Proc. Assoc. Advmt. Anim. Breed. Genet. 20:459-462

GENETIC ANALYSIS OF ABSENCE OF BREECH STRIKE AND BREECH STRIKE INDICATOR TRAITS IN SOUTH AFRICAN MERINO SHEEP

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SUMMARY

The sheep blowfly is an economically important ectoparasite of sheep, and impacts on animal health and welfare under pastoral conditions in South Africa. The absence of flystrike in the breech (ABS) was recorded in 2198 Merino hoggets on the Tygerhoek Research Farm. This trait was analysed together with dag score (DS; n=1623); neck wrinkle score (NWS; n=2162); midrib wrinkle score (MWS; n=2162) and breech wrinkle score (BWS; n=2162) in a five-trait threshold model, using Bayesian inference and Gibbs sampling. ABS occurred at a frequency of 0.89. Estimates of direct heritability (s.e.) amounted to 0.20 (0.06) for ABS, 0.24 (0.07) for DS, 0.31 (0.08) for NWS, 0.34 (0.06) for MWS and 0.36 (0.08) for BWS. The genetic correlation of ABS with DS was favourable at -0.47 (0.20) and significant ($P < 0.05$). The genetic correlations of ABS with NWS, MBS and BWS were all favourable at -0.78 (0.21), -0.74 (0.16) and -0.78 (0.18) respectively (all $P < 0.05$). Genetic correlations among wrinkle scores (WS) were all high (> 0.88). Selection for a reduction in DS and in wrinkles on any part of the body will benefit ABS.

INTRODUCTION

Mulesing in South Africa was officially banned in 2009 as a method to control breech strike in woolled sheep when the South African National Wool Grower's Association (NWGA) and the National Society for the Prevention of Cruelty to Animals (NSPCA) jointly announced: '*The practice of mulesing is cruel and causes pain and stress to the animal and is a contravention of the Animal Protection Act no. 71 of 1962'* (NWGA 2009). With the cessation of mulesing world-wide as a method to control breech strike, studies have been increasingly directed towards genetic alternatives for the prevention of breech strike (see references in Table 3). The susceptibility of a flock to breech strike is strongly associated with the degree of breech wrinkles and/or dags. It is conceded that emphasis on each of the latter traits could vary dependent upon the environment and type of sheep. Other traits, such as breech cover scores, urine stain and wool colour scores were also identified as potential indicator traits for the prevention of breech strike. Genetic parameters for these indicator traits are available in the literature; indicating that they do exhibit additive genetic variation (see Table 3 for recent estimates on dag and wrinkle scores). This paper reports on genetic parameters for the latter breech strike indicator traits under South African conditions.

MATERIALS AND METHODS

Records were obtained from Merino sheep maintained on the Tygerhoek Research Farm, near Riviersonderend in the Western Cape Province, from 2003 to and including 2010. The climate at this site is Mediterranean, with approximately 60% of the annual rain of 425 mm expected from April to September. Peaks in blowfly activity are expected during October-November and again in February-March. Ewes were mated during October-November to lamb during March-April of the following year, throughout the period of data recording. All progeny born were tail docked at the third palpable joint before they were four weeks old. Lambs were shorn as weaners in August-September of each year, crutched in February and shorn again as hoggets in August-September of the following year when they had 1 year of wool growth. Weaners were maintained in single flocks (separated on gender) after weaning. All progeny were subjected to visual appraisal of wrinkle score (WS) on the neck (NWS), midrib (MWS) and breech (BWS) at an age of approximately 16 months (Dun and Hamilton 1965). WS was assessed on a 1-6 scale (with 1 being lowest level), which differs from the method of Mortimer *et al*. (2009) and others which only used a 1-5 scale. Progeny were also visually appraised for dag score (DS) just before being shorn as hoggets. The latter trait was scored on a 5-point scale, with 5 being the highest level. DS and BWS are considered as indicator traits for ABS during selection. ABS was recorded in all animals during the 1-year wool growth period between weaner and hogget shearing (Cloete *et al*. 2001). These records were confirmed at hogget shearing in August-September, where needed. Routine management for the prevention of flystrike included the prophylactic treatment of all short-wool animals during November-December. Spot treatment with a long-acting chemical was administered to those sheep suffering from breech strike after the strike had been recorded. Individual sheep were recorded as either having contracted breech strike or not, (i.e. the distribution was binomial). Data were available on a total of 2198 animals. No ABS or WS data were recorded for the progeny group of 2004, and data for this year were excluded. Recording of DS data (n=1623) commenced later, starting with the progeny group of 2006.

