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James Kroll

Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, jkroll@sfasu.edu

Ben Koerth

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Author(s): Ben H. Koerth and James C. Kroll

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Juvenile-to-Adult Antler Development in White-Tailed Deer in South Texas

BEN H. KOERTH,¹ *Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962, USA*
JAMES C. KROLL, *Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962, USA*

ABSTRACT Past studies using penned deer provide conflicting results on the age when reliable predictions about antler growth potential in white-tailed deer (*Odocoileus virginianus*) can be made. We captured wild whitetail males via aerial net gun on 12 ranches in 5 counties in south Texas, USA, from 1999 to 2007 to determine if a reliable juvenile-to-adult relationship in antler development existed. We individually marked and released captured animals at the trap site after we took antler and body measurements. We recaptured marked animals as possible in subsequent years or until we obtained final measurements after legal harvest. Amount of growth in the first set of antlers in whitetail males was a poor predictor of antler growth at maturity. By 4.5 years of age there were no differences ($P > 0.05$) in antler measurements regardless of the amount of development of the first set of antlers at 1.5 years. We concluded culling of yearling males based on number of antler points would have little positive effect on overall antler quality in future years. (JOURNAL OF WILDLIFE MANAGEMENT 72(5):1109–1113; 2008)

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KEY WORDS antler development, *Odocoileus virginianus*, Texas, white-tailed deer.

Determining if there is a predictable juvenile-to-adult relationship in antler growth in white-tailed deer (*Odocoileus virginianus*) has been a point of controversy among deer managers. Results of various studies on captive whitetails have produced recommendations ranging from removing all spike-antlered yearlings as inferior to complete protection of all yearling males despite the amount of antler growth exhibited (Armstrong et al. 1994, Jacobson 1998). Inferior, in this case, refers to an animal perceived to have less potential for future antler growth than other cohort members.

Most studies on predicting antler growth potential in whitetails were conducted using penned animals in an attempt to isolate genetic effects from environmental effects (e.g., nutrition, health status) that may influence antler growth. In Texas, USA, Williams et al. (1994) concluded spikes on yearling whitetails were highly heritable and were an antler morphotype exhibiting low potential for high-antler quality in future years. Data from Williams et al. (1994) suggested substantial progress could be attained in overall antler quality in the future by intentionally culling spike-antlered yearlings. In contrast, Lukefahr and Jacobson (1998) found spike antlers on yearlings in Mississippi had low heritability, were related to many factors besides genetics, and could not be used reliably to predict antler growth potential. Conclusions from Lukefahr and Jacobson (1998) indicated little or no improvement in future antler quality could be expected by culling based on yearling antler traits.

It often is difficult to directly extrapolate results from studies on confined animals with a known history, held at unnaturally high densities, and fed a high-quality diet ad libitum to wild animals born under varying range and management conditions. Hence, more studies similar to those on captive populations need to be conducted on a large

scale with wild populations to determine efficacy of management recommendations when applied to those populations as a whole. Our objective was to determine if a whitetail male's first set of antlers was a good predictor of antler growth at maturity (≥ 4.5 yr old) in wild populations.

STUDY AREA

We conducted our study from 1999 to 2007 on 12 private ranches in south Texas, USA, located in Dimmit, Duval, McMullen, Webb, and Zavalla Counties. With one exception, all ranches in the study were fenced with 2.4-m-tall net-wire fencing to restrict movement of deer across property boundaries. High-fenced ranches ranged in size from approximately 485 ha to 6,070 ha. The low-fenced property was approximately 3,642 ha.

Counties on our study area were located in the South Texas Plains vegetational area, which is described as level to rolling with numerous ephemeral drainages (Gould 1975). Flora on the ranches was typical of the area with numerous herbaceous species and an overstory of various small trees, shrubs, subshrubs, and cacti as described in Everitt and Drawe (1993). Mean annual precipitation varied from 40 cm in the western to 76 cm in the eastern part of the region. Annual precipitation typically was bi-modal with peaks in May–June and September (Correll and Johnston 1979).

