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The Spermatogenic Cycle of *Dermophis mexicanus* (Amphibia: Gymnophiona)

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The general notion that amphibian reproduction in the tropics is non-cyclic and aseasonal (cf. Duelman and Trueb, 1986) is countered by the spermatogenic cycles of caecilians. In fact, for virtually all caecilians investigated, spermatogenic cycles (and particularly sperm release, fertilization, and hatching or birth) are synchronous and seasonal. Spermatogenesis has been described for members of four of the five currently recognized families of caecilians. Seshachar, in a series of papers, carefully described spermatogenesis in the ichthyophiid *Ichthyophis annulatus* (Wake, 1968, 1977, 1981; and unpubl.). Extensive histological examination yields no evidence that females store sperm in their cloacas or oviducts, so this suggests that sperm transfer takes place only during a short part of the year, despite males having a long period of sperm production, or that copulations are "wasted" on already pregnant females or those unable to be fertilized since their ova are not yet fully yolked. There are no published records of mate recognition, courtship, or copulation for any terrestrial caecilian, and I do not have field observations, so neither of these hypotheses about timing of sperm transfer can be examined at present.

The spermatogenic cycle of *Dermophis mexicanus* was determined from gross and histological examination (see Wake, 1968). Testis lobes located at the posterior end of the anterior ⅔ of the testis strip were excised from males collected in January, March–August, October, and December from the northwestern Guatemalan population analyzed by Wake (1980). Specimens were fixed in 10% neutral buffered formalin and stored in 70% ethanol. Lobes were sectioned frontally at 7µ, and stained with hematoxylin-eosin. They were then examined to ascertain the spermatogenic cycle. Testes from 3–5 individuals collected at any one period were examined to assess populational synchrony in spermatogenesis. Testes of individuals collected from the same month of the year, even in different years, were at the same stage of spermatogenesis, so activity is synchronous. The testis lobes of animals collected in December (Fig. 1a) were recrudescing. Extensive interstitial tissue was present in each lobe. Many primary spermatocytes occurred peripherally in lobules, some apparently had undergone mitoses to form cell nests, and one or two lobules contained nests of secondary spermatocytes (see Wake, 1968, for nuclear characteristics of spermatocytes). The testis lobes of January animals illustrate more advanced spermatogenesis (Fig. 1b). Many more lobules had formed, and interstitial tissue was markedly reduced among lobules. Several cell nests, some of primary and some of secondary spermatocytes, were present in each lobe. By March, large lobules containing cell nests in which sperm are apparently fertilized in May–June, and birth in the subsequent April–May. Thus females are pregnant for 11 months, and spend the following year recruiting ova, so that they reproduce biennially (Wake, 1980). Birth in *Dermophis mexicanus* is correlated with the inception of the rainy season, and apparently with an increase in prey items (Wake, 1980); birth is similarly correlated in *Gymnophis multiplicata* (Wake, 1968, 1977, and unpubl.), and in *Typhlonectes compressicaudus* (Exbrayat and Flatin, 1985).

The synchrony of reproduction in these several species with diverse modes presents a paradox, for males are apparently in active spermatogenesis for much of the year in most species of caecilians (see above references and Wake, 1977, 1981; and unpubl.). Excessively long spermatogenic cycles present a paradox, for males are apparently in active spermatogenesis for much of the year in most species of caecilians (see above references and Wake, 1977, 1981; and unpubl.). Extensive histological examination yields no evidence that females store sperm in their cloacas or oviducts, so this suggests that sperm transfer takes place only during a short part of the year, despite males having a long period of sperm production, or that copulations are "wasted" on already pregnant females or those unable to be fertilized since their ova are not yet fully yolked. There are no published records of mate recognition, courtship, or copulation for any terrestrial caecilian, and I do not have field observations, so neither of these hypotheses about timing of sperm transfer can be examined at present.

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were dominated by clusters of cell nests; most nests included either secondary spermatocytes or spermatids (Fig. 1d). Some new lobules that contained single nests of primary spermatocytes were forming. Interstitial tissue was increasing. In May the testis (Fig. 1e) was characterized by great increase of interstitial tissue and extensive interconnecting ducts among lobules. The lobules contained nests of spermatids and masses of mature sperm migrating into the ducts. A few primary spermatocytes were located peripherally in some lobules. In June and July, testes (Fig. 1f, g) were characterized by extensive interstitial tissue and by lobules that contained cell nests of predominantly primary spermatocytes (June) and cell nests of either primary and secondary spermatocytes (July). The stroma was reduced in the lobules of these testes. In August the testis was regressed (Fig. 1h). Interstitial tissue was limited; lobules were largely evacuated with little stroma but numbers of peripheral primary spermatocytes were present.

