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Spermatozoan numbers and testicular characteristics of male white-tailed deer fawns during the mating season

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Testicular spermatozoan numbers, testes weight, testes length, body weight, and kidney fat index (KFI) were obtained for male white-tailed deer *Odocoileus virginianus* (Zimmerman, 1780) fawns during the mating season at the Savannah River Site (SRS) in South Carolina. Mean values for testicular spermatozoa, testes weight, and testes length increased significantly over the study period (late October – late December) whereas body weight and KFI did not change with time. Testicular spermatozoa were found in 28% of all fawns examined and the proportion of sexually mature fawns increased greatly over the course of the study and was highest during December. These findings suggest that male fawns breed later than adults at a time that coincides with the mean conception date in doe fawns. Testes weight, testes length, body weight, and KFI were significantly greater in fawns with testicular spermatozoa compared to those without testicular spermatozoa. We suggest that testes weight is closely associated with the presence of testicular spermatozoa in fawns from SRS.

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Introduction

Knowledge of the reproductive capabilities of all age groups in a population is essential for the development of appropriate management strategies for any wildlife species. For example, in some situations white-tailed deer *Odocoileus virginianus* (Zimmerman, 1780) fawns may represent an important component of breeding populations (Schultz and Johnson 1992). Doe fawns commonly breed on the Savannah River Site (SRS) in South Carolina (Urbston 1967, 1976). Several investigators have described breeding and reproductive characteristics of doe fawns at SRS (Urbston 1967, Johns *et al.* 1977, Rhodes *et al.* 1986, 1991, Johns 1994).

Although much less data exist regarding reproduction in male fawns than in female fawns, studies conducted in enclosed populations have demonstrated that male fawns are capable of breeding successfully (Lambiase *et al.* 1972, Schultz and Johnson 1992). However, only two studies to date have examined reproductive characteristics of male fawns in free-ranging populations from temperate regions

(Urbston 1976, Scanlon and Lenker 1983) and no studies have examined the timing of reproduction in this age class. Thus, more information regarding reproductive characteristics of male fawns during the mating season is needed to assess the potential contribution of this age class to breeding populations, such as the deer herd at SRS.

The purpose of this investigation was to describe short-term changes in reproductive and physical characteristics of male fawns during the mating season. Specifically, we examined the effects of time on testicular spermatozoa numbers, testes weight, testes length, body weight, and kidney fat index (KFI) of male fawns during the mating season. We also examined the potential influence of testicular characteristics, body weight and KFI on the ability of fawns to reach puberty.

Methods

Reproductive characteristics were determined for 173 male white-tailed deer fawns harvested during managed hunts at the Savannah River Site (SRS). Fawns were distinguished from other age classes based on the pattern of toothwear and eruption (Severinghaus 1949). Hunts were conducted twice weekly from 27 October – 29 December 1984. Body weight, paired testes weight, and paired testes length were determined for each harvested deer. Kidneys and perirenal fat were removed from each individual following the procedure of Riney (1955). The weight of perirenal fat (both kidneys combined) was divided by total kidney weight and multiplied by 100 to obtain a kidney fat index (KFI; Finger *et al.* 1981).

Testicular spermatozoan numbers were estimated using the procedure of Amann and Almquist (1961). The right and left testes of each individual were each homogenized separately in 200 ml of a 0.9% NaCl solution containing 0.05% Triton X-100. Aliquots were then obtained from each homogenate and the number of spermatozoa were counted using a hemocytometer. Spermatozoa from each homogenate were counted on six hemocytometer slides and the mean of these counts was used to estimate the total number of spermatozoa present in the homogenate. Testicular spermatozoa were reported as number per paired testes.

The nine-week investigation was divided into three time periods (Period 1 = 27 October – 14 November, Period 2 = 17 November – 5 December, Period 3 = 8–29 December). One-way analysis of variance (ANOVA) was used to examine the effects of time on testicular spermatozoa, paired testes weight, paired testes length, body weight, and KFI (log transformed). The Bonferroni-Dunn Procedure was used for separation of means where appropriate. Contingency chi-square analysis was used to determine whether the proportion of fawns with testicular spermatozoa differed among time periods. Student's *t*-tests were used to compare mean testes weight, testes length, body weight, and KFI between fawns with testicular spermatozoa and those without testicular spermatozoa.

