

ESTIMATES OF GENETIC CORRELATIONS BETWEEN PELVIC MEASUREMENTS AND CALVING EASE FOR AUSTRALIAN ANGUS

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SUMMARY

Pelvic measurements on about 7,500 Angus cattle, consisting of pelvic height, pelvic width, pelvic area and hip height records obtained as part of the MRC funded validation project were correlated to calving ease scores for about 20,000 calvings. Direct-maternal genetic correlation estimates for calving ease were moderately antagonistic (-0.5). Estimates of direct correlations between calving ease and pelvic measurements taken between 300 and 700 days of age ranged from 0.21 to 0.65, while corresponding direct-maternal genetic correlations were -0.27 to -0.51.

Keywords : Genetic parameters, calving ease, pelvic measurements

INTRODUCTION

Disregarding malpresentations, calving difficulties are generally the result of a discrepancy between size of the calf and size and shape of the cow's pelvic opening (Meijering 1984). Pelvic measurements (PM) have thus been advocated as an auxiliary selection criterion to reduce the incidence of difficult calvings. To examine the utility of PM, records were taken by contracted field officers in a number of selected herds between 1991 and 1994 as part of the so-called 'validation project' funded by the Australian Meat Research Corporation. Earlier work showed that PM taken at 400 or 600 days of age are moderately to highly heritable with strong, positive genetic correlations between males and females (Upton and Bunter 1995). Correlations with calving ease (CE) were not previously estimated as this required records on calving performance of animals measured, and heifers with PM records had not yet calved. These data have become available in the meantime, and this paper presents estimates of genetic correlations between CE scores and PM for Australian Angus.

MATERIAL AND METHODS

Data. Records consisted of pelvic height (PHT), pelvic width (PWD), pelvic area (PA) and hip height (HH) measurements taken between 300 and 700 days of age. As done previously, these were split according to age at recording considering records at 400 days (300-500 days) and 600 days (501-700 days) to be different traits. A total of 21,191 CE scores for calves born between 1989 and 1996 were available. The incidence of calving difficulties was very low, only 393 (1.85 %), 162 (0.76 %) and 6 births were scored as 2 (assisted), 3 (difficult) and 4 (veterinary assistance), respectively. Eliminating duplicate and invalid records, malpresentations and embryo transfer animals left 19,968 records.

Analyses. Estimates of (co)variance components and genetic parameters were obtained by restricted maximum likelihood (REML) fitting an animal model, including maternal genetic and permanent environmental effects as additional random effects where applicable. Univariate analyses for CE, considered to be a trait of the calf, were carried out fitting different models to assess the importance of maternal effects. Model 1 (M1) was a simple animal model, while Model 2 (M2) fitted a maternal

permanent environmental effect in addition. Models 3 (M3) and 4 (M4) included direct and maternal genetic effects, ignoring and allowing for a direct-maternal genetic covariance (σ_{AM}), respectively. Models 5 (M5) and 6 (M6) were as M3 and M4 but included a permanent environmental maternal effect as well. Analyses treated CE as a continuous trait. Additional pedigree information, obtained by looping twice through the Angus animal file, was incorporated into the analysis. Fixed effects fitted were an age class of dam (heifer <29 months, cow 29+ months, unknown) and contemporary groups, defined as herd-year-season (of birth)-management group-sex subclasses. Management group codes were obtained by searching the Angus weights file for the first weight of an animal, recorded up to 300 days of age, i.e. management groups at birth were assumed to be equal to weaning weight management groups. In addition, age of dam was fitted as a linear and quadratic covariable, within age subclass for Model 1 and across ages for the other models.

Bivariate analyses of CE together with PHT, PWD, PA and HH at 400 or 600 days of age were carried out fitting both maternal effects for CE (M6), and a simple animal model (M1) only for PM. While PM at these ages were expected to be subject to maternal effects, at least through maternal effects on size (weight), previous analyses failed to identify consistent maternal effects on these traits. For CE, fixed effects fitted in the bivariate analyses were as for univariate analyses. For PM, fixed effects taken into account were contemporary groups (as defined in previous validation project analyses), sex, age of dam status (heifer vs. cow, as above), and age at recording and dam age as linear and quadratic covariables, respectively.

RESULTS AND DISCUSSION

Characteristics of the data structure are summarised in Table 1. Estimates from univariate analyses of CE under all 6 models are given in Table 2. Both direct (h^2) and maternal (m^2) heritabilities were low, about 4 % and 3 %, respectively. While low, m^2 was significantly different from zero. Analyses identified a massive permanent environmental effect of the dam (c^2), explaining about a third of the phenotypic variance. Direct-maternal genetic correlation (r_{AM}) estimates were moderate and negative, -0.47 under M6. An antagonistic relationship between direct and maternal genetic effects via animals' size is plausible (big calves or small dams are more likely to have difficult calvings). However, estimates of m^2 and h^2 were increased when allowing for a non-zero r_{AM} (M6 and M4) compared to estimates assuming $r_{AM}=0$ (M5 and M3). Such pattern has been observed previously, mainly for weaning weight analyses in beef cattle (e.g. Meyer 1992). It has been attributed to a bias arising from inappropriate definition of contemporary groups or a negative, direct-maternal environmental covariance not taken into account. A similar bias in the estimate of r_{AM} in this case cannot be ruled out. A likelihood ratio test showed that Model 6 fitted significantly better than other models.

