# Faecal nematode egg counts and haematology in Perendale ewes near lambing

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## ABSTRACT

Perendale flocks bred for divergence in lambs' faecal nematode egg count (FEC) were used as a resource to study genetic factors affecting FEC in peri-parturient ewes. The objectives were

(i) to compare selection flock means for FEC in peri-parturient ewes in the absence of drenching, and

(ii) to estimate the heritability and repeatability of FEC and selected blood traits in ewes.

Selection in lambs was based on High or Low FEC or on acquired immunity (i.e. a large reduction in FEC between the responses to first and second challenge), and these flocks were managed alongside a contemporary Control flock. There were four years of ewe data (1990-93), consisting of 2748 FEC records from 218 ewes, the daughters of 43 sires. Faecal samples were obtained for FEC beginning four weeks before the expected mean lambing date, and finishing about four months later. Blood samples were obtained from ewes in 1993 to analyse concentrations of antibody to *Haemonchus contortus* and *Ostertagia circumcincta*, and other components. All FEC analyses used a $\log_e$ (FEC+100) transformation.

The overall mean FEC for peri-parturient ewes was 6.19 (388 eggs/g on the original scale) with a phenotypic standard deviation of 0.86. Selection flock differences were significant ($P<0.001$). Relative to the High flock mean, the Control, Acquired and Low flock means were $-0.01 \pm 0.10$, $-0.18 \pm 0.09$ and $-0.38 \pm 0.10$ $\log_e$ units, i.e. a 38% lower FEC in Low than High flock ewes. The within-flock heritability of individual FEC records was $0.27 \pm 0.07$, and for antibody concentrations to *H. contortus* and *O. circumcincta* heritabilities were $0.18 \pm 0.34$ and $0.20 \pm 0.23$, whilst repeatabilities were $0.38 \pm 0.08$, $0.73 \pm 0.48$ and $0.50 \pm 0.31$, respectively. The genetic correlation estimate between ewe-lamb FEC and adult-ewe FEC was $0.63 \pm 0.57$. Eosinophil and total white cell counts were significantly higher in Low FEC than High FEC ewes ($P<0.05$). It was concluded that lamb differences in FEC were also expressed in peri-parturient ewes, and the ewe trait itself had a significant heritability.

**Keywords:** faecal egg count; nematode; Perendale; sheep; peri-parturient rise.

## INTRODUCTION

Genetic studies have demonstrated that divergent selection for faecal nematode egg count (FEC) in lambs is successful, both under conditions of natural parasitic challenge (Morris *et al.*, 1995) and under artificial challenge (Watson *et al.*, 1992). However, although selection for reduced lamb FEC can reduce the nematode contamination on pasture, most of the early-season contamination of pasture can be derived from ewes because they become temporarily susceptible to nematode challenge during the peri-parturient period (Vlassoff, 1976). It is therefore important to discover whether direct selection responses in FEC in lambs have led to indirect FEC responses in ewes. We have already demonstrated this indirect response in one set of Romney flocks selected for divergence in lamb FEC (Morris *et al.*, 1993). The ewe FEC data from AgResearch's corresponding Perendale selection flocks have provided us with the opportunity to estimate the heritability of peri-parturient FEC. Four years of Perendale data compared with the two years of Romney data have meant that more ewe-sires are represented in the Perendale file. Blood samples were also taken from the Perendales in one year, to study variation in antibody concentration and other traits.

The objectives of this paper were (i) to compare the Perendale selection flocks for peri-parturient FEC levels in the absence of drenching, and (ii) to estimate the heritability and repeatability of FEC and selected blood traits in peri-parturient ewes.

