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GENETIC PARAMETERS FOR BODY WEIGHT, CARCASS AND WOOL TRAITS IN DOHNE MERINO

L. Li[1], D.J. Brown[1] and J.S. Gill[2]

[1]Animal Genetic and Breeding Unit[*], University of New England, Armidale, NSW 2351
[2]Meat and Livestock Australia, University of New England, PO Box U254, Armidale, NSW 2351

SUMMARY

The Dohne Merino was introduced to Australia as a dual-purpose (wool and meat) breed at the end of 1990s with very limited genetic parameters available. Up to 373,639 records per trait were used to estimate genetic parameters for eight traits in this study. Heritability estimates (± s.e.) were 0.34 ± 0.02 for weaning weight (Wwt), 0.27 ± 0.01 for yearling weight (Ywt), 0.13 ± 0.01 for yearling fat depth (Yfat), 0.19 ± 0.05 for yearling eye muscle depth (Yemd), 0.37 ± 0.01 for yearling greasy fleece weight (Ygfw), 0.27 ± 0.01 for yearling clean fleece weight (Ycfw), 0.46 ± 0.01 for yearling fibre diameter (Yfd) and 0.28 ± 0.01 for yearling fibre diameter coefficient of variation (Ydcv), respectively. Significant maternal and maternal environmental effects (± s.e.) were found, being highest for Wwt (0.12 ± 0.01 and 0.05 ± 0.01, respectively) and of smaller magnitude for Ywt, Ygfw and Ycfw (ranging from 0.02 to 0.04). Negative correlations between direct and maternal genetic effects was found for Wwt, Ywt, Ygfw and Ycfw, ranging from -0.41 to -0.75. The genetic and phenotypic correlations between Ygfw and Ycfw were high (0.79 ± 0.01 and 0.89 ± 0.01, respectively) and moderate positive genetic correlations were found between Wwt and Ywt, Wwt and Ygfw, Yfat and Yemd, ranging from 0.26 to 0.54. These values were within the range of estimates found in the literature for Merino sheep.

INTRODUCTION

With the increasing interested in both wool and meat production in the Australian sheep industry, more dual-purpose (wool and meat) sheep breeds have been introduced to Australia (Brown and Fozi 2005). The Dohne Merino, originating from a cross between German Mutton Merino rams and South African Merino ewes in the 1930s (Cloete *et al.* 2001), is such a breed, which was introduced to Australia at the end of 1990s (Casey 2002). The Dohne Merino has been proved an adaptable dual-purpose breed, with easy-care and an ability to thrive under diverse environmental conditions (van Wyk *et al.* 2008). Many records are now available in the Sheep Genetics (SG) database (Brown *et al.* 2007). However, very few genetic parameters have been published for the Dohne Merino. Accurate estimates of variances and covariances are essential for the multiple trait genetic evaluation system used by SG to predict breeding values and further index development. The objective of this study was to estimate genetic parameters for 2 body weight, 2 carcass and 4 wool traits recorded in the Dohne Merino.

MATERIALS AND METHODS

Performance records were extracted from SG database. The traits analysed were weaning weight (Wwt), yearling weight (Ywt), yearling fat depth (Yfat), yearling eye muscle depth (Yemd), yearling greasy fleece weight (Ygfw), yearling clean fleece weight (Ycfw), yearling fibre diameter (Yfd) and yearling fibre diameter coefficient of variation (Ydcv). The minimum and maximum numbers of records were 111,304 for Yemd and 373,639 for Ywt which contained 154 and 130 Australian and South African flocks, respectively. The pedigree was built using all available ancestors in the SG database. A summary of the data for each trait is shown in Table 1.

