

## GENETIC PARAMETERS FOR PHYSIOLOGICAL CHARACTERS IN MERINO RAMS IN CENTRAL AND NORTH WEST QUEENSLAND

Mary Rose and P.M. Pepper

Sheep and Wool Institute, Dept of Primary Industries, Animal Research Institute, Yeerongpilly, Qld 4105

### SUMMARY

Genetic and phenotypic parameters for respiration rate (RR) and rectal temperature (RT) are presented for weaner and hogget Merino rams, at Longreach and Julia Creek, Queensland. Heritability estimates for RT and RR at both sites and at both ages ranged from moderate to very high. Phenotypic and genetic correlations between these characters are also reported.

**Keywords:** Merino rams, genetic parameters, rectal temperature, respiration rate.

### INTRODUCTION

Rose (1972; 1974) has reported very low productivity in Merino sheep in the semi-arid tropics. Heat stress and the very seasonal pasture conditions (Moule 1956) account for much of the loss of production. Hopkins *et al.* (1976) and Eady (1987) suggested that there were “adapted” Merinos which had significantly lower rectal temperatures and respiration rates when exposed to summer conditions and that these animals displayed significantly better production performances than the less adapted ones in the same flock. The current project was designed to identify the characteristics of sheep which may be better adapted to and more productive in this area (Rose and Pepper 1999). Data were obtained to estimate the phenotypic and genetic parameters for a large range of wool, reproduction, body and physiological characters. These parameters may then be used in selection strategies for breeding sheep with improved efficiency and production. This paper presents estimates of parameters for rectal temperature (RT) and respiration rate (RR), both as 8-month old weaners (<sup>w</sup>) and as 20-month old hoggets (<sup>h</sup>), and relationships between them at Longreach and Julia Creek, Queensland.

### MATERIALS AND METHODS

**Location, sheep and design.** These have been described in detail previously (Rose and Pepper 1999).

**Physiological measurements.** RTs and RRs were recorded in the morning commencing at 0800h and again in the afternoon commencing at 1500h during summer. The afternoon measurements were not recorded at Longreach in 1992. There were 1175 male progeny records available for RTam<sup>w</sup> and RRam<sup>w</sup>, 938 for RTpm<sup>w</sup> and RRpm<sup>w</sup>, 1128 for RTam<sup>h</sup> and RRam<sup>h</sup> and 1129 for RTpm<sup>h</sup> and RRpm<sup>h</sup>. The very few triplets were grouped with twins.

**Statistical analyses.** Analyses used the program ASREML (Gilmour *et al.* 1995 and 1998) and the model:  $y = X\beta + Z\mu + \varepsilon$  where  $y$  is a vector of observations;  $X$  is a design matrix for fixed effects  $\beta$  - site (Longreach, Julia Creek); year of birth (1992,1993,1994); birth type (single, twin) and their interactions;  $Z$  is a design matrix for random effects  $\mu \sim (0, \sigma^2G)$  - site by sire **interaction**; Residuals  $\varepsilon \sim (0, \sigma^2R)$ . Non-significant interactions of the fixed effects were dropped from the models. Heritabilities were estimated from univariate analyses. Phenotypic and genetic correlations were estimated from bivariate analyses with unstructured variance for site.sire **interaction**.

## RESULTS

**Table 1. Means for rectal temperature (RT) and respiration rate (RR) of medium Peppin Merino weaner rams measured in the morning (am) and in the afternoon (pm)**

Factors		Site	RTam (°C)	RTpm (°C)	RRam (/min)	Main effects	RRpm* (/min)	
<i>Year of birth</i>	1992	<i>Longreach</i>	40.3	a	22.9	<i>Site</i>	<i>Longreach</i>	17.5
		<i>Julia Creek</i>	39.5	40.0	13.3		<i>Julia Creek</i>	21.5
	1993	<i>Longreach</i>	39.7	40.1	16.0	<i>Year of birth</i>	1992	26.5
		<i>Julia Creek</i>	39.7	39.7	21.8		1993	21.7
	1994	<i>Longreach</i>	39.3	40.0	14.7		1994	21.9
		<i>Julia Creek</i>	39.7	40.0	19.1			
<i>Birth type</i>	Single		39.7	b	17.4	<i>Birth type</i>	Single	21.7
	Twin		39.7		18.5		Twin	21.9

a – RTpm and RRpm were not recorded at Longreach in 1992. b – Not estimable as the value depends on the order model terms are fitted. \* - Site x year interaction not significant for RRpm

**Effects of environmental factors.** Table 1 presents means for rectal temperatures (RT) and respiration rates (RR) of medium Peppin Merino weaner rams measured in the morning (am) and in the afternoon (pm) for each site and for year of birth. Site x year interactions were significant for all characters except RRpm. RRpm was higher at Julia Creek than at Longreach and was highest for rams born in 1992. Birth type had a very much smaller effect on each character and there were no significant interactions with site or year. RT and RR means for medium Peppin Merino hoggets measured at 20 months of age in the morning (am) and in the afternoon (pm) for each site and for year of birth are shown in Table 2. Again site x year interactions were significant for all characters while birth type had a much smaller effect on the characters measured and there were no significant interactions with site or years. For all estimates, year of birth and year of measurement were confounded and site was confounded with temperature and humidity. Since dry and wet bulb measurements were recorded at the start and end of the measurement period and the order of measurement of sheep was recorded, use of these as covariates may eliminate or elucidate the interactions between year and site.

