HERITABILITY AND PHENOTYPIC CORRELATIONS FOR BREECH STRIKE AND BREECH STRIKE RESISTANCE INDICATORS IN MERINOS

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SUMMARY

Mulesing is a means of blowfly strike control in Australian Merinos. Among potential mulesing alternatives, selective breeding for resistance is widely viewed to be the best long-term solution. Using data from the CSIRO Breech Strike Resistance Flock at Armidale (n=1656), heritability and phenotypic correlations between breech strike and indicator traits (including breech and crutch cover, wrinkles, dags, urine stain and fleece characteristics) are reported. Weaner breech strike heritability was estimated at 0.32 (0.11). With the exception of dags (0.09) all of the breech strike indicators were at least moderately heritable (>0.20). Breech wrinkle and dags were the indicator traits most closely correlated phenotypically with breech strike (both 0.22).

INTRODUCTION

Selection of Australian Merinos for breech strike resistance is a potential alternative to mulesing as a means of reducing breech strike (James 2006). It is undesirable on both ethical and economic grounds to artificially challenge animals with flystrike for selection purposes, so knowledge of potential indirect selection criteria is necessary to aid incorporation of breech strike resistance into Merino breeding programs. Using the CSIRO Armidale Breech Strike Resistance Flock, heritability and phenotypic correlations for breech strike and a suite of potential indicator traits were estimated with the aim of determining which of those indicators are the most promising candidates as selection criteria for breech strike resistance in Merino breeding programs.

METHOD

Animals. The Breeding for Breech Strike Resistance Project is an evaluation of the impact of not mulesing and the effectiveness of breeding for breech strike resistance using indicator traits. The program is being carried out in two different environments, Armidale in NSW representing the summer rainfall zone and Mt Barker in WA representing the winter rainfall zone. The flock at each location comprises 3 lines – an unselected control (UC), a commercial improvement line (CI, utilising a base of unselected ewes mated to plain breech sires), and a plain breech line (PB, both ewes and sires selected for plain breech characteristics). The Armidale flock was established in 2005 from a combination of purchased 2005 drop ewe weaners (n=644, from 11, mostly finewool, eastern states flocks) and 600 CSIRO Chiswick Station ewes, screened into the 3 selection lines based on phenotypic adult body wrinkle. Replacement ewes for the PB line are selected using breech strike resistance indicator traits (primarily breech cover, crutch cover and breech wrinkle), and for the UC and CI lines are chosen at random and the number balanced across lines. Link sires are used across years and sites. Most of the sires represented are from industry flocks (of a range of wool types) evaluated in Sheep Genetics (Brown *et al.* 2007). Half of the animals within each selection line are mulesed and the other half are unmulesed. No preventative chemical treatments for flystrike are applied. The 2005 drop animals, sourced from industry had unknown pedigree. In total, 34 sires from 17 Merino studs are represented with 14-78 progeny per sire group.

Measurements. Incidence of breech and body strike was recorded during the first flystrike season for weaner animals born between 2005 and 2008 inclusive (n=1656). Flystrike usually occurs in

the Armidale environment in the period Oct-Apr inclusive and the animals were approximately 2 mths of age at the start of the flystrike season. The sheep were inspected for flystrike at least 3 times weekly throughout the flystrike season. Struck animals had details of the strike recorded and were treated with short-acting insecticide (Extinosad^{TM}). The breech strike trait reported here is a count (natural logarithm transformed) of breech strikes during the flystrike challenge period.

Breech strike indicator traits were recorded at post-weaning stage (6mths, late February). The breech traits were breech cover, crutch cover, body wrinkle, breech wrinkle and dags (AWI 2007)). Urine stain was scored 1-5 on females. Yearling (pre-shearing) greasy wool colour and fleece rot scores were also recorded. All of these traits were approximately normally distributed.

Statistical analyses. Univariate analysis of covariance was conducted using ASReml to determine fixed effects (Gilmour *et al.* 2002). The factors included were selection line, sire and dam wool type, year/property-of-origin, mulesed/unmulesed, sex, damage, birth-rearing type, lambing management flock, scorer, and cannonbone length (as an indicator of body size) and weaning bodyweight were fitted as covariates. The sire and dam wool types, based on Sheep Genetics (2006) groupings, were effectively genetic group effects fitted to adjust for sheep type differences among selection lines. Bivariate sire models were fitted to estimate heritabilities and phenotypic correlations among the breech traits. At this stage the dataset is not sufficiently robust to justify reporting of the genetic correlations, the standard errors of which are large. Initially, repeatability analysis of flystrike (by month) was attempted, but the flystrike data were too sparse for that statistical model to operate effectively, which is why the trait reported upon here is the total count of flystrikes for the season.

RESULTS

Flystrike rates. 2006 and 2007 were the higher flystrike challenge years (Table 1). Mulesed animals consistently had lower breech strike rates than unmulesed animals and the extent of selection line differences varied with year. Breech strike rates were not significantly different among selection lines but were affected by sire wool type ($P<0.001$), where progeny from ultrafine/superfine sires had higher breech strike rates than other wool types. Year/property-of-origin ($P<0.01$), mulesing ($P<0.001$), sex ($P<0.05$, males lower than females), birth-rearing type ($P<0.01$, singletons higher than multiples) and weaning bodyweight ($P<0.001$, where smaller animals were more likely to get breech strike) were also significant effects on breech strike.

Main effects on indicator traits. Animals in the selected lines had significantly lower body and breech wrinkle and breech and crutch cover than those in the control line ($P<0.001$). Mulesed animals had significantly less breech wrinkle and cover than unmulesed animals ($P<0.001$). Progeny of ultrafine/superfine sires had higher wrinkle, breech and crutch cover than progeny of either fine/fine medium or medium/strong wool sires ($P<0.001$). Males had less body wrinkle than females ($P<0.001$), and animals born as singletons had lower body and breech wrinkle than those born and reared as multiples ($P<0.05$).