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Variance and covariance components were estimated using an animal model in ASREML (Gilmour *et al.* 2009). Contemporary groups described animal's breed, flock, year, sex and management group and were fitted as fixed effects in the model for each trait. Additional fixed effects included birth type (1 to 4), age of animal at recording (covariate) as well as age of dam and body weight (fitted as quadratic polynomial) depended on the specific trait (Table 2). Rearing type (1 to 4) was only significant for Wwt, however the solutions were not biologically sensible, so it was not included in the model. Random effects including additive genetic effects of individual animal, maternal genetic effects and maternal environmental effects were evaluated by log likelihood ratio tests in univariate analyses. The maternal genetic and maternal environmental effects did not significantly improve the fit of the models for Yfat, Yemd, Yfd and Ydcv and were therefore not included in the models for these traits. A complete set of bivariate analyses was then performed for each trait combination.

Table 1. Summary statistics of the phenotypic data for weaning weight (Wwt), yearling weight (Ywt), yearling fat depth (Yfat), yearling eye muscle depth (Yemd), yearling greasy fleece weight (Ygfw), yearling clean fleece weight (Ycfw), yearling fibre diameter (Yfd) and yearling fibre diameter coefficient of variation (Ydcv)

Traits	Animals with data	Total Pedigree	Sires	Dams	No. CG	Mean	SD	Min	Max
Wwt (kg)	149,001	154,914	2,100	38,044	4,590	25.0	3.79	7.4	46.6
Ywt (kg)	373,639	421,675	6,019	121,133	6,636	45.0	4.70	19.3	82.7
Yfat (mm)	111,472	122,417	1,931	32,860	2,731	2.5	0.58	0.5	7.0
Yemd (mm)	111,304	122,156	1,931	32,736	2,733	27.5	4.86	10.0	48.0
Ygfw (kg)	123,838	131,093	1,971	33,696	3,395	3.5	0.55	0.8	9.0
Ycfw (kg)	279,441	330,702	5,377	101,268	4,383	2.5	0.38	0.1	7.0
Yfd (micron)	370,278	418,685	6,023	120,378	6,565	17.5	1.07	11.1	27.4
Ydcv (%)	123,772	130,690	1,971	33,502	3,378	17.8	2.55	10.2	32.8

RESULTS AND DISCUSSION

Solutions and levels of significance of the fixed effects for each trait are presented in Table 2. Relative to single born animals, twin born lambs were 2.81 and 1.84 kg lighter for Wwt and Ywt and produced 0.19 and 0.02 kg lighter greasy and clean fleece, with 0.14 micron and 0.09% higher fibre diameter and variation in fibre diameter respectively. Triple and quadruple lambs had similar trends as twin lambs with solutions of slightly higher magnitude. Old ewes and animals had significantly increased weaning and yearling weights and yearling greasy fleece weight, with the exception of the non-significant effect of animal age on yearling clean fleece weight. Yearling fat and eye muscle depth increased with heavier body weight. These results are similar to those observed in Australian Merino sheep (Huisman *et al.* 2008). No significant effect of rearing type on Ywt was found in this study, unlike the result found in Australian Merino sheep by Huisman *et al*. (2008), where animals reared as a single were heavier as yearlings than other rearing types.

The phenotypic variances were found similar or slightly lower for 4 wool traits, lower for 2 body weights and higher for 2 carcass traits compared to the estimates of 13.50 (Wwt), 21.80 (Ywt), 0.29 (Yfat) and 4.37 (Yemd) reported by Huisman *et al*. (2008) in Australian Merino sheep. Moderate direct heritabilities were estimated for Wwt (0.34), Ywt (0.27), Ygfw (0.37), Ycfw (0.27) and Ydcv (0.28) (Table 3). These were comparable to estimates of 0.30 (Wwt), 0.30 (Ywt) and 0.22 (Ycfw) reported by Olivier and Cloete (2011) in the South African Dohne Merino. Direct heritabilities of 0.13 and 0.19 were estimated for Yfat and Yemd, respectively. The highest direct heritability estimate (0.46) was found for Yfd, which was very similar to the estimates reported by Cloete *et al.* (2001) and Olivier and Cloete (2011) in the South African Dohne Merino. These values were within the range found in the Merino sheep (Safari and Fogarty 2003).