Paired Student's *t*-tests were used to compare differences in testicular spermatozoa (mature fawns only), testes weight, and testes length between the right and left portions of the reproductive tract. For each fawn with testicular spermatozoa, estimates of mean spermatozoan numbers were calculated based on 2, 3, 4, 5, and 6 counts for each testis. Estimates based on these counts were compared using repeated-measures ANOVA to determine the number of aliquots needed to obtain reliable estimates of spermatozaon numbers in fawns.

Results

Mean testicular spermatozoa ($F = 5.45, p = 0.005$), testes weight ($F = 6.72, p = 0.002$), and testes length ($F = 7.24, p = 0.001$) of fawns differed significantly among

Table 1. Mean (± SE) values for testicular spermatozoa ($\times 10^9$), paired testes weight (g), paired testes length (mm), body weight (kg), and kidney fat index (KFI; untransformed) of white-tailed deer fawns on the Savannah River Site during three time periods (27 October – 14 November, 17 November – 5 December, and 8 – 29 December) in 1984. Sample sizes are given in parentheses. Means with different letters are significantly different (Bonferroni-Dunn Test, $p < 0.05$) among time periods.

Characteristic	Period 1	Period 2	Period 3
Testicular spermatozoa	0.001 ± 0.001^a (62)	0.043 ± 0.021^a (51)	0.290 ± 0.106^b (60)
Testes weight	12.6 ± 0.8^a (62)	16.9 ± 1.6^b (48)	18.4 ± 1.3^c (60)
Testes length	72.6 ± 1.6^a (62)	79.8 ± 2.4^b (48)	82.6 ± 2.1^b (60)
Body weight	28.5 ± 0.6^a (62)	28.5 ± 0.7^a (51)	30.2 ± 0.6^a (60)
KFI	15.7 ± 1.1^a (57)	20.5 ± 1.1^b (50)	19.0 ± 1.1^b (57)

time periods, whereas no significant effect of time was observed for mean body weight ($F = 1.94, p > 0.05$) or KFI values ($F = 2.56, p > 0.05$). In general, values for all reproductive characteristics (Table 1) increased over time and were significantly higher in Period 3 compared to Period 1. In addition, testicular spermatozoan numbers increased significantly between Periods 2 and 3, testes length increased significantly between Periods 1 and 2, and testes weight increased significantly among all time periods.

Testicular spermatozoa were found in 28% (48 of 173) of all fawns examined. The proportion of fawns with testicular spermatozoa differed significantly among time periods (Period 1 = 0.06, Period 2 = 0.24, Period 3 = 0.55; $\chi^2 = 36.24, p = 0.001$). Mean values for testes weight ($t = -12.53, p < 0.001$), testes length ($t = 10.76, p < 0.001$), body weight ($t = -6.01, p < 0.001$), and KFI ($t = -2, p = 0.04$) were significantly greater in fawns with testicular spermatozoa compared to those without (Table 2). The percentage of fawns with testicular spermatozoa increased steadily among weight classes (Fig. 1A). Although the percentage of fawns reaching puberty also increased over KFI classes (Fig. 1B), a relatively large percentage of fawns in the highest KFI class were without testicular spermatozoa.

Significant differences were observed between the right and left sides of the reproductive tract regarding testes weight ($t = -3.32, p = 0.001$, left > right) and testes length ($t = -6.41, p < 0.001$, left > right). However, testicular spermatozoan numbers of fawns did not differ significantly between the right and left sides of the reproductive tract ($t = -1.35, p > 0.05$). No significant differences were observed among estimates of mean testicular spermatozoan numbers based on 2, 3, 4, 5, and 6 counts per testis ($F = 1.51, p > 0.05$).