Heritability and phenotypic correlations. Body and breech wrinkle were correlated (0.29), and more wrinkly animals tended to have more urine stain (Table 2). Breech and crutch cover were correlated (0.29), but both were poorly correlated with wrinkles. Among the indicator traits, breech wrinkle and dags were those most closely correlated with breech strike (both 0.22). Breech strike and breech cover were not correlated. Yearling greasy wool colour and fleece rot were correlated (0.20), but neither of those traits were correlated with any of the other breech strike indicators, nor breech strike itself (-0.05 – 0.09), except that wool colour was correlated with urine stain (0.20).

Body and breech strike were not correlated (0.08). Body strike was correlated with fleece rot (0.23), but not wool colour (0.07).

Table 1. Percentage flystrikes by year, selection line (UC=unselected control, CI = commercial improvement, PB = plain breech), and mulesing group (M=mulesed, UM=unmulesed)

Drop	Line	n		Body strikes[#] (%)		Breech Strikes (%)		Total strikes (%)	
		M	UM	M	UM	M	UM	M	UM
2005	UC	105	111	6	0	0	7	6	7
	CI	109	109	0	1	2	14	2	15
	PB	105	105	0	0	0	8	0	8
2006	UC	70	72	3	6	17	90	20	96
	CI	67	66	6	9	0	24	6	66
	PB	70	75	1	1	1	22	3	24
2007	UC	38	38	8	13	5	71	13	84
	CI	43	44	16	20	2	36	19	57
	PB	43	43	14	7	2	33	16	40
2008	UC	52	55	4	0	4	25	8	25
	CI	60	59	3	2	3	14	7	15
	PB	60	60	0	2	5	8	5	10

[#] includes poll strikes

Table 2. Heritability (bold), phenotypic variance (V_p) and phenotypic correlations among breech strike and indicators.

Trait	V_p	Body wrinkle	Breech wrinkle	Breech cover	Crutch cover	Dag	Urine stain	Breech strike
Body wrinkle	0.38	**0.25 (0.10)**	0.29	0.03	0.11	-0.00	0.22	0.04
Breech wrinkle	0.57		**0.36 (0.12)**	0.02	0.09	0.06	0.21	0.22
Breech cover	0.45			**0.23 (0.09)**	0.29	0.01	0.05	0.01
Crutch cover	0.35				**0.47 (0.14)**	0.04	-0.05	0.09
Dag	0.43					**0.09 (0.06)**	0.00	0.22
Urine stain	0.40						**0.30 (0.20)**	0.04
Breech strike	0.06							**0.32 (0.11)**

s.e. on all correlations 0.03-0.04 except for those with urine stain which were 0.06-0.07

DISCUSSION

Low breech wrinkle and dag were the characteristics with greatest effect on breech strike rate. There was no evidence that lower breech cover reduced breech strike. Breech wrinkle and dag have also been shown to be associated with breech strike in the Mt Barker, WA flock, but there is evidence in that flock that reduced breech strike rate is also associated with lower breech cover (Greeff and Karlsson 2009). The mean breech cover score in the WA flock is lower than that in the Armidale flock which may explain the different outcomes observed.

Breech strike and, with the exception of dags, all of the breech traits were moderately heritable. However, only breech wrinkles and dags were sufficiently correlated with breech strike to be useful selection criteria. Published heritability estimates for dags vary widely with environment and age (Greeff and Karlsson 1998, 1999; Woolaston and Ward 1999). Compared to winter rainfall areas, dags in the summer rainfall environment is a somewhat 'transient' trait. This may make dags of limited use as a selection criterion for breech strike in summer rainfall areas.

Breech wrinkle however, is moderately correlated with breech strike, and is also heritable, repeatable across ages, and exhibits approximately normal distribution in the Merino population (Raadsma and Rogan 1987; Lewer *et al.* 1995; JL Smith, *unpublished data*). Breech wrinkle is also highly correlated genetically with body wrinkle (reviewed by James 2006), for which there exists considerable genetic data, including that body wrinkle measured at different ages is highly repeatable (Robinson *et al.* 2007; Hatcher *et al.* 2009). All of these features indicate breech wrinkle to be a good candidate as an indirect selection criterion for breech strike in Merinos.

The phenotypic correlation between body and breech wrinkle reported here (0.29) is lower than reports in the literature of wrinkle score correlations across the body (James 2006), and also lower than at other ages in this experiment (not reported here). This may be due to the wool length (6mths) at wrinkle scoring employed here (i.e. there is lower variance in body wrinkle with more wool length, J.L. Smith, *unpublished data*).

Preliminary evidence from the project indicates the phenotypic correlation between weaner and yearling age breech strike is moderate (not detailed here). A review by Raadsma and Rogan (1987) concluded repeatability across ages of fleece rot and body strike to be age and environment (incidence) dependent. There are insufficient data at this point to determine the correlation between weaner and adult breech strike. However, given that wrinkle score is repeatable across ages and breech wrinkle is correlated with breech strike, it could be expected that selection for low wrinkle in young animals (weaner or yearling) will be a useful selection criterion for lifetime breech strike resistance.

Breech strike was affected by sire wool type (rather than selection line), where progeny of ultrafine/superfine sires were more likely to be affected by breech strike than those with broader wool type sires. There were however, statistically significant differences among both the sire wool types and the selection lines in all of the breech strike indicator traits except dags. This might suggest that with further selection, line differences in breech strike will emerge.

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