

Seasonal variations of spermatogenesis and of the sexual segment of the kidney in the Carpet Python, *Morelia spilota imbricata* (Serpentes: Boidae)

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Abstract

Testes, vasa deferentia and kidneys of museum specimens of *Morelia spilota imbricata* from south-western Australia have been histologically studied. *Morelia spilota imbricata* shows a pre-nuptial spermatogenetic pattern. During summer the germinal epithelium is quiescent; multiplication of spermatogonia begins in late summer. In autumn, spermatocytogenesis and spermiogenesis progress quickly, the culmination phase of spermiogenesis and spermiation occurring in November. Only during this time of the year is the sexual segment of the kidney hypertrophied; during summer, autumn and winter it is completely regressed, corresponding to the period of sexual quiescence. The male reproductive cycle of the Carpet Python in south-western Australia corresponds to patterns found in some snakes of other families in the temperate and subtropical zone.

Introduction

Although several species of boas and pythons (Boidae) are regularly bred in captivity, data on male gonadal cycles of these snakes are still scarce. The most complete description of the reproductive cycle in any species of Boidae is that given by Slip and Shine (1988) for *Morelia spilota spilota* (Pythoninae) in eastern Australia. But data on the histology of the male reproductive organs in this species are entirely lacking; Slip and Shine (1988) based their conclusions regarding the male reproductive cycle on behaviour of wild animals and on observations of turgid or flaccid testes in museum specimens. Saint Girons (1972) described histologically the sexual segment of the kidney of one specimen of the north-american boa *Charina bottae* (Boinae), without giving details of the testicular state or of the time of the year when this animal was sacrificed.

The major patterns of reproductive cycles in male snakes have been discussed by Saint Girons (1982) and Seigel and Ford (1987). The limited data for *Morelia spilota spilota* suggest a pre-nuptial spermatogenetic pattern (Slip and Shine, 1988), a pattern which is commonly found in tropical and subtropical snakes (Saint Girons 1982). *Morelia spilota* is widely distributed in Australia and New Guinea, covering an enormous variety of climatic conditions, from tropical rainforests to deserts and to temperate regions (Cogger 1988). This paper describes histologically the annual cycle of the testis and of the sexual segment of the kidney of *Morelia spilota imbricata*, a subspecies which inhabits temperate climate with good winter rains and dry summers in south-western Australia (Smith 1981). This snake is declared as rare by the Western Australian Wildlife Conservation Act and fully protected by law. Therefore this study was restricted to preserved specimens in the collection of the Western Australian Museum.

