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## Notes on Reproduction in the Central American Coral Snake, *Micrurus nigrocinctus* (Serpentes: Elapidae) from Costa Rica

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**ABSTRACT.**—Reproduction in the Central American coral snake, *Micrurus nigrocinctus* was studied from a histological examination of gonadal material from museum specimens. Fourteen of fifteen (93%) testes were undergoing spermiogenesis from *M. nigrocinctus* collected during January-March, June, August-September and December. Vasa deferentia from all males examined contained sperm suggesting that *M. nigrocinctus* has the potential for breeding in all months sampled. Two females, one collected in April and one from November had started yolk deposition. Clutch sizes of 3, 4, 5, 7 were recorded. Clutches of three and four eggs represents new minimum clutch sizes for *M. nigrocinctus*.

**KEYWORDS.**—Spermiogenesis, ovarian cycle, clutch sizes

The Central American coral snake, *Micrurus nigrocinctus* (Girard) occurs in lowlands and premontane areas from southeastern Oaxaca, Mexico and northwestern Honduras southward to northern Colombia (Savage 2002). The purpose of this note is to provide additional data to those by Solórzano and Cerdas (1988) on the reproductive biology of Costa Rican *M. nigrocinctus* using histological examinations of reproductive tissues from museum specimens.

Thirty-four adult *Micrurus nigrocinctus* consisting of 15 males (mean snout-vent length, [SVL] = 530 mm ± 54 SD, range = 450-640 mm) and 19 females (mean SVL = 606 mm ± 86 SD, range = 490-793 mm) were examined from the herpetology collection of the Natural History Museum of Los Angeles County, Los Angeles, California (Appendix). *Micrurus nigrocinctus* were collected from 1959-1983, originally fixed in 10% formalin, and stored in 70% ethanol.

The left ovary or testis and vas deferens was removed, dehydrated in ethanol, and embedded in paraffin. Histological sections were cut at 5  $\mu\text{m}$  and stained in hematoxylin followed by an eosin counterstain. Enlarged follicles (> 8 mm length) or oviductal eggs were counted, but no histology was performed on them. Histological sections of ovarian follicles were examined for the presence of yolk deposition (= secondary yolk deposition, *sensu* Aldridge 1979). Sections of testes were examined to determine the stage of the testicular cycle. An unpaired *t*-test was used to compare male and female body sizes.

Testicular histology was similar to that reported by Goldberg (1997) for another elapid, the western coral snake, *Micruroides euryxanthus* (Kennicott). In this study, only two stages were present in *Micrurus nigrocinctus*, regression and spermiogenesis. In the regressed testis, germinal epithelium was exhausted and consisted of spermatogonia; occasional Sertoli cells were found. In spermiogenesis (= sperm formation), the lumina were lined by rows of metamorphosing spermatids. Mature spermatozoa were the predominant cells in the seminiferous tubules. Fourteen of fifteen (93%) testes were undergoing spermiogenesis from *Micrurus nigrocinctus* collected during January (2/2), February (4/4), March (2/3), June (1/1), August (1/1), September (3/3), and December (1/1). The only regressed testis was from snake (LACM 153717, SVL = 490 mm) collected in March. Vasa deferentia from all 15 males examined contained sperm, suggesting that *M. nigrocinctus* has the potential for breeding in all months

sampled. The smallest reproductively active (spermiogenesis in progress) male (LACM 153721) measured 450 mm SVL and was collected in March. The testicular cycle of *M. nigrocinctus* cannot be completely described because data were not available from specimens collected in all months. Nevertheless, the presence of males undergoing spermiogenesis from January-March, June, August-September and December suggests a long period of spermiogenesis. Prolonged periods of spermiogenesis were reported in *Micruroides euryxanthus* from Arizona and Sonora, Mexico (Goldberg 1997) and in the Texas coral snake, *Micrurus tener* (Baird and Girard) from Texas Quinn (1979). Female *Micrurus nigrocinctus* were significantly larger than males ( $t = 3.0$ ,  $df = 32$ ,  $P = 0.005$ ), which was also found for populations of *M. n. nigrocinctus* and *M. n. mosquitensis* in Costa Rica (Solórzano and Cerdas 1988). Monthly distribution of stages in the ovarian cycle of *M. nigrocinctus* are shown in Table 1. The large number of reproductively inactive females with no yolk deposition (13/19, 68%) may suggest only a portion of females produce offspring in a reproductive season, which was reported for various colubrid snake species from the southwestern United States (see, Goldberg 2000, 2001). However, it is possible that some of the reproductively inactive females (Table 1) may have already produced clutches before they were collected or would have produced clutches later in the year. Two females, one collected in April (LACM 153681, SVL = 570 mm) and one from November (LACM 153720, SVL = 523

TABLE 1. Monthly distribution of stages in ovarian cycle of *Micrurus nigrocinctus* from Costa Rica. One female with seven oviductal eggs (LACM 153675) had no collection date and is not included in this table.

Month	<i>n</i>	Inactive	Early yolk deposition	Advanced yolk deposition (follicles >8 mm length)	Oviductal eggs
January	2	0	0	2	0
March	3	2	0	0	1
April	2	1	1	0	0
May	2	2	0	0	0
June	2	2	0	0	0
July	5	5	0	0	0
September	2	1	0	1	0
November	1	0	1	0	0

mm) had started yolk deposition as evidenced by basophilic yolk granules in the follicular ooplasm, but it is not known when yolk deposition would have been completed. One female (LACM 153675, SVL = 643 mm) with seven oviductal eggs (mean length = 21.4 mm  $\pm$  3.2 SD, range = 18-26 mm) has no collection date and is not listed in Table 1. One female (LACM 153672, SVL = 612 mm) collected in January contained five enlarged ovarian follicles (>8 mm length) that would have presumably completed yolk deposition and been ovulated. Another female (LACM 153686, SVL = 547 mm) also collected in January contained three enlarged ovarian follicles (> 14 mm length). One female (LACM 153734, SVL = 540 mm) collected in March contained four oviductal eggs (mean length = 28.2 mm  $\pm$  4.9 SD, range = 21-32 mm). One female (LACM 153759, SVL = 530 mm,) collected in September contained two enlarged ovarian follicles (>11 mm length). Other ovarian follicles in this *M. nigrocinctus* were damaged making it impossible to accurately count the clutch size. However, this is evidence that yolk deposition in *M. nigrocinctus* occurs in September. The smallest reproductively active female (yolk deposition in progress) measured 523 mm SVL (LACM 153720). Solórzano and Cerdas (1988) reported that females from the Pacific population of *M. n. nigrocinctus* produced 7.9 (5-14) eggs and females from the Atlantic population produced 6.7 (5-8) eggs. The breeding season of the Atlantic population appeared longer than that of the Pacific population. My finding of clutches of three and four eggs represents new minimum clutch sizes for *M. nigrocinctus*.

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#### APPENDIX

Costa Rica Provinces and museum (LACM) numbers of *Micrurus nigrocinctus* examined.

Alajuela 153714; Cartago 153713, 153715, 153717, 153719-153723, 153725; Guanacaste 153690, 153691, 153694, 153695, 153716, 153748; Heredia 153681, 153737; Limón 153711; Puntarenas 153731, 153732, 153734, 153756, 153759; San José 153672, 153675-153679, 153682, 153684-153686.