Reproductive Characteristics of Yearling and Adult Male White-tailed Deer

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Abstract: Differential development of reproductive characteristics and sex organs among age classes of male white-tailed deer (*Odocoileus virginianus*) during the breeding season was studied in west-central South Carolina. Blood samples and reproductive organs were obtained from 292 hunter-harvested deer from 26 October through 21 December 1985. Peak serum testosterone concentrations of ≥3.5-year-old deer occurred during the first week of the study, whereas peak concentrations in younger deer occurred approximately 4 weeks later. Testosterone concentrations were higher ($P < 0.03$) in older age classes. Data support the hypothesis that younger males reach peak rutting condition later than prime-aged (≥3.5 years old) individuals. Correlations ($P < 0.01$) among testosterone concentration, testicle length, and scrotal circumference were observed in yearling and 2.5-year-old bucks, but not in the ≥3.5 year olds.

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As seasonal breeders, white-tailed deer display annual rhythms in reproductive physiology and behavior. Peaks in gonadotropin and steroid hormone production are concurrent with the peak in reproductive activity (McMillin et al. 1974, Mirarchi et al. 1977*b*, 1978; Bubenik et al. 1983), as are peaks in spermatazoa pro-

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duction and testicular size (Lambiase et al. 1972, Mirarchi et al. 1977*a*, Scanlon and Lenker 1983). Highest concentrations of testosterone are present in prime-aged deer (Bubenik and Schams 1986) of high social rank (Miller et al. 1987). Mature males also have higher spermatozoan production than yearlings (Lambiase et al. 1972).

Behaviorally, yearling bucks enter reproductive condition later during the breeding season and display less courtship and scent-marking behavior than older bucks (Ozoga and Verme 1985). In cervids, levels of aggression and ritualized rutting behavior are dependent on age, experience, and testosterone concentrations (Lincoln et al. 1972, Bubenik et al. 1977, Miller et al. 1987). Therefore, older bucks may be physiologically capable of entering rutting condition earlier than yearlings. Although these previous studies have described the annual rhythms of hormone production and sex organ development, no investigations have compared the temporal changes among age classes within the breeding season. Our objective was to investigate possible differences in reproductive characteristics and sex organ development of adult and yearling male deer during the breeding season.

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Methods

The study was conducted on the 80,972-ha Savannah River Plant near Aiken, South Carolina. Detailed descriptions of this area can be found in Smith et al. (1982).

During fall 1985, samples from 292 male deer ($\geq$1.5 years old) were taken during managed hunts. Hunts were held twice weekly from 26 October through 21 December. Deer were driven to hunters through the use of dogs, resulting in minimal hunter selectivity. After each drive, harvested deer were brought to the check station and all samples were taken within 2 hours after harvest.

Data for the 2 weekly hunts were combined over the 9 week period. Deer ages were determined by tooth wear and eruption (Severinghaus 1949). Antler measurements included total number of points, length of each beam, and greatest spread. The degree of staining of the tarsal gland was rated subjectively on a scale of 1 to 5. Scrotal circumferences was recorded as described by Foote (1984), after which the testicles were removed and measured. Blood was obtained from the heart or alternately from other body cavity organs. Serum testosterone concentrations were determined by radio-immunoassay as described by Kattesh et al. (1979).

The development of rutting characteristics was compared among yearling, 2.5-year-old, and adult ($\geq$3.5 years old) bucks. We tested for normality of the data using a Kolomogorov-Smirnov D-statistic. For normally distributed data sets, the significance of differential rutting characteristics among the age classes was determined using an analysis of variance, and means were separated using Duncan's

Multiple Range Test (DMRT). Non-normal data were analyzed using a Kruskal-Wallis Chi-square Approximation (K–W). Correlations among characteristics were tested using a Kendall's tau-b statistic (Kendall).

Results

Mean yearling serum testosterone concentrations never exceeded 1 ng/ml (Fig. 1). Mean concentrations of testosterone in 2.5 year olds peaked during the third week of November, while highest mean concentrations in the oldest age class occurred during the last week of October. Within age classes, weekly differences occurred in mean testosterone concentrations ($P \leq 0.03$, K–W). A decreasing pattern of testosterone concentrations was noted in all 3 age classes after the third week of November. Mean testosterone concentrations in yearlings were lower ($P \leq 0.03$, K–W) than concentrations in the 2 older age classes during the first 3 weeks of November. Concentrations in all 3 age classes did not differ ($P > 0.05$) from the fourth week of November through the end of the study.

