HETEROSIS AND BREED TRANSMITTED AND MATERNAL EFFECTS IN GROWTH TRAITS TO WEANING IN ANGUS, CRIOLLO AND RECIPROCAL CROSS CALVES

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SUMMARY

Data from 377 Angus (A), Criollo (C) and reciprocal cross calves born from 1981 to 1984 were analyzed on birth weight (BW), average absolute daily gain (ADG) relative daily gain (RGR) and weaning weight (WW) to estimate heterosis and differences in breed transmitted and maternal effects. Genetic components were estimated using orthogonal contrasts on least-squares means. There was no heterosis for BW, C transmitted effects were 11% over A (P<.05), and A maternal effects 7% over C (P<.05). Breeds and crosses were very similar for RGR showing no heterosis or difference in any of the components analyzed. For ADG and WW genetic components followed the same trend in male and female calves but their statistical significance differed: heterosis was significant (P<.05) only for females (ADG: 9%, WW: 9%); for male calves, the C transmitted effects were 19% over A (P<.05) and A maternal effects were 11% over C (P<.05).

INTRODUCTION

In order to plan crossbreeding systems it is necessary to know the magnitude of the genetic components of breeds and crosses.

Data analyzed in this paper were obtained from the crossbreeding program carried out by the INTA Experimental Station of Balcarce, Argentina whose general objective is the evaluation of hardy breeds in crosses.

Reviews of literature on the effects of heterosis in cattle show that heterosis can be expected for preweaning growth traits in crosses among British breeds, their crosses with Continental European breeds and with Zebu (Long, 1980; Cundiff, 1983).

The objective of this paper is to estimate individual heterosis and differences in transmitted and maternal effects for birth weight, average absolute and relative daily gain to weaning and weaning weight from Angus, Criollo and reciprocal cross calves.

MATERIALS AND METHODS

The experience was carried out at the INTA Experimental Station of Balcarce, Province of Buenos Aires, Argentina.

Artificial insemination was done every year from October 1st to December 31st. Animals were kept on pastures mainly composed of Lolium perenne, Festuca arundinaea, Trifolium repens. In winter, cows were supplemented with low quality hay so that they maintained their weight. When calves were born, cows and calves were taken to good quality reserved pastures and kept there until weaning at 180±7 days of age.

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Angus dams used were of the small type, their average weight after calving being about 360 kg. The Criollo herd was derived from Criollo bulls and cows brought from the North of Argentina. Nineteen Angus and 13 Criollo bulls were used. Angus and Criollo dams were inseminated with both Angus and Criollo bulls using in general, the same bulls every year on each breed of dam. From 3 to 5 bulls of each breed were used every year, repeating 2 or 3 of them every year.

Data from the 1981 to 1984 calving seasons were included in the analyses. Calves were weighted at birth (BW), within the first week of age and from then on, every 28 days until weaning. Absolute average daily gain (ADG) was calculated as the regression of weight on age and the relative growth rate as the regression of the natural log of weight on age (RGR). The weight at weaning (WW) was calculated using the ADG and adjusting to 180 days of age.

All male calves were castrated at about 2 months of age except a very small proportion of them that were kept as bulls.

The statistical model for analyzing ADG and WW included age of dam, month and year of birth, sex and breed of calf and breed x sex. For BW and RGR, the model did not include the interaction because previous analyses have shown that they were not important. Orthogonal contrasts among least-squares means were used to estimate heterosis and differences in average transmitted and maternal effects of the Criollo and Angus breeds according to Dickerson's (1969) description. SAS (1982) was used for all statistical analyses.

RESULTS AND DISCUSSION

Least-squares means

Least-squares means, their standard errors and the number of observations for each mean for all traits and breeds are presented in table 1. The interaction breed x sex was statistically significant (P/ .05) for ADG and WW so that breed means for each sex are presented for these two traits.

Breed or cross was statistically significant (P/ .05) for all traits except for RGR, showing the little variation existing among the breeds and crosses in this study for it. Since all genetic components estimated from these means were close to zero, they are not presented in this paper.

The relationship between the WW mean of male over female calves was: 1.08, 1.14, 1.08 and .97 for AxA, CrxCr, CrxA and AxCr respectively, showing the larger dimorphism in straightbred Criollo than in other breeds or crosses. The relationship for ADG and WW of the AxCr is lower than it would be expected according to the difference between sexes in these traits usually found (Woldehawariat, 1977). The number of calves in these means is relatively low so that sampling error should not be discarded.

The absence of breed x sex interaction for BW and the significant levels (P/ .05) reached for ADG and WW indicates that this interaction becomes more important as differences in hormonal levels increases.
Heterosis

Heterosis effects for all traits are included in table 2. They were statistically significant (P< .05) only for ADG and WW of female calves.

Heterosis for BW was found by several authors (Long, 1980). In previous studies, Miquel and Lopez Saubidet (1980) did not find significant heterosis among British breeds and Miquel and Molinuevo (1982) found 11% heterosis between Angus and Charolais for BW.

Heterosis was statistically significant (P< .05) only for ADG and WW of female calves.

