Proc. Assoc. Advmt. Anim. Breed. Genet. 20:183-186

INHERITANCE OF FLYSTRIKE RECORDED IN A NON-SEASONAL RAINFALL ENVIRONMENT

T.L. Bird-Gardiner[125], D.J. Brown[3], J.L. Smith[4] and S.I. Mortimer[5]

[1]Cooperative Research Centre for Sheep Industry Innovation, UNE, Armidale, NSW, 2350, [2]University of New England, Armidale, NSW, 2351, [3]Animal Genetics and Breeding Unit, UNE, Armidale, NSW, 2350, [4]CSIRO Animal, Food and Health Sciences, Armidale, NSW, 2350, [5]NSW Department of Primary Industries, Trangie, NSW, 2823

SUMMARY

Flystrike records from the Sheep CRC Information Nucleus Flock (IN) were evaluated to assess the influence of sex, birth and rearing type, dam age and sire and dam breed on yearling breech and non-breech strike. Heritability of breech and non-breech strike was estimated under a range of different models, on data comprising records from progeny of three genotypes, namely Merino, Maternal-Merino and Terminal cross, run in a variable non-seasonal rainfall environment. Observed heritability estimates ranged from 0.30 ± 0.10 to 0.43 ± 0.13 for breech strike and 0.16 ± 0.06 to 0.32 ± 0.16 for non-breech strike across genotypes and models. Heritability estimates for both traits on the underlying scale were all high (>0.6), with large standard errors. Flystrike was found to have a similar heritability to estimates obtained in other environments. The identification of key indicator traits for non-seasonal rainfall environments is warranted.

INTRODUCTION

The practice of mulesing to control breech strike in sheep is under scrutiny for social and ethical reasons (James 2006). Flystrike can be controlled through various other methods, such as shearing, crutching, chemical application and breeding for flystrike resistant sheep. Research into breeding breech strike resistant sheep is currently being conducted in 2 environments, which have either a summer (Armidale, NSW; Smith *et al.* 2009) or winter dominant rainfall (Mt. Barker, WA; Greeff and Karlsson 2009). Early results from these studies have shown breech strike to be heritable. While these 2 environments represent a large proportion of sheep production areas in Australia, they do not represent pastoral areas with variable non-seasonal rainfall.

Within the IN Flock of the Cooperative Research Centre for Sheep Industry Innovation (Sheep CRC), parasite resistance of progeny bred within the flock was assessed at all 8 sites (Fogarty *et al.* 2007) and this included flystrike observations on any part of the sheep. Most of the flystrike data collected was within a non-seasonal rainfall environment. The aim of this study was therefore to identify the importance of fixed effects on the expression of yearling breech and non-breech strike in a variable non-seasonal rainfall environment and compare heritability estimates derived from different trait expression models.

MATERIALS AND METHODS

The combination of environmental effects and achieving a balance between collecting information for the parasite program and other IN programs meant that some sites implemented regimes which reduced the expression of flystrike. This is evident in the variation in flystrike across sites (Table 1). Of the 8 IN sites, incidence of flystrike was greatest at the Trangie site and it is these records that were used in this analysis. Progeny were born in 2008 to 2011 inclusive and were not mulesed. Flystrike control at the Trangie site was specific to a contemporary group and included shearing or crutching at weaning and suitable preventative chemical application on the breech and body for progeny evaluated for meat or wool traits respectively (Fogarty *et al.* 2007). Flystrike was recorded on ewes and wethers from marking to shearing (approximately 10 months of age) for wool evaluation progeny and until slaughter for meat evaluation progeny (5-10 months of age). Progeny genotypes were: Merino, Maternal-Merino and Terminal cross. Sires were only used in one year and dams across years. Sire breeds comprised: 4 Merino strains being fine, medium, strong, generic or strain cross; 5 Maternal (Dohne, South African Meat Merino, Coopworth, Corriedale, Border Leicester) and 4 Terminal (Poll Dorset, Texel, Black Suffolk, White Suffolk). SAMM, Texel and Black Suffolk sired progeny had no expression of flystrike to yearling age and were excluded from all analyses. No breech strike was recorded for White Suffolk progeny to yearling age, so these records were only included in the non-breech strike analysis. Dam breeds were condensed into 4 groups for analysis: fine Merino, medium Merino, strong Merino and crossbred. Two traits were analysed: breech strike and non-breech strike. Non-breech strike was defined as flystrike other than the breech area (Watts *et al*. 1979). Two data sets were analysed within each trait. The full data set (All) contained all Merino, Maternal and Terminal cross breeds, the Merino data set (Mer) only comprised Merinos retained for wool evaluation. The full data set contained 1321 and 1353 animals for the breech and non-breech strike respectively, whereas the Merino data set comprised 580 animals for both traits. The data were analysed as: Strikes, sum of strikes between marking and shearing for each animal; and Struck, presence of flystrike (not struck, 0; struck, 1) for each trait.