Maternal genetic and maternal environmental effects were significant for Wwt, Ywt, Ygfw and Ycfw, with small estimates, which ranged from 0.02 to 0.03, except for Wwt (0.12 and 0.05). The estimates for Wwt compared well with the weighted mean of 0.10 and 0.07 presented by Safari *et al.* (2005). However higher estimates have been reported for Merino sheep for all traits (Huisman *et al*. 2008) and in Dohne Merino for Wwt, Ywt and clean fleece weight (Cloete *et al.* 2001).

Table 2. Solutions of fixed effects including birth type (BT), dam age, animal age (Age), body weight (Wt) for each trait with standard errors in subscript (excluding CG)

Traits	BT2 [A]	BT3 [A]	BT4[A]	Dam Age	Dam Age^2	Age	Wt	Wt^2
Wwt (kg)	**-2.81**$_{0.03}$	**-3.76**$_{0.09}$	**-3.61**$_{0.36}$	**0.62**$_{0.03}$	**-0.06**$_{0.004}$	**0.13**$_{0.002}$		
Ywt (kg)	**-1.84**$_{0.02}$	**-2.72**$_{0.05}$	**-2.23**$_{0.17}$	**0.96**$_{0.02}$	**-0.09**$_{0.003}$	**0.09**$_{0.001}$		
Yfat (mm)							**0.087**$_{0.001}$	**-0.0004**$_{0.00001}$
Yemd (mm)							**0.456**$_{0.005}$	**-0.0017**$_{0.00005}$
Ygfw (kg)	**-0.19**$_{0.01}$	**-0.27**$_{0.01}$	**-0.29**$_{0.05}$	**0.07**$_{0.01}$	**-0.01**$_{0.001}$	**0.01**$_{0.0002}$		
Ycfw (kg)	**-0.02**$_{0.00}$	**-0.10**$_{0.01}$	**-0.08**$_{0.01}$	**0.08**$_{0.01}$	**-0.01**$_{0.001}$	0.0004$_{0.0001}$		
Yfd (micron)	**0.14**$_{0.01}$	**0.23**$_{0.01}$	**0.21**$_{0.04}$	-0.01$_{0.01}$	**0.00**$_{0.001}$			
Ydcv (%)	**0.09**$_{0.01}$	**0.18**$_{0.05}$	**0.17**$_{0.20}$	**0.05**$_{0.02}$	-0.003$_{0.002}$			

[A]The solutions for birth type are relative to a single born lambs. Estimates in bold are significant (P<0.05).

Table 3. Estimates of phenotypic variance (σ^2_p), direct (h^2) and maternal (m^2) heritability, maternal environmental effect (pe^2) as a proportion of phenotypic variance, correlation between direct and maternal genetic effects (r_{DM}) as well as genetic (above diagonal) and phenotypic (below diagonal) correlations with standard errors in subscript

