Antler Characteristics and Body Mass of Spike- and Fork-antlered Yearling White-tailed Deer at Maturity

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Abstract: We compared antler characteristics and body mass at 4.5 years of age (adult) of 140 white-tailed deer (*Odocoileus virginianus*) reared in a captive herd at the Kerr Wildlife Management Area (Hunt, Texas) from 1973 to 1990. Each yearling (1.5 years old) was classified as spike- ($N = 43$) or fork-antlered ($N = 97$), and its live body mass recorded. Fork-antlered yearlings were further partitioned into 3–5 points ($N = 33$) and ≥6 points ($N = 64$) subclasses based on the number of antler points ≥2.54 cm in length. All deer were reared in 1.62-ha enclosures and maintained on a 16% crude protein diet ad libitum. In ensuing years, antlers were removed and live body mass recorded. At 4.5 years, the gross Boone and Crockett (GBC) score of each buck was measured. The average GBC score of adult deer that were fork-antlered yearlings (127.8 ± 2.0 SE) was greater ($P < 0.001$) than those of spike-antlered yearlings (89.9 ± 2.8). This difference arose from increases ($P < 0.001$) among fork-antlered yearlings relative to spike-antlered yearlings in the average score of 4 GBC components. Adults that had forked antlers as yearlings also had greater ($P < 0.001$) tine lengths and beam circumferences than did adults that were spike-antlered yearlings at each of the 4 GBC measurement positions. Mean body mass of fork-antlered yearlings was greater ($P < 0.001$) than that of spike-antlered yearlings at both 1.5 years (54.0 ± 0.7 vs. 43.6 ± 1.0 kg, respectively) and 4.5 years (78.7 ± 1.0 vs. 66.7 ± 1.6 kg). When fork-antlered yearlings were partitioned into 3–5 points and ≥6 points classes, the GBC scores at maturity of the 3 classes of yearlings differed significantly ($P < 0.05$). Average GBC scores of adults that had ≥6 points as yearlings (134.0 ± 2.3) exceeded that of adults that were spike-antlered as yearlings by 44 GBC points; and all GBC components differed (P <0.001) among the classes of deer. Our results show that classifying yearlings as either spike- or fork-antlered was useful for predicting antler characteristics and body mass at maturity, and that spike-antlered bucks continued to produce smaller antlers at maturity in our controlled population.

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The relative expression of antler traits and overall antler quality in white-tailed deer changes with age (Sauer 1984). However, because antler development is physiologically linked to body maintenance and growth (French et al. 1956, Moen 1978), the expression of antler traits can be correlated with body mass within (Severinghaus and Moen 1983, Williams et al. 1983) and among (Williams and Harmell 1984) age-classes and with body condition within age-classes (Smith et al. 1983). Given the linkage between body condition and the expression of antler traits, it is axiomatic that variation in the nutritional quality of forage included in the diet plays a significant role in generating variation in antler trait expression (Teer et al. 1965, Ullrey 1983).

Antler size and body mass vary also as a function of an individual's multilocus genotype, as demonstrated by the finding of significant heritabilities for body mass and antler traits at 1.5 years of age (Harmel et al. 1989, Williams et al. 1994, but see Lukefahr and Jacobson 1998). Moreover, antler quality can vary as a function of heterozygosity within an age-class (Smith et al. 1983; Scribner et al. 1984, 1989; Scribner and Smith 1990).

At the population level, antler quality varies temporally within populations (Smith et al. 1983, Scribner et al. 1989) and spatially among populations with differences in habitat quality (Scribner et al. 1984, Shea et al. 1992*a*). Within the yearling age-class, the production of spike antlers in white-tailed deer is influenced by parental genotypes (Harmel 1983, Smith et al. 1983, Harmel et al. 1989, Williams et al. 1994) and nongenetic factors, such as maternal effects (Lukefahr and Jacobson 1998), and parturition date (Knox et al. 1991, Shea et al. 1992*b*, but see Causey 1990).

