Reproduction in the Schokari sand racer, *Psammophis schokari* (Squamata: Colubridae) from Israel

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ABSTRACT - In this study data on reproduction from a histological examination of gonadal material of *Psammophis schokari* from Israel is reported. Male and female reproductive activity is synchronous and occurs in spring. Five is a new smallest reported clutch size for *P. schokari* from Israel. Published clutch sizes for *P. schokari* from other parts of its range are presented.

INTRODUCTION

The Schokari Sand Racer, *Psammophis schokari* (Forskal, 1775) occurs through the entire state of Israel (Bar & Haimovitch, 2011) and is broadly distributed occurring in northern Africa from Mauritania to Egypt; East Africa, south to Somalia; the Sinai and Arabian Peninsula, Near East, to western India, southern Turkmenistan in the north and north-western India in the east (Ananjeva et al., 2006; Schleich et al., 1996). In Israel it is a ground-dwelling, diurnal snake (Bar & Haimovitch, 2011). There are currently 34 recognised species of *Psammophis* (Uetz & Hosek, 2014). Despite its wide distribution, little information is available on its reproductive cycle. Bar & Haimovitch (2011) reported *P. schokari* deposited 6-10 eggs per clutch in Israel. The purpose of this paper is to supply additional information on the reproductive cycle of *P. schokari* from a histological examination of museum specimens from Israel, as part of an ongoing series of studies on the timing of events in the reproductive cycle of Middle-Eastern Snakes. Due to the difficulty in obtaining collecting permits for large monthly samples of reptiles, utilization of previously collected specimens in museums has become increasingly important.

MATERIALS AND METHODS

A sample of 30 *P. schokari* consisting of 11 males (mean snout-vent length, SVL =533.6 mm ± 70.7 SD, range = 452-693 mm, and 19 females (mean SVL = 548.1 mm ± 58.9 SD, range = 472-681 mm) collected in Palestine/ Israel between 1946-2012 and deposited in the Zoological Museum of Tel Aviv University (TAUM) was examined (by region): A'rava Valley, TAUM: 1277, 14355, 15936, 16196; Central Negev, TAUM 109, 115, 1325, 1326, 12847, 13306, 15996, Dead Sea Area, TAUM: 1024, 1424; HaSharon, TAUM: 2492, 2799; Karmel Ridge, TAUM: 2026; Northern Coastal Plain, TAUM: 1513, 1793; Northern Negev, TAUM: 1816, 1818 , 2844; Southern Coastal Plain, TAUM: 117, 1336 , 1677, 1678, 1817, 3835, 8357, 12177, 14051; Southern Negev, TAUM: 1828.

A small slit was made in the left side of the abdomen and the left testis was removed from males and the left ovary was removed from females for histological examination. Enlarged ovarian follicles (> 7 mm) were counted in situ. No histology was performed on them. There was a high probability that follicles of > 7 mm size would have completed yolk deposition and ovulated. Removed gonads were embedded in paraffin, sections were cut at 5μm and stained by Harris' hematoxylin followed by eosin counterstain (Presnell & Schreibman, 1997). Slides of the testes were categorised as to the stage of the testicular cycle. Slides of ovaries were examined for yolk deposition; oviductal eggs or enlarged ovarian follicles were grossly noted. Mean body sizes (SVL) of male and female *P. schokari* were compared using an unpaired t-test (Instat vers 3.0b, Graphpad Software, San Diego, CA).

RESULTS AND DISCUSSION

There was no significant size difference in mean SVL length between male and female samples of *P. schokari* (unpaired t-test, t = 0.61, p = 0.55). Three stages were noted in the testicular cycle (Table 1): (1) spermiogenesis (seminiferous tubules lined by clusters of sperm and/or metamorphosing spermatids; (2) recrudescence = renewal (proliferation of germ cells for the next period of spermiogenesis). Primary spermatocytes predominated; (3) regressed, seminiferous

Month	N	Regressed	Recrudescence	Spermio-genesis
February	1	0	1	0
April	4	0	0	4
May	1	1	0	0
July	1	1	0	0
November	2	2	0	0
December	2	0	2	0

Table 1. Monthly stages in the testicular cycle of 11 *P. schokari* males from Israel.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 7 mm	Oviductal eggs
January	2	2	0	0	0
February	1	1	0	0	0
March	1	1	0	0	0
April	5	3	1	1	0
May	3	2	0	0	1
September	1	1	0	0	0
November	3	3	0	0	0
December	3	3	0	0	0

Table 2. Monthly stages in the ovarian cycle of 19 *P. schokari* females from Israel

Clutch Size	Locality	Source
2-6	Iran	Latifi, 1991
5-6	North Africa	Schleich et al. 1996
oviparous, no clutch	Turkmenistan	Szczerbak, 2003
4-10	Pakistan	Khan 2006
5-6	Ethiopia, Eritrea	Largen & Spawls, 2010
5-6	Oman, United Arab Emirates	Gardner, 2013
5-6	Israel	This paper

Table 3. Clutch sizes of *P. schokari* from different parts of its range.

tubules contain spermatogonia and interspersed Sertoli cells. All males undergoing spermiogenesis (N = 4) were collected in April, indicating mating occurs during spring. The smallest reproductively active male (spermiogenesis) measured 452 mm SVL (TAUM 109) and was collected in April.

The smallest reproductively active female (five oviductal eggs) measured 509 mm SVL (TAUM 1513) and was collected during May. Five is a new minimum clutch size for *P. schokari* in Israel. Spring reproductive activity in *P. schokari* (Table 2) occurred in April and May, as was evidenced by one female from April exhibiting early yolk deposition (TAUM 1024) and one (TAUM 1817) containing six enlarged follicles (> 7 mm length) that would have constituted a clutch later in the spring. Clutch sizes of *P. schokari* from different parts of its range are in Table 3.

The presence of sperm-containing males and reproductively-active females in spring indicates synchrony in the reproductive cycles of both sexes. The reproductive cycle of *P. schokari* most closely fits the category "III. Spermatogenesis Vernal and Prenuptial A" of Saint Girons (1982) in which spermiogenesis runs from February to April, matings occur in April, followed by ovulation at the end of May. The female reproductive cycle of *P. schokari* would appear to fit the "monoestrous" type of Schleich et al. (1996) in which one egg clutch is produced in a fixed (spring) reproductive period.

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