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REPRODUCTION IN THE WESTERN SHOVELNOSE SNAKE, *CHIONACTIS OCCIPITALIS* (COLUBRIDAE), FROM CALIFORNIA

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Key words: reproduction, Chionactis occipitalis, *western shovelnose snake, California.*

The western shovelnose snake (*Chionactis occipitalis*) occurs from southwestern Nevada to the upper end of the Gulf of California, México, and southern Arizona to the desert base of peninsular ranges of southern California (Stebbins 1985). Anecdotal accounts of reproduction in this species appear in Cowles (1941), Wright and Wright (1957), Stebbins (1954, 1985), and Behler and King (1979). In this report I provide information on reproduction of *C. occipitalis* from California.

I examined 135 *Chionactis occipitalis* (109 males, mean snout-vent length [SVL] = 243.1 mm ± 20.2 *s*, range 194–288 mm; 26 females, mean SVL = 267.8 mm ± 23.5 *s*, range 198–308 mm) from California in the herpetology collections of Arizona State University (ASU), Tempe; Museum of Vertebrate Zoology, University of California at Berkeley (MVZ); and the Natural History Museum of Los Angeles County (LACM), Los Angeles (Appendix 1). Counts were made of oviductal eggs or enlarged follicles (>3 mm diameter). The left gonad and part of the male kidney were removed for histological examination, embedded in paraffin, and cut into 5 μm sections. Slides were stained by Harris' hematoxylin followed by eosin counterstain. Testes slides were examined to determine the stage of the male cycle; ovary slides were examined for the presence of yolk deposition. Kidney sexual segments were examined for secretory activity. Histology slides are deposited in LACM.

Data on the male *Chionactis occipitalis* seasonal testicular cycle are presented in Table 1. Testicular histology was similar to that reported in Goldberg and Parker (1975) for 2 other colubrid snakes, *Masticophis taeniatus* and *Pituophis melanoleucus*. In the regressed testes seminiferous tubules contained spermatogonia and Sertoli cells. In recrudescence there was renewal of spermatogenic cells characterized by spermatogonial divisions; primary and secondary spermatocytes and spermatids may have been present. Metamorphosing spermatids and mature sperm were present in spermiogenesis.

Spermiogenic males were found March through July (Table 1). Epididymides and vasa deferentia of spermiogenic males contained sperm. The smallest spermiogenic male measured 194 mm in SVL. Males with regressed testes first appeared in June, suggesting the testicular cycle was nearing its conclusion. The sexual segment of the kidney was enlarged and contained densely staining secretory granules in spermiogenic males. According to Saint Girons (1982), mating coincides with hypertrophy of the sexual kidney segment. Johnson et al. (1982) reported that elevations of blood testosterone levels coincided with hypertrophy of the renal sexual segment in the cottonmouth (*Agkistrodon piscivorous*). The lack of spermiogenic males and the occurrence of males with regressed testes during August–November likely indicate that *Chionactis occipitalis* does not breed during this period.

Data on the *Chionactis occipitalis* seasonal ovarian cycle are presented in Table 2. Reproductively active females were found May–July. I recorded 6 clutch sizes: 11 May, 3 enlarged follicles (4–5 mm diameter); 18 May, 3 enlarged follicles (5–6 mm diameter); 24 May, 2 oviductal eggs (4–5 mm diameter); 27 May, 2 oviductal eggs (5–6 mm diameter); 2 June, 4 enlarged follicles (3–4 mm diameter); 8 July, 2 enlarged follicles (3–4 mm diameter). The vitellogenic follicles in 1 female from 13 August were

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TABLE 1. Monthly distribution of conditions in seasonal testicular cycle of *Chionactis occipitalis*. Values shown are the numbers of males exhibiting each of the 3 conditions.

Month	N	Regressed	Recrudescence	Spermiogenesis
March	4	0	1	3
April	22	0	3	19
May	36	0	0	36
June	27	4	0	23
July	13	5	0	8
August	4	4	0	0
September	2	1	1	0
November	1	1	0	0

TABLE 2. Monthly distribution of conditions in seasonal ovarian cycle of *Chionactis occipitalis*. Values shown are the number of females exhibiting each of the 4 conditions.