While there is general agreement that the incidence of spike-antlered yearlings varies temporally and spatially within and among populations within a region, and among regions, data directly addressing the relative importance of genetic and environmental factors in the production of spike-antlered yearlings in natural populations are nonexistent. Moreover, data addressing this issue in controlled populations are both scant and contradictory (Williams et al. 1994, Lukefahr and Jacobson 1998). As a result, there is disagreement concerning the relative roles of environmental and genetic variation in the production of spike-antlered yearlings in the scientific and especially the popular literature, which is readily accessible to the land manager (Brothers and Ray 1982, Kroll 1991, Armstrong et al. 1995). Thus, the management decision to protect or remove spike-antlered bucks in natural or high-fenced populations remains controversial throughout the southeastern United States (Jacobson and White 1985, Armstrong et al. 1995).

Two central questions must be addressed to resolve this controversy. First, do yearling spike bucks continue to exhibit smaller antlers and reduced body masses at later ages compared to their nonspike counterparts, and second, to what extent are antler and body mass traits heritable? The competing hypotheses regarding question one are (1) spike-antlered yearlings continue to express smaller antlers and lower body mass than fork-antlered yearlings in subsequent age-classes (Armstrong et al. 1995) and (2) spike-antlered bucks exhibit compensatory growth in body mass and antler characteristics and thus recover in later age-classes (Jacobson and White 1985). We provide comparative data on body mass and antler characteristics of spike- and fork-antlered yearlings reared under controlled environmental conditions to 4.5 years of age.

We chose the Boone and Crockett scoring system (Boone and Crockett 1982) to compare antler characteristics of spike- and fork-antlered yearling white-tailed deer at 4.5 years of age for 3 reasons. First, the controversy surrounding the management of spike-antlered bucks is ultimately about the overall quality of antlers produced by each class of deer. Antler traits such as total mass and main beam length, length and/or number of points, symmetry, and inside and outside spread influence observer perceptions of the overall quality of antlers produced by mature white-tailed deer. No single element of antler conformation summarizes overall antler quality, and perceptions of quality vary among observers because of differences in the relative weighting assigned to individual components, differences in environmental context (e.g., variation among local or regional population averages for the above traits), and differences in observer experience. As a consequence, the notion of antler quality varies in spatial, temporal, and social contexts. The Boone and Crockett scoring system provides a standardized metric for summarizing overall antler quality and the relative contribution of each component of antler quality. Second, the Boone and Crockett system is widely used for comparison in the popular white-tailed deer literature perused by private and public managers and especially hunters (the end recipient of management objectives). Third, white-tailed deer managers, guides, and hunters are adept at estimating gross Boone and Crockett (GBC) scores under field conditions.

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Methods

Herd history and composition of the data set

We examined case records of 140 male white-tailed deer reared from 1973 to 1990 in a pedigreed white-tailed deer herd at the Kerr Wildlife Management Area, a facility owned and operated by the Texas Parks and Wildlife Department, near Hunt, Kerr County, Texas. The Kerr deer herd was established in 1974 from stock obtained throughout Texas and is thus representative of Texas white-tailed deer. The herd has been maintained as a closed breeding population to study genetic and environmental contributions to variation in antler and body traits of white-tailed deer. The foundation stock consisted of 6 buck fawns obtained in 1973 from the following locations: Brazos, Kendall, Kerr, and Walker counties, and Abilene and Midland, Texas. Bred does (sires unknown) of independent parentage were live-trapped throughout Texas and used as foundation females. Importantly, the Kerr herd has been shown to exhibit a level of heterozygosity that as of 1996 was comparable to natural deer herds throughout Texas (R.L. Honeycutt, unpubl. data).

Criteria for inclusion of deer in the present study were that buck fawns must have been born into the captive herd (with the exception of foundation males), fawns must have been reared on a continuous ad libitum high protein diet following weaning, and all bucks must have complete data on antler characteristics for both ages 1.5 and 4.5 years and body mass at age 4.5 years. Records for body mass at age 1.5 were available for 121 of the 140 bucks. All buck fawns in the Kerr herd from 1973 to 1990 meeting these criteria were included in the study. Records of spike-antlered yearlings were available for 11 of 18 years of the study period. Records of fork-antlered yearlings were available for 15 of the 18 years.