Although livestock were present on some of the ranches, primary management focus for all ranches was white-tailed deer. All ranches planted small fields of cool-season cereal grains, primarily oats (*Avena sativa*), as a supplemental forage crop and for attracting animals for hunting. Likewise, timed feeders dispensed shelled corn to attract animals during the hunting season. Feed stations offered a commercial, pelleted deer feed all year to supplement native forage but were not the primary food source (L. Wheeler and others [see Acknowledgments], ranch owners, personal communication). Deer densities ranged from 1 deer/8.5 ha to 1 deer/12.5 ha and were considered normal for the habitat

¹ E-mail: bkoerth@sfasu.edu

in the region (L. Wheeler and others, unpublished data). Peak of the breeding season for whitetails was mid- to late December with most fawns born by 25 July (Traweek et al. 1996).

METHODS

We captured males annually via helicopter and net gun (DeYoung 1988) in late January through late February from 1999 to 2007. We used net gunning because a primary problem in studying wild populations is identification of a large number of known-age animals, as well as the ability to handle animals in a manner where repeated measurements can be taken throughout the animal's life. The helicopter net-gun technique facilitates rapid and precise capture of desired individuals and allows for safe handling of animals before being released at the capture site (DeYoung 1988).

Upon initial capture, we aged males using the tooth wear and replacement technique (Severinghaus 1949) and marked them with ear tags color-coded to year of birth. Ear tags were numbered individually to uniquely identify animals. We also tattooed a letter and number corresponding to the ear tag color and number inside the ear in case the ear tags failed.

To reduce stress and release the animal faster after capture, we took the inside antler spread measurement to the nearest 0.317 cm (0.125 inch), as per Nesbitt and Wright (1981), and removed both antlers approximately 2.5 cm above the base. We marked removed antlers with the deer identification number and later scored them using standard Boone and Crockett (B&C) measurements (Nesbitt and Wright 1981). We converted B&C measurements from Imperial to metric for publication.

During the first year of capture, we instructed helicopter crews to capture all of the fawn (0.5 yr old) and yearling (1.5 yr old) males encountered. Although the tooth wear and replacement technique has questionable accuracy in adult animals, there is little doubt about using the method to identify fawns and yearlings (DeYoung 1989, Gee et al. 2002). Although fawns did not have hardened antlers, they provided known-age animals marked in the population for future measurements. In subsequent years, we attempted to recapture as many of the marked animals, regardless of age, as possible. Additionally, we also captured and marked unmarked animals in the fawn and yearling age classes to increase sample size. We used only animals initially marked as fawns or yearlings for analyses in the study.

Some of our marked animals were killed by hunters during hunting seasons. We asked each ranch to return complete B&C antler measurements and a photograph of all marked animals taken by legal harvest. We treated a legally harvested buck as the final recapture of that individual.

We divided yearling males into 2 antler-point categories (≤ 3 and ≥ 4 points) for analyses because we believed they represented categories that would be easily identifiable by hunters and managers wishing to make culling decisions. Also, these categories conformed to the antler point restrictions mandated by the Texas Parks and Wildlife

Department for all or part of 61 counties in Texas (Texas Parks and Wildlife Department 2006). Designation of an antler point followed Nesbitt and Wright (1981). The only exception to the discreet categories was that we classified males with ≥ 3 antler points on one side, but having an unbranched antler on the other, in the ≤ 3 point category to maintain uniformity with antler point restrictions. Although we had measurements from some males as old as 8.5 years, we pooled males ≥ 5.5 years old because of the small number of animals in individual age classes > 5.5 years and because antler measurements of whitetail males typically level off at that age (DeYoung 1990, Heffelfinger 2006).

