GENETIC PARAMETERS FOR WEIGHT, FAT AND EYE MUSCLE DEPTH IN SOUTH AUSTRALIAN MERINO SHEEP

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SUMMARY

Data from the SARDI Selection Demonstration Flocks were used to estimate heritability of and genetic correlations between live weight, fat depth and eye muscle depth at five months of age under an animal model. Two models, with and without weight adjustment, were used for fat and eye muscle depth. Heritability estimates were 0.28 (0.08), 0.26 (0.06) and 0.35 (0.07) for weight, adjusted fat and adjusted eye muscle depth, respectively. Phenotypic correlations ranged from 0.27 to 0.66 and genetic correlations ranged from 0.16 to 0.73. The estimates reported here are similar to those previously reported for other sheep breeds. This suggests that sufficient genetic variation exists to enable selection to improve these traits for Merinos. Moderate heritabilities and correlations for weight adjusted traits suggest that there is potential for improvement in fat depth and eye muscle shape in Merinos. The similarity of these estimates to those reported for other sheep breeds indicates that selection used for meat breeds may be directly applicable to, or easily adapted for Merinos.
Keywords: Merino, sheep, selection, heritability, correlation

INTRODUCTION

Merinos have traditionally been selected for wool. Recent trends in wool and lamb prices, have increased the proportion of producer's income derived from lamb, and therefore a greater emphasis has been placed on growth and carcase attributes (Clarke *et al.* 2002; Davidson *et al.* 2002; Ingham and Ponzoni 2001; Safari *et al.* 2001). Parameter estimates are widely available for fleece traits and weight traits at birth, weaning and older ages (Ponzoni and Fenton 2000). However there are few genetic parameter estimates of weight traits between weaning and yearling ages, and fewer estimates of carcase traits at any age for Merinos. It is important for the further development and proper use of the Merino as a dual-purpose breed that the gaps in our knowledge of the interactions between weight and carcase traits be filled. An intensive schedule of weight and live carcase measurement has been carried out as part of the SARDI Selection Demonstration Flocks Project. This study presents genetic parameter estimates from the five month data obtained from these flocks.

MATERIALS AND METHODS

Animals. The 1761 lambs studied were from the 2000 and 2001 drops of SARDI Selection Demonstration Flocks (Ponzoni *et al.* 2000; Ingham and Ponzoni 2001). They were weaned at three months of age and measured at five months of age for body weight, ultrasonic fat and eye muscle depth (over the 12th rib, C site) by a Lambplan accredited scanner. There was no pedigree information available for the 86 sires and 1045 dams of the lambs. Table 1 shows the number of records available, the mean and the standard deviation for each of the traits.

Statistical analysis. Preliminary analyses to determine the fixed effects included in the model were carried out using univariate analysis with ASReml (Gilmour *et al*. 1999). Phenotypic and genetic correlations were estimated using multivariate analysis. Fat and eye muscle depth were analysed with and without adjustment for body weight. The base model included fixed effects for year of birth, flock, sex, age of dam (aod) and type of birth and rearing (tobr). Age fitted as day of birth (dob) was included as a linear covariate. Interactions fitted for all traits were; year x sex, year x flock, year x tobr, sex x dob and tobr x dob. The extended model used for fat and eye muscle depth included separate weight regressions for each sex. An animal term was fitted allowing optimal analysis of a finite, selected population. A dam term was included as a random effect for weight but was negligible and dropped from the final models for fat or eye muscle depth.

Table 1. Number of records available, simple means, standard deviations (s.d.) and range for weight (kg), fat and eye muscle depth (mm)

Trait	No. of records	Simple mean	s.d.	Range
Weight	1761	31.8	6.33	13 – 56
Fat depth	1657	1.4	0.59	0.5 – 3.5
Eye muscle depth	1657	18.9	3.08	10 – 28

RESULTS AND DISCUSSION

Fixed effects. *Weight.* There was a significant linear increase in weight associated with age of dam (Table 2a). Sex also had a major impact on weight with weight of males being greater than females. This difference was greater in 2001 drop lambs than in 2000 drop lambs (Table 2a). The regression on age was higher for males than females and higher for single born lambs than twins, and for single reared twins than twin reared twins (Table 2b).

Fat. Sex had a major impact on fatness interacting significantly with weight, tobr and year. Females were fatter than males and more so in the 2001 drop than the 2000 drop (Table 2a). The regression on weight was higher for females than for males. The regression on age was higher for females than for males and higher for twins than single born lambs, and for single reared twin lambs than for twin reared twin lambs (Table 2b)

Eye muscle depth. There was a significant linear decline in eye muscle depth associated with age of dam (Table 2a). Sex also had a major impact on eye muscle depth with muscle depth being less for females and the difference being greater in the 2001 drop lambs than the 2000 drop lambs (Table 2a). The regression on weight was lower for females than for males, however the pattern in age regressions for sex and tobr was similar to that for fat.