A total of 38 different sires between 1973 and 1990 produced the 140 buck fawns whose records are analyzed herein. Of these 38 sires, 9 are represented in the data set by spike offspring only, 7 are represented by both spike- and fork-antlered offspring, and 22 are represented by fork-antlered offspring only. These distributions represent the number of spike- and fork-antlered offspring surviving to 4.5 years, not the relative number of spike- and fork-antlered yearlings produced by each sire. Following parturition, there was no selective culling of offspring before attainment of yearling status. Thus, the availability of yearling bucks was determined by "natural" mortality alone. Mortality records for cohorts of fawns born during 1979–1990 indicate that 54% of fawns born into the herd (253 males and 228 females) died from natural mortality before reaching yearling status.

Some bucks whose records are analyzed herein have been included in previously published qualitative or quantitative analyses of body mass and antler traits of the Kerr herd. For example, 54 of the 140 bucks provided records of yearling body mass and antler traits in the study by Williams et al. (1994). These 54 deer were produced by random mating from 1984 to 1990. Also included are records of those yearling bucks qualitatively analyzed at ages 1.5, 2.5, and 3.5 years by Harmel et al. (1989) that subsequently survived to age 4.5. These deer (birth years 1974 to 1981) resulted in some instances from nonrandom breeding and selection that were used to generate the "spike and fork lines" referred to by Harmel et al. (1989). However, true line breeding was not employed during this period, hence the use of the terms "spike line" and "fork line" has proven to be both confusing and unfortunate. The influence of this deviation from random mating on the data set analyzed herein is partially mitigated by 2 factors. First, the same does were bred in alternate years to both the spike and fork line sires of Harmel et al. (1989). Since females contribute 50% of the genes each generation, genetic bias is reduced. Second, inspection of the pedigrees of the offspring used in the present study showed approximately equal representation of sires from both "lines" of deer; i.e., 21 sires represented the spike line and 17 represented the fork line.

Each buck included in the study was classified as either spike- ($N = 43$) or fork-antlered ($N = 97$) as a yearling. Fork-antlered yearlings were further partitioned into 2 subclasses based on the number of antler points ≥2.54 cm in length; 3–5 points ($N = 33$) and ≥6 points ($N = 64$). All deer were reared in 1.62-ha enclosures and maintained on a 16% crude protein diet (Verme and Ullrey 1972, Harmel et al. 1989) ad libitum throughout the study. We captured, weighed, measured inside antler spread, and removed antlers 1 cm above the base of the pedicel of all bucks during the last 2 weeks of October and the first week of November.

GBC score was computed for each adult buck based on the formula: $GBC = \Sigma MB + \Sigma G_N + \Sigma H_N + SP + \Sigma NTPTS$; where ΣMB = combined lengths of the main beams of the right and left antlers; ΣG_N = total length of tines G_1 to G_N on both the left and right antlers; ΣH_N = total beam circumferences H_1 to H_4 at the 4 measurement positions for both left and right beams; SP = maximum inside spread between the antlers; and $\Sigma NTPTS$ = total length of all nontypical points. Nontypical points were used in computing GBC scores at 4.5 years but were not further analyzed because so few deer of either class expressed such points. All measurements were recorded in mm by means of a flexible steel tape and were converted to inches to compute GBC scores (standardly expressed in inches). Both right and left antlers were measured for all deer to yield the summations ΣMB, ΣG_N, and ΣH_N. A preliminary comparison of right and left antler characteristics showed no significant bilateral asymmetry. Tests of normality and homogeneity of variances showed that no transformations were required for any dependent variables analyzed herein.

Statistical Analyses

GBC scores at 4.5 years and live body mass at 1.5 and 4.5 years were compared between spike- and fork-antlered yearlings by analysis of variance (ANOVA). Separate ANOVAs tested the null hypotheses that each of the 4 GBC components did not differ at maturity between the 2 classes of yearling deer. Two further ANOVAs were conducted to determine if the subcomponents of ΣG_N and ΣH_N differed between the 2 classes of bucks.

