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Faecal nematode egg counts and facial eczema susceptibility in Romneys

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ABSTRACT

A study was carried out in two groups of flocks to estimate the relationship between susceptibility to facial eczema (FE) and susceptibility to nematode parasites. Faecal egg count (FEC) data on lambs born in 1989-92 from 53 sire groups were collected on the Ruakura Romney flocks which have been divergently selected for resistance/susceptibility to FE. In addition, the Romney flocks selected at Rotomahana/Tokanui Stations for resistance/susceptibility to FEC were sampled to provide the converse (i.e. FE data) on lambs born in 1988 and 1989, and representing 43 sires. Faecal samples for FEC were collected from lambs in January and March (separated by an anthelmintic treatment) and the FEC data were analysed using a $\log_e$ transformation. FE susceptibilities, using the enzyme gamma-glutamyltransferase (GGT) as an indicator, were obtained in the FE flocks at Ruakura after an oral sporidesmin challenge in May, and in the FEC flocks at Tokanui after unintentional field challenge; the GGT data were also analysed using a $\log_e$ transformation. The weighted average heritabilities of $\log_e$ GGT and $\log_e$ (FEC+100) were 0.44±0.03 and 0.33±0.05, respectively. At Ruakura, the two traits had a genetic correlation of 0.15±0.15, and at Tokanui, the corresponding correlation was 0.22±0.12, with a combined estimate of 0.19±0.09 ($P<0.05$). These results indicated that there was a tendency for the two traits to be positively associated among sire groups, when both types of challenge were applied in sequence.

Keywords: nematodes; faecal egg count; facial eczema; correlation; sheep.

INTRODUCTION

The growth of lambs in Northern New Zealand is potentially compromised by a number of diseases, two of which are nematode parasitism and facial eczema (FE). Heritability estimates for the resistance of young sheep to both diseases are known, averaging 0.23 ± 0.02 for internal parasite resistance as expressed by faecal egg count (FEC) (Morris *et al.*, 1995a) and 0.45 ± 0.03 for FE (Morris *et al.*, 1995b), and there has been success in single-trait selection for resistance to each disease (Morris *et al.*, 1995a, b). The objective of the present analyses was to test for the possibility of any inter-relationships between the two diseases. A significant correlation between the two disease traits does not necessarily imply a genetic correlation in the usual sense because animals which suffered the first disease may have become predisposed to the second disease.

Data collected over four years from the Ruakura FE selection flocks, and data collected over two years from the Tokanui FEC selection flocks, were analysed to investigate a possible relationship between the two diseases. For the purpose of the analyses, the concentration of the enzyme gamma-glutamyltransferase (GGT) was taken as the indicator of resistance of FE (Towers and Stratton, 1978), and FEC was taken as the indicator of parasitic resistance (i.e. ability to maintain a relatively low count of nematode worm eggs in the host, and linked to the number of worms established, although this is not the only type of anti-parasitic variation expressed by the host).

MATERIALS AND METHODS

Selection Flocks

Facial Eczema Flocks

The Romney flocks selected at Ruakura for resistance or susceptibility to FE were established in 1975, and a Control Romney flock has been managed alongside them since 1981. Animals from the 1989-92 birth years were studied here. Details of flock management and selection practices were given by Morris *et al.* (1995b). Briefly, lambs were born in August/September, were weaned in November, were protected from pasture carrying sporidesmin challenge by the use of fungicide-sprayed pasture in summer/autumn, and ram lambs were challenged orally in May with sporidesmin. Details of the FE challenge are given later. Selection decisions to determine which ram lambs within flock should be retained for breeding were made on the performance- and progeny-test gamma-glutamyltransferase (GGT) results combined. All ewe lambs were retained for breeding. There were 53 sire groups tested over the 4-year period.

Faecal Egg Count Flocks

The Romney flocks selected for resistance or susceptibility to nematode parasites were established at Rotomahana Station in 1985 and a Control Romney flock was added in 1986. All three flocks were transferred to Tokanui Station in December 1988. The lambs from the 1988 and 1989 birth years were used in this analysis, with data collected over the lambs' first summer/autumn at Tokanui. Selection procedures in these flocks were de-

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scribed by Baker *et al.* (1990), but briefly they consisted of performance- and progeny-test data on FEC collected in January and March, and analysed to provide breeding values for candidate rams. Unlike the FE flocks at Ruakura, the FEC flocks were open to introductions of some outside genetic material (from Wallaceville). Most ewe lambs were retained for breeding. There were 43 sires with progeny born in 1988-89.

Experimental Protocol

Facial Eczema Data

At Ruakura, the protocol in May involved dosing Resistant FE flock males at a high rate with sporidesmin (generally 0.15 mg/kg liveweight), susceptible flock males at a low dose rate (generally 0.04 mg/kg), and a sample half of the Control flock males at each dose rate. The Control flock was used to provide links between the other two flocks. Details were given by Morris *et al.,* (1995b), but one exception was the 1989-born lambs, where an unintentional pasture challenge was encountered by lambs of both sexes. The resulting GGT data from all animals were used, except for the Resistant-flock males which were still dosed.

