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Repeatability estimates and selection flock effects for faecal nematode egg counts in Romney breeding ewes

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ABSTRACT

A selection experiment to breed for high (H), control (C) or low (L) faecal egg count (FEC) levels in weaned Romney lambs was established in 1985, being maintained at Rotomahana (until weaning 1988) and at Tokanui thereafter. In winter 1990, pregnant ewes (aged 2 to 6 years) were drafted into grazing groups according to expected lambing date ('early' and 'late' ewes), in order to study periparturient FEC. Non-pregnant ewes and unmated yearling females were also recorded. Faecal samples for FEC were taken from all females (n=253) before and after the pregnant ewes lambed (median lambing dates for early and late ewes being 19 August and 31 August), and then in October and in November. Lambs were also faecal sampled at 3-month weaning. A mixed model was fitted to $\log_e$ (FEC + 100), with fixed effects for selection flock, group (early ewes, late ewes, non-pregnant ewes, yearlings), sample day and the interaction of group and day, and with 'animal' as a random effect. The repeatability was 0.50 ± 0.04 and selection flock means (transformed from the log scale) were: H, 349; C, 160 and L, 140 eggs/g, with significant differences ($P<0.001$) between the H and C or L flocks. Over all flocks, the means were highest immediately after lambing (292 eggs/g) and lowest in November (135 eggs/g). Ewes which were early, late or non-pregnant and yearling females had means of 325, 259, 154 and 119 eggs/g, respectively ($P<0.01$). Regressions of the lamb's log FEC on the dam's mean log FEC, with or without adjustment for selection flock, showed that a 10% increase in the dam's FEC was associated with a 2.3% or 4.7% increase in the lamb's FEC, respectively.

Keywords: Internal parasites, selection, faecal egg count, ewes, repeatability.

INTRODUCTION

Heritable differences in the faecal nematode egg counts (FEC) of young lambs are well known (Baker *et al.*, 1991; Gray, 1991). However, periparturient ewes are the main source of the pasture nematode contamination (Arundel and Ford, 1969), and the present study provides estimates of repeatability among Romney breeding ewes (following repeated samplings) and selection flock differences in FEC in these breeding ewes. The relationship between the FEC of periparturient dams and the FEC of their lambs when subsequently weaned was also studied.

MATERIALS AND METHODS

Experimental design

Selection flocks for high (H), control (C) and low (L) FEC in lambs were established with Romneys in 1985 at Rotomahana near Rotorua, and these were later transferred (December 1988) to Tokanui near Te Awamutu. The history of these flocks was described by Baker *et al.* (1990). Briefly, FEC data from lambs in summer/autumn were used to set up H and L selection flocks born in 1985 (and in controls beginning in 1986), and subsequent selection has been applied to lambs of both sexes using best linear unbiased prediction (BLUP) techniques on log FEC. Flocks have been open to immigration by other Romney animals based on breeding values for log FEC.

The present experiment is concerned with the FEC data from selection flock ewes lambing at Tokanui in 1990, and with the FEC data from their lambs at weaning.

Recording

Ewes lambed over the 38-day period from 3 August to 10 September 1990 and they were divided for faecal sampling into those pregnant in the first or second 16-day mating cycle. With the additional variation of gestation length superimposed, the first group (early) finally corresponded to julian days 215 to 236 of the year (n=67 ewes; median day = 231 or 19 August), and the second group (late) to julian days 237 to 253 (n=48 ewes; median day = 243 or 31 August). Faecal samples were obtained from the early and late groups before lambing on days 204 and 232 (sample 1), soon after lambing on days 253 and 261 (sample 2), in late September or in October on days 270, 281 and 298 (sample 3), and in late October or in November on days 298, 309 and 330 (sample 4) at weaning.

Faecal samples were taken at the same time from non-pregnant ewes ('dries') and from unmated yearling females (n=138). The dry ewes were run, for experimental purposes, with the early pregnant ewes. A faecal sample was also taken from each lamb at weaning (at dates ranging from 25 October to 26 November 1990).

Ewes of the H, C and L lines had been run together at all times since the end of single-sire mating in April.

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Data analysis

The Genstat (1990) computer programme was used initially to compare different fixed effects models for $\log_e$ (FEC + 100), including effects for selection flock (n=3), sample day (n=4) and animal group (early ewes, late ewes, dries and yearlings) and the interaction between sample day and group. All the above factors were significant (P<0.001). The main effect for age of ewe and the interaction between sample day and flock were also tested, but they were not significant and were not considered further. A restricted maximum likelihood (REML) analysis (Patterson and Thompson, 1971) was then used to fit the significant fixed effects above with 'animal' as a random effect, in order that an estimate of repeatability among animals could be obtained.

Analyses of lamb FEC at weaning (n=97) were carried out using Genstat (1990). Fixed effects were tested for selection flock (n=3), sex of lamb, birth rank (single or twin), and age of dam (2, 3, 4, >4 years) with a covariate for date of birth. Flock and sex were significant factors (P<0.001), but the other three effects were not significant and were then discarded. A covariate for dam's mean $\log_e$ (FEC + 100), obtained from the previous REML analysis of ewe data including all sample days, was fitted to test the relationship between the log FEC of lamb and dam. These covariate analyses were then repeated excluding the effect of selection flock (both in the lamb model and in another REML ewe model which had been run to provide the covariate values).