Statistical analysis. Data were analysed using ASReml (Gilmour *et al.* 2009) fitting generalised linear mixed models to evaluate fixed effects and sire or animal fitted as a random effect. Sex, year of birth x contemporary (CG; management group within birth year), birth rearing type, dam age, sire and dam breed and their interactions were fitted to each trait and were included in the models if significant (P <0.05). Variance components from the different models were used to estimate heritabilities on the observed scale and heritabilities on the underlying normal distribution scale. Data for Strikes were analysed with a sire and pedigreed animal model on the observed scale. Struck data was analysed using a sire model on the observed scale and on the underlying scale using a logit link function in a sire threshold model. The method described by Hill and Smith (1977) was used to transform heritability estimates.

RESULTS AND DISCUSSION

The incidence of flystrike was greatest at the Trangie site, with 18.2% of total animals affected. The higher incidence of flystrike at the Trangie site was due to optimal fly wave conditions occurring in 2010 and 2011 when excessive (226mm above average) rainfall was recorded.

Table 1. Flystrike incidence recorded in IN flocks, expressed as a percentage of total animals

Site	Animals	Strike Type		Breed		Age	
		Breech (%)	Non-breech (%)	Merino (%)	Non-Merino (%)	0-12m (%)	>12m (%)
Kirby	3325	0.6	0.0	0.8	0.4	0.6	0.0
Trangie	1695	14.5	6.9	36.7	6.9	9.1	12.8
Cowra	2110	3.5	1.8	11.2	1.5	1.6	3.6
Rutherglen	2213	3.6	0.6	11.2	0.8	3.7	0.6
Hamilton	1970	2.4	0.4	5.6	1.0	2.7	0.1
Struan	1980	0.9	0.6	2.7	0.7	0.9	0.6
Turretfield	2476	4.3	1.4	10.1	2.6	3.2	2.4
Katanning	4181	4.9	0.5	8.5	3.2	5.1	0.2
All sites	19950	4.0	1.2	9.4	2.1	3.3	1.9

Fixed effects. The fixed effects were of greater significance in models fitted to Strikes data than those fitted to Struck data. Only fixed effects for Strikes data are reported.
Breech strike. The expression of yearling breech Strikes was influenced (P <0.001) by sex, CG and sire by dam breed interaction for both data sets. Females had a higher incidence of breech Strikes than males. For the Merino data set, progeny born in the 2009 CG had a significantly lower expression of yearling breech Strikes than progeny born in other CG. The sire by dam breed interaction indicated that progeny from the same sire breed had varying levels of breech Strikes depending on the dam breed. The fixed effects fitted to breech Strikes were similar to previous studies (Smith *et al.* 2009).
Non-breech strike. Sex had no effect on the expression of non-breech Strikes, irrespective of breed. Significant fixed effects for the all breed data were CG with a sire by CG interaction (P <0.001) and sire by dam breed interaction (P <0.05). Only sire breed by CG (P <0.001) influenced non-breech Strikes in the Merino data.

Heritability estimates. The various models produced observed heritability estimates of similar magnitude across genotypes for breech Strikes 0.32 ±0.08 to 0.43 ± 0.13, but varied more for non-breech Strikes 0.16 ± 0.06 to 0.30 ± 0.15 (Table 2). Despite the lower incidence of non-breech Strikes compared to breech Strikes the standard errors were similar for both traits on the observed scale. Merino breech Strikes heritability estimates were similar to those reported by Smith *et al.* (2009) (0.32 ± 0.11 on the observed scale) and Greeff *et al.* (2013) (0.58 ± 0.16 on the underlying scale). The all breeds heritability estimates for Struck derived on the underlying scale were high for both traits, with large standard errors. Observed heritability estimates transformed to the underlying scale were higher than those derived from the logit link function model and some were above one (not reported). The scaling factor in the model described by Hill and Smith (1977) can

Table 2. Phenotypic variance (σ^2p) and heritability (±s.e.) estimates for yearling breech and non-breech flystrike traits; all breeds (All), Merinos (Mer), flystrike incidence (%)