Table 2. Mean values (± SE) for paired testes weight (g), paired testes length (mm), body weight (kg), and kidney fat index (KFI; untransformed) of white-tailed deer fawns with and without testicular spermatozoa on the Savannah River Site during 27 October – 29 December 1984. Means are also given for all fawns combined. Sample sizes are given in parentheses. Mean values for each characteristic differed significantly between fawns with and without testicular spermatozoa in all cases (*t*-test, $p < 0.001$).

Characteristic	Fawns with testicular spermatozoa	Fawns without testicular spermatozoa	All fawns
Testes weight	23.0 ± 1.0 (47)	11.4 ± 0.4 (118)	14.8 ± 0.6 (165)
Testes length	91.2 ± 1.4 (47)	71.1 ± 1.1 (117)	76.8 ± 1.1 (164)
Body weight	32.4 ± 0.6 (49)	27.8 ± 0.4 (124)	29.0 ± 0.4 (173)
KFI	20.9 ± 1.2 (47)	17.2 ± 1.1 (117)	18.2 ± 1.2 (164)

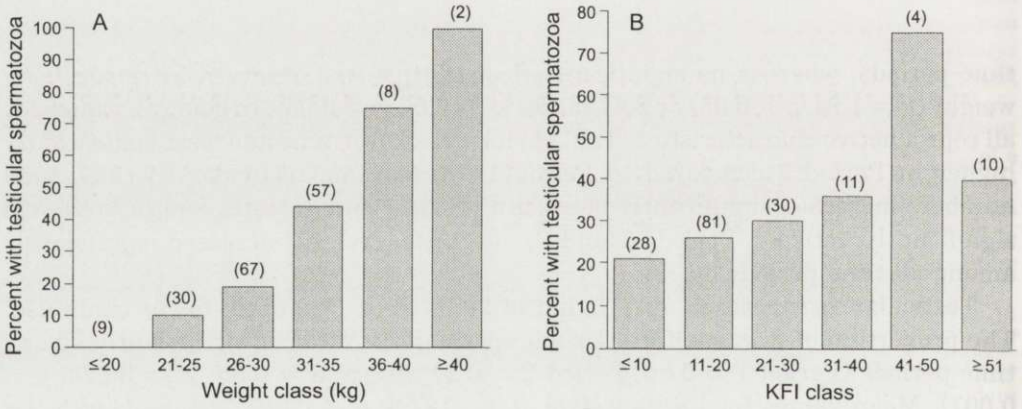

Fig. 1. Percent of male white-tailed deer fawns in each (A) weight class and (B) kidney fat index (KFI) class that had testicular spermatozoa. Fawns were collected from the Savannah River Site during 27 October – 29 December 1984. Sample sizes for each weight class are given in parentheses.

Discussion

In a previous investigation conducted at SRS, Scanlon and Lenker (1983) found testicular spermatozoa in 6 of 17 fawns examined during early November and early December. During a similar time period, Lambiase *et al.* (1972) obtained sperm from 8 of 10 of male fawns in an enclosed population. Our results support these findings and suggest that at least a portion of fawns in the SRS population reach

puberty and have the potential to breed during their first year. This is important since breeding by male fawns may impact the population dynamics of some herds (Schultz and Johnson 1992), such as the one at SRS, where age structure has been skewed toward younger age classes by harvesting practices (Scribner *et al.* 1985).

Although our results indicate that some male fawns in the SRS herd can potentially breed, individuals in this age class may still be denied mating opportunities when dominant older males are present (Marchinton and Hirth 1984). However, when compared to previous observations of adults, our results regarding short-term changes in reproductive characteristics of fawns during the mating season suggest that fawns reach breeding condition much later than adult males. For example, spermatozoan numbers and testicular characteristics of adult males at SRS have been shown to decrease significantly over the same time period in which our study was conducted (M. H. Smith, unpubl. data). Miller *et al.* (1987) also demonstrated that testosterone levels of adults decrease significantly over this same time period. By breeding later than adult males, fawns may decrease the chances of competitive interactions with dominant older males and increase their chances of obtaining mating opportunities with available does. Data regarding mating activity by male fawns is necessary to test this hypothesis.