Statistical Analysis: A five-trait threshold animal model, applying Bayesian inference and Gibbs sampling in THRGIBBS1F90 software were used (Misztal 2008) to estimate additive genetic variances for each trait. The analysis involved 300000 samples, 50000 of which formed the burn-in period. Every 10th sample of the subsequent 250000 samples was used to calculate posterior means and posterior standard deviations depicting the genetic and environmental (co)variances. Post-Gibbs analysis was done with POSTGIBBSF90 (Misztal 2008).

RESULTS AND DISCUSSION

Distributions for DS and WS approximated normality, but all were treated as threshold traits (Table 1). The highest WS was recorded on the neck of the animals. ABS occurred at a frequency of 0.89.

Table 1. Descriptive statistics for the traits included in the five-trait analysis

Trait	Number	Mean±s.d.	Range	Skewness	Kurtosis
Dag score	1623	2.13 ± 1.17	1-5	0.84	-0.22
Absence of breech strike	2198	0.89 ± 0.31	0-1	4.49	-2.55
Neck wrinkle score	2162	3.73 ± 0.90	1-6	0.23	0.12
Midrib wrinkle score	2162	3.13 ± 0.73	1-6	0.56	0.61
Breech wrinkle score	2162	3.22 ± 0.76	1-6	0.79	1.50

All traits were moderately heritable, estimates ranging from 0.20 for ABS to 0.36 for BWS (Table 2). DS was moderately heritable at 0.24. Estimates from the literature (last 5 years) for DS varied widely, ranging from 0.08 to 0.63 (Table 3), a range that included the present estimate. ABS on the underlying scale was also moderately heritable at 0.20. Preventative chemical treatment and crutching applied to the animals could protect animals against breech strike for up to 12 weeks. Strikes occurring in the remainder of the period, albeit sporadic in some years, were sufficient for genetic variation to be detected. This opens up the possibility of increasing ABS by direct selection, thereby reducing reliance on chemicals for prevention and for spot treatment of strikes, as well as the need for the Mules operation. Estimates for the heritability of breech strike were generally higher than the present estimate, ranging from 0.32 to 0.57 (Table 3). The present heritability estimate for NWS (0.31) was slightly below estimates amounting to 0.42 in the literature (Table 3). The heritability estimate for MWS (0.34) is comparable to recent estimates of 0.25 to 0.42 (Table 3). Heritability estimates for BWS ranged from 0.35 to 0.69 in the literature (Table 3). The heritability estimate of 0.36 reported in this study is on the lower boundary of this range. Results from this and other studies suggest that heritability estimates for WS on the respective body regions are high enough to support substantial selection gains.

Table 2. Phenotypic variance components (σ^2_P) and (co)variance ratios (±s.e.) for dag score (DS), absence of breech strike (ABS), neck wrinkle score (NWS), midrib wrinkle score (MWS) and breech wrinkle score (BWS)

Trait	DS	ABS	NWS	MWS	BWS
Variance ratios and posterior standard deviations (PSD)					
σ^2_P	1.629	1.260	0.854	0.345	0.609
(Co)variance ratios (heritability in bold on the diagonal, r_g above the diagonal and r_e below the diagonal)					
DS	**0.24 ± 0.07**	-0.47 ± 0.20	0.03 ± 0.15	0.17 ± 0.16	0.09 ± 0.015
ABS	0.18 ± 0.07	**0.20 ± 0.06**	-0.78 ± 0.21	-0.74 ± 0.16	-0.78 ± 0.18
NWS	0.03 ± 0.05	0.01 ± 0.06	**0.31 ± 0.08**	0.95 ± 0.17	0.89 ± 0.15
MWS	-0.05 ± 0.06	0.01 ± 0.07	0.79 ± 0.09	**0.34 ± 0.06**	0.95 ± 0.18
BWS	0.09 ± 0.06	-0.04 ± 0.07	0.62 ± 0.08	0.71 ± 0.10	**0.36 ± 0.08**

