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GENETIC (CO)VARIANCES FOR YEARLING TRAITS AND REPRODUCTION IN THE SOUTH AFRICAN DOHNE MERINO BREED

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SUMMARY

Data of Dohne Merinos in the South African National Small Stock Improvement Scheme were analysed for weaning weight (WW), yearling weight (YW), clean fleece weight (CFW), fibre diameter (FD), number of lambs born (NLB), number of lambs weaned (NLW) and the number of production years (PY). Derived heritability estimates were 0.30 for WW, 0.30 for LW, 0.22 for CFW, 0.49 for FD, 0.15 for NLB, 0.14 for NLW and 0.13 for PY. Maternal heritability amounted to 0.07 for WW. Genetic correlations among production traits were generally high, namely 0.83 between WW and LW, 0.32 between WW and CFW, 0.12 between WW and FD, 0.17 between LW and CFW, 0.17 between LW and FD, and 0.18 between CFW and FD. Genetic correlations of production traits with NLB were 0.12 for WW, 0.15 for LW, 0.12 for CFW and 0.20 for FD. Corresponding genetic correlations were 0.21, 0.16, 0.20 and 0.22, with NLW and 0.00, 0.02, 0.06 and 0.04 with PY. Significant genetic correlations were mostly favourable, except for the positive genetic correlations of FD with WW, LW and CFW, as well as with NLB and NLW.

INTRODUCTION

The Dohne Merino is a composite breed that originated from a cross between the Merino and the then German Merino (presently known as the South African Mutton Merino) (Van Wyk *et al.* 2008). The intention was to develop a genotype that would adapt to the seasonal nutritional undersupply during winter in the Eastern Cape sourveld region of South Africa. The Dohne is regarded as an adaptable Merino-type wool breed with easy-care properties able to adapt to highly variable environmental conditions. This has resulted in an expansion to other areas in South Africa and a sustained growth in numbers. The breed contributes approximately 24% of the records to the South African National Small Stock Improvement Scheme (NSIS) (Cloete and Olivier, 2010). Germplasm of the breed has also been exported to other major sheep producing countries.

Genetic (co)variances for yearling live weight and wool traits in the breed were published by Van Wyk *et al.* (2008). Records of weaning weights and ewe reproduction traits have accumulated steadily since 2000. We thus constructed models to estimate genetic parameters for weaning weight, yearling traits as well as for reproduction traits for the South African Dohne Merino breed.

MATERIALS AND METHODS

Data obtained from Dohne Merino breeders contributing data to the NSIS were used to estimate genetic parameters for several economically important traits. Traits that were recorded included yearling body weight (LW), clean fleece weight (CFW), mean fibre diameter (FD) (described by Van Wyk *et al.* 2008), as well as weaning weight (WW). These records were used to construct the following records for ewe reproduction: Total number of lambs born (NLB), total number of lambs weaned (NLW) and number of years in production (PY). The latter trait was defined as the date of the birth of the first lamb of individual ewes subtracted from the date of birth of the last lamb, divided by 365. This measure only included ewes that were born up to 2005, to allow ewes to be assessed over at least four lambing opportunities to 2010. It is conceded that ewes that failed to lamb repeatedly had no lambing dates in the data. As a result, such ewes could not be recorded. However, it is contended that these animals constituted a minority, and that their omission would not compromise the analyses to a great extend. It was possible to assess NLB and NLW relative to PY for ewes with adequate records. Average (±SD) ages at the recording of WW and LW were respectively 112±17 days and 377±53 days. A total number of 57 breeders contributed data to the NSIS Dohne Merino database, and the pedigree file contained 153265 animals, the progeny of 1718 sires and 44452 dams.

The data for WW and yearling traits were subjected to a four-trait genetic analysis using ASREML (Gilmour *et al.* 2006). Fixed effects were contemporary group x sex (male vs. female), birth type (single vs. multiple), dam age (maiden or mature), animal age as a linear covariate for WW and LW as well as the interaction of sires with flock-year-season classification (defined as unique contemporary groups) as an additional random effect for yearling traits. Fitting the latter effect to WW data proved to be problematic, as it was recorded over a much shorter interval, and fewer sires used across flock-year-season groups provided data. Direct additive effects were fitted for all traits, while the maternal genetic effect and the covariance between direct and maternal genetic effects (for the estimation of the direct-maternal correlation – r_{AM}) were fitted additionally for WW. The analysis of reproduction traits included contemporary group and PY as a linear covariate on analyses on NLB and NLW, to adjust for the fact that some ewes had more opportunities to reproduce. Only the direct additive effect of animal was fitted for these traits.