Testes length of yearlings tended to decrease over the course of the study. Similar trends in testicle length of 2.5 and ≥3.5 year olds were not observed. During October and November, lengths were similar among age classes. However, testicle length of yearlings was lower ($P \leq 0.05$, DMRT) than for the older age classes during December.

Mean scrotal circumferences and mean serum testosterone concentrations reflected a similar trend in all 3 age classes (Fig. 1). Mean scrotal circumferences peaked in late October and decreased through the end of December. The only variations ($P \leq 0.05$, DMRT) in scrotal circumferences among age classes occurred during the last week of October.

The degree of tarsal gland staining did not vary ($P > 0.05$, DMRT) within age classes, but was different ($P \leq 0.05$, DMRT) among age classes. On average, glands of deer in the oldest age class were stained darker than those in the other 2 classes. Yearlings possessed the least stained glands.

Correlations ($P \leq 0.01$, Kendall) occurred among some of the reproductive and physical characteristics collected (Table 1). These relationships were likely the result of the significant effects of age on the variables.

Within age classes, serum testosterone concentrations, scrotal circumferences, and right testicle length were correlated to body weight (Table 1). Right testicle length also was correlated to scrotal circumference in all age classes. Both right testicle length and scrotal circumference were correlated to antler beam length in the yearling and 2.5 year olds.

In yearlings, testosterone concentrations were correlated to scrotal circumferences, although correlation coefficients were low, but not to testicle lengths. The degree of staining of the tarsal gland was not correlated to any reproductive or physical variables. Testosterone concentrations in 2.5 year olds were correlated to scrotal circumferences and to testicle lengths. Unlike yearlings, tarsal gland condi-

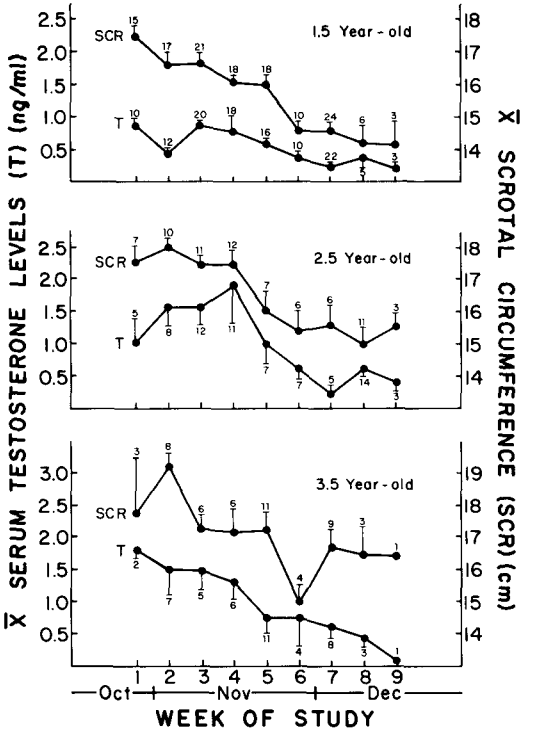

Figure 1. Temporal variations, by age class, in mean serum testosterone concentrations and scrotal circumferences of white-tailed bucks on the Savannah River Plant during the 1985 breeding season.

tion was correlated to body weights and to total number of antler points. A correlation between scrotal circumference and testes length was the only relationship among the reproductive variables detected in $\geq$3.5 year olds.

Discussion

Although mean testicle length and scrotal circumference were greater in the older age classes, differences among age classes were significant in only a few sampling periods. Lambiase et al. (1972) also reported that testicle weight did not differ between yearling and older age classes. However, pooled data over the entire study period indicated that mean testes weights and scrotal circumferences for yearlings were less than those of the older age classes ($P \leq 0.001$, DMRT). Within age classes, scrotal circumferences were correlated with body weight. In domestic bulls and sheep scrotal circumference is used in the evaluation of breeding soundness (Chenoweth and Ball 1980, Foote 1984). Provided this technique can be applied to

Table 1. Kendall tau-b coefficients for relationships among reproductive variables and physical characteristics in 3 age-classes of male white-tailed deer from the Savannah River Plant near Aiken, S.C.