	Wwt	Ywt	Yfat	Yemd	Ygfw	Ycfw	Yfd	Ydcv
σ^2_p	13.50$_{0.08}$	21.80$_{0.06}$	0.29$_{0.00}$	4.37$_{0.02}$	0.32$_{0.00}$	0.15$_{0.00}$	1.27$_{0.00}$	4.52$_{0.02}$
h^2	0.34$_{0.02}$	0.27$_{0.01}$	0.13$_{0.01}$	0.19$_{0.01}$	0.37$_{0.01}$	0.27$_{0.01}$	0.46$_{0.00}$	0.28$_{0.01}$
m^2	0.12$_{0.01}$	0.03$_{0.00}$	-	-	0.03$_{0.00}$	0.02$_{0.00}$	-	-
pe^2	0.05$_{0.00}$	0.03$_{0.00}$	-	-	0.04$_{0.00}$	0.03$_{0.00}$	-	-
r_{DM}	-0.69$_{0.02}$	-0.41$_{0.03}$	-	-	-0.75$_{0.04}$	-0.65$_{0.03}$	-	-
Wwt		0.54$_{0.02}$	-0.13$_{0.04}$	-0.11$_{0.03}$	0.33$_{0.03}$	0.10$_{0.03}$	0.04$_{0.02}$	-0.16$_{0.02}$
Ywt	0.60$_{0.00}$		0.03$_{0.04}$	-0.02$_{0.03}$	0.04$_{0.02}$	0.01$_{0.02}$	0.16$_{0.01}$	-0.19$_{0.02}$
Yfat	-0.05$_{0.00}$	0.09$_{0.00}$		0.44$_{0.03}$	-0.10$_{0.04}$	-0.05$_{0.06}$	0.12$_{0.02}$	-0.09$_{0.03}$
Yemd	0.00$_{0.00}$	0.02$_{0.01}$	0.26$_{0.00}$		-0.10$_{0.03}$	-0.16$_{0.05}$	0.05$_{0.02}$	-0.10$_{0.03}$
Ygfw	0.31$_{0.01}$	0.37$_{0.00}$	-0.02$_{0.00}$	0.00$_{0.00}$		0.79$_{0.01}$	0.15$_{0.02}$	0.20$_{0.02}$
Ycfw	0.30$_{0.01}$	0.33$_{0.00}$	0.00$_{0.01}$	-0.01$_{0.01}$	0.89$_{0.001}$		0.16$_{0.01}$	0.20$_{0.03}$
Yfd	0.08$_{0.00}$	0.16$_{0.00}$	0.08$_{0.00}$	0.05$_{0.00}$	0.19$_{0.00}$	0.19$_{0.00}$		-0.10$_{0.02}$
Ydcv	-0.10$_{0.00}$	-0.13$_{0.00}$	-0.05$_{0.00}$	-0.06$_{0.00}$	0.02$_{0.00}$	-0.01$_{0.01}$	-0.10$_{0.00}$	

The genetic correlation between direct and maternal genetic effects was highly negative (ranging from -0.41 to -0.75) for Wwt, Ywt, Ygfw and Ycfw in this study. It was different to the weighted mean of 0.34 for dual purpose sheep reported by Safari *et al*. (2005), but similar to estimates published in the studies of Huisman *et al*. (2008) and Cloete *et al.* (2001). These high estimates were considered to be inflated by the data structure as described by Clement *et al*.(2001). It is noteworthy that lower direct heritabilities were estimated for Wwt (0.19), Ywt (0.22), Ygfw (0.24) and Ycfw (0.20) when covariance between direct and maternal genetic effects was fixed at zero in the models.

Highly positive genetic and phenotypic correlations between Ygfw and Ycfw (0.79 and 0.89, respectively) and moderate positive genetic correlations between Wwt and Ywt, Wwt and Ygfw, Yfat and Yemd, ranging from 0.26 to 0.54, were found in this study. Very few estimates have been reported for the correlations between these traits in the Dohne Merino. van Wyk *et al.* (2008) obtained similar genetic and phenotypic correlations between mean fibre diameter and yearling weight (0.13 and 0.13) and clean fleece weight (0.16 and 0.18) in this breed. Higher genetic correlations between Wwt and Ywt (0.83), Ycfw (0.32) along with Yfd (0.12) were reported in the same breed by Olivier and Cloete (2011). Compared to the estimates in Australian Merino sheep, most of estimates are in agreement with those found by Huisman and Brown (2008 and 2009) with some exceptions including much higher genetic and phenotypic correlations between Ywt with Yfat (0.29 and 0.47), Yemd (0.85 and 0.83) and Ygfw (0.32 and 0.32) along with higher genetic correlation between Ygfw and Yfd (0.42), Ycfw and Yfd (0.42) in Australian Merino sheep.

CONCLUSIONS

Accurate genetic parameters were estimated for 2 body weight (Wwt and Ywt), 2 carcass (Yfat and Yemd) and 4 wool (Ygfw, Ycfw, Yfd and Ydcv) traits with large amounts of phenotypes available from SG database for the Dohne Merino. Most of these estimates were similar to other Merino breeds. These genetic parameters will be used to review those being used in the SG evaluation system and further index development for the Dohne Merino.

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