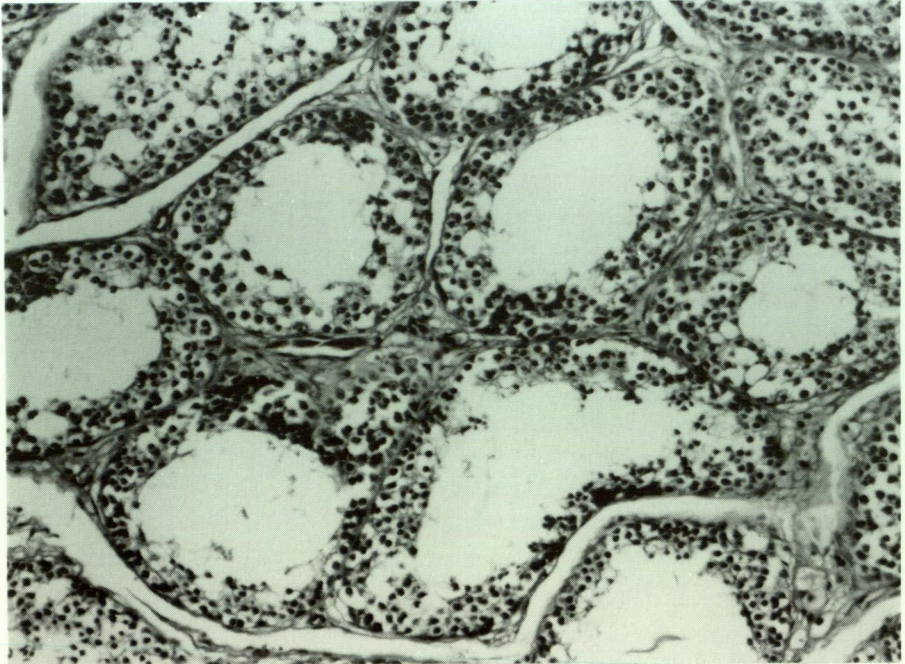


Figure 1. Testis, 28. April (X 250): The tubuli seminiferi have a large lumen, the germinal epithelium is thin, the only germ cells are spermatogonia which start to multiply.

Materials and Methods

All specimens of *Morelia spilota imbricata* in the collection of the Western Australian Museum were examined. The urogenital organs of 11 mature males with known date of collection and preservation were used in this study. Pieces of one testis and of the mid part of one kidney, together with the vas deferens, were paraffin embedded, sectioned (nominally $6\mu\text{m}$) and stained with Haematoxylin and Eosin. Nine specimens of adult males which were well enough preserved for histology were available for the months January, April, May, July, October, November and December. Measurements of transversally sectioned parts of tubules were performed with an ocular micrometer. The mean of 15 measurements per structure and animal is presented, smoothed to the nearest unit of measurement (μm). Spermatogenetic stages and the development of the sexual segment of the kidney were determined according to the criteria of Saint Girons (1972, 1982).

Results

The spermatogenetic cycle of *M. s. imbricata* commences in late summer when spermatogonia begin to multiply (Figure 1). Few spermatocytes of I. order appear

during April and May and spermatocytogenesis proceeds slowly until winter (July). During spring, spermatocytogenesis and spermiogenesis progress quickly, and by the end of October spermiogenesis and spermatids of all stages are abundant. By late October most spermatozoa are clustered at the distal end of Sertoli cells and the vas deferens contains no sperm. The culmination phase of spermiogenesis is reached during November (Figure 2), with massive spermiation and discharge of spermatozoa into the efferent ducts; the vas deferens is enlarged and filled with a dense mass of spermatozoa (Figure 3a). By the beginning of December the testes regress; during summer the only germ cells in the germinal epithelium are inactive spermatogonia; the lumen of the seminiferous tubules is filled with cell debris of spermatocytes and spermatids. The vas deferens becomes more-or-less devoid of spermatozoa and its diameter decreases markedly until next spring (Figure 3b, c, Tab. 1). The annual variations of the diameter of the tubuli seminiferi reflect the changes in the germinal epithelium, with the largest diameter being reached in November at the height of spermiogenesis and spermiation (Table 1).

The sexual segment of the kidney is involuted during summer, autumn and winter and has similar diameters to adjacent tubular regions. With the onset of spermiogenesis in