Characteristics	Scrotal circumference (SC)	Right testes length (RTL)	Tarsal gland condition (TGC)	Length antler beam (LRAB)	Total number points (TNP)	Serum testosterone concentration (STL)
			1.5 years old			
Live Weight (LW)	0.24[c]	0.13[a]	0.03	0.29[c]	0.25[c]	0.28[c]
SC		0.35[c]	0.02	0.20[c]	0.11	0.19[c]
RTL			−0.10	0.20[b]	0.06	0.06
TGC				0.08	0.02	−0.01
LRAB					0.48[c]	0.05
TNP						0.04
			2–5 years old			
LW	0.59[c]	0.50[c]	0.24[b]	0.47[c]	0.28[c]	0.21[a]
SC		0.50[c]	0.11	0.26[b]	0.16	0.28[b]
RTL			0.17	0.17[a]	0.02	0.34[c]
TGC				0.17	0.27[b]	0.06
LRAB					0.46[c]	0.05
TNP						−0.01
			3.5+ years old			
LW	0.43[c]	0.34[c]	0.01	0.30[b]	0.05	0.21[a]
SC		0.36[c]	−0.04	0.08	0.10	0.11
RTL			0.03	0.19	0.13	−0.14
TGC				0.00	−0.05	−0.07
LRAB					0.05	−0.03
TNP						−0.09

[a] $P \leq 0.05$, Kendall.
[b] $P \leq 0.01$, Kendall.
[c] $P \leq 0.001$, Kendall.

deer, heavier animals within age classes may be more reproductively sound than others in their cohort. In yearlings and 2.5 year olds, scrotal circumference and body weight also were correlated to serum testosterone concentrations, possibly indicating that larger deer within these age classes may be more active reproductively than smaller deer. Whether these results reflect attainment of a higher dominance status or advanced physical maturity is unknown.

Considerable variations in serum testosterone concentrations within age classes were noted during each sampling period. Variations probably are due to the episodic nature of testosterone secretion (Bubenik et al. 1983, Lincoln and Short 1980) in addition to individual differences in testosterone production. Low correlation coefficients between serum testosterone concentrations and other measurements probably reflect the nature of testosterone secretion.

Mean serum testosterone concentrations for yearlings and 2.5 year olds were similar to those for captive deer in Georgia (Miller et al. 1987). Concentrations for $\geq$3.5 year olds, however, were less than for the captive deer. According to Bubenik and Schams (1986), maximal testosterone concentrations in captive bucks occur between 4.5 and 8.5 years of age. During the first 4 weeks of this study (coincident

with maximal testosterone concentrations), 24% of the bucks in our ≥3.5 age class were ≥4.5 years old. These deer did not have higher testosterone concentrations ($P > 0.05$) than the 3.5-year-old bucks.

Peak testosterone concentrations in yearling and 2.5 year olds occurred during the middle of November, while peak concentrations in the oldest age class occurred at or before the beginning of the study (Fig. 1). Social aggression and the performance of certain ritualized rutting behaviors, such as scent marking, may be dependent on serum testosterone concentrations (Lincoln et al. 1972, Bubenik et al. 1977, Miller et al. 1987) as well as the physical/behavioral maturity of the buck (Miller et al. 1987, Ozoga and Verme 1985). Thus, yearlings and 2.5 year olds may not exhibit rutting behaviors as early in the breeding season as older males, due to delayed rises in testosterone. Lower peak testosterone concentrations in yearlings also may indicate that these deer may express less rutting behavior than older males. These conclusions are supported by Ozoga and Verme's (1985) report that younger males scent mark less often than older individuals.

Unfortunately, our data do not include the earliest portion of the breeding season (September to mid-October), although they do include the majority of conception dates ($\bar{X}$ = 20 November, SD = 27 days) (Rhodes 1987). Variations in testosterone concentrations and sex organ development by age classes during the period of dominance hierarchy formation (Kile and Marchinton 1977, Nielsen et al. 1982) remains to be investigated.

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