RELATIONSHIPS OF SIRE SCROTAL CIRCUMFERENCE TO OFFSPRING REPRODUCTION AND GROWTH

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ABSTRACT

Reproductive and growth data were obtained on 779 and 564 yearling beef heifers and bulls, respectively, that had sires with yearling scrotal circumference data at the San Juan Basin Research Center, Hesperus, CO. Partial regression coefficients of reproductive and growth traits on inbreeding (FXC) and age of the individual and adjusted scrotal circumference of sire (SCSI) were obtained. Growth and reproductive traits of heifers and growth and breeding soundness traits of bulls were analyzed. Separate analyses for each sex were performed, but least squares models were similar. Models included fixed effects of breed, birth year (BY), age of dam (AOD) and the covariates FXC, age (day of birth in heifer analyses) and SCSI. Scrotal circumference of sire was adjusted for age, FXC, AOD and BY using values obtained in a separate analysis. Seminal traits improved as age increased, and there was a seasonal effect present for age of puberty. Inbreeding had a detrimental effect on reproductive traits. Partial regression coefficients for the reproductive traits on SCSI were: age of puberty, -.796 d/cm; age of first calving, -.826 d/cm; julian day of first calving, -.667 d/cm; julian day of second calving, .597 d/cm; most probable producing ability, .132 %/cm; percent sperm motility, -.74 %/cm; percent primary sperm abnormalities, .08 %/cm; percent secondary sperm abnormalities, .92 %/cm; percent normal sperm, -1.28 %/cm; total breeding soundness examination score, .28 units/cm and scrotal circumference, .306 cm/cm. A heritability of .39 was obtained for scrotal circumference.

(Key Words: Beef Cattle, Scrotum, Growth, Reproduction.)


Introduction

Increasing cow costs have cattle producers looking for a way to improve reproductive fitness in their cow herds. Most female reproductive traits are lowly heritable and selection intensities for them usually are low; thus, little improvement through selection is expected. Because higher selection intensity is possible with bulls, it may be more advantageous to select for reproductive efficiency through males.

Preliminary research results indicate that scrotal circumference in yearling bulls may be an indicator of reproductive fitness in both male and female offspring. Scrotal circumference is measured easily and accurately and appears to be highly heritable. It has been studied extensively and may be useful to predict age of puberty in bull (Lunstra et al., 1978) and heifer offspring (Brinks et al., 1978). Yearling scrotal circumference appears to be related favorably to measures of cow fertility and productivity and with age of puberty in daughters and half-sib heifers. Earlier ages at puberty in heifers is related favorably to measures of subsequent fertility and productivity (Brinks et al., 1978).

The objective of this study was to obtain regression coefficients of male and female
growth and reproductive traits on sire yearling scrotal circumference. In addition, regression coefficients for age (day of birth in heifers analyses) and inbreeding of calf were obtained.

**Materials and Methods**

*Data.* Growth and reproductive data were analyzed separately on 779 females and 564 yearling bulls that had sires with a yearling scrotal circumference measurement at the San Juan Basin Research Center (SJBRC), Hesperus, Co. Breeds included Hereford, Angus and Red Angus. Management practices were described by Smith et al. (1989a,b). Female growth traits included birth weight (BW), weaning weight (WW), yearling weight (YW), average daily gain from weaning either to yearling age (ADGY) or to onset of first estrus or cycling (ADGC). Female reproductive traits studied were age of puberty (AOP), age of first calving (AOC), julian day of first calving (DOC), julian day of second calving (DOSC) and most probable producing ability (MPPA). Male growth traits included BW, WW, YW and post-weaning average daily gain (ADG) taken from the SJBRC 140-d performance test. Male reproductive traits were the Breeding Soundness Examination (BSE) components: percent motility (PMOT), percent primary abnormalities (PPRIM), percent secondary abnormalities (PSEC), percent normal sperm (PNOR), total BSE score (BSESC) and scrotal circumference (SC) (Ball et al., 1983). Breeding soundness examinations were performed approximately 1 wk after bulls completed the performance test at an average age of 389 d.

