Short Communication

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Reproductive cycle of the western three-striped skink, *Trachylepis occidentalis* (Squamata: Scincidae), from southern Africa

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Abstract. Males of *Trachylepis occidentalis* follow a testicular cycle with a period of sperm formation in spring and early summer followed by an abrupt regression in February. Recovery (recrudescence) promptly begins and continues into early spring. Females contained enlarged ovarian follicles (> 5 mm) in summer. Some females began to deposit yolk the previous summer from which young were born. Not all females reproduce annually. Mean clutch size for five females was 6.0 ± 1.2, range: 5-8. Reports of oviparity versus viviparity for *T. occidentalis* in the literature raise the question of possible geographic differences in the mode of female reproduction.

Key words. Scincidae, *Trachylepis occidentalis,* reproductive cycle, southern Africa.

The western three-striped skink, *Trachylepis occidentalis* (sensu Bauer 2003) is known from karroid areas of the Cape, including western Little Karoo valleys, through Namibia and southwest Botswana to southern Angola; it is terrestrial and hibernates during winter (Branch 1998). There is little information about reproduction in *T. occidentalis*. Information on reproduction consists of reports of clutch/litter sizes in DeWaal (1978), Pianka (1986), Auerbach (1987), Branch (1998). The purpose of this paper is to provide additional information on the reproductive cycle of *T. occidentalis* from a histological examination of museum specimens.

One hundred thirty-one *T. occidentalis* from southern Africa were examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, U.S.A. The sample consisted of 52 females (mean snout-vent length (SVL) = 81.5 mm ± 5.9 SD, range 70-94 mm), 75 males (mean SVL = 75.4 ± 5.2 SD, range 63-88 mm) and 4 neonates (mean SVL = 32.0 mm ± 1.8 SD, range 30-34 mm). *Trachylepis occidentalis* were collected 1969 and 1970 as part of an ecological study by Pianka (1971) or in 1972, 1975, and 1981 by other individuals. Museum catalogue numbers and collection locality information are provided in Appendix 1.

For histological examination, the left testis and epididymis were removed from males and the left ovary was removed from females. Enlarged follicles (> 5 mm length) were counted. Tissues were embedded in paraffin and cut into sections of 5 µm. Slides were stained with Harris hematoxylin followed by eosin counterstain (Presnell & Schreibman 1997). Testes slides were examined to determine the stage of the spermatogenic cycle and epididymides were examined for the presence of sperm. Ovary slides were examined for the presence of yolk deposition or corpora lutea. An unpaired *t*-test using Instat (vers. 3.0b, Graphpad Software, San Diego, CA) was performed to compare *T. occidentalis* male and female SVL.

Because *T. occidentalis* is inactive during winter months (Huey et al. 1977), samples were limited from this period. Seasonal changes in the testicular cycle are presented in Table 1. Five stages could be distinguished in the examined samples: (1) Regression: seminiferous tubules contain spermatogonia and interspersed Sertoli cells; (2) Recrudescence: recovery for the next period of sperm formation has started and is marked by a proliferation of spermatogonia and primary spermatocytes; (3) Late recrudescence: this is prior to the period of sperm formation. Primary and secondary spermatocytes and spermatids predominate. No metamorphosing spermatids or sperm are seen; (4) Spermiogenesis: spermatozoa line the lumina of the seminiferous tubules, several rows of metamorphosing spermatids are present, sperm is present in the epididymides; (5) Late spermiogenesis: fewer numbers of spermatozoa are produced as compared to stage (4), small amounts of sperm remain in the epididymides. The germinal epithelium (spermatogonia, spermatocytes) is reduced to a few cell layers.

Testes undergoing spermiogenesis were observed from September to February. The period of spermiogenesis concluded in February when 71% of the sample (n = 35) contained testes that were in late spermiogenesis or regressed. The smallest reproductively active male (LACM 80867) (spermiogenesis in progress) measured 66 mm SVL and was from December. Males close to this size were also reproductively active: (SVL = 67 mm, LACM 80791 spermiogenesis) and (both SVL = 68 mm, LACM 80683 late spermiogenesis, LACM 80744 spermiogenesis).

Female *T. occidentalis* were significantly larger than males (t = 6.2, d.f. = 125, P < 0.0001). The seasonal ovarian cycle is presented in Tab. 2. Ovaries without yolk deposition were found in all months. Oviductal eggs or embryos were previously removed; their mean value is in Pianka (1986) so I have no data on their seasonal occurrence. Five females with enlarged follicles (> 5 mm length) from the Northern Cape Province, South Africa were found in January and February; no trace of embryos were observed. Mean clutch (n = 5) was 6.0 ± 1.2 S.D, range; 5-8. Females undergoing early yolk deposition (basophilic yolk granules in ovarian follicles) were found in December-February. Corpora lutea were present in the ovaries of females from January-March. The smallest reproductively active female (LACM 80693) was undergoing early yolk deposition, measured 73 mm SVL and was from February. Another female from February (LACM 80694) measured 75 mm SVL and contained enlarged follicles (> 5 mm). Four presumably neonates (range 30-34 mm SVL) were from January-February.

Trachylepis occidentalis follows a seasonal testicular cycle in which the period of spermiogenesis occurs in spring and early summer. It is likely that *T. occidentalis* mates during this time. Spermiogenesis concludes

Tab. 1. Monthly distribution of reproductive conditions in seasonal testicular cycle of 75 *Trachylepis occidentalis*. Values are the percentages of males exhibiting each of the five conditions. Sequence of months begins with austral spring.