If male fawns in the SRS herd are able to successfully mate, we suggest that most breeding by these individuals likely takes place with females in the same age class. Nearly 40% of doe fawns at SRS breed, and conception in most of these fawns occurs between mid-December and mid-January at SRS (Johns *et al.* 1977, Rhodes *et al.* 1986). In contrast, adult does breed much earlier (mean conception date = 13 November; Rhodes *et al.* 1986). In the present investigation, the proportion of male fawns with testicular spermatozoa was much higher during Period 3 (December) compared to the earlier time periods. These findings suggest that male fawns reach puberty at a time that coincides with the peak reproductive activity of female fawns.

Patterns of change in body weight and KFI of male fawns were similar to those observed in previous investigations (Johns *et al.* 1982, Johns *et al.* 1984). It is interesting to note that fat levels have been shown to increase in male fawns from July through December but decrease dramatically in adults during this time (Johns *et al.* 1982, Johns *et al.* 1984). This decline in fat levels among adults has been attributed to increased energy expenditures and decreased food intake during the breeding season (Johns *et al.* 1982, Johns *et al.* 1984). In addition, KFI values of male fawns have been shown to decrease between December and March. Although this decrease may be related to the energetic demands of growth and/or thermoregulation, there exists the possibility that KFI values may decrease as a result of breeding activity by fawns during this time period.

Results demonstrate that fawns with testicular spermatozoa differ from those without spermatozoa regarding testicular characteristics, body weight, and KFI (Table 2). Testes weight appears to be associated with the ability of fawns to reach puberty since the mean testes weight of fawns without spermatozoa was only 49.4%

of the testes weight of fawns with testicular spermatozoa. Furthermore, the pattern of increase in testicular spermatozoa over time is similar to the pattern observed for testes weight. This increase in testes weight and subsequent increase in testicular spermatozoan numbers likely results from the initiation of spermatogenesis and increased activity of the semineferous tubules (Mirarchi *et al.* 1977) during the sexual maturation process.

Body weight has been shown to be an important factor influencing reproductive rate in doe fawns (Sauer 1984), and therefore, may also be related to the ability of male fawns to reach puberty. In the current investigation, no male fawns weighing less than 21 kg reached puberty, 80% of those in the 36–40 kg weight class reached puberty, and all individuals >41 kg obtained puberty (Fig. 1A). In contrast, the percentage of fawns having testicular spermatozoa generally increased with increasing KFI values (Fig. 1B), but 60% of fawns in the highest KFI class did not reach puberty.

Although the proportion of fawns with testicular spermatozoa increased among weight classes, it is important to note that testicular spermatozoan numbers increased steadily with time but body weight did not differ significantly among time periods (Table 1). One possible explanation for these conflicting observations is that a threshold body weight may be necessary for the increased development of testicular characteristics and the initiation of spermatogenesis. Although body weight in male white-tailed deer increases over several years of life, the most rapid increase in body weight occurs during the first several months (Leberg *et al.* 1992). Thus, the observation that the proportion of fawns with testicular spermatozoa increased among weight classes may simply reflect a relationship between age and body weight.

The present investigation also provided an opportunity to address questions regarding methods used for examining reproductive characteristics in white-tailed deer. For example, our findings demonstrated that weight and length differ significantly between the right and left testes. These findings conflict with previous observations, (Scanlon and Lenker 1983) and suggest that the entire reproductive tract should be sampled to provide an accurate representation of reproductive characteristics. Our results also demonstrate that as few as two aliquots per testes are necessary to accurately estimate testicular spermatozoan numbers. This observation should save future investigators a great deal of time and effort when estimating spermatozoan numbers.

The study of reproduction in white-tailed deer fawns has important implications for the development of management programs where fawn breeding is expected to play a significant role. This includes situations where a large proportion of the adult males are harvested, captive breeding programs, or in deer introduction programs (Schultz and Johnson 1992). Management decisions for a particular deer herd should incorporate knowledge regarding age structure and the reproductive success of fawns in the herd. In herds where fawns are a potentially important component of the breeding population, management programs should give con-

sideration to the factors that might potentially influence the ability of fawns to reach puberty.

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