We used ANOVA to determine whether GBC scores at 4.5 years and live body weights of yearlings and adults differed among deer that had spike antlers, antlers with 3–5 points, or antlers with ≥6 points as yearlings. The null hypothesis that each GBC component did not differ at maturity among the 3 classes of yearling deer was then tested using ANOVAs followed by comparison of means. Tukey's studentized range test ($\alpha = 0.05$) was used for all means comparisons.

Results

GBC Scores and Body Mass

Spike-antlered yearlings produced GBC scores at maturity (4.5 years old) that were less than those of fork-antlered yearlings ($\bar{x} = 89.9 \pm 2.8$ [SE], $N = 43$,

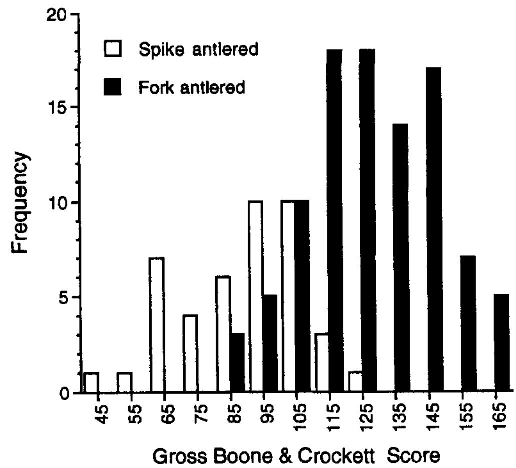

Figure 1. Distribution of Gross Boone and Crockett (GBC) scores for white-tailed deer at 4.5 years of age that as yearlings were spike-antlered ($N = 43$) or fork-antlered ($N = 97$) in the Kerr deer herd, Kerr County, Texas, 1973–1990.

and 127.8 ± 2.0, $N = 97$ respectively; $F_{1,138} = 115.9$; $P < 0.001$). The distribution of GBC scores of the 2 classes of bucks overlapped minimally, and the production of "near trophy class" (≥120 GBC) and "trophy class" (≥130 GBC) bucks differed markedly between spike- and fork-antlered yearlings (Fig. 1). Most fork-antlered yearlings (62%) produced GBC scores ≥120 at 4.5 years,whereas only 2.3% of spike-antlered yearlings had similar scores. All trophy-class bucks developed from fork-antlered yearlings. Spike-antlered yearlings also weighed less than fork-antlered yearlings at 1.5 years of age ($\bar{x} = 43.6 \pm 1.0$ kg. $N = 34$ and $\bar{x} = 54.0 \pm 0.7$ kg, $N = 87$ respectively; $F_{1,119} = 63.6$; $P < 0.001$) and at 4.5 years of age ($\bar{x} = 66.7 \pm 1.6$ kg, $N = 43$ and $\bar{x} = 78.7 \pm 1.0$ kg, $N = 97$; $F_{1,136} = 44.4$; $P < 0.001$; Fig. 2).

Components of GBC Scores

At maturity, fork-antlered yearlings produced higher scores than did spike-antlered yearlings for all GBC components (P <0.001 for all comparisons, Table 1). These results indicate that the 42% increase in GBC scores at maturity for fork-antlered yearling bucks (38 inches of additional antler) arose from differences in every component of GBC score. Most notably, the total length of tines produced by fork-antlered bucks exceeded that of spike-antlered bucks by an average of 98%. This difference arose because of significant increases in the length of tines produced by fork-antlered bucks at each measurement position ($P < 0.001$ for all comparisons, Fig. 3). Similarly, the 26% increase in total circumference scores for adult fork-antlered bucks arose from significant increases in circumference at all measured positions ($P < 0.001$ for all comparisons, Fig. 4).