**Phenotypic and genetic parameters.** Table 3 presents heritabilities and genetic and phenotypic correlations for each of the characters, measured as weaners and as hoggets. While it would have been possible to estimate a combined parameter across sites for some of the characters, for consistency the random sire by site interaction term has been retained in the final model for all parameters. The estimates of heritability for both sites were similar and moderately high for RTam<sup>w</sup>, RRpm<sup>w</sup> and RRam<sup>h</sup> and low to zero for RTpm<sup>h</sup>. For the characters, RTpm<sup>w</sup>, RRam<sup>w</sup> and RTam<sup>h</sup>, the estimates were high at Julia Creek and low at Longreach while the heritability of RRpm<sup>h</sup> was high at Longreach and low at Julia Creek. The highest phenotypic correlations were positive ones between RTam<sup>w</sup> and RTpm<sup>w</sup> at Julia Creek, between RRam<sup>h</sup> and RRpm<sup>h</sup> at both Longreach and Julia Creek and between RRam<sup>w</sup> and RRpm<sup>w</sup> at Julia Creek. Many of the estimates were low or zero and there

were inconsistencies in the estimates between sites. There were a number of very high genetic correlations but again many of the estimates were low or zero.

**Table 2. Means for rectal temperature (RT) and respiration rate (RR) of medium Peppin Merino hogget rams measured in the morning (am) and in the afternoon (pm)**

Factors		Site	RTam ( $^{\circ}$ C)	RTpm( $^{\circ}$ C)	RRam(/min)	RRpm(/min)
<i>Year of birth</i>	1992	<i>Longreach</i>	39.8	40.2	22.3	25.1
		<i>Julia Creek</i>	39.6	39.7	19.1	18.9
	1993	<i>Longreach</i>	39.6	39.5	16.7	20.7
		<i>Julia Creek</i>	39.6	39.9	12.9	22.4
	1994	<i>Longreach</i>	39.4	39.9	23.0	26.8
		<i>Julia Creek</i>	39.4	39.6	16.3	19.5
<i>Birth type</i>	Single		39.6	39.8	19.0	22.8
	Twin		39.5	39.8	17.9	21.7

## DISCUSSION

As expected these characters are heritable. The interactions and resultant differences between sites may result from measurement under field conditions where ambient temperature and humidity may differ between sites as well as during measurement. Morning records would be expected to show the sheep's normal RT and RR while the afternoon measurement would record RT and RR after the hottest part of the day. If there is a threshold temperature above which only more "adapted" animals can control their RT and RR, measuring them at different temperatures may record quite different things. Some sheep at Julia Creek have been shown not to be able to return their RTs to the normal range overnight during very hot weather. Under such conditions even RTam would be elevated above normal. Use of dry and wet bulb thermometer readings and the order of measurement of animals may elucidate this. Further analyses of relationships of corrected parameters and production characters will allow the examination of the use of physiological characters as selection criteria for breeding objectives appropriate to the area.

## ACKNOWLEDGEMENTS

We acknowledge the field work of all at Longreach and Julia Creek, especially Joanne Bailey, Susan Peart, Quenton Scott and David Cobon and the assistance of Annette Cotton and Roselyn Bright.

## REFERENCES

- Eady, S.J. (1987) MSc Thesis: James Cook University of North Queensland.  
 Gilmour, A.R., Cullis, B.R., Welham, S.J. and Thompson, R. (1998) ASREML. NSW Agriculture.  
 Gilmour, A.R., Thompson, R. and Cullis, B.R. (1995) *Biometrics* **51**:1440.  
 Hopkins, P.S., Pratt, M.S., and Knights, G.I. (1976) In "Sheep Breeding", p.131, editors G.L. Tomes, D.E. Robertson and R.J. Lightfoot, Butterworths: Sydney.  
 Moule, G.R. (1956) In *Aust. Vet. J.* **32**:289.  
 Rose, Mary (1972) *Aust. Soc. Anim. Prod.* **9**:48.  
 Rose, Mary (1974) *Aust. Soc. Anim. Prod.* **10**:367.