Month	N	Inactive	Yolk deposition	Enlarged follicles	Oviductal eggs
March	1	1	0	0	0
April	5	5	0	0	0
May	13	9	0	2	2
June	2	1	0	1	0
July	3	2	0	1	0
August	1	0	1[a]	0	0
September	1	1	0	0	0

[a]Vitellogenic follicles were undergoing atresia.

undergoing atresia (degeneration). It is thus unlikely that an egg clutch would have been produced. The smallest reproductively active female (enlarged follicles >5 mm diameter) measured 257 mm in SVL. No evidence of reproductive activity (yolk deposition) was seen in the 19 remaining females.

Information on reproduction in *Chionactis occipitalis* includes reports of clutch sizes (2–4; Klauber 1951, Stebbins 1954, 1985, Wright and Wright 1957, Behler and King 1979); clutches are deposited during summer (Behler and King 1979, Stebbins 1985). Cowles (1941) reported 2 March females containing 6 and 9 enlarged ova. Thus, my clutch sizes (2–4) are within the range of previously reported values. The smallest reproductively active female *C. occipitalis* (257 mm SVL) was smaller than the minimal size (289 mm) reported by Klauber (1951).

Only 6 of 24 (25%) of the female sample (collected April–August) were reproductively active, suggesting only part of the female population breeds each year. Breeding by only part of the female population appears to be widespread in snakes. Seigel and Ford (1987) surveyed proportions of breeding females per year for 85 snake species and found proportions varied from 7% to 70%. I have found only part of the female population to breed each year in other North American desert snakes: *Chilomeniscus cinctus, Phyllorhynchus browni, P. decurtatus, Salvadora hexalepis,* and *Trimorphodon biscutatus* (Goldberg 1995a, 1995b, 1995c, 1996).

Klauber (1931,1951) reported *Chionactis occipitalis* has a seasonal activity pattern in southern California that peaks in May–June, with few snakes observed after the end of June (Klauber 1951). This marked seasonal activity pattern accounts for the scarcity of *C. occipitalis* in herpetology collections from months other than May–June and explains why most of my specimens were from these two months. Nevertheless, it is clear from the high percentages of spermiogenic males in May (36/36, 100%) and June (23/27, 85%) that the peak of *C. occipitalis* mating activity coincides with the time of maximum aboveground activity. Moreover, the appearance of 4 of 27 (15%) regressed males in June, 5 of 13 (38%) in July, and 4 of 4 (100%) in August suggests the mating period of *C. occipitalis* is concluding. A similar pattern of peak reproductive activity coinciding with maximum aboveground activity occurred in *Chilomeniscus cinctus* from Arizona (Goldberg 1995c).

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APPENDIX 1

Specimens examined by county from herpetology collections at Arizona State University (ASU), Natural History Museum of Los Angeles County (LACM), Museum of Vertebrate Zoology (MVZ).

Imperial: LACM 9117-19, 52221, 52246, 63618, 133830. **Inyo:** MVZ 61099. **Kern:** LACM 52219, 123760. **Los Angeles:** LACM 52203. **Riverside:** LACM 22623, 22625, 22629-30, 22641, 22643, 22650, 52227-28, 52291-92, 52294, 52296, 52299-300, 52305, 52311, 52313, 52321, 52328-29, 52334, 52341, 52344, 52353-55, 52358-59, 52361, 52365-66, 52376, 52379, 52383, 52386, 52392-93, 52397, 52403-406, 52417, 52421, 52424-25, 52430, 52432, 52434, 63624, 75275, 75278, 102760, 102763, 102765-66, 102768, 102770, 122099-100. MVZ 65749, 66397-98, 74456, 78004, 147938, 180172, 180179. **San Bernadino:** ASU 1620, 23602. LACM 21620-21, 21623-24, 21627-28, 21636-37, 27704-705, 27708, 52205, 52211, 52216, 52234, 52239, 52241, 52245, 52280-81, 52283, 52286, 102772, 133831. MVZ 49935, 49938, 115916, 193306, 204194, 207931, 214636, 215612. **San Diego:** LACM 2185, 27713, 27715, 27717-18, 27720, 52251-52, 52254, 52257, 52261, 52265, 52267, 52270-72, 52275, 52278, 76292-93, 125991.