PRELIMINARY GENETIC PARAMETERS FOR LIVE WEIGHT AND ULTRASOUND SCAN TRAITS IN MERINOS

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SUMMARY

The Australian Merino has traditionally been bred as a wool-producing sheep, however it also contributes significantly to prime lamb and mutton production. To breed for improved growth and carcase characteristics (such as live weight, fat depth and eye muscle depth) accurate genetic parameters are required. This paper reports on estimates of the heritabilities and genetic and phenotypic relationships between these traits. Results show that all traits are moderate to highly heritable. There are moderate genetic and phenotypic correlations between fat depth and eye muscle depth at both yearling and hogget age. These results indicate that there is merit in selecting Merinos for better growth and carcase traits using available genetic technologies of estimated breeding values.

Keywords: live weight, fat depth, eye muscle depth, genetic parameters, Merino

INTRODUCTION

Merino sheep in Australia have traditionally been bred for wool production. Much research has concentrated on the genetic and phenotypic relationships between wool traits and between wool traits and live weight. Until recently, little consideration has been given to meat traits in Merinos. Davidson *et al.* (2002) and Safari *et al.* (2001) have estimated the heritability of a number of meat traits in Merinos; however, these studies have been restricted to approximately 2000 and 1000 animals respectively. There are no reported correlations between live weight and ultrasonic scanned fat and eye muscle depth in Australian Merinos.

The Merino Validation Project (Clarke *et al.* 2002) has the aim to collect on-farm data from over 150 Merino ram breeding flocks over three years. This project aims to improve the accuracy of selection for carcase traits in Merinos through more accurate genetic parameter estimates. The data used for this analysis comes from flocks participating in the Merino Validation Project that has been entered into the Merino Genetic Services database.

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This paper reports on heritability estimates for live weight, C fat and eye muscle depth at two ages (yearling and hogget) in Merinos. The correlations between traits at each age are also examined.

MATERIALS AND METHODS

Data were extracted from the Merino Genetic Services database. Traits examined were: 1) Yearling live weight, 2) Yearling C site fat depth, 3) Yearling eye muscle depth, 4) Hogget live weight, 5) Hogget C site fat depth; and 6) Hogget eye muscle depth. Extracted data met the following criteria: 1) at least sire or dam was known, 2) date of birth was known, 3) sex was identified as either male or female, 4) age of dam was less than 12 years; and 5) pure-bred Merinos. Observations more than three standard deviations from the mean of their contemporaries were also deleted, as were all animals with less than 10 animals in their contemporary groups. The pedigree was built using all available ancestors. Table 1 details the data used for each trait. Even though all animals would have been scanned for C site fat and eye muscle depth at the same time, the numbers of animals with records for each trait (Table 1) differs due to the deletion of observations more than three standard deviations from the mean of their contemporaries.

Table 1. Number of records, mean and standard deviation for each trait

Trait	Number	Mean	Standard Deviation
Yearling live weight (kg)	28825	44.16	12.26
Yearling C fat depth (mm)	6412	2.21	0.85
Yearling eye muscle depth (mm)	6435	22.06	4.62
Hogget live weight (kg)	43115	48.97	10.91
Hogget C fat depth (mm)	5273	2.72	0.85
Hogget eye muscle depth (mm)	4906	22.87	3.91

The average age of the animals was 356 days at yearling age and 442 days at hogget age. There were varying numbers of flocks involved in each analysis. This ranged from 46 flocks with hogget live weight recorded to 23 flocks with hogget fat and eye muscle depth. For the weight traits, there were 1457 sires and 13153 dams included in the analysis. This provided 60075 of the animals with a sire recorded and 22098 with a dam. There were 14 years of data available from animals born in 1988 to 2001, with 22% of the data for weight traits coming from the last year (2001). For carcase traits, there were seven years of data from 1994 to 2001, however 74% of the data came from the last year. There was overlap in animals with more than one weight record. There were 17789 animals with only a yearling weight, 32089 animals with only a hogget weight record and 11023 animals with weights at both yearling and hogget age. With nearly 20% of animals with both records, comparisons across ages can be made. In terms of fat (and muscle) records, 5529 had only yearling records, 4543 had only hogget records and 706 animals had both yearling and hogget records.

Statistical analyses. Genetic parameters were estimated using an animal model in ASREML (Gilmour *et al.* 1999). For live weight the fixed effects included mean, age, age of dam and contemporary group (CG). For fat and eye muscle depth the fixed effects were mean, live weight, live weight^2 and CG. CG for all traits was defined by breed, flock, year, sex and management group.

$$\mathbf{y} = \mathbf{X}b + \mathbf{Z_1 a} + \mathbf{Z_2 m} + e$$

Where **y** is the vector of observations, b is the vector of fixed effects, **a** and **m** are vectors of direct and maternal genetic effects, **X, Z_1** and **Z_2** are incidence matrices relating observations and effects, and **e** is the vector of random residuals. Also with g = [a m]. Var g (= [a m]) = A*G_0, Var(e) = I*R_0. Heritabilities were obtained from the univariate analyses and correlations from the trivariate analyses for the three traits at each of the two ages.