*Statistical Analyses.* Data were analyzed by least squares procedures as described by Harvey (1975). Male and female analyses were performed separately with similar models. The model included fixed effects of birth year, age of dam and breed. Covariates included were age (day of birth in female analyses), inbreeding of calf and adjusted scrotal circumference of sire. Day of birth was removed as a covariate in the analysis of AOC, DOC and DOSC because adjustment for it caused them to be nearly identical traits. Percent motility was not recorded in 1982 and 1984; thus, a subset of 437 records was used to analyze this trait.

Scrotal circumference measurements on 60 sires were adjusted to 365 d of age (.024 cm/d), 0% inbreeding (−.028 cm/%) and for age of dam (7 yr old) and birth year. Age of dam was grouped into 2, 3, 4, 5, 6, 7, 8, 9 and 10+ yr classes. The average inbreeding was 9.7% and 15% for heifers and bulls, respectively. The estimated covariance between paternal half-sibs was .46 for bulls. Thus, the regression of offspring on sire heritability estimate for scrotal circumference was obtained by multiplying the regression coefficient by 1.282 (1/R, where R = .78) instead of 2.

**Results and Discussion**

*Male Analyses.* The effect of birth year was highly significant for all traits. Age of dam was a highly significant source of variation for BW, WW and PMOT and was significant for YW and PPRIM. Analyses of variance tables were similar to those reported by Smith et al. (1989a).

The linear regressions of all traits on age (Table 1) were highly significant except for BW, ADG and PSEC (P < .05). Seminal and growth traits improved with age. Regressions on age for PMOT (.22) and PPRIM (.087) reported by Abadia et al. (1976) were somewhat higher, whereas PSEC (−.075) was slightly lower and PNOR (.16) was identical to values in Table 1. Additionally, the regression of SC on age (.025 cm/d) agreed with the value (.026) reported by Bourdon and Brinks (1986).

The inbreeding covariate was highly significant for all traits except PMOT and PSEC (P < .05) (Table 2). Increased inbreeding was detrimental for all traits. The effects of inbreeding of calf on growth traits were slightly higher than those reported by Brinks and Knapp (1975). Regressions of PMOT, PPRIM and PNOR on inbreeding were slightly different from values reported by Abadia et al. (1976) (−.158, .182 and −.247, respectively), whereas the value they reported for PSEC was identical to that in Table 1.

Linear regressions of YW, ADG, PSEC, PNOR and SC on scrotal circumference of sire were highly significant (Table 1). For each additional centimeter of scrotal circumference of sire, BW decreased slightly, whereas all other growth traits increased. These findings agree with results of other studies that have looked at various relationships of early growth with measures of early reproductive performance. Andersen et al. (1988) reported genetic correlations for BW, WW and YW with
Table 1. Partial regression coefficients for male growth and reproductive traits

<table>
<thead>
<tr>
<th>Covariate</th>
<th>BW, kg</th>
<th>WW, kg</th>
<th>YW, kg</th>
<th>ADG, kg/d</th>
<th>PMOT, %</th>
<th>PPRIM, %</th>
<th>PSEC, %</th>
<th>PNOR, %</th>
<th>BSESC, cm</th>
<th>SC, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, d</td>
<td>-.013</td>
<td>.658</td>
<td>.721</td>
<td>.00027</td>
<td>.13</td>
<td>-.07</td>
<td>-.09</td>
<td>.16</td>
<td>.24</td>
<td>.025</td>
</tr>
<tr>
<td>Inbreeding, %</td>
<td>-.040</td>
<td>-.436</td>
<td>-.894</td>
<td>-.0022</td>
<td>-.04</td>
<td>.07</td>
<td>.08</td>
<td>-.16</td>
<td>-.21</td>
<td>-.030</td>
</tr>
<tr>
<td>Scrotal circumference of sire, cm</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

Abbreviations are as follows: BW = birth weight, WW = weaning weight, YW = yearling weight, ADG = avg daily gain, PMOT = percent motility, PPRIM = percent primary abnormalities, PSEC = percent secondary abnormalities, PNOR = percent normal sperm, BSE = breeding soundness examination and SC = scrotal circumference.

Percent motility taken from subset of 437 records.

*P < .05.