## MATERIALS AND METHODS

### Flock description and experimental protocol

The selection experiment began in 1984, when 3-month Perendale lambs were selected from a reproduction research flock at Wairakei for extreme high or low faecal egg count (FEC) at weaning. The ram lambs were transferred to indoor facilities at Ruakura, cleansed of internal parasites and challenged with doses of *Haemonchus contortus* on two occasions, with the doses being abbreviated by anthelmintic treatment. After infection the lambs were monitored for degree of immunity by measuring FEC. No further testing was applied to the ewe lambs. The ram selection procedure was repeated on the 1985 crop. A High FEC and a Low FEC flock were established, and selected rams and ewes were first mated within lines at Ruakura in 1986. Later an Acquired Immunity selection flock (AIS) was established, and a Control unselected flock was also maintained. Further details were given by Watson *et al.* (1992). Briefly, the protocol for ewes recorded and analysed here was as given below.

Four years of data were collected on peri-parturient FEC, from 1990 to 1993. Ewes of 1.5 years of age and older were mated at Tokanui within flock in single-sire mating groups for two 16-day cycles each year. In addition, some ewes in 1992 and 1993 were synchronised as embryo transplant donors and then naturally mated. After mating each year, ewes grazed over the winter in one management group, and were then drafted before the beginning of lambing at Ruakura into lambing cycles. Most

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ewes in 1990-92 lambed in the first cycle, and only first-cycle data were included for analysis in those years. Both cycles were included for FEC data in 1993. Average dates of lambing, for ewes whose records were analysed, were 23 August 1990, 31 August 1991, 3 October 1992, 5 August 1993 (cycle 1) and 21 August 1993 (cycle 2). In 1993 all ewes were run together again from weaning time, having grazed by rotation over common pastures until weaning.

In 1990-92, a grab sample of faeces for FEC was taken from ewes before lambing, approximately 4 weeks before the average first-cycle lambing date. In all four years, subsequent to lambing, later faecal samples were taken (n = 3 per ewe in 1990; 4 in 1991; 8 in 1992; 12 in 1993 for first-cycle ewes and 3 for second-cycle ewes). Sampling was continued until mid-November in 1990 and 1993, and until mid-December in 1991 and 1992 (Table 1). Faecal larval cultures were prepared by flock.

**TABLE 1:** Year, sample week and selection flock effects on $\log_e$ (faecal egg count[a] + 100) in peri-parturient ewes.

| Item | | Year | | | |
|---|---|---|---|---|---|
| | | 1990 | 1991 | 1992 | 1993 |
| Number of records | | 143 | 472 | 916 | 1217 |
| Sample week | -4[a] | 6.33 | 6.27 | 5.35 | |
| | +3 | | | 6.23 | 6.34 |
| | 4 | | 6.29 | 6.09 | 6.41 |
| | 5 | 7.10 | | 6.10 | 6.54 |
| | 6 | | | 6.43 | 6.67 |
| | 7 | | 5.77 | 6.30 | 6.73 |
| | 8 | 6.43 | | 6.02 | 6.23 |
| | 9 | | | 6.58 | 5.99 |
| | 10 | | 6.08 | | 6.21 |
| | 11 | | | 6.09 | 6.14 |
| | 12 | 6.25 | | | 6.10 |
| | 13 | | | | 5.96 |
| | 14 | | 5.24 | | 5.55 |
| | Average s.e.d. | 0.21 | 0.15 | 0.16 | 0.17 |
| Flock[b] | High | 6.33 | | | |
| | Control | 6.32 | | | |
| | Acquired | 6.15 | | | |
| | Low | 5.95 | | | |
| | Average s.e.d. | 0.10 | | | |

[a] Units = eggs/g; sample weeks are relative to the mean lambing date each year.

[b] All years combined.

In 1993 a sample half of the ewes were experimentally infected with *H. contortus* three weeks after lambing (5800 infective larvae per animal), and experimental infection status was tested as a factor in subsequent analyses of each trait. In this year, blood samples were obtained from all first-cycle ewes, once before lambing and at 3-week intervals after lambing, as described below. Ewe live weights were also recorded before and after lambing.