Month	n	Regression (%)	Recrudescence (%)	Late Recrudescence (%)	Spermiogenesis (%)	Late Spermiogenesis (%)
September	5	0	40	20	40	0
October	10	10	0	20	70	0
November	5	0	20	0	80	0
December	5	0	0	0	100	0
January	8	0	0	0	100	0
February	35	37	6	0	23	34
April	2	50	50	0	0	0
May	4	25	75	0	0	0
July	1	0	100	0	0	0

Tab. 2. Monthly distribution of reproductive conditions in seasonal ovarian cycle of 52 *Trachylepis occidentalis*. Values are the percentages of females exhibiting each of the four conditions. *Includes one female with squashed eggs that could not be counted. **Includes two females with squashed eggs that could not be counted. Sequence of months begins with austral spring.

Month	n	No yolk deposition (%)	Early yolk deposition (%)	Follicles > 5 mm length (%)	Corpora lutea (%)
September	2	100	0	0	0
October	7	100	0	0	0
November	1	100	0	0	0
December	5	60	40	0	0
January	10	20	30	40**	10
February	19	58	16	26*	5
March	5	80	0	0	20
May	2	100	0	0	0
August	1	100	0	0	0

abruptly in February (late summer) and early recrudesence (renewal of the germinal epithelium) is first seen during that month. *Chondrodactylus angulifer* from southern Africa followed a testicular cycle similar to *T. occidentalis* with spermiogenesis occurring in spring and summer (Goldberg 2006a). Commencement of spermiogenesis appeared to be later in *T. occidentalis* as compared to the congener *Trachylepis spilogaster* (sensu Bauer 2003) in which it begins during autumn in some males (Goldberg 2006b).

Pianka (1986) reported a mean clutch size of 6.7 ± 1.6 for 32 *T. occidentalis* which is close to the value reported herein (6.0 ± 1.2 SD). *Trachylepis occidentalis* neonates were recorded from January-February indicating young appear in summer. *Trachylepis occidentalis* females follow a seasonal ovarian cycle similar to its congener *T. spilogaster* (Goldberg 2006b) in that many females were reproductively inactive (no yolk deposition) in spring and summer, suggesting only a portion of the population produced young each year and raising the question if reproduction might be biennial. Van Wyk (1991) reported biennial reproduction in female *Cordylus giganteus* from South Africa.

Some *T. occidentalis* females possessed ovarian follicles in early yolk deposition during summer when it would not have been possible to complete it during the current year. Assuming these follicles do not undergo atresia, this suggests some *T. occidentalis* females may commence vitellogenesis as early as summer for next year's litter. This was reported for females of *T. spilogaster* (Goldberg 2006b). There are conflicting reports regarding the mode of development of young *T. occidentalis* and it is possible that females may be either live-bearing or egg-laying within different parts of their range. Branch (1998) reported Kalahari female *T. occidentalis* lay 5-7 eggs and Auerbach (1987) reported it was oviparous averaging 6-7 per clutch. In contrast, De Waal (1978) reported a female from the Free State with seven undeveloped embryos. My observation of no trace of embryos in the five females with enlarged follicles from the Northern Cape Province suggests that *T. occidentalis* from that area are oviparous. It is conceivable that climate may influence the mode of development exhibited by *T. occidentalis*. This has been reported for the Australian skinks, *Lerista bougainvillii* and *Saiphos equalis* which exhibit a tendency to retain the young in cooler climates (Greer 1989). Subsequent study on the ovarian cycle of *T. occidentalis* from different parts of its range will be needed to resolve the issue of possible geographic differences in the mode by which young develop in females.

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Appendix

Natural History Museum of Los Angeles County (LACM) accession numbers and locality information for *Trachylepis occcidentalis*.

BOTSWANA: Kgalagadi District, 11 km S Tsabong (26°08'S, 22°28'E) LACM 80837-80841, 80843, 80845, 80846, 80848, 80852, 80854, 80857-80860. 9 km N, 11 km E Twee Rivieren (26°23'S, 20°43'E) LACM 80805, 80808, 80812, 80813, 80816, 80819- 80822, 80827. Gemsbok National Park (25°00'S, 22°00'E) LACM 139051-139056.

NAMIBIA: Erongo Region, Swakop River, 47 km S Wilhelmstal (21°58'S, 16°21'E) 77616. 16 km S, 7 km W Usakos (22°00'S, 15°35'E) 114661. Karas Region, 50 km S, 25 km E Aroab (27°14'S, 19°56'E) 80866, 80867. 46 km N, 17 km E Aroab (26°22'S, 19°49'E) LACM 80741-80743. 89 km ENE Koes (26°00'S, 19°15'E) 77212, 77213, 77220, 77222. 25 km WNW Helmeringhausen (25°54'S, 16°57'E) 77010, 77011. Kunene Region, Namib Desert Park (22°57'S, 14°29'E) 127493.

SOUTH AFRICA: Northern Cape Province, 121 km N, 16 km E Upington (27°22'S, 21°25'E) LACM 80785, 80787, 80789-80791. 31 km N, 100 km E Upington (28°13'S, 22°16'E) 80721-80725, 80727, 80728, 80730, 80733, 80737. 129 km N, 65 km W Upington (27°17'S. 21°54'E) 80703-80706, 80708, 80711. 120 km N, 54 km W Upington (27°22'S, 20°43'E) 80635-80642, 80645-80647, 80651, 80653, 80654-80659, 80661-80665, 80668, 80671. 29 km S, 40 km E Rietfontein (27°00'S, 20°27'E) 80673-80688, 80690-80697, 80699. 24 km N, 83 km E Upington (27°22'S, 21°25'E) 80795, 80799. Twee Riverien (26°26'S, 20°37'E) 80801.1 km W Kameelsleep (25°45'S, 20°44'E) 80744, 80774, 80751, 80754, 80756, 80758, 80763, 80766, 80772, 80773. 128 km NW Upington (27°28'S, 20°07'E) 80803.

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