We compared recaptured males in the 2 antler-point categories using *t*-tests to determine differences in antler growth at 2.5 years, 3.5 years, 4.5 years, and ≥ 5.5 years of age. Dependent variables consisted of number of points, inside spread, total beam length, total tine length, total antler circumference, and gross B&C score. We used chi-square analysis to determine if percentage of males reaching ≥ 330 cm (long-term mean for the area; DeYoung and Lukefahr 1995) or ≥ 381 cm (arbitrarily assigned trophy class) gross B&C score at ≥ 4.5 years of age was associated with yearling antler point categories. We considered males ≥ 4.5 years old mature because they are approaching their maximum potential antler size (Brothers and Ray 1998), have obtained $\geq 95\%$ of maximum body mass (Knowlton et al. 1979, Strickland and Demarais 2000) making visual estimates of specific ages in live animals difficult, and they typically have established a stable home range (Webb et al. 2007). We compared antler measurements of harvested deer by age class using linear regression to determine if number of points on a male's first set of antlers was a good predictor of gross B&C score at harvest. Dependent variable was gross B&C score and independent variable was number of antler points on the animal's first set of antlers.

We collected data under scientific permit number SPR-0191-336 from the Texas Parks and Wildlife Department.

RESULTS

At 2.5 years of age, males that started with ≤ 3 antler points had a mean of 1.3 fewer points and remained smaller ($P < 0.05$) in all measurements used to calculate B&C score (Table 1). At 3.5 years of age, males starting with ≤ 3 antler points still had a mean of 0.6 fewer points and remained smaller ($P < 0.05$) in all B&C measurements except circumference. Smaller antlered yearlings caught up in antler mass (represented by beam circumferences) but not length measurements.

By their third set of antlers, yearlings that started with ≤ 3 antler points appeared to be accelerating antler growth at a faster rate than their larger antlered cohorts. Differences in mean antler measurements between 2.5 years and 3.5 years old for yearlings starting with ≤ 3 and ≥ 4 antler points was 1.5 versus 0.8 points, 7.3 cm versus 4.9 cm inside spread, 18.6 cm versus 13.7 cm beam length, 30.0 cm and 21.4 cm tine length, and 14.5 cm versus 9.4 cm circumference, respectively (Table 1).

Table 1. Means (\pm SE) by age class for antler measurements of white-tailed deer males that had ≤ 3 or ≥ 4 antler points as yearlings, captured in south Texas, USA, from 1999 to 2007.

Yearling point category	N	No. of points		Inside spread (cm)		Beam length (cm)		Tine length (cm)		Circumference (cm)		Gross B&C ^a (cm)	
		\bar{x}	SE	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE
2.5 yr old													
≤ 3 points	180	6.9	0.11	30.5	0.13	72.6	0.29	42.4	0.52	48.5	0.17	194.1	0.95
≥ 4 points	166	8.2	0.08	34.5	0.14	83.1	0.30	65.0	0.57	55.9	0.19	238.5	1.01
Total	346												
P-value ^b		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
3.5 yr old													
≤ 3 points	85	8.4	0.10	37.8	0.23	91.2	0.44	72.4	0.79	63.0	0.51	264.4	1.43
≥ 4 points	89	9.0	0.14	39.4	0.19	96.8	0.43	86.4	0.97	65.3	0.26	287.8	1.52
Total	174												
P-value		<0.001		0.038		<0.001		<0.001		0.099		<0.001	
4.5 yr old													
≤ 3 points	41	9.0	0.18	41.1	0.32	103.4	0.76	91.9	1.44	70.4	0.36	306.8	2.20
≥ 4 points	49	9.0	0.17	42.2	0.30	102.1	0.51	96.8	1.42	73.4	0.73	314.7	2.27
Total	90												
P-value		0.845		0.264		0.584		0.357		0.190		0.320	
≥ 5.5 yr old													
≤ 3 points	24	9.8	0.18	46.5	0.42	114.0	0.58	115.3	2.18	78.0	0.50	354.1	2.82
≥ 4 points	32	9.7	0.20	45.0	0.40	111.0	0.83	122.7	1.86	79.0	0.46	357.4	2.84
Total	56												
P-value		0.880		0.332		0.271		0.318		0.557		0.745	

^a Boone and Crockett score converted from Imperial to metric for publication.