Results from the literature are not consistent regarding differential heterosis between sexes; Gregory et al (1978), mentioned a higher level of heterosis for WW in males than in female calves among Red Poll, Brown Swiss, Hereford and Angus as well as Pahnish et al. (1969) working with Hereford, Angus and Charolais breeds. Results form Gregory et al. (1965) showed a small difference, not statistically significant in level of heterosis favoring female calves in weaning weight and those form Long and Gregory (1974) indicated similar heterosis in both sexes. In this study, the ADG and WW of the AxCr male calves were much lower than those of the reciprocal cross, thus causing a heterosis effect almost null.

Breed transmitted effects

Differences in breed transmitted effects, were statistically significant (P< .05) and favoring the Criollo for BW, and male ADG and WW. For these last two traits, female calves followed the same trend as the males, but the difference did not get the significant level.

The larger difference in male than female calves for ADG and WW is indicating an interaction between sex and breed. This interaction, if maintained for growth during the post weaning period and then for mature weight, may be result of the evolution process since a large sexual dimorphism very probably have a selective advantage under the environment where the Criollo lived for the last 80 generations.

Breed maternal effects

Calves with Angus dams were heavier at birth, at weaning and presented higher ADG. The differences with Criollo dams were statistically significant (P< .05) for BW and for ADG and WW of male calves.

The reciprocal difference includes differences in maternal effects and also some difference that may arise in individual average genetic merit for the sample of sires and dams used. It is worth to note that the AxCr and CrxA male calves have inherited the set of sexual chromosomes from different breeds. Anyhow, in spite of the difference in statistical significance found according to sex, the tendency for the Angus dams to wean heavier calves is maintained through sexes.
CONCLUSIONS

No heterosis was found for BW, breed transmitted effects were higher for Criollo than for Angus and calves from Angus dams were heavier at birth than those from Criollo dams.

Breeds and crosses were very similar for RGR showing no heterosis or difference in any of the components analyzed. The genetic components followed the same trend in male and female calves for ADG and WW but their statistical significance differed: heterosis was significant only for females; for male calves, statistical differences were found between breed transmitted effects of Criollo over Angus and maternal effects were higher for Angus than Criollo dams.

The larger sexual dimorphism for ADG and WW of the straightbred Criollo relative to Angus and other crosses was due to a larger difference between the Criollo over Angus transmitted effects found in male than in female calves.

The Criollo ($\sigma^r$) x Angus ($\varphi$) cross allows to obtain higher WW than other breeds or crosses in this study by exploiting heterosis, the Criollo transmitted effects and the better maternal ability of Angus dams relative to Criollo dams.

REFERENCES


sults from crossing beef x beef and beef x dairy breeds. Calf performance to wea­


of genetic and environmental statistics and conformation characters of beef cat­
Table 1: Least squares means, standard errors and number of observations for all traits.

<table>
<thead>
<tr>
<th>Breeding group</th>
<th>N°</th>
<th>BW (kg)</th>
<th>RGR (% × 100/day)</th>
<th>ADG (s/d)</th>
<th>WW (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X ± se</td>
<td>X ± se</td>
<td>M F</td>
<td>M F</td>
</tr>
<tr>
<td>A x A</td>
<td>132</td>
<td>25.8 ± .4</td>
<td>.948 ± .007</td>
<td>69 676± 13</td>
<td>63 622±11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>69 148.5±2.5</td>
<td>63 137.0±2.5</td>
</tr>
<tr>
<td>C x C</td>
<td>78</td>
<td>26.7 ± .5</td>
<td>.940 ± .009</td>
<td>39 721± 17</td>
<td>39 629±14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>39 158.4±3.4</td>
<td>39 138.3±2.8</td>
</tr>
<tr>
<td>C x A</td>
<td>123</td>
<td>27.7 ± .4</td>
<td>.947 ± .007</td>
<td>71 738± 13</td>
<td>52 688±12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>71 161.6±2.6</td>
<td>52 150.1±2.4</td>
</tr>
<tr>
<td>A x C</td>
<td>44</td>
<td>25.7 ± .6</td>
<td>.950 ± .011</td>
<td>22 655± 21</td>
<td>22 684±17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22 144.3±4.2</td>
<td>22 148.2±3.5</td>
</tr>
</tbody>
</table>

\( ^a \) A: Angus, C: Criollo, in crossbreeds: sire breed is listed first.

\( ^b \) B: Birth weight; RGR: relative growth rate; ADG: absolute daily gain; WW: weaning weight.

Table 2: Estimated additive individual, maternal breed effects and their standard errors for preweaning growth traits.

<table>
<thead>
<tr>
<th>Component</th>
<th>BW (kg)</th>
<th>ADG (s/day)</th>
<th>WW (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>h A.C.</td>
<td>.5 ± .4</td>
<td>3 ± .01</td>
<td>60± 13</td>
</tr>
<tr>
<td>g_A - g_C</td>
<td>-2.8± .9</td>
<td>-128± 31</td>
<td>-11± 20</td>
</tr>
<tr>
<td>g_A - g_C</td>
<td>1.9± .7</td>
<td>83± 24</td>
<td>17.5±4.9</td>
</tr>
</tbody>
</table>

\( ^* \) P < .05

\( ^a \) h: heterosis, g <sup>1</sup> breed transmitted effect; g <sup>M</sup>; breed maternal effect; A: Angus; C: Criollo.

\( ^b \) M: Male calves; F: Female calves.