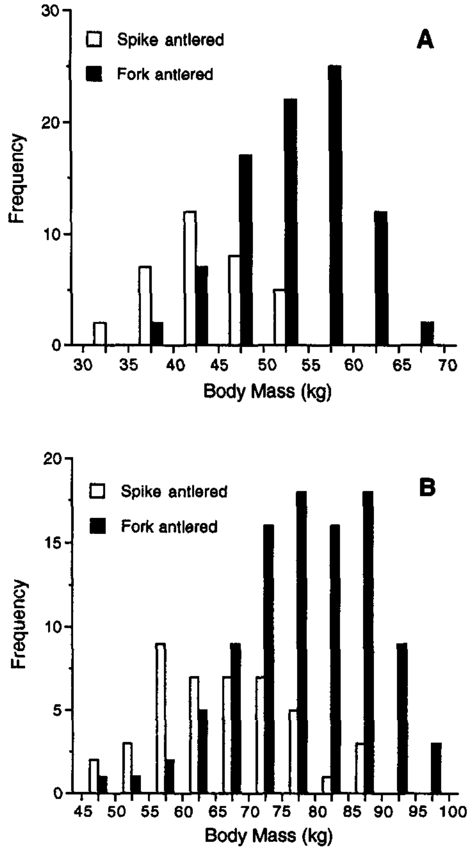

Figure 2. Distribution of body mass of (A) spike-antlered ($N = 34$) and fork-antlered ($N = 87$) yearling white-tailed deer at 1.5 years of age and (B) spike-antlered ($N = 43$) and fork-antlered ($N = 97$) yearlings at 4.5 years of age in the Kerr deer herd, Kerr County, Texas. 1973–1990.

Table 1. Comparison of Gross Boone and Crockett (GBC) component scores (in inches) between spike-antlered ($N = 43$) and fork-antlered ($N = 97$) yearling white-tailed deer at 4.5 years of age in the Kerr deer herd, Kerr county, Texas, 1973–1990.

	Spike antlered		Fork antlered			
GBC component(a)	$\bar{x}$	SE	$\bar{x}$	SE	% increase[b]	$P > F$
ΣMB	31.8	0.7	39.0	0.5	+22.6	<0.001
ΣG_N	21.1	1.6	41.8	1.1	+97.6	<0.001
ΣH_N	22.2	0.5	28.1	0.4	+26.5	<0.001
SP	14.4	0.4	16.5	0.3	+14.3	<0.001

a. Components are: ΣMB = combined length of right and left main beams; ΣG_N = combined length of all tines on the right and left antler; ΣH_N = combined circumference of the 4 measurement positions of both the right and left antler; and SP = maximum inside spread between right and left antlers.

b. Percent increase relative to spike score = [(fork antlered − spike antlered)/spike antlered] *100.

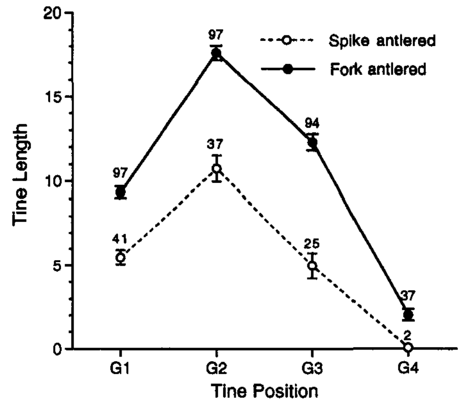

Figure 3. Mean (± SE) total length of tines at measurement positions G_1 to G_4 on the main beam (Σ left + right antlers) at 4.5 years of age for spike- and fork-antlered yearlings in the Kerr deer herd, Kerr County, Texas, 1973–1990. Number above SE bars indicate the number of individuals in which total length of tines was greater than 0 at each measurement position. Total tine length is expressed in inches.

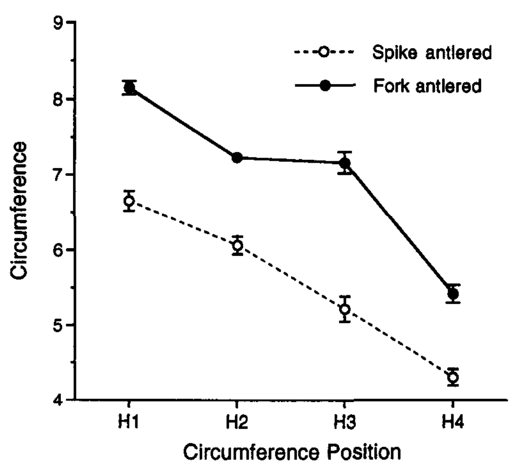

Figure 4. Mean (± SE) circumference as a function of measurement positions (H_1 to H_4) along the main beam at 4.5 years of age for spike- and fork-antlered yearling white-tailed deer in the Kerr deer herd, Kerr County, Texas, 1973–1990. Circumference is the sum of right and left antlers in inches. Sample size = 43 and 97 at all measurement positions for spike- and fork-antlered yearlings, respectively.