^b *t*-test.

By 4.5 years of age there were no differences in any antler measurements regardless of the yearling antler-point category (Table 1). Smaller antlered yearlings had attained a mean antler size equal in width, mass, length, and number of points as their larger antlered cohorts. The same relationship continued through the age class ≥ 5.5 years old.

Yearling antler-point category did not appear to affect percentage of males reaching the long-term mean B&C score for the area of 330 cm ($\chi^2_1 = 0.003$, $P = 0.956$) or our arbitrarily assigned trophy B&C score of 381 cm ($\chi^2_1 = 0.282$, $P = 0.596$). Slightly less than half the yearlings from each antler point category reached the long-term mean score (Table 2). Approximately 1 of 6 and 1 of 8 yearlings with ≤ 3 or ≥ 4 antler points, respectively, achieved our designated trophy score.

Some males were harvested as cull males throughout the study. As it could be argued the observed lack of differences in antler measures at maturity could have been influenced by

Table 2. Number and percent of yearling white-tailed deer males captured from 1999 to 2007 in south Texas, USA, with ≤ 3 or ≥ 4 antler points that reached either ≥ 330 cm or ≥ 381 cm of gross Boone and Crockett^a score at ≥ 4.5 years of age.

Category	No. of points at 1.5 yr old	
	≤ 3	≥ 4
No. of M	65	81
No. of M that scored ≥ 330 cm	31	39
% of M that scored ≥ 330 cm	47.7	48.1
No. of M that scored ≥ 381 cm	10	10
% of M that scored ≥ 381 cm	15.4	12.3

^a Boone and Crockett score converted from Imperial to metric for publication.

this practice, we examined these animals as a subset of our data. Gross B&C score showed a positive relationship to number of antler points at 1.5 years for the 49 deer culled at 2.5 years of age ($t_1 = 3.55$, $P = 0.001$; Fig. 1). However, the low determination value (0.211) indicated a wide variation in score based on number of yearling points. Yearlings with ≤ 3 antler points made up most of the 2.5-year-olds harvested but also had the lowest and highest B&C scores.

For the 45 deer culled at 3.5 years of age, gross B&C score showed a positive relationship with the number of antler points at 1.5 years ($t_1 = 2.10$, $P = 0.042$; Fig. 1). However, predictability of score from antler points indicated only a small portion ($r^2 = 0.093$) of the variability in B&C score was accounted for by number of yearling antler points.

For deer culled at either 4.5 years ($n = 35$) or at ≥ 5.5 years of age ($n = 29$) the slope of the relationship between gross B&C score and number of antler points at 1.5 years was not different from zero ($t_1 = -0.52$, $P = 0.608$, and $t_1 = 1.89$, $P = 0.070$, respectively; Fig. 1). Low determination values (0.012 for 4.5 yr old and 0.116 for ≥ 5.5 yr old) for both mature age classes also indicated poor predictability based on number of yearling antler points.

DISCUSSION

Number of antler points and B&C antler measurements increased for all males as they matured. However, it appeared smaller antlered yearlings exhibited a higher amount of antler growth in succeeding years than did their larger antlered cohorts resulting in smaller antlered yearlings being statistically equal in number of antler points and all B&C measurements by their fourth year (Table 1). Thus, truncating age classes at 5.5 years did not appear to affect