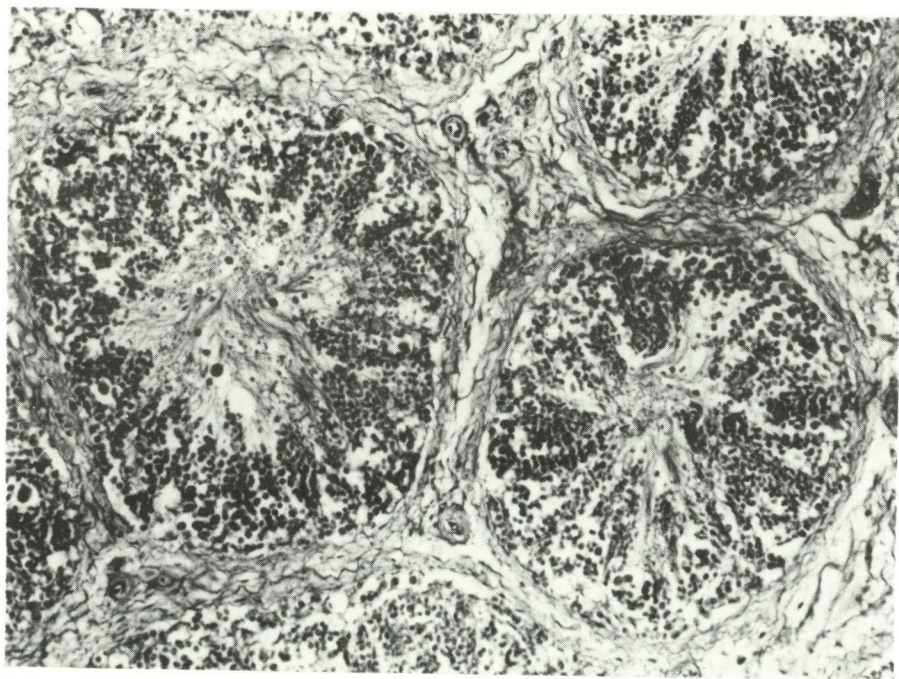


Figure 2. Testis, 13. November (X 250): Culmination phase of spermiogenesis; all types of germ cells are present in the germinal epithelium: spermatogonia, spermatocytes, spermatids in all stages of differentiation, and spermatozoa which are partly clustered at the distal end of Sertoli cells and partly free in the lumen.