In May, the testis contained mature sperm and well developed ducts for transporting the sperm to the ducts of the kidney, then to the archinephric duct (see Wake, 1968, 1970, 1972, 1977, 1981, for description of sperm transport to the cloaca). Fertilization should occur in May, based on female morphology and data on embryonic development (Waké, 1980). Therefore in Dermophis mexicanus, spermiogenesis peaks in May, at the time of presumed copulation. The second wave of testicular activity (June–July), following sperm maturation in May, but before testis regression in August, is difficult to explain, though it may be similar to the "secondary spermatogenesis" reported by Exbrayat (1986) in Typhlonectes. The testes of the October specimens were in the same state as those of the August sample, so testes apparently were regressed from August through November. In fact, no evidence exists that the spermatocytes in Dermophis testes from this period reach maturity. Cells may simply be resorbed, or my small sample (three each) may not include animals in which sperm have matured. However, the latter hypothesis requires that sperm mature, but either are resorbed or, if transmitted to females, are not involved in fertilization.

The testis lobes of animals collected December through July had the "bubble" external appearance that Wake (1968) considered to reflect active spermatogenesis. Data for Dermophis mexicanus support that conclusion, but the generalization must be refined to indicate that activity alone cannot be used to determine the stage(s) of spermatogenesis occurring in the lobule. The data further indicate that while some spermatogenesis occurs throughout much of the year, only one sub-set of sperm may mature, and that maturation coincides with the female's reproductive cycle and especially the gestation period that permits birth at a particular time. These data suggest that the reproductive biology of both males and females is closely tied to environmental cues. A general assumption is often made (cf. Duellman and Trueb, 1986) that tropical amphibians breed throughout the year, assuming equable climatic conditions. In fact, such conditions rarely obtain in the tropics, and apparently most caecilians breed seasonally, in correlation with the rainy season. The reports cited above indicate that both oviparous and viviparous caecilians have reproductive biologies that are environmentally cued. Virtually no data exist for caecilians on reproductive endocrinology and environmental effects, and few on embryonic and larval development. These data must be gathered in order to understand caecilian reproductive biology and especially the evolution of viviparity in these amphibians.

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Pseudemys concinna suwanniensis in a Florida Spring

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The herbivorous feeding habit of the river cooter (Pseudemys concinna) has been well documented (Allen, 1938; Marchand, 1942; Carr, 1952; Ernst and Barbour, 1989). Pseudemys c. suwanniensis (Suwannee river cooter) is one of the five recognized subspecies of this predominantly freshwater turtle. In Florida, the Suwannee river cooter ranges from the Apalachicola river southward along the Gulf coast to the Tampa Bay region (Jackson, 1992). Although the abundance of P. c. suwanniensis is not well documented, it is believed to have declined in recent years, and has been designated as a "Species of Special Concern" in Florida (Jackson, 1992).

One population of the Suwannee river cooter in Florida occurs in Wakulla Springs. The spring bowl and approximately 4.5 km of the Wakulla River are located within the Edward Ball Wakulla Springs State Park. Since the early 1970s, Egeria densa, an exotic, aquatic plant, has been present in Wakulla Springs. Currently, it is estimated to cover 60% of the river that occurs within the park boundary (Ledbetter, unpublished). The use of E. densa as a food source by the Suwannee river cooter is unknown. The objective of this study was to determine the use of E. densa as a food source by the Suwannee river cooter and to evaluate management options for the control or removal of this exotic plant.

We collected turtles in the spring run of the Edward Ball Wakulla Springs State Park, Wakulla County, Florida between 24 April and 2 June 1991. Turtles were captured with a dip net (53 cm diameter opening, 5.7 cm stretched mesh) from the bow of a 12 ft, V-hulled aluminum boat, powered by a 7.5 hp motor. Location of capture, time, and date were recorded. Captured animals were placed individually in woven plastic sacks and transported to the laboratory. Maximum straight-line plastron length and body mass were recorded for each animal. Animals were sexed as males based on the secondary sexual characteristics of three long front claws and observed position of the vent beyond the carapace (Cahn, 1937; Jackson, 1970; Buhlmann and Vaughan, 1991). Each turtle was marked by notching the marginal scutes with a hand saw for future individual identification. The upper digestive tract (mouth, esophagus, and stomach) of each animal was gently flushed according to Legler (1977) and Parmenter (1980). Flushed upper digestive tract (UDT) contents were frozen until they were analyzed. We released the turtles at the site of capture either the same day of capture or the following morning.

Contents obtained from the UDTs were thawed and
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