Analysis of 3 Antler Classes

GBC scores differed (P <0.001) among adult bucks that as yearlings had spike antlers ($\bar{x} \pm SE = 89.9 \pm 2.8, N = 43$), antlers with 3–5 points ($\bar{x} = 114.6 \pm 3.0, N = 33$), and antlers with ≥6 points ($\bar{x} = 134.0 \pm 2.3, N = 64$). This analysis indicates a general relationship between the overall quality for antlers produced at 1.5 years of age and those produced at 4.5 years. The 38-point difference in GBC scores between adults that were either spike or fork-antlered as yearlings increased to 44 points when adults that were spike-antlered as yearlings were compared with adults that had ≥6 points as yearlings.

Each component (ΣMB, ΣG_N , ΣH_N, and SP) of GBC score at 4.5 years of age also differed among the 3 classes of yearling deer (P <0.001). Comparison of means for each GBC component at 4.5 years among the 3 yearling antler classes demonstrated clear differences between each of the yearling classes for each component and the intermediate performance of 3–5 point yearlings at maturity (Fig. 5).

Body mass of yearling bucks with spike antlers, antlers with 3–5 points, and antlers with ≥6 points also differed (P <0.05) at both 1.5 and 4.5 years of age (Table 2). At maturity, spike-antlered yearlings attained only 83% of the live body mass achieved at maturity by yearlings with ≥6 points.

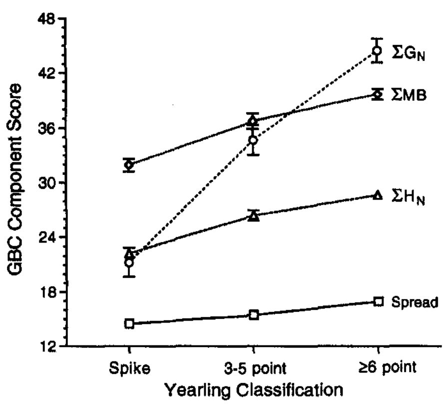

Figure 5. Means (± SE) of GBC components (ΣMB = combined length of right and left main beams; ΣG_N = combined length of all tines on the right and left antler; ΣH_N = combined circumference of the 4 measurement positions of both the right and left antler; and spread = maximum inside spread between right and left antlers) at 4.5 years of age for spike-antlered yearlings, yearlings with 3–5 points, and yearlings with ≥6 points in the Kerr deer herd, Kerr County, Texas, 1973–1990. With the exception of mean values of spread for spike-antlered and 3–5 point yearlings, the mean scores of each GBC component differed (P <0.05) among the three classes. Component scores are expressed in inches. Error bars are subsumed by symbols for some means.

Table 2. Live body mass (kg) at 1.5 and 4.5 years of age for yearling bucks with spike antlers, antlers with 3–5 points, or antlers with ≥6 points in the Kerr deer herd, Kerr County, Texas, 1973–1990.

Yearling classification	Body mass (1.5) years)[a]			Body mass (4.5 years)		
	$\bar{x}$	SE	N	$\bar{x}$	SE	N
Spike antlers	43.6^{A}	1.0	34	66.7^{A}	1.6	43
3–5 points	48.6^{B}	1.0	26	75.4^{B}	2.0	33
≥6 points	56.3^{C}	0.8	61	80.5^{C}	1.1	64

a. Results based on ANOVA followed by means comparison using Tukey's studentized range test. For 1.5 years, $F_{2,117} = P < 0.0001$; for age 4.5 years, F_2 (136) = 25.8, $P < 0.0001$. Means followed by different letters within a year-class are significantly different at $P < 0.05$.

