nine eggs in May, June, August and September from *M. melanolomus* from Costa Rica but gave no minimum or mean clutch size. Thus, I cannot compare my mean clutch

Table 1 - Monthly distribution of stages in the ovarian cycle of 29 *Mastigodryas melanolomus* from Costa Rica. Values shown (as percentages) are the numbers of females exhibiting each of the four conditions.

Month	*n*	No yolk deposition	Early yolk deposition	Enlarged follicles > 8 mm length	Oviductal eggs
January	1			100	
March	1			100	
April	5	40	20	40	
May	6			50	50
June	3			67	33
July	6		33	33	33
August	2	50		50	
September	3	33		67	
October	1			100	
November	1			100	

Table 2 - Month and locality of collection, snout-vent length (SVL), clutch size and museum voucher numbers (LACM) for 23 *Mastigodryas melanolomus* from Costa Rica. Clutch size was estimated by counts of enlarged follicles > 8 mm length or oviductal eggs*.

Month	SVL (mm)	Clutch size	Province	LACM #
January	740	6	Alajuela	153475
March	904	5*	San José	153472
April	844	6	Cartagena	153428
April	751	5	Cartagena	153439
May	686	5	Puntarenas	114114
May	690	6	Cartagena	153435
May	838	6*	San José	153437
May	665	6	Cartagena	153474
May	787	4	Cartagena	153478
May	773	6	Cartagena	153480
June	623	4	Limón	153429
June	758	6	San José	153473
June	773	6*	Limón	153483
July	658	5	Guanacaste	153420
July	770	2	Cartagena	153431
July	715	4*	Puntarenas	153457
July	735	6	Cartagena	153460
July	753	6*	Guanacaste	153465
August	751	5*	Puntarenas	153452
September	656	5	Puntarenas	153421
September	684	4	Cartagena	153433
October	707	3	Cartagena	153481
November	753	6	Cartagena	153426

size and range with other *M. melanolomus* from Costa Rica. Censky and McCoy (1988) reported a mean clutch size and range of 3.1 ± 0.90 SD, 2-5 for 42 *M. melanonomus* from the Yucatan Peninsula, Mexico, which is smaller than my values reported herein.

Censky and McCoy (1988) suggested that females of *M. melanolomus* from the northern Yucatan Peninsula, Mexico, exhibited a biennial reproductive cycle (produce eggs every other year). There is insufficient data to know if this pattern occurs in *M. melanonomus* from Costa Rica.

Neonates of *M. melanolomus* from Yucatan, Mexico, were observed from November to January (Censky and McCoy 1988). However, my findings combined with those of Solórzano (2004) of neonates appearing through most of the year (January to March and May to December) suggests *M. melanolomus* produces young over a longer period in Costa Rica than occurs in Mexico.

The preceding observations on the reproductive cycle of males and females indicates that *M. melanolomus* has a prolonged reproductive cycle in Costa Rica in which both sexes are in reproductive condition, at least, through most of the year. My data extends the period in which females with eggs and neonates occur as given in Solórzano (2004). Subsequent field

observations are needed to correlate environmental factors (e.g. food, temperature, moisture) with the reproductive cycle as well as to ascertain the degree of geographic variation exhibited by different populations of *M. melanolomus*.

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Appendix I – Specimens Examined

COSTA RICA – Alajuela, 153462, 153475, 153509; Cartagena, 153416, 153419, 153424, 153426, 153428, 153430-153433, 153435, 153436, 153439, 153445, 153460, 153463, 153467, 153474, 153477, 153478, 153480-153482, 153491, 153496, 153499, 153500, 153502, 153504, 153516; Guanacaste, 153420, 153425, 153447, 153458, 153465; Heredia, 153448, 153453, 153456, 153461; Limón, 153427, 153517,153429, 153443, 153483, 153497, 153501, 153510, 153511; Puntarenas, 114114, 153418, 153421, 153442, 153450-153452, 153455, 153457, 153476, 153503, 153506, 153523; San José, 153417, 153437, 153472, 153473,153490, 153498.