**P < .01.

Table 2. Partial regression coefficients for female growth and reproductive traits

<table>
<thead>
<tr>
<th>Covariate</th>
<th>BW, kg</th>
<th>WW, kg</th>
<th>YW, kg</th>
<th>ADGY, kg/d</th>
<th>ADGC, kg/d</th>
<th>AOP, d</th>
<th>DOC, d</th>
<th>DOSC, d</th>
<th>MPPA,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day of birth, d</td>
<td>.015</td>
<td>-.636</td>
<td>-.717</td>
<td>-.0023</td>
<td>.000003</td>
<td>-616</td>
<td>*</td>
<td>*</td>
<td>.123</td>
</tr>
<tr>
<td>Inbreeding, %</td>
<td>-.048</td>
<td>-.443</td>
<td>-.622</td>
<td>-.0010</td>
<td>-.0008</td>
<td>.146</td>
<td>.209</td>
<td>.173</td>
<td>.007</td>
</tr>
<tr>
<td>Scrotal circumference of sire, cm</td>
<td>-.124</td>
<td>.341</td>
<td>.958</td>
<td>.0039</td>
<td>.0047</td>
<td>-.796</td>
<td>-.826</td>
<td>-.567</td>
<td>.597</td>
</tr>
</tbody>
</table>

Abbreviations are as follows: BW = birth weight, WW = weaning weight, YW = yearling weight, ADGY = ADG to yearling, ADGC = ADG to cycling, AOP = age of puberty, DOC = julian day of first calving, DOSC = julian day of second calving and MPPA = most probable producing ability.

*P < .05.

**P < .01.
Coefficients for growth traits were similar in magnitude to those found for bulls. A definite seasonal effect for AOP was evident. Those heifers that were born later in the year reached puberty at an earlier age \((b = -0.616 \text{ d/d})\). This value agrees well with those found by King et al. (1983) \((-0.51 \pm 0.21 \text{ d/d})\) and Anderson et al. (1983) \((-0.63 \pm 0.19 \text{ d/d})\). In preliminary analyses, day of birth within birth-year subclass regressions were obtained. They were not significant and therefore were not included in the final model. Inbreeding was highly significant for all growth traits except ADGC \((P < 0.05)\) and was significant for AOC and DOC (Table 2). Increased inbreeding again was detrimental to growth traits. Whereas the effect of inbreeding on heifers was more pronounced for birth and weaning weights, bull calves were more negatively affected post-weaning. Estimates for the effect of inbreeding on AOC and DOC reported by Bailey (1985) were much higher \((0.683 \text{ and } 0.746)\) than those found in this study.

Even though only the linear regression of ADGY on scrotal circumference of sire was significant, favorable trends existed for all growth and reproductive traits (Table 2). Regression coefficients for growth traits were lower in magnitude than those found for bulls. However, for each additional centimeter of scrotal circumference of sire, BW tended to decrease slightly, whereas WW, YW, ADGY and ADGC tended to increase. These results agree with those reported by Makarechian et al. (1983) and Knights et al. (1984) in that there is a positive association between testicular size of sire and postnatal growth rate of progeny.

The coefficient for the regression of AOP on scrotal circumference of sire \((-0.796 \text{ d/cm})\) indicated a favorable relationship between size of testes in sires and ages of puberty in their heifer offspring. Although no previous studies have reported an offspring on parent regression of AOP on scrotal circumference of sire, several have reported strong favorable genetic correlations (Brinks et al., 1978; King et al., 1983).

The favorable relationship between increased scrotal circumference of sire and earlier age at first calving found in this study \((b = -0.826 \text{ d/cm})\) is in disagreement with the genetic correlation \((0.58)\) obtained from sire-daughter relationships reported by Toelle and Robison (1985). However, their estimate from the half-sib genetic correlation \((-0.14)\) was in more agreement with our results. Increased scrotal circumference of sire also was associated with an earlier DOC, later DOSC and increased MPPA. The favorable relationship of scrotal circumference of sire with DOC follows the same trend as AOP and AOC. The increase in DOSC may have been caused by the fixed calving season because heifers that calve early commonly calve later as 3-yr olds.

**Implications**

Bulls with larger scrotal circumference can be expected to sire calves with moderate birth weight and above-average growth rates, sons with larger testicles and better milking daughters that reach puberty at an earlier age. Although management plays a vital role in determining when heifers reach puberty, it is essential that they have the genetic potential for attaining early puberty.

**Literature Cited**