RESULTS AND DISCUSSION

Descriptive statistics for the data are represented in Table 1. The coefficients of variation accorded with the range of comparable values for wool breeds sourced from the literature.

Table 1. Number of records (N), means, standard deviations (SD), coefficients of variation (CV) and the data range for weaning weight (WW), yearling live weight (LW), yearling clean fleece weight (CFW) yearling mean fibre diameter (FD), number of lambs born (NLB), number of lambs weaned (NLW) and years in production (PY)

Trait	N	Mean	SD	Range of values	CV (range in the literature*)
WW (kg)	128994	30.1	6.9	10.0 – 60.0	22.9 (16 – 25)
LW (kg)	92316	53.0	13.5	21.0 – 103.0	25.5 (13 – 28)
CFW (kg)	90668	3.16	1.14	0.57 – 9.94	36.1 (17 -42)
FD (μm)	91203	18.7	1.6	13.1 – 25.9	8.4 (7 – 12)
NLB	18331	3.18	2.20	1 – 16	69.1 (46 – 65)
NLW	18331	2.74	2.04	1 – 16	74.5 (47 – 81)
PY (years)	9084	2.54	1.44	1 – 9	56.7

*Safari *et al*. (2005); Olivier and Cloete (2007); Safari *et al*. (2007); Huisman *et al*. (2008)

Random effects. Sire x flock-year-season effects amounting to approximately 0.02 for yearling traits were consistent with previous estimates of 0.017 to 0.019 for the Dohne Merino breed (Van Wyk *et al*. 2008). Derived heritability (h^2) estimates were contrasted with those in the literature for Dohne Merinos (mostly from within flock analyses, except for the paper by Van Wyk *et al*. 2008), and Merinos (from comparable breed analyses, or from a large across experimental flock analysis in the case of Safari *et al*. 2007). The h^2 estimates from the present study were within the ranges reported previously for Dohne Merinos for the respective yearling traits. With the exception of WW, the estimates were slightly below the range reported for analyses on Merinos involving large databases. When literature values were compared, the range of h^2 estimates for Dohne Merinos appeared to be slightly below those for Merinos, although some overlap occurred.

The estimates of the maternal heritability (m^2) for WW amounted to 0.12±0.01, with an estimate for r_{AM} of -0.37±0.02. These values were consistent with estimates of 0.12 for m^2 and -0.21 for r_{AM} in Australian Merino resource flocks (Safari *et al*. 2007). Corresponding values for commercial Australian Merinos were 0.23 for m^2 and -0.37 for r_{AM} when progeny of known parentage were used (Huisman *et al*. 2008). Safari *et al*. (2005) reported averaged parameters of 0.21 for m^2 and 0.35 for r_{AM} in wool sheep.

Table 2. Estimates for the phenotypic variance (σ^2_P), sire x flock-year-season effect (SFYS), direct heritability (h^2), genetic correlations (r_g) and phenotypic correlations (r_g) for weaning weight (WW), yearling live weight (LW), clean fleece weight (CFW) and mean fibre diameter (FD)

Parameter and trait	Trait			
	WW	**LW**	**CFW**	**FD**
σ^2_P	17.7	30.3	0.285	1.46
SFYS	-	0.02±0.00	0.02±0.00	0.02±0.00
Estimates of h^2 (on diagonal), r_g (above diagonal) and r_p (below diagonal)				
WW	**0.30±0.01**	0.83±0.01	0.32±0.02	0.12±0.02
LW	0.29±0.01	**0.30±0.01**	0.17±0.02	0.17±0.02
GFW	0.18±0.00	0.37±0.00	**0.22±0.01**	0.18±0.02
FD	0.05±0.01	0.21±0.01	0.18±0.00	**0.49±0.01**
Range of h^2 values in the literature				
Dohne Merino*	0.21	0.17 – 0.33	0.19 – 0.35	0.43 – 0.61
Merino**	0.23 – 0.40	0.33 – 0.43	0.29 – 0.42	0.55 – 0.77