Discussion

Traditionally, participants in the controversy regarding alternative protocols to employ in managing spike bucks have considered yearling bucks to fall neatly into 2 categories: spike or fork antlers (Brothers and Ray 1982, Kroll 1991, Armstrong et al. 1995). We tested and rejected the long-standing controversial hypothesis that spike- and fork-antlered yearling bucks do not differ at maturity in antler characteristics and body weights. Direct comparison of spike- and fork-antlered yearling bucks at 4.5 years of age after being reared under controlled conditions demonstrated unequivocally that mean antler quality and body mass of spike-antlered yearlings at maturity were less than for fork-antlered yearlings. Fork-antlered yearlings reared during a 18-year study in the Kerr Wildlife Management Area captive deer herd consistently produced GBC scores and body masses that averaged nearly 1.4- and 1.2-*x* greater than those of spike-antlered yearlings, respectively. Thus, classifying yearling white-tailed bucks as either spike- or fork-antlered is a reliable tool for predicting overall antler quality and live body mass at maturity.

Our results were consistent with prior published studies of the relationship between antler traits and body mass of yearling deer and the expression of these traits in later age-classes (Williams et al. 1983, Scribner et al. 1984, Williams and Harmel 1984, Harmel et al. 1989, Schultz and Johnson 1992). Earlier studies of the Kerr deer herd (Williams et al. 1983, Williams and Harmel 1984) showed that the average body mass of yearlings at 1.5, 2.5, and 3.5 years of age was significantly less for deer that had <6 points as yearlings compared to those with ≥6 points. The number of antler points at 1.5 years of age was correlated with number of antler points at 2.5 and 3.5 years. As a consequence, yearlings with ≥6 points produced inferior antlers in their second and third antler sets. In an analysis of harvested free-ranging bucks, Scribner et al. (1984) showed that the body mass of 1.5-, 2.5-, and 3.5-year-old bucks that had spike antlers as yearlings was significantly less than those that had forked antlers as yearlings. Harmel et al. (1989) qualitatively compared 64 spike- and fork-antlered yearlings produced within the Kerr deer herd from 1.5 through 3.5 years of age and showed that spike-antlered yearlings (N = 26), remained inferior to fork-antlered yearlings ($N = 38$) in antler mass, main beam length, number of points, and body mass through 3.5 years of age. The current quantitative study strengthens the qualitative study of Harmel et al. (1989) and extends the results of Williams et al. (1983), Williams and Harmel (1984), and Harmel et al. (1989) to the 4.5 year age-class.

Our results show that differences in antler quality (indexed in earlier studies as a series of individual, although not uncorrelated, metrics—e.g., antler mass, number of points, basal circumference, beam length, and spread) translated into large differences in a single measure of overall antler quality, i.e., GBC score. Moreover, our results document that differences in overall quality arose because of significant increases in each component (ΣMB, ΣG_N, ΣH_N, and ΣSP) of GBC score.

Increased tine lengths and, to a lesser extent, beam circumferences, were the primary contributors to the increased GBC scores of fork-antlered yearlings at 4.5 years. Adult deer allocated resources similarly (i.e., no differences in the shape of the relationships between tine length or beam circumference and measurement position illustrated in Fig. 4–5), but fork-antlered yearlings apparently committed more total resources to bone growth throughout antler development (i.e., at each successive measurement position).

In the only other published study of antler and body mass characteristics of spike- and fork-antlered yearling white-tailed deer conducted on a captive herd other than the Kerr herd, Schultz and Johnson (1992) demonstrated that spike-antlered yearlings had smaller antler mass than fork-antlered yearlings at 1.5, 2.5, and 3.5 years of age. Differences in antler mass diminished in their Louisiana deer herd at 4.5 years of age, however, and no difference in body mass at 1.5 years of age was detected (the only year for which we can directly compare data). Because sample sizes decreased from age-classes 1.5 to 4.5 throughout Schultz and Johnson's study (N decreased from 20 to 6 and from 53 to 13 for spike- and fork-antlered yearlings, respectively), and because criteria for selecting the subset of individuals that continued in the study are not given, the extent to which results at age-class 4.5 years are unbiased in this study cannot be assessed.

