

## THE HERITABILITY OF CONGENITAL ENTROPION IN DUAL-PURPOSE NEW ZEALAND SHEEP

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### SUMMARY

Congenital entropion, a condition in which one or more eyelids are inverted, resulting in contact between the eyelashes and the cornea, was recorded in three South Island progeny test flocks between 2000 and 2018. A total of 42,535 lambs were scored for entropion (as 0, 1 or 2, where the score reflected the number of eyes affected) within 24 hours of birth. The overall incidence rate for entropion was 6.5%. The incidence of entropion varied between flock ( $P < 0.0001$ ) and year ( $P < 0.0001$ ), ranging from 1% to 15%. The heritability of entropion was estimated to be 0.18 ( $\pm 0.01$ ), indicating that the incidence of entropion within flocks can be reduced through selective breeding.

### INTRODUCTION

Entropion is a condition in which one or more eyelids are inverted, resulting in contact between the eyelashes or external hair and the cornea, which can lead to blindness. Many mammalian species are affected by congenital entropion, including humans (Vallabhanath and Carter 2000), domestic animals (Priester 1972; Glaze 2005) and livestock (Warwick and Berry 1962; Allbaugh and Davidson 2009; Donnelly *et al.* 2014; Mészáros *et al.* 2015).

In sheep, the incidence of congenital entropion is variable. Reported frequencies of entropion range from 1% to 11% (Warwick and Berry 1962; Green *et al.* 1995; Claine *et al.* 2013; Greber *et al.* 2013). Congenital entropion is usually present at birth or occurs soon afterward and can be detected by either examination of the eye, or observation of excessive ocular discharge, conjunctivitis or keratitis (Boileau and Gilmour 2012). Treatment is relatively straightforward, however if left untreated, the contact between the eyelashes and the cornea can lead to blindness (Moore and Whitley 1984).

There is evidence of both between-breed and within-breed variation in the occurrence of entropion in sheep. In intensively reared lambs in south west England, Charollais and Texel sired lambs had an increased risk of entropion compared to Suffolk sired lambs (Green *et al.* 1995). In a separate study in France, Ile de France and crossbred lambs were significantly more affected by entropion than purebred Texel lambs (Claine *et al.* 2013). Heritability estimates for entropion range between 0.08 and 0.21 in purebred (Columbia, Polypay, Rambouillet, Suffolk, and Targhee) and crossbred sheep in the U.S. (Sakul and Kellom 1997), however, the incidence and heritability of entropion in New Zealand lambs has not been reported.

### MATERIALS AND METHODS

**Animals and data.** Animals were managed in accordance with the provisions of the New Zealand Animal Welfare Act 1999, and the New Zealand Codes of Welfare developed under sections 68–79 of the Act.

Congenital entropion was recorded on all lambs born in three genetically linked progeny test flocks, run at the Woodlands Research Station in Southland (flocks A and C), and Invermay Research Farm in Otago (flock B). Recording began in 2000 in flock A, 2002 in flock C, and 2011 in flock B, and continued until 2017 (flocks A and C) or 2018 (flock B). Dams were composites of the main dual-purpose sheep breeds used in New Zealand, including Romney, Coopworth and Perendale, and

sires were from a mixture of dual-purpose and terminal breeds.

A total of 42,535 lambs from 574 sires were scored for the presence or absence of entropion (EYE) within 24 hours of birth. EYE was initially scored on a 0-5 scale for each animal, depending on the number of in-turned eyelids and the presence or absence of infection, but this was reduced to a 0/1/2 score in 2014, where the score reflected the number of eyes affected. Subsequently, all scores were converted to a 0/1/2 scale.

**Statistical Analysis.** All pedigree and phenotypic records were obtained from Sheep Improvement Limited (SIL), the New Zealand sheep genetic evaluation database. Contemporary group (CG) was defined as flock, birth year, sex and weaning mob, and records were removed if the contemporary group contained less than five observations or had a mean incidence of entropion of zero. The resulting dataset consisted of 37,208 animals (Table 1).

Heritability of EYE was examined firstly using the reported values transformed using the formula  $EYE_t = EYE / \sqrt{[EYEm * (2 - EYEm)]}$ , where m is the mean incidence rate within the CG where phenotypic score is being adjusted, and secondly reporting it as a binary (presence/absence) trait. Fixed effects were determined using the GLM procedure in SAS (SAS Institute Inc., Cary NC, USA). The final model included fixed effects of contemporary group, birthday deviation from the mean of the contemporary group (BDEV), birth-rearing rank (BRR) and age of dam (AOD). Heritability estimates were obtained by running a univariate analysis using ASREml (Gilmour et al. 2015).

## RESULTS AND DISCUSSION

Of the 37,208 animals with records remaining after data cleaning, 2,409 lambs had congenital entropion, giving an overall incidence rate over 19 years of 6.5%. The incidence of entropion varied between flock ( $P < 0.0001$ ) and year ( $P < 0.0001$ ), ranging from 0.01 to 0.13 (Table 1).

Heritability estimates ( $\pm$  standard error) for entropion adjusted for incidence rate per contemporary group (EYE<sub>t</sub>) and reported as a binary trait (EYE<sub>b</sub>) were 0.18 ( $\pm$  0.01) and 0.19 ( $\pm$  0.01), respectively. This is in line with a previous study that examined the heritability of entropion in purebred and crossbred U.S. sheep, which gave an overall estimate of 0.15 (ranging from 0.08-0.21). While entropion has not been reported to impact upon lamb growth (Claine *et al.* 2013), reduction in flock incidence will alleviate welfare concerns. This can therefore be achieved through scoring of lambs at birth for congenital entropion, and the use of the scores in selective breeding programs.

**Table 1. Incidence of congenital entropion (% = incidence) between 2000 and 2018 in lambs at birth in three pedigree-recorded flocks. EYE score reflects the number of eyes affected (0 = unaffected; 1= one eye affected; 2 = both eyes affected)**

Year	EYE Flock A				EYE Flock B				EYE Flock C			
	0	1	2	%	0	1	2	%	0	1	2	%
2000	1,393	58	43	7%								
2001	1,105	53	45	8%								
2002	1,039	44	25	6%	615	10	18	4%				
2003	1,010	67	78	13%	679	61	55	15%				
2004	1,024	48	35	7%	589	7	15	4%				
2005	1,145	66	44	9%	937	9	13	2%				
2006	1,089	63	44	9%	761	31	32	8%				
2007	1,162	71	43	9%	1,013	47	14	6%				
2008	1,150	56	35	7%	479	11	8	4%				
2009	1,116	89	59	12%	1,070	33	36	6%				
2010	973	30	42	7%	930	18	23	4%				
2011	1,157	72	39	9%	1,178	33	26	5%	43	3	3	12%
2012	1,214	21	47	5%	997	21	10	3%	110	0	2	2%
2013	1,092	26	30	5%	866	35	20	6%	272	15	10	8%
2014	1,499	45	20	4%	1,022	50	26	7%	314	2	4	2%
2015	653	9	10	3%	930	34	17	5%	70	0	2	3%
2016	183	1	1	1%	1,241	16	11	2%	110	3	1	4%
2017	821	15	12	3%	1,005	52	34	8%	70	0	1	1%
2018					673	34	17	7%				
Overall	18,825	834	652	7%	14,985	502	375	6%	989	23	23	4%

This study provides the first estimate of the heritability of congenital entropion in dual-purpose New Zealand lambs.

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