* Cloete *et al*. (1998); Cloete *et al*. (2001); Van Wyk *et al*. (2008)
** Safari *et al*. (2005); Olivier and Cloete (2007); Safari *et al*. (2007); Huisman *et al*. (2008)

The genetic correlation between WW and LW amounted to 0.83, a value comparable to estimates of 0.78 for commercial Australian Merinos (Huisman and Brown 2008), and 0.85 derived from the literature (Safari *et al*. 2005). Genetic correlations of weight traits with CFW were positive, as was correlations with of body weights and CFW with FD. Comparable genetic correlations derived by Safari *et al*. (2005) from the literature were 0.21 between WW and CFW, 0.24 between LW and CFW, 0.05 between WW and FD, 0.20 between LW and FD and 0.28 between CFW and FD. The present estimates are consistent with these. The genetic correlation between LW and FD accordingly amounted to 0.22 in the study of Huisman and Brown (2008).

Heritability estimates for reproduction traits amounted to 0.15±0.01 for NLB, 0.14±0.01 for NLW and 0.13±0.02 for PY. Corresponding values in the literature for reproduction over a number of lambing seasons were 0.14 for NLW in Western Australian Merinos (Cloete *et al.* 2002). Estimates of h^2 for Australian Merinos amounted to 0.09 for NLB and 0.07 for NLW (Huisman *et al*. 2008). The correspondence of derived coefficients of variation and h^2 estimates for reproduction traits with literature values indicates that the analyses were quite robust. The exclusion of a minority of ewes that failed to reproduce repeatedly (and thus not contribute any data to analyses on reproduction traits) thus seems to have a minor effect. This is not surprising, as Merino ewes failing to lamb at both 2 and 3 years of age only constitute ~3% of ewes recorded (Cloete and Heydenrych 1987)

Genetic and phenotypic correlations of reproduction traits with WW and yearling LW as well as with fleece traits are provided in Table 3. Genetic correlations with NLB were positive, ranging from 0.12 in the case of CFW to 0.20 in the case of FD. Genetic correlations with NLW were accordingly positive, with a range from 0.16 for LW to 0.22 for FD. Comparable genetic correlations with NLB for Australian Merinos amounted to 0.26 for WW and 0.16 for LW (Huisman and Brown 2008). Corresponding genetic correlations with NLW were 0.23 and 0.20 respectively. Genetic correlation estimates derived from the literature by Safari *et al.* (2005) also reflect positive correlations of live weight with reproduction. With NLB, these correlations amounted to 0.15 for WW and 0.23 for LW. Corresponding correlations with NLW were respectively 0.18 and 0.29. Cloete *et al.* (2002) accordingly reported positive correlations of NLW with CFW (0.29) and FD (0.16). These results suggest that higher reproducing sheep will also have broader fibres. Production traits were not significantly related to PY. The genetic correlation between NLB and NLW amounted to 0.81±0.00. This estimate accorded with the corresponding genetic correlation of 0.84 as derived by Safari *et al.* (2005).

Table 3. Genetic and phenotypic correlations of weaning weight (WW), yearling liveweight (LW), clean fleece weight (CFW) and mean fibre diameter (FD) with the reproduction traits number of lambs born (NLB), number of lambs weaned (NLW) and years in production (PY)

Reproduction Trait	Type of correlation	Production trait			
		WW	LW	CFW	FD
NLB	Genetic	0.12±0.04	0.15±0.04	0.12±0.04	0.20±0.04
	Phenotypic	0.08±0.01	0.11±0.01	0.06±0.01	0.06±0.01
NLW	Genetic	0.21±0.04	0.16±0.04	0.20±0.04	0.22±0.04
	Phenotypic	0.03±0.00	0.10±0.01	0.07±0.01	0.06±0.01
PY	Genetic	0.00±0.03	0.02±0.06	0.06±0.06	0.04±0.06
	Phenotypic	-0.01±0.01	0.02±0.01	-0.00±0.01	-0,00±0.01

CONCLUSIONS

This study suggests that genetic parameters for the South African Dohne Merino breed were mostly consistent with those for other Merino type breeds in the literature, albeit that h^2 estimates for yearling traits were in the lower ranges of those reported for Merinos. Breeding plans similar to those in other wool breeds may thus be implemented successfully in the Dohne Merino. The only unfavourable genetic correlations were those of FD with LW, CFW and reproduction. Based on these parameters, sustainable genetic progress seems feasible in the breed.

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