Heritability. The heritability estimates were 0.28 (0.08) for weight, 0.26 (0.07) for fat adjusted for weight and 0.35 (0.07) for eye muscle depth adjusted for weight (Table 3). There is a paucity of estimates for post weaning weight reported for Merinos. However the literature indicates that heritability of weight generally increases with age. Fogarty (1995) reports ranges in heritability of weaning weight for Merinos from 0.08 to 0.41 and post weaning weight in dual purpose breeds of 0.03 to 0.49. Our estimate is consistent with these values. The very small maternal genetic effect estimated for weight (0.04 SE 0.04) was not significant (P>0.05). There are also few estimates of carcase traits for Australian Merinos. Safari *et al.* (2001) reported heritabilities of 0.20 and 0.27 for weight adjusted fat depth (C site), and eye muscle depth respectively, measured in slaughtered 17 month old rams. Davidson *et al.* (2002) reported heritabilities of 0.28 (0.07) and 0.23 (0.07) for weight adjusted fat and eye muscle depth measured in the live animal at 16 months of age. Estimates from this study are in agreement with these for fat depth but are greater for eye muscle depth and are measured in much younger animals. Adjusting fat depth for weight had little effect on the heritability but reduced that of eye muscle depth by 0.06 due to a greater reduction in the genetic variance.

Table 2a. Predicted year x sex means, weight x sex regression coefficients and age of dam (aod) regression coefficients for weight, fat and eye muscle depth

			Weight	Fat depth	Eye muscle depth
aod			0.42	-	-0.07 (0.03)
weight		M		0.03 (0.002)	0.30 (0.01)
		F		0.04 (0.002)	0.28 (0.01)
year	2000	M	33.3 (0.31)	1.28 (0.03)	18.8 (0.11)
		F	29.8 (0.32)	1.43 (0.03)	18.7 (0.11)
	2001	M	34.5 (0.30)	1.29 (0.03)	19.1 (0.10)
		F	30.1 (0.30)	1.62 (0.02)	18.6 (0.10)

Table 2b. Regression coefficients of weight, fat and eye muscle depth on age (adjusted for weight), for sex, and type of birth and rearing (tobr) classes

	Weight			Fat depth			Eye muscle depth		
tobr	11	22	21	11	22	21	11	22	21
M	0.308 (0.010)	0.272 (0.010)	0.327 (0.010)	0.002 (0.001)	0.003 (0.001)	0.008 (0.001)	0.004 (0.005)	0.013 (0.005)	0.027 (0.005)
F	0.260 (0.010)	0.225 (0.010)	0.280 (0.010)	0.008 (0.001)	0.010 (0.001)	0.014 (0.003)	0.030 (0.005)	0.039 (0.005)	0.053 (0.005)

Correlations. Phenotypic correlations between weight and fat depth were moderate without weight adjustment but were lower with adjustment (Table 3). Genetic correlations were lower than phenotypic for both models. Correlations between weight and eye muscle depth were moderate to high but followed the same trend as weight and fat correlations when weight adjustment was included in the model. Correlations between fat and eye muscle depth were moderate to high. All estimates fit within reported ranges for other breeds (Fogarty 1995). These estimates suggest that selection for an increase in any of these traits, for example weight, will result in an increase in the other two component traits.

Table 3. Phenotypic variances, heritabilities (on diagonal), correlations (above the diagonal), and genetic correlations (below the diagonal) between body weight, fat depth and eye muscle depth at 5 months of age (± se in brackets)

Trait	Model	Phenotypic Variance	Weight	Fat depth	Eye muscle depth
Weight	1	17.9	0.28 (0.08)	0.40 (0.02)	0.66 (0.02)
	2			0.27 (0.03)	0.51 (0.02)
Fat depth	1	0.215	0.34 (0.16)	0.23 (0.06)	0.50 (0.03)
	2	0.140	0.16 (0.18)	0.26 (0.07)	0.36 (0.02)
Eye muscle depth	1	3.82	0.73 (0.08)	0.67 (0.10)	0.42 (0.07)
	2	2.93	0.57 (0.10)	0.60 (0.12)	0.35 (0.07)

CONCLUSIONS

This small group of 'new' parameters is encouraging for Merino breeders and producers as the moderate heritabilities and positive correlations between all traits suggests that enough genetic variation exists to enable selection to improve these traits. Moderate heritabilities and correlations for weight adjusted traits suggest that there is potential for improvement in fat depth and eye muscle depth in Merinos. The similarity of these estimates to those reported for other sheep breeds indicates that selection indicies used for meat breeds may be directly applicable to, or easily manipulated for Merinos. More work should be carried out to determine interactions between wool, growth and carcase traits for Merinos.

ACKNOWLEDGEMENTS

The Selection Demonstration Flocks are funded by Australian woolgrowers through Australian Wool Innovation. Financial assistance for the fat and eye muscle depth scanning was provided by Meat and Livestock Australia. Funds for attendance were provided by the Australian Sheep Industry CRC. The staff at Turretfield Research Centre (SARDI) are thanked for their help in collecting and preparing data.

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