Rose, Mary and Pepper, P.M. (1999) *Proc. Assoc. Advmt Anim. Breed. Genet.***13**:114.

**Table 3. Phenotypic and genetic parameters for rectal temperature (RT) and respiration rate (RR) of medium Peppin Merino rams measured in the morning (am) and in the afternoon (pm) as weaners (<sup>w</sup>) and as hoggets (<sup>h</sup>)**

Factors	RTam <sup>w</sup> (°C)	RTpm <sup>w</sup> (°C)	RRam <sup>w</sup> (/min)	RRpm <sup>w</sup> (/min)	RTam <sup>h</sup> (°C)	RTpm <sup>h</sup> (°C)	RRam <sup>h</sup> (/min)	RRpm <sup>h</sup> (/min)
L.S. Mean	39.7	40.0	18.0	21.8	39.6	39.8	18.4	22.2
Heritability								
<i>Longreach</i>	0.31 (0.12)	0.18 (0.13)	0.19 (0.10)	0.34 (0.15)	0.13 (0.09)	0.12 (0.09)	0.26 (0.11)	0.50 (0.15)
<i>Julia Creek</i>	0.32 (0.15)	0.62 (0.18)	0.67 (0.18)	0.36 (0.14)	0.30 (0.14)	0.06 (0.10)	0.30 (0.13)	0.13 (0.11)
RTam <sup>w</sup>								
<i>Longreach</i>		0.37(0.04)	0.21(0.04)	0.11(0.05)	0.24(0.04)	0.09(0.04)	0.06(0.04)	-0.01(0.04)
<i>Julia Creek</i>		0.56(0.03)	0.36(0.05)	0.11(0.05)	0.10(0.05)	0.04(0.05)	0.03(0.05)	0.05(0.05)
RTpm <sup>w</sup>								
<i>Longreach</i>	0.17(0.43)		0.01(0.05)	0.18(0.05)	0.18(0.05)	0.20(0.05)	-0.04(0.05)	0.04(0.05)
<i>Julia Creek</i>	0.90(0.08)		0.27(0.05)	0.21(0.05)	0.09(0.05)	0.09(0.05)	0.11(0.05)	0.14(0.05)
RRam <sup>w</sup>								
<i>Longreach</i>	-0.03(0.33)	-0.59(0.46)		0.33(0.04)	-0.04(0.04)	0.02(0.04)	0.26(0.04)	0.21(0.04)
<i>Julia Creek</i>	0.38(0.19)	0.44(0.17)		0.42(0.04)	-0.04(0.05)	-0.03(0.05)	0.28(0.05)	0.34(0.05)
RRpm <sup>w</sup>								
<i>Longreach</i>	-0.34(0.33)	-0.60(0.40)	0.88(0.23)		0.01(0.05)	0.11(0.05)	0.26(0.05)	0.34(0.04)
<i>Julia Creek</i>	0.50(0.20)	0.47(0.18)	0.98(0.07)		-0.03(0.05)	-0.06(0.05)	0.33(0.04)	0.36(0.04)
RTam <sup>h</sup>								
<i>Longreach</i>	0.75(0.28)	-0.38(0.59)	0.24(0.43)	-0.22(0.46)		0.24(0.04)	0.16(0.04)	0.15(0.04)
<i>Julia Creek</i>	-0.45(0.21)	0.02(0.22)	-0.14(0.21)	-0.01(0.24)		0.27(0.04)	0.09(0.05)	-0.01(0.05)
RTpm <sup>h</sup>								
<i>Longreach</i>	0.12(0.35)	1.08(0.40)	0.10(0.44)	0.56(0.47)	0.63(0.42)		0.09(0.04)	0.19(0.04)
<i>Julia Creek</i>	0.05(0.34)	0.37(0.30)	-0.12(0.30)	-0.15(0.33)	0.76(0.26)		0.01(0.05)	0.14(0.05)
RRam <sup>h</sup>								
<i>Longreach</i>	-0.28(0.29)	-1.06(0.34)	0.76(0.25)	1.06(0.20)	-0.24(0.40)	-0.14(0.41)		0.44(0.03)
<i>Julia Creek</i>	0.40(0.23)	0.45(0.20)	0.70(0.15)	0.82(0.14)	0.05(0.24)	0.40(0.34)		0.45(0.04)
RRpm <sup>h</sup>								
<i>Longreach</i>	-0.50(0.23)	-0.34(0.36)	0.66(0.22)	0.93(0.14)	0.04(0.33)	0.82(0.30)	0.77(0.15)	
<i>Julia Creek</i>	0.61(0.20)	0.56(0.20)	0.96(0.11)	1.17(0.11)	0.11(0.27)	0.35(0.35)	0.68(0.17)	

Phenotypic correlations are above the diagonal and genetic correlations below (SE in brackets)