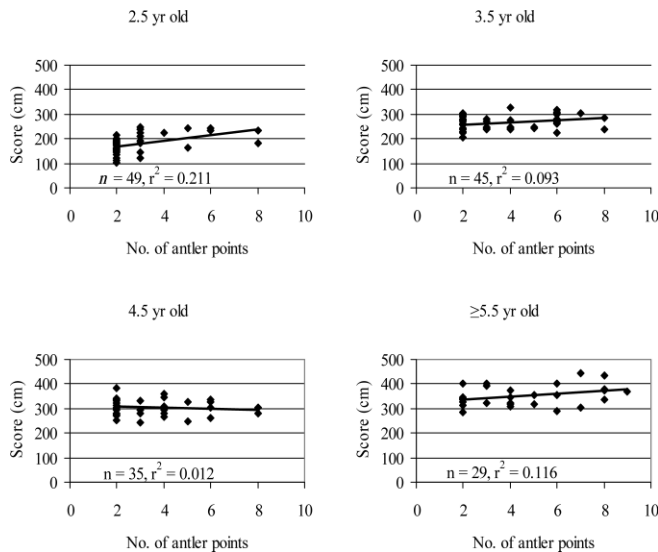


Figure 1. Relationship of gross Boone and Crockett score of white-tailed deer males harvested at various ages to number of antler points at 1.5 years of age of males captured in south Texas, USA, from 1999 to 2007. We converted the score from Imperial to metric for publication.

the analysis. Schultz and Johnson (1992) also found yearlings with fewer antler points added points at a higher rate in succeeding years than did yearlings starting with more points.

We found that number of antler points at 1.5 years of age was not a reliable predictor of antler growth potential at maturity. Our results agree with Lukefahr and Jacobson (1998) and Schultz and Johnson (1992) who found poor correlations between number of points on yearling males and antler size at maturity. Likewise, DeYoung (1998) found neither number of antler points nor an antler score index for yearling males reliably predicted future antler growth.

It has been hypothesized that there are different antler growth patterns in whitetail males (Kroll and Koerth 1998). One pattern is high antler growth for the first few years. Growth then becomes asymptotic followed by only slight increases each year thereafter. The second hypothesized pattern is incremental growth throughout the productive life of the animal. The third pattern is low antler growth at first, followed by an increased rate of growth at some point in the animal's life. An untested hypothesis is that all 3 patterns end with the same mean score at maturity. Perhaps number of antler points at 1.5 years old may be a representation of different antler growth patterns of males and not a predictor of antler growth potential.

Mean gross B&C score of 329 cm for all males ≥ 4.5 years old in our study closely agreed with DeYoung and Lukefahr's (1995) estimate of a mean score of approximately 330 cm for adult males in the south Texas region. However, our yearling antler-point category was not associated with percentage of males reaching the mean antler score or percentage of males reaching our arbitrarily designated trophy classification of 381 cm (Table 2). We found no evidence supporting the suggestion of Williams et al. (1994)

that yearling males exhibiting small antlers with few points were less likely to grow large antlers if allowed to mature.

We believe the final antler development of a male at maturity can be influenced by a variety of factors, only some of which may be related to genetics. Among these factors are social position, physiological and nutritional efficiency, breeding history, and environmental stress (Kroll 1991, Heffelfinger 2006). Traditionally, these types of factors might be assumed controlled in penned studies. However, the unnatural social interactions created by high-density confinement may make controlling these types of confounding factors difficult. Even with unlimited feed, Ozoga and Verme (1982) recorded density dependent changes in antler growth, as well as other physiological parameters, in an enclosed deer herd in Michigan when the population increased from 0.09 deer/ha to 0.63 deer/ha.

Early in our study we thought it conceivable our results could be affected by hunters removing small antlered males at young age classes, only allowing animals with high-scoring antlers to survive. However, our results showed the number of points on yearling males accounted for only a small percentage of variation in gross B&C score for males culled at any age (Fig. 1). It appeared multi-pointed yearlings were as likely to be culled at maturity as were males starting with few antler points.

MANAGEMENT IMPLICATIONS

Our results suggest there is no predictable relationship between a male's first set of antlers and those produced at maturity in a free-living environment. For unexplained reasons, it appears to take some animals more time to manifest their antler growth potential. We found no phenotypic basis for removing young males based on number of points on their first set of antlers as part of a genetic improvement strategy. We believe no genetic improvement or increase in overall antler size of mature animals would be expected by culling of spikes and other small-antlered yearlings.

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