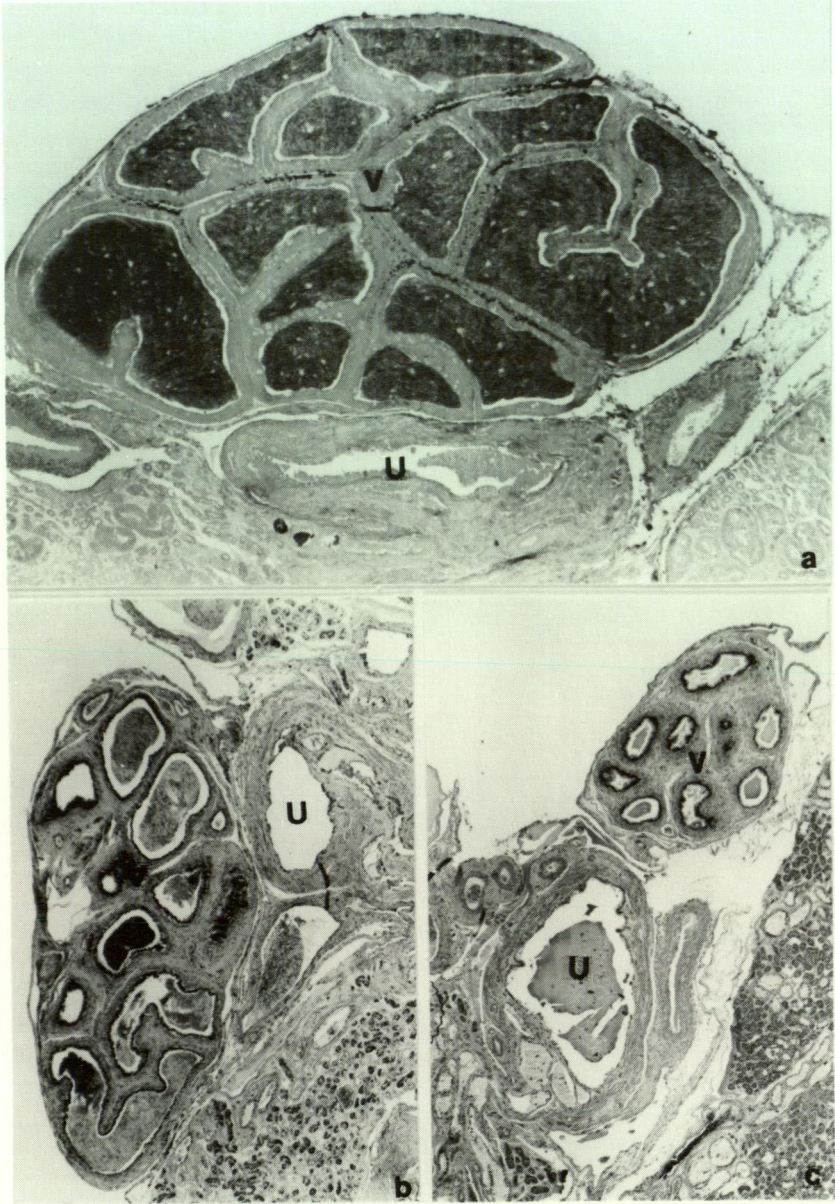


Figure 3. Vas deferens (V) and ureter (U), transversely sectioned with the mid part of the kidney (X 40); a: 11. November, lumen of vas deferens filled with a dense mass of spermatozoa; b: 12. December, only few spermatozoa in vas deferens; c: 12. May, vas deferens has a small diameter and is devoid of spermatozoa.

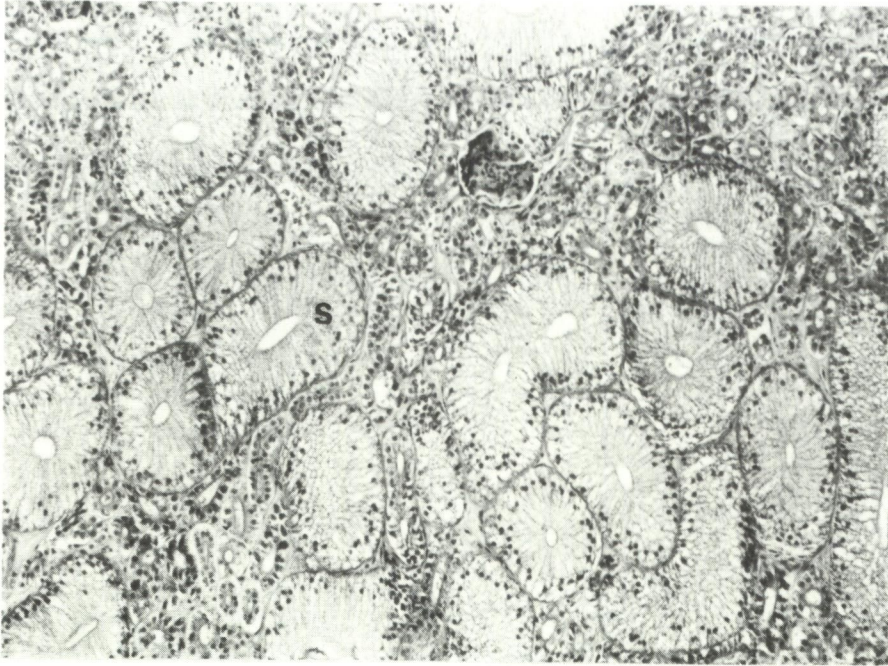


Figure 4. Kidney, 13. November (X 150): The sexual segment (S) is hypertrophied and shows high, columnar epithelial cells with basal nuclei.

spring, the diameter increases and the epithelium consists of high columnar cells with basal nuclei; the maximal tubular diameter is reached in November at the culmination of spermiation (Figure 4; Table 1).

Discussion

The hypertrophied and secretorily active sexual segment of the kidney and the masses of spermatozoa found in the vas deferens during November indicate that this is the mating time of *M. a. imbricata*. Spermatogenesis is of the prenuptial type, the reproductive pattern seems to be similar to that of *M. s. spilota* in coastal New South Wales (Slip and Shine 1988) where seasonal temperature conditions are comparable with those in south-western Australia. However, no direct observations of reproductive activity are available for *M. s. imbricata* in the wild. In *M. s. spilota* in coastal eastern Australia near Sydney, copulations have been observed during late October and November; females oviposited in late December or early January (Slip and Shine 1988). In tropical northern Queensland (Townsville), however, several captive *M. s. variegata* mated during August and eggs were laid in November (Charles *et al.* 1985). This indicates that timing of reproduction in *Morelia spilota* varies with the climatic conditions. In general, Australia snakes which live in relatively cool (temperate zone) climates seem to be remarkably