Table 1. Characteristics of the data structure

	400 days					600 days			
	CE	PHT	PWD	PA	HH	PHT	PWD	PA	HH
No. records	19,968	6,034	6,034	6,034	5,640	1,952	1,952	1,952	1,437
No. animals ^A	34,117	15,681	15,681	15,681	14,873	7,726	7,726	7,726	6,290
No. sires	781	376	376	376	354	198	198	198	149
No. dams	9,455	3,935	3,935	3,935	3,693	1,689	1,689	1,689	1,256
No. CG ^B	1,265	697	697	697	651	445	445	445	362
Mean	1.0343	14.38	12.12	174.8	118.3	15.99	13.48	216.1	124.8
SD	0.2246	0.96	0.88	21.8	5.8	1.09	0.93	26.5	5.5

^A Including parents without records^B Contemporary groups**Table 2. Estimates from univariate analyses of calving ease**

	h^2	m^2	c_{AM}	r_{AM}	c^2	σ_p^2
M1	0.043					0.03230
M2	0.041				0.357	0.03554
M3	0.036	0.029				0.03236
M4	0.061	0.047	-0.030	-0.563		0.03241
M5	0.036	0.027			0.333	0.03556
M6	0.051	0.039	-0.021	-0.467	0.332	0.03352

Results from bivariate analyses of CE together with pelvic measurements are summarised in Table 3. Estimates of genetic parameters for individual traits (h^2 , m^2 , c^2) generally agreed with results from corresponding univariate analyses. Similarly, estimates of the direct-maternal genetic correlation for CE (r_{AM11}) were consistent with the univariate estimate of -0.47 , their range of -0.45 to -0.53 reflecting sampling variation. On the whole, estimates of correlations between CE and pelvic measurements were higher for records taken at 600 days than at 400 days of age. This implies that pelvic size at 600 days is not only a better predictor of mature size, but also that fluctuations in growth have 'evened out' sufficiently by then for it to have a closer relationship with size at birth. For weight of beef calves, a higher genetic correlation between birth weight and 400 day weight than between birth weight and 200 day weight has been reported repeatedly.

Estimates of the direct genetic correlation were low to moderate and unfavourable (except for PWD at 400 days), ranging from -0.22 to 0.21 and from 0.21 to 0.66 for 400 and 600 day measurements, respectively. For all traits, a model allowing for non-zero covariances between direct and maternal genetic effects (M6) fitted the data better than a model assuming no correlation (M5). All estimates of the genetic correlation between animals' direct additive genetic effect for pelvic size and their maternal genetic effect on CE (r_{AM21}) were favourable, albeit low. Again, correlations were stronger for later than for earlier records, ranging from -0.05 to -0.28 and -0.27 to -0.51 for 400 and 600 day records, respectively.

Table 3. Estimates^A from bivariate analyses of calving ease and pelvic measurements^B

		PHT400	PWD400	PA400	HH400	PHT600	PWD600	PA600	HH600
N ^C	CE	16,016	16,016	16,016	16,250	19,025	19,025	19,025	19,438
	PM	2082	2082	2082	1922	1009	1009	1009	907
	Both	3952	3952	3952	3718	943	943	943	530
M5	h_1^2	0.034	0.035	0.034	0.034	0.033	0.034	0.033	0.034
	r_a	0.116	-0.247	-0.106	0.165	0.316	-0.062	0.041	0.428
	h_2^2	0.364	0.421	0.445	0.791	0.447	0.494	0.594	0.604
	m_1^2	0.028	0.027	0.028	0.027	0.028	0.027	0.028	0.027
	c_1^2	0.328	0.327	0.327	0.327	0.328	0.328	0.328	0.327
	r_E	-0.003	0.055	0.035	-0.023	-0.127	-0.126	-0.185	-0.345
	r_P	0.011	0.003	0.007	0.019	-0.035	-0.078	-0.086	-0.109
M6	h_1^2	0.048	0.051	0.050	0.048	0.048	0.046	0.046	0.046
	r_a	0.094	-0.216	0.054	0.205	0.655	0.206	0.421	0.443
	h_2^2	0.403	0.420	0.448	0.791	0.481	0.510	0.615	0.597
	m_1^2	0.038	0.040	0.041	0.037	0.044	0.040	0.042	0.037
	r_{AM11}	-0.460	-0.525	-0.498	-0.478	-0.520	-0.460	-0.490	-0.447
	r_{AM21}	-0.069	-0.053	-0.278	-0.106	-0.513	-0.374	-0.490	-0.267
	c_1^2	0.324	0.323	0.322	0.323	0.320	0.325	0.322	0.325
	r_E	-0.002	0.056	0.017	-0.039	-0.061	-0.174	-0.316	-0.170
	r_P	-0.004	-0.002	-0.001	0.017	0.028	-0.090	-0.122	-0.031

^A h_1^2 : direct heritability for trait i, m_1^2 : maternal heritability for trait i, c_1^2 : permanent environmental maternal effect for trait i, r_a : direct genetic correlation, r_E : residual correlation, r_P : phenotypic correlation, r_{AMij} : direct-maternal genetic correlation between traits i and j

^B PHT: pelvic height, PWD: pelvic width, PA: pelvic area, HH: hip height

^C Number of animals with: CE only, PM only, both records

Results emphasise the antagonistic relationship between direct and maternal genetic effects for pelvic measurements. Correlations are sufficiently low (-0.5 or weaker) though to allow for a slow progress for both components in attempting to reduce genetic disposition for calving difficulties. It has to be borne in mind, that this analysis was based on a data set with a very low incidence of difficult calvings. Corresponding estimates for other breeds with higher rates of calving difficulties and different growth pattern (Neville *et al.* 1978) might differ. However pelvic measurement is an intrusive procedure, which in some countries can only be performed by veterinarians. This is an indication that recording this trait can become an animal welfare issue particularly on older heifers. Therefore we have not recommended to continue recording pelvic measurements for the genetic evaluation in BREEDPLAN and rely instead on the combined analysis of calving ease score, birth weight and gestation length (Tier and Graser 1995).

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