Estimation of direct and maternal genetic parameters for weights of Welsh Black Cattle

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Introduction

The importance of maternal effects on birth weight and early growth is well known. These effects represent the contribution of the dam through milk and other aspects of mothering ability (i.e. uterine environment) (Meyer, 1993; Robinson, 1996). In this study a series of animal and animal maternal models were fitted using MTDFREML (Boldman et al., 1995) allowing estimates of direct and maternal genetic paremeters on weights of Welsh Black Cattle.

Materials and methods

Weight records and pedigree information were obtained from MLC from a single herd database recorded between 1970-1996. Traits considered were birth weight (n=2553), 100-day weight (n=2226), 200-day weight (n=1611), 300-day weight (n=1901) and 400-day weight (n=851). Preliminary analyses were conducted to identify significant fixed effects, eliminating non-significant terms by a step-down procedure. For all traits the final model included terms for birth type, birth year, birth month, sex and linear effects of dam age. Estimates of variance components for each trait were obtained by MTDFREML with six different models incorporating all available pedigree information (Meyer, 1992; Robinson, 1996). Model 1 was an animal model with animals' additive genetic variance as the only random factor. Permanent environmental effects (PEE) associated with dam (Model 2) and maternal effects (Model 3) were taken into account by including additional random effects in Model 1. Model 4 was the same as Model 3 but allowed for a covariance between direct and maternal effects (ME). Model 5 included both PEE and ME. Model 6 was the same as Model 5 but with a covariance between direct and ME.

Results

Estimates of genetic parameters obtained by the best models (lowest -2LogL) are summarised in Table 1. In all cases except 400-day weight, the most comprehensive model (Model 6) allowing for both genetic and environmental maternal effects and direct-maternal covariance provided the lowest -2LogL. Estimates of m^2 were generally higher than estimates of c^2. While some 'carry-over' effects of maternal influence was observed up to the 300-day weight, this became less important for 400-day weight as expected. Fitting a covariance between direct and maternal genetic effects (Model 6) resulted in negative estimates of r_{AM} for all traits except birth weight.

Table 1. Parameter estimates from the best model for each trait.

Traits	Model No	h^2	m^2	c^2	r_{AM}
Birth weight (BWT)	6	0.12	0.03	0.08	0.03
100-day weight	6	0.31	0.10	0.04	-0.43
200-day weight	6	0.27	0.08	0.07	-0.76
300-day weight	6	0.28	0.08	0.01	-0.57
400-day weight	4	0.42	0.02	-	-0.77

h^2, direct heritability; m^2, maternal heritability, r_{AM} direct-maternal genetic correlation; c^2, permanent environmental variance due to the dam as a proportion of phenotypic variance;

Conclusion

Estimates of the genetic parameters were similar to previous studies (Meyer, 1992: Swalve, 1993: Robinson, 1996). Negative correlations between direct and maternal effects are a common feature of many analyses of field data (Meyer, 1992). The results suggest that further research is required into modelling of maternal effects, in particular to investigate the nature of the negative correlation between direct and maternal effects. Model 6 is suggested as the best model for 100- and 200-day weight, given the results of previous studies (Meyer, 1992; Robinson, 1996) and the well-known biological effects of the dam (genetic and permanent environmental) on calf growth to weaning. For 300- and 400-day weight there was no statistical or biological advantage in going beyond Model 1.

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