RESULTS AND DISCUSSION

The model was run both with and without fitting maternal genetic effects and log likelihoods compared to determine significance. Maternal effects were not significant for most traits; however, there was a small significant maternal genetic effect on yearling eye muscle depth 0.14 (0.03). Heritability of live weight traits at yearling and hogget age were moderate to high (0.34 and 0.49 respectively) (Table 2). Eye muscle depth also had a moderate heritability at both ages (0.27 and 0.26). A lower heritability was estimated for C fat depth at both hogget and yearling age (0.19) The hogget heritability estimates reported are in close agreement to those of Greeff *et al.* (2003). However, the heritability of fat depth at hogget age is lower than that reported by Davidson *et al.* (2002) and Fogarty (1995) for meat sheep breeds.

Table 2. Phenotypic variance (s_p), direct heritability (on diagonal), genetic (below diagonal) and phenotypic (above diagonal) correlations among traits for yearling age live weight (Ywt), C fat depth (Yfat), eye muscle depth (Yemd), and among traits for hogget age live weight (Hwt), C fat depth (Hfat) and eye muscle depth (Hemd), standard errors in brackets

	Ywt (kg)	Yfat (mm)	Yemd (mm)	Hwt (kg)	Hfat (mm)	Hemd (mm)
s_p	27.48	0.20	3.40	28.82	0.27	2.11
Ywt (kg)	**0.35 (0.02)**	0.27 (0.02)	-0.15 (0.02)			
Yfat (mm)	0.29 (0.09)	**0.19 (0.03)**	0.28 (0.01)			
Yemd (mm)	-0.20 (0.08)	0.41 (0.09)	**0.27 (0.04)**			
Hwt (kg)				**0.49 (0.02)**	0.16 (0.02)	-0.06 (0.02)
Hfat (mm)				0.12 (0.10)	**0.19 (0.03)**	0.23 (0.02)

Hemd (mm)	-0.12 (0.10)	0.61 (0.10)	**0.26 (0.05)**

Genetic and phenotypic correlations between traits at yearling and hogget age are shown in Table 2. There were moderate positive phenotypic correlations between C fat depth and eye muscle depth at both yearling (0.28) and hogget ages (0.23). The genetic correlations for these traits were much stronger (0.41 and 0.61). There was a moderate phenotypic correlation between live weight and C fat depth at yearling age that reduced at hogget age, with a similar result for the genetic relationship between these traits. Live weight and eye muscle depth were found to have a small negative relationship that reduced with age. This may be due to the smaller numbers of animals involved in the hogget analyses.

The phenotypic correlations between C fat depth and eye muscle depth (0.23) and C fat depth and hogget weight (0.16) are not dissimilar to those found at 16 months of age in the South Australian Selection Demonstration flocks led by Raul Ponzoni (Ingham *pers comm*). These relationships were 0.33 and 0.13 respectively. There was however a large discrepancy in the phenotypic correlation between hogget live weight and eye muscle depth (-0.06 vs 0.58). Likewise, the genetic correlation was similar for C fat depth and eye muscle depth, but in disagreement for hogget live weight and eye muscle depth (-0.12 vs 0.39).

CONCLUSIONS

The low heritability estimates for fat depth may be due to the fact that most of the data for this trait is from animals born in 2001 and measured in 2002. These animals may not be expressing their genetic potential due to the seriousness of the drought that has affected most of eastern Australia. As an example the phenotypic variance that is currently used by Merino Genetic Services is 0.9, whereas in this study the phenotypic variance is 0.27. As further information from the Merino Validation Project becomes available, these relationships will require further analysis.

There are no other published correlations between live weight, live animals scanned C fat and eye muscle depth in Australian Merinos. There are differences between these findings and those in South Australia (Ingham, *pers comm*) and Western Australia (Greeff, *pers comm*). This may suggest the likelihood of a genetic by environment interaction and requires further attention. The hogget correlations shown in Table 3 are similar to those found by Greeff (*pers comm*) for the relationships between eye muscle depth and live weight and eye muscle depth and C fat depth. The correlations between C fat and live weight, however, vary in magnitude and direction to what has been reported in previous studies in both Merino and other sheep breeds. Again, this may be due to the abnormal growing conditions imposed on the animals measured. In studies where sheep had been restricted in weight and re-fed (Ball, 1996), large differences in the relative rates of fat and muscle deposition were noted. In a season as experienced over 2002, where sheep were subjected to severe feed restrictions, the relationship between fat and growth rate may differ to normal expectations of growth

ACKNOWLEDGEMENTS
This research is funded by Meat and Livestock Australia. The support and effort of breeders that are participating in the Merino Validation Project is greatly appreciated.

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