## Blood sample analyses

Blood samples were analysed to estimate concentrations of antibody to *H. contortus* and *Ostertagia circumcincta* (antibody *H.c.* and *O.c.*), and to estimate concentrations of haemoglobin, total white blood cells, and their constituent cell types.

## Statistical methods

The FEC data were analysed on a transformed scale, $\log_e$ (FEC+100), using an animal model with restricted maximum likelihood procedures, to account for genetic relationships and repeated records (Johnson and Thompson, 1995). The final model for FEC data consisted of fixed effects for year x sample week, age of ewe (4 classes), lambing type (producing a single or twins) and selection flock, and random-effect terms for animal and sample-within-animal. There were in total 2748 FEC records (Table 1) from 218 ewes, the progeny of 43 sires. Genetic correlation estimates were also made between ewe-lamb FEC and adult-ewe FEC records.

Blood sample results were analysed using the Genstat (1990) computer programme, fitting effects for flock, age of ewe and sample week. Other factors were also tested, but were not significant, including whether artificially infected or not, lambing type (producing a single or twins) and the interaction between flock and sample week (i.e. time since lambing). Mixed-model REML analyses were also used, but there was only one year of data with limited numbers of records.

# RESULTS

## Faecal egg counts

Table 1 shows the mean of $\log_e$ (FEC+100) for each year x sample week, and for each flock overall. Four weeks before lambing (3 years' data), means transformed to the original scale averaged 333 eggs/g. Highest mean values recorded each year were: 7.10 (1112 eggs/g) in 1990, 5 weeks after lambing; 6.29 (439 eggs/g) in 1991, 4 weeks after lambing; 6.58 (621 eggs/g) in 1992, 9 weeks after lambing; and 6.73 (737 eggs/g) in 1993, 7 weeks after lambing. Where there was a pre-lambing record, there was a significant rise ($P<0.05$) in one or more of the post-parturient values in 1990 and 1992, but not in 1991. In 1993, where a pre-lambing record was not available, there was a significant increase and subsequent decrease in FEC ($P<0.05$) relative to the +3 week value. Ewes lambing twins had a higher mean $\log_e$ FEC overall than those lambing singles ($P<0.05$), with back-transformed values of 418 and 355 eggs/g, respectively. Age of ewe was also a significant effect ($P<0.001$), with 2-year-olds having highest FEC, relative to 3-, 4- and >4-year-olds.

Table 1 also shows significant flock effects ($P<0.001$). Transforming the FEC means back, overall flock values were 461 eggs/g (High), 456 eggs/g (Control), 369 eggs/g (AIS) and 284 eggs/g (Low). The mean for the Low flock was thus 38% below that for the High flock. In preliminary analyses, we were unable to show any significant interaction between flock and sample week. Faecal larval cultures showed a predominance of *Ostertagia* and *Trichostrongylus*. In 1993, in spite of the artificial infection with *Haemonchus*, no larvae of this genus were recovered (although some would have been expected in late September).

The heritability of adult ewe FEC on the log scale was 0.27 ± 0.07, and the repeatability was 0.38 ± 0.08. The phenotypic standard deviation on the same scale was 0.86, indicating a coefficient of variation of 86% on the original scale.

Genetic correlations were estimated between ewe-lamb FEC in summer/autumn and adult-ewe FEC for the same animals over the peri-parturient period. From six non-inde-

pendent estimates the mean correlation was 0.63 ± 0.57 (range of estimates 0.23 to 0.96). From High versus Low flock mean differences in $\log_e$ (FEC+100) for both ewe lambs and adult ewes, the realised genetic correlation was 0.21.