Traits and Model	Incidence %	Breed	Observed scale		Transformed	Underlying scale
			σ^2p	h^2	h^2	h^2
Breech						
Strikes - Sire	8.6	All	0.11	0.42 ± 0.12	-	
Strikes - Animal	8.6	All	0.11	0.32 ± 0.08	-	
Struck - Sire	8.6	All	0.07	0.30 ± 0.10	0.95 ± 0.32	
Struck - Sire threshold	8.6	All	4.10			0.79 ± 0.26
Strikes - Sire	14.0	Mer	0.17	0.42 ± 0.17	-	
Strikes - Animal	14.0	Mer	0.16	0.43 ± 0.13	-	
Struck - Sire	14.0	Mer	0.11	0.33 ± 0.15	0.80 ± 0.36	
Struck - Sire threshold	14.0	Mer	3.85			0.58 ± 0.27
Non-breech						
Strikes - Sire	3.7	All	0.06	0.19 ± 0.08	-	
Strikes - Animal	3.7	All	0.06	0.16 ± 0.06	0.87 ± 0.33	
Struck - Sire	3.7	All	0.03	0.22 ± 0.09	-	
Struck - Sire threshold	3.7	All	3.98			0.69 ± 0.40
Strikes - Sire	4.3	Mer	0.07	0.30 ± 0.15	-	
Strikes - Animal	4.3	Mer	0.07	0.18 ± 0.10	0.88 ± 0.49	
Struck - Sire	4.3	Mer	0.04	0.32 ± 0.16	-	
Struck - Sire threshold	4.3	Mer	4.16			0.83 ± 0.53

produce inflated estimates when incidence levels within the population are less than 30% (Gilmour *et al.* 1985), as was the case in this study for both traits. Merino heritability estimates for non-breech Struck on the observed scale were similar to estimates reported by Raadsma *et al.* (1989) of 0.27 ± 0.12, but these estimates were only for body strike. Standard errors obtained on the underlying scale were larger than other published work but were similar on the observed scale (Greeff and Karlsson 2009; Smith *et al.* 2009). The size and structure of the data and incidence of flystrike would have contributed to the large standard errors obtained (van der Werf *et al.* 2010).

Heritability of binomial traits such as flystrike (when observed as absence or presence of flystrike) is related to the incidence in the population (Atkins 1979), making prediction to selection response difficult when the expression varies from year to year. Using the underlying scale of susceptibility to flystrike, the mean and heritability is not dependent on the incidence within the population. The underlying scale maps flystrike susceptibility on a continuous normal distribution scale which is expressed on the observed scale once a certain threshold is reached. Results from this study and other research indicate that susceptibility to breech strike on the underlying scale is moderately heritable and comparable to other heritability estimates derived for traits which have a continuous distribution of phenotypes such as greasy fleece weight, indicating potential for improvement through selection. But flystrike is highly dependent on environmental conditions making it difficult to include in routine selection practices. The practice of indirect selection is used to improve traits that are difficult to measure such as susceptibility to flystrike. Therefore it is important to identify easy to measure correlated traits that are associated with the expression of flystrike, which can be incorporated into breeding programs. Identifying key correlated traits (to allow selection when flystrike is not expressed) would provide selection tools to breed for flystrike resistant sheep. As research has identified that some key indicator traits are environment specific (Greeff *et al.* 2013; Smith *et al.* 2009), it is important to establish indicator traits for non-seasonal rainfall environments.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Cooperative Research Centre for Sheep Industry Innovation. Drs Arthur Gilmour and Gavin Melville are gratefully acknowledged for their statistical advice.

REFERENCES

Atkins K.D. (1979) National symposium on the sheep blowfly and flystrike in sheep. Department of Agriculture, New South Wales.

Fogarty N.M., Banks R.G., van der Werf J.H.J., Ball A.J. and Gibson J.P. (2007) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **17:**29.

Gilmour A.R., Anderson R.D. and Rae A.L. (1985). *Biometrika* **72:** 593.

Gilmour A.R., Gogel B.J., Cullis B.R. and Thompson R. (2009) 'ASReml User Guide release 3.0' VSN International Ltd: Hemel Hempstead, UK.

Greeff J.C. and Karlsson L.J.E. (2009) *Proc. Assoc. Advmt. Anim. Breed. Genet.***18:** 272.

Greeff J.C., Karlsson L.J.E. and and Schlink A.C. (2013) *Anim. Prod. Sci.* http://dx.doi.org/10.1071/AN12233

Hill W.G. and Smith C. (1977) *Biometrics* **33:** 234.

James P.J. (2006) *Aust. J. Exp. Agric*. **46:**1.

Raadsma H.W., Gilmour A.R., and Paxton W.J. (1989) *Aust. J. Agric. Res*. **40:** 207.

Smith J.L., Brewer H.G. and Dyall T. (2009) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **18:** 334.

Van der Werf J.H.J., Kinghorn B.P. and Banks R.G. (2010) *Anim. Prod. Sci.* **50:** 998.

Watts J.E., Murray M.D. and Graham N.P.H. (1979) *Aust. Vet. J.* **55:** 325.