RESULTS

Ewe data

Tables 1 and 2 show the REML analyses of all FEC data on ewes and yearling females, consisting of effects of selection flock, animal group and sample day. The H flock was significantly higher in FEC (P<0.001) than the C and L flocks (having more than double the means, on the untransformed scale). Since there was no significant interaction between flock and sample day, it was concluded that flock differences were consistent over time of season.

TABLE 1: Effects of selection flock on faecal egg count (FEC), in units of eggs/g, from breeding ewes and yearling females

Trait	Selection flock High	Control	Low	Average s.e.d.
$\log_e$ (FEC + 100)	6.107	5.561	5.479	0.141
FEC[a]	349	160	140	37

[a] Antilog of $\log_e$ values; phenotypic standard deviation = 0.98 $\log_e$ units, or approximately 505 eggs/g.

Means for the four sample days overall were 183 eggs/g before the lambing time of pregnant ewes, 292 eggs/g immediately after lambing, and 226 and 135 eggs/g respectively on sample days 3 and 4. There was a significant interaction between animal group and sample day. Early lambing ewes experienced the greatest rise in FEC from the pre-lambing to the post-lambing sample. Late-lambing ewes, sampled at the same physiological stages as early-lambing ewes, showed a rise of 132 eggs/g which was similar to the FEC rise in dry ewes. The FEC in dry ewes fell from sample days 2 to 3, whereas it was still elevated in early- and late-lambing ewes.

TABLE 2: Effects of animal group and sample day on faecal egg count, in units of eggs/g

Animal group	Sample day[a] 1	2	3	4	All
Early lambing ewes	254[b]	583	484	132	325
Late lambing ewes	182	314	381	196	259
Dry ewes	134	264	123	117	154
Non-pregnant yearlings	175	129	80	103	119
All	183	292	226	135	203

[a] Sample days were: 1. before lambing, 2. soon after lambing, 3. about three weeks after sample 2, 4. at weaning. Dates are given in the text.
[b] Antilog of $\log_e$ values; average s.e. of differences among all pairs = 66 eggs/g, average s.e. of differences among animal group means = 49 eggs/g and among sample day means = 28 eggs/g.

Overall means for early and late ewes were not significantly different, but both values were significantly higher than those of dry ewes (P<0.05) and of non-pregnant yearling females (P<0.01). The latter two groups did not differ significantly.

The repeatability of $\log_e$ (FEC + 100) in ewes and non-pregnant yearlings was 0.50 ± 0.04. A further repeatability estimate, on lambing ewes only, gave a value of 0.48 ± 0.06.

Lamb data

Table 3 shows that there were large differences in FEC among selection flocks of lambs at weaning (P<0.001). The within-flock regression for dam's FEC was positive (log.log scale), although the estimate of 0.23±0.14 was not significant. When the analyses were repeated without fitting selection flock, the regression for dam's FEC doubled to 0.47±0.14 (P<0.001). Presented another way, a 10% increase in dam's FEC was associated with a 2.3 or 4.7% increase in lamb's FEC, depending on whether the data were or were not adjusted for flock, respectively.

TABLE 3: Effects of selection flock and of dam's mean faecal egg count (covariate adjustment) on lamb's faecal egg count at weaning, in units of eggs/g.

Adjustment	Selection flock High	Control	Low	Covariate, (log.log scale)
no[a]	1364[b]	1049	420	-
yes[a]	1252	1039	459	0.23 ± 0.14

[a] Average s.e. of differences among selection flock means: with no covariate adjustment, 235 eggs/g; with adjustment, 247 eggs/g.
[b] Antilog of $\log_e$ values; the residual standard deviation (without the covariate) was 0.80 $\log_e$ units, or approximately 1172 eggs/g.

DISCUSSION

Ewe data

The results of this experiment with Romneys showed that peri-parturient ewes of the high, control and low selection flocks had different average FECs. Lamb FEC was the selection criterion in each flock, and the differences in lambs were in the same direction as differences in peri-parturient ewes. Watson *et al.* (1992) found a similar result with FEC-selected Perendales at Ruakura, and Woolaston (1992) has reported a similar finding in Merinos in an FEC selection experiment in Australia. Our data were also consistent with Woolaston's in that early-lambing ewes showed a greater elevation of FEC than late-lambing ewes. The high repeatability (0.50) among animals showed that individuals were consistently higher or lower in FEC than their contemporaries.

Lamb data

Results in Table 3 showed that there was already a 3-fold difference in FEC between lambs of the H and L flocks by weaning time. There were insufficient data to estimate a genetic correlation between dam's and lamb's FEC with precision, but part of the positive relation between the two (a 4.7% increase in lambs for a 10% increase in dams) was presumably genetic because FEC is a heritable trait (Baker *et al.,* 1991). However, it is also likely that antibodies passed from dam to lamb could be important in controlling this relationship.

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