## Blood sample results

Table 2 shows comparisons of the High and Low flocks for blood sample parameters. Means are not presented for the Control and AIS flocks, because of small numbers. There were significant selection flock differences in haemoglobin concentration, total white cell count and eosinophil count, where the Low FEC flock values were all greater than those of the High FEC flock. For haemoglobin and total white blood cells, the Low flock advantage was 4 to 5% of the High flock value. There were generally significant age of ewe differences and sample-week differences. For antibody (*O.c.*), lowest values were at 3 and 6 weeks after lambing. For haemoglobin concentration, lowest values were at 6 and 9 weeks after lambing, whereas for neutrophils and total white blood cell count, lowest values were at 9 and 12 weeks after lambing. Antibody (*H.c.*) and lymphocyte counts showed no effects of sample week. Transformations were tested, in order to normalise the distribution of the data, but they had no effect on fixed-effect conclusions drawn.

We obtained heritability and repeatability estimates for four of the blood sample traits. These were antibody (*H.c.*), 0.18 ± 0.34 and 0.73 ± 0.48 respectively; antibody (*O.c.*), 0.20 ± 0.23 and 0.50 ± 0.31; total white blood cells, 0.26 ± 0.27 and 0.59 ± 0.37; and lymphocyte count, 0.26 ± 0.27 and 0.60 ± 0.38.

**TABLE 2:** Comparison of the 1993 High and Low selection flocks for the concentrations of antibody to *Haemonchus contortus* and *Ostertagia circumcincta* and for blood cell parameters.

| Trait | Number of records | Flock | | | Residual s.d. |
|---|---|---|---|---|---|
| | | High | Low | Significance | |
| Antibody[a] to | | | | | |
| *H. contortus* | 137 | 0.840 | 0.885 | n.s. | 0.21 |
| *O. circumcincta* | 406 | 0.681 | 0.665 | n.s. | 0.15 |
| Haemoglobin concentration, g/l | 343 | 114.1 | 119.0 | P<0.001 | 11.9 |
| **White blood cells, $10^9$ x g/l** | | | | | |
| Neutrophils | 343 | 25.7 | 27.5 | n.s. | 11.1 |
| Lymphocytes | 343 | 48.7 | 50.1 | n.s. | 11.7 |
| Eosinophils | 343 | 2.3 | 2.9 | P<0.01 | 1.5 |
| Total[b] | 343 | 79.3 | 83.4 | P<0.05 | 16.6 |

[a] Optical density units.

[b] The total also includes basophils and monocytes present in very low proportions.

## Live weight

Selection flocks did not differ in average live weight, combining pre- and post-lambing records. The overall mean was 52.8 kg (± residual standard deviation of 6.4 kg). None of the fixed effects tested for live weight (flock, age of ewe, single or twin produced, and a covariate for $\log_e$ FEC) was significant, except age (P<0.001).

## DISCUSSION

Results in this Perendale study support those from Morris *et al.* (1993) with Romney data, showing that selection for divergence in lamb FEC led to related differences in the FEC of peri-parturient ewes. One of the benefits of selection for reduced FEC in lambs thus appears to be reduced pasture contamination by ewes; this is now being tested in 1995-97 in a project where different selection flocks are grazed separately.

Between-ewe repeatabilities for $\log_e$ FEC were reasonably high in both studies, 0.50 ± 0.04 in the Romneys and 0.38 ± 0.08 in the present study with Perendales. The heritability of FEC in ewes (0.27 ± 0.07) was about the same as in studies with lambs (Morris *et al.*, 1995).

From the limited antibody analyses from blood samples in one year, we were unable to demonstrate significant ewe-flock differences. In view of the larval cultures which also showed *Trichstrongylus* present, antibodies to this species should also probably have been measured. The lack of a response to the experimental infection is probably explained, in hindsight, by challenging too late (3 weeks after lambing). An earlier challenge was not possible for technical reasons.

The white blood cell counts showed significantly greater Low flock than High flock levels for eosinophils and for the total count. Our eosinophilia results were consistent with other studies (Buddle *et al.*, 1992). They showed in Romney selection-flock lambs that eosinophilia was associated with the expression of resistance to nematode infection.

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