At Tokanui, the autumns of 1989 and 1990 (1988 and 1989 birth years) led to unintentional FE challenges of lambs. GGT data were included in the present analyses on each occasion when at least 25% of the animals had elevated values (taken as >60 i.u./l). The thresholds were exceeded in May 1989 (90/245 animals or 37%), and in March and May 1990 (104/290 or 36%, and 120/272 or 44% respectively). May 1989 coincided with a significant late challenge across many North Island dairy farms (Morris *et al.,* 1990), and the autumn of 1990 led to similar FE challenge conditions at Ruakura and Tokanui.

Faecal Egg Count Data

In both the Ruakura and Rotomahana/Tokanui experiments, all lambs received an anthelmintic drench at weaning. Either the drench or the fertiliser was supplemented with Se, depending on year. At weaning, Tokanui lambs also received a vaccine against the 5 common clostridial organisms in New Zealand, whilst the same vaccination at Rotomahana was carried out at docking. At intervals through the summer and autumn, a monitor group of lambs was faecal sampled, and when the mean FEC in this group reached about 800 eggs/g, all lambs were faecal sampled for FEC and drenched with anthelmintic according to manufacturer's instructions. The challenge, sampling and drenching was repeated, so that two FECs were available on each animal by March/April.

Data Analyses

The data from each site were first subjected to least squares analyses of $\log_e$ transformed (FEC + 100) or $\log_e$ GGT, in order to determine appropriate models of fixed effects. Subsequently, restricted maximum likelihood (REML) procedures (Johnson and Thompson, 1995) were applied to $\log_e$ (FEC + 100) or $\log_e$ GGT at each site, using an animal model. For GGT in the FE flocks, and FEC in the FEC flocks, data from the beginning of the selection experiment were also included. Univariate and multivariate models were applied. A relationship matrix was included in order to account for the use of some related sires. The relationship matrix rather than a fixed selection-flock effect was also used to take care of direct selection effects on heritabilities. One exception to the animal model was the univariate analysis of $\log_e$ (FEC+100) in the FE flocks (repeated record analysis), where a solution could only be obtained with a sire model.

RESULTS

Table 1 shows the heritability and repeatability estimates from both experimental flocks. All values were of moderate size. Weighted average heritabilities for $\log_e$ GGT and loge (FEC+100) were 0.44±0.03 and 0.33±0.05, respectively. The heritabilities for each trait were not significantly different between flocks, although the repeatability for $\log_e$ (FEC +100) was significantly lower in the FE flocks. No repeated measure of FE (i.e. $\log_e$ GGT) was taken in the FE flocks.

TABLE 1. Heritabilities, repeatabilities, phenotypic standard deviations and genetic correlations between gamma-glutamyltransferase (GGT) enzyme levels and faecal egg count (FEC) data at two sites

Item	Facial eczema flocks	FEC flocks
Site	*Ruakura*	*Tokanui*
Records[a] on the non-selection trait		
No. of sire groups	53	43
No. of animals	666	542
$\log_e$ GGT		
Heritability	0.45 ± 0.03	0.31 ± 0.10
Repeatability	-	0.72 ± 0.03
Phenotypic s.d.	0.90	0.79
$\log_e$ (FEC + 100)		
Heritability	0.34 ± 0.11[b]	0.33 ± 0.05
Repeatability	0.19 ± 0.05	0.43 ± 0.02
Phenotypic s.d	0.88	0.82
Genetic correlation[c]	0.15 ± 0.15	0.22 ± 0.12

[a] Records on the selected trait were included from the initial selection year of the experiment onwards.
[b] Sire-model estimate.
[c] Between $\log_e$ GGT and $\log_e$ (FEC+100).

Table 1 also shows the genetic correlations between $\log_e$ GGT and $\log_e$ (FEC + 100), for both sets of selection flocks. The correlation estimates both had the same sign, although standard errors were relatively large. The combined estimate was 0.19±0.09 (P<0.05).

Plotting flock-year means from the REML solution files for the correlated trait (Y axis) against the selection trait (X axis) in each experiment led to regressions of 0.16±0.03 for log Y on log X (Ruakura flocks, 4 years' data) and 0.26±0.07 for log Y on log X (Tokanui flocks, 2 years' data).

DISCUSSION

At the time when the studies on these selection flocks were undertaken, selection had been applied for 16 years in the FE flocks and for just four years in the FEC flocks.

In both experiments, the parasite challenge was applied first and this was followed by the FE challenge. As noted earlier, the correlation estimates between traits cannot necessarily be regarded as genetic correlations, because there may have been some residual effect of parasitic infestation on the ability to mount a response to the FE challenge.

Each GGT record and each FEC record was treated as a separate trait for genetic correlation analyses. For example at Tokanui four pairwise correlations were estimated, and these were combined by weighting proportionally to the reciprocal of the sampling variances. However, univariate analyses with a repeatability model showed that GGT and FEC were both repeatable, so that the standard errors for genetic correlations in Table 1 may be conservative.

The genetic regressions obtained from plotting flock-year means of the correlated trait on the selected trait were consistent in sign with the correlations in Table 1. The results from the two experiments were also consistent with each other.

Overall, the susceptibilities to FE and internal parasites appeared to be correlated, although the mode of action required to generate an apparent genetic correlation here is uncertain.

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