Table 3. Heritability estimates (h^2) from the literature (last 5 years) for post-weaning (unless indicated otherwise) dag score (DS), absence/presence of breech strike (ABS), neck wrinkle score (NWS), midrib wrinkle score (MWS) and breech wrinkle score (BWS)

Trait	h^2	Reference	Comment
DS	0.09 ± 0.06	Smith *et al*. (2009)	6 months old (post-weaning stage)
	0.28 ± 0.02	Brown *et al*. (2010)	Late (yearling and hogget age)
	0.31 ± 0.01	Pickering *et al*. (2010)	Lambs (8 months)
	0.08 ± 0.07	Scobie *et al*. (2011)	Yearlings
	0.63 ± 0.08	Greeff *et al*. (2013)	Yearlings
	0.37 ± 0.05	Greeff *et al*. (2013)	Hoggets
ABS	0.46 ± 0.23	Scholtz *et al*. (2010)	15 – 16 month unmulesed animals
	0.57 ± 0.28	Greeff and Karlsson (2009)	Birth – hogget age; threshold trait
	0.32 ± 0.11	Smith *et al*. (2009)	Weaners; continuous trait
	0.51 ± 0.10	Greeff *et al*.(2013)	Birth – hogget age; threshold trait
NWS	0.42 ± 0.01	Mortimer *et al*. (2009)	15 - 16 month old ewes
	0.42 ± 0.12	Scholtz *et al*. (2010)	15 – 16 months unmulesed animals
MWS	0.25 ± 0.10	Smith *et al*. (2009)	6 months old (post weaning stage)
	0.42 ± 0.01	Mortimer *et al*. (2009)	15 - 16 month old ewes
	0.30 ± 0.10	Scholtz *et al*. (2010)	15 – 16 month unmulesed animals
BWS	0.36 ± 0.12	Smith *et al*. (2009)	6 months old (post-weaning stage)
	0.69 ± 0.05	Brown *et al*. (2010)	Late (yearling and hogget age)
	0.45 ± 0.13	Scholtz *et al*. (2010)	15 – 16 month unmulesed animals
	0.35 ± 0.06	Greeff *et al*. (2013)	Yearlings
	0.50 ± 0.08	Greeff *et al*. (2013)	Hoggets

The occurrence of flystrike depends on weather conditions, which are often transient and unpredictable. Selection gains under such conditions are often difficult to achieve, even without the added complication of ABS being evaluated on the binomial scale and the fact that adequate blowfly challenge impinges on the welfare of animals. Significant heritability estimates reported here and in the literature suggest that direct selection for ABS will be successful under adequate challenge. Selection responses may, however, be slow under conditions of suboptimal challenge. The unpredictability of flystrike, the widespread use of prophylactic treatments such as jetting and crutching, as well as animal welfare concerns under adequate challenge conditions, adds to arguments for indirect selection instead of direct selection for ABS (Scholtz *et al*. 2010).

Genetic correlations of ABS with the indicator traits were all favourable and larger than twice the corresponding standard error, ranging from -0.47 for DS to -0.78 for NWS and BWS (Table 2). Wrinkly sheep are thus more susceptible to breech strike than their plainer contemporaries. Genetic correlations between breech strike and BWS amounted to 0.23 (Greeff and Karlsson 2009) as well as to 0.27 (yearling age) and 0.13 (hogget age) (Greeff *et al*. 2013). The difference in sign between the latter estimates and those in the present study stems from the ABS being analysed in the present study, whereas the latter authors studied the incidence of breech strike.

The genetic correlations among WS on different body parts were all higher than 0.88 and approached unity in some cases (Table 2), suggesting that WS is effectively the same trait irrespective of body location. These estimates are consistent with earlier genetic correlations exceeding 0.90 among WS on different body regions (Jackson and James 1970; Mortimer and Atkins 1993, Mortimer *et al*. 2009), confirming these traits to be genetically very similar.

CONCLUSIONS

It is evident that selection for a reduction in DS and wrinkle score on any part of the body will benefit ABS in this environment in South Africa. Further research on the incorporation of direct and indirect selection for ABS as part of an integrated blowfly management programme is needed, to ensure that the problem is dealt with in a sustainable manner while simultaneously ensuring that the welfare of animals is not compromised.

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