Management Implications

Our analyses show clear differences between the size of antlers and body mass of adult white-tailed bucks that were spike- or fork-antlered as yearlings in our control herd. If the results of penned studies are applicable to free-ranging or managed populations, then the distinction between these classes of yearlings could be of value to those wishing to improve the average GBC scores of mature bucks. Improvement of GBC scores within a herd could be accomplished by selectively culling spike yearling bucks. This technique would increase mean antler quality at maturity within a cohort of bucks simply by reducing the number of small-antlered bucks contributing to the population mean (Armstrong et al. 1995). Improvement would be realized within the population, at the expense of cohort size, regardless of the genetic basis of antler traits.

Most management, however, is directed at habitat improvement and/or long-term (genetic) improvement of herd performance. Both habitat improvement and genetic improvement seek to reduce the incidence of spike-antlered yearlings. For selective culling of spikes to produce long-term genetic improvement, not only must the expression of antler traits at the yearling stage reliably predict antler traits at maturity, but antler traits must exhibit heritable variation (Armstrong et al. 1995). Williams et al. (1994) demonstrated intermediate to high heritability in yearling Texas white-tailed bucks for number of points, main beam length, inside spread, basal circumference, and antler mass. Our results and those of Williams et al. (1994) imply that for Texas white-tailed deer, the average value of antler traits at maturity, or a measure that summarizes a suite of antler traits (e.g., GBC score), could be increased between generations in managed populations by selective culling of small-antlered bucks. This implication follows directly from a basic tenet of selection theory, namely that the response of a trait to selection is a product of the intensity of selection and the heritability of the trait (Falconer 1989). We concur with Scribner et al. (1984), Harmel et al. (1989), Schultz and Johnson (1992), and Armstrong et al. (1995) that selective culling of spikes could be considered as a component of management for improved average antler development of a herd. We note, however, that Lukefahr and Jacobson (1998) found low heritability values for incidence of spikes vs. forks, number of points, maximum inside spread, total antler weight, and main beam length in yearling males in a captive Mississippi deer herd and hence discouraged the use of antler records from yearling males as criteria for selective harvest when genetic improvement is a goal.

Results of our 3-group analysis demonstrated large differences among spike, 3–5 point, and ≥6 point yearling bucks and suggested that for maximum antler expression, the decision of which yearling bucks to protect or remove from managed herds is not as simple as the convenient classification system "spike- or fork-antlered" would suggest. White-tailed deer managers and hunters must recognize that antler and body weight are correlated, continuously distributed traits whose expression at maturity may be correlated with their expression at the yearling stage. As indicated by basic selection theory (Lerner 1950) and discussed by Williams and Harmel (1984), management strategies that favor the removal of all but the largest-antlered yearling bucks (under the appropriate conditions) will lead to the greatest gain in mean herd performance. The short-term cost of improvement in antler quality is fewer harvestable animals at maturity. Obviously within different herds (and even the same herd in different years), the subset of the yearling population to be culled will differ, but in each population "top-end" yearling bucks should be identified and preserved, if the long-term management goal is to improve antler quality.

Understanding the comparative performance of spike- and fork-antlered yearling white-tailed deer at maturity in free-ranging populations has suffered from an abundance of conflicting opinions (Brothers and Ray 1982, Kroll 1991, Armstrong et al. 1995) combined with a lack of published data. No comparative longitudinal studies of antler characteristics and body mass of spike- and fork-antlered yearling white-tailed deer have been conducted in free-ranging populations. Thus, the relative performance of spike- and fork-antlered yearlings at maturity in natural populations remains virtually unknown and can only be inferred from the few and conflicting published studies of penned deer. Our results extend the findings of earlier studies of pen-raised Texas deer, and make it clear that for Texas white-tailed deer raised on a high-quality diet, spike-antlered yearlings are smaller than fork-antlered yearlings at maturity in both antler and body mass.

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