Reproductive cycle of the Carpet Python

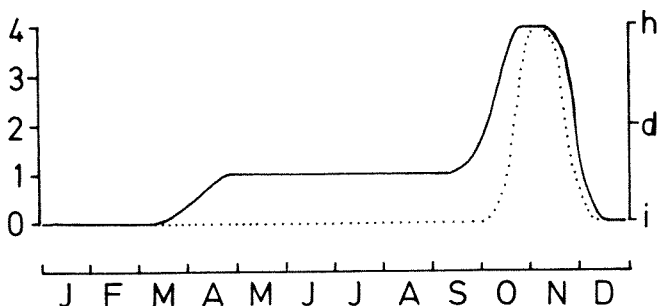


Figure 5. Diagrammatic representation of the annual cycle of spermatogenesis (left ordinate and solid line), where 0-1 = multiplication of spermatogonia (with the first spermatocytes appearing at 1); 1-2 = spermatocytogenesis; 2-2 = early spermiogenesis; 3-4 = continuation of spermiogenesis; the plateau at 4 = culmination phase of spermiogenesis, spermiation; 4-0 = end of spermiogenesis and spermiation. Right ordinate and dotted line give the relative development of the sexual segment of the kidney, where i = sexual segment regressed and mucous; d = sexual segment differentiated but not hypertrophied; h = sexual segment hypertrophied and serous.

consistent in their seasonal timing of reproduction: ovulation occurs in late spring, eggs are laid in early summer and offspring hatch (or are born) in late summer (Shine 1985). A prenuptial spermatogenetic pattern has been found in several Australian elapids (Shine 1977).

During most of the year, the sexual segment of the kidney of *M. s. imbricata* is completely regressed and mucous, corresponding to the period of sexual rest (Figure 5). A comparable pattern has been found in two Mediterranean Colubridae and in the Saharan Viperidae *Cerastes cerastes* (Saint Girons 1982). As in *M. spilota*, females of these species have a single ovulation in late spring or early summer. In many other snakes of temperate or subtropical regions, the sexual segment of the kidney shows only one brief period of partial regression in summer and remains secretory over most of the year (Saint Girons 1982).

Pythons inhabit mainly tropical regions where the climatic conditions allow spermatogenesis to proceed at any time during the year. In tropical snakes, spermatogenesis is always prenuptial when not continuous (Saint Girons 1982). The prenuptial spermatogenetic pattern of *M. s. imbricata* reflects the tropical origin of this snake which has been able to extend its range into temperate regions. In general, the temperate climate constrains female rather than male reproduction, which demands much less energy. But, despite being prenuptial, the testicular cycle of *M. s. imbricata* is not purely vernal, since spermatogonia start to multiply in late summer and spermatocytogenesis proceeds slowly during autumn and winter (Figure 5). This pattern is common in most snakes of temperate and subtropical zones which show prenuptial spermatogenesis in spring (Saint Girons 1982). In temperate and subtropical zones purely vernal, prenuptial spermatogenesis occurs only in some lizards from arid regions (Bradshaw 1986).

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Table 1. Seasonal variations in male reproductive organs of *Morelia spilota imbricata*.

Date	mean diameter of tubuli seminiferi (μm)	abundance of spermatozoa in vas deferens	mean diameter of the sexual segment (μm)
? Jan.	73	±	41
19. Apr.	91		41
28 Apr.	119	±	51
12 May	114		40
26 July	102		41
27 Oct.	190		98
11 Nov.	192	++	107
13 Nov.	223	++	133
12 Dec.	80	+	42

a ++: dense mass of spermatozoa; +: spermatozoa abundant; ±: sporadic few spermatozoa; -: no spermatozoa