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Correlated responses in fleece weight to selection for divergence in faecal nematode egg count in New Zealand Romneys and Perendales

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ABSTRACT

Three selection experiments, two involving Romneys (at Wallaceville and Ruakura) and the third involving Perendales (at Ruakura), have resulted in breeding lines showing significant divergence in faecal nematode egg count (FEC), under natural challenge. The High and Low FEC lines in each experiment experienced 18, 8 and 11 years of selective breeding respectively to 1996. The geometric means of FEC in the three experiments were 7.3, 2.0 and 4.5 times greater in the High than the Low lines, equivalent to divergences of 2.12, 0.80 and 1.27 phenotypic standard deviations. In the present analysis, the High and Low lines were compared for greasy fleece weights using both yearlings (YFW) and mixed-age ewes (EFW). Relative to the Low lines, the corresponding High lines had greater YFWs by 14.6±3.0, 7.9±2.4 and 5.3±3.1% respectively (mean of three, 9.1±1.6%), and they had greater EFWs by 14.9±1.7, -3.2±3.8 and 8.0±2.7% (mean of three, 10.9±1.3%). The conclusion is that single-trait selection for reduced FEC in Romneys and Perendales is associated with reduced greasy fleece weight, when they and less resistant animals graze together.

Keywords: sheep; nematode parasites; selection; faecal egg count; fleece weight.

INTRODUCTION

Faecal nematode egg count (FEC) under natural or artificial challenge has been used widely as a selection trait in studies of the feasibility of breeding sheep for improved resistance to internal parasites. FEC has proved to be moderately heritable in sheep (Morris *et al.*, 1995; Woolaston and Eady, 1995), and selection for low FEC in lambs leads to significantly reduced worm burdens of the majority of economically important ovine nematode species (Bisset *et al.*, 1996). However, despite this it has become apparent, at least in dual-purpose sheep, that resistance to infection by nematode parasites is not necessarily synonymous with resistance to the effects of nematode challenge while grazing (Bisset and Morris, 1996). Genetically Low FEC Romney lambs appear to have no significant growth rate advantage over their High FEC counterparts when both genotypes graze together under natural challenge (Morris *et al.*, 1995). Other trials in New Zealand have indicated a slightly unfavourable genetic association (McEwan *et al.*, 1992, 1995). Comparisons also show an unfavourable genetic association between FEC and dags (faecal soiling of the breech area) (Watson *et al.*, 1986; Douch *et al.*, 1995). Bisset *et al.* (1991) speculated that this may be the result of a more severe inflammatory response by some "resistant" genotypes to larval challenge in the gut than normally occurs in their more "susceptible" counterparts. Furthermore, evidence is accumulating of an unfavourable association between FEC and yearling greasy fleece weight (YFW) (Howse *et al.*, 1992; McEwan *et al.*, 1992, 1995).

In view of the fact that the primary goal of most work directed at breeding for nematode resistance in livestock is to minimise the amount of anthelmintic treatment required to maintain productivity in grazing animals, a good understanding of the correlated responses which can be expected following direct selection for the trait is vital. This paper reports the results of an analysis of YFW and mixed-age ewe greasy fleece weight (EFW) in three sets of FEC selection lines established at AgResearch Wallaceville and Ruakura between 1979 and 1986.

MATERIALS AND METHODS

The three sets of FEC selection lines used in the present analyses were managed on farms owned by AgResearch (formerly the Ministry of Agriculture & Fisheries), and their histories are as follows: 1. Romneys established in 1979 at Wallaceville Animal Research Centre (Upper Hutt) and selected each year to the present day for High or Low FEC following natural challenge (mainly *Ostertagia circumcincta* and *Trichostrongylus colubriformis*) of 4- to 7-month-old lambs on pasture (Bisset *et al.*, 1996). 2. Romneys established by Ruakura staff in 1985 (Baker *et al.*, 1990), run on two local sites (Rotomahana and Tokanui) until 1992 inclusive; they were selected as lambs for High or Low FEC as at Wallaceville but with an unselected Control flock also maintained from 1986 on-

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wards. From 1993 the elite High and Low animals and all Controls were transferred to and integrated with the Wallaceville lines. 3. Perendales established by Ruakura staff in 1986 (Watson *et al.*, 1992), run at four North Island sites until the present day, and selected for High or Low FEC in 4- to 7-month-old lambs, using artificial challenge to generate the test infection (*Haemonchus contortus* or *Trichostrongylus colubriformis*) in early years and subsequently natural challenge as at Wallaceville.

The geometric mean of FEC was on average 7.3 times greater in the High than the Low line for the Wallaceville Romneys (1994 and 1995 lamb crops), and corresponding values were 2.0 for the Ruakura Romneys (1991 and 1992) and 4.5 for the Ruakura Perendales (1994 and 1995). These three values were equivalent to 2.12, 0.80 and 1.27 phenotypic standard deviations, respectively.

YFW data were collected throughout the Ruakura Romney trial. In the Wallaceville Romneys and the Perendales, YFW data collection did not begin until the 1990 and 1989 birth years respectively. In addition in some years, High and Low lines grazed separately so that we could investigate the effects of selection for FEC on nematode epidemiology, and thus the production data are not suitable for inclusion in this summary. The most recent valid years of YFW data from each set of selection lines are summarised here. For breeding ewes, the first EFW data were collected in late 1991 and late 1992 from young Ruakura Romney ewes, and in late 1995 and 1996 from the mixed-age Wallaceville Romneys and the Perendales. Since September 1995, replicates of the Perendale selection lines have grazed individual farmlets, with three replicates per line. Results were analysed using least squares, fitting selection line and significant fixed effects (originally testing for year of birth, age of dam, birth type, and date of birth as a covariate).

RESULTS

The comparisons of YFW and EFW for each set of High and Low lines are shown in Table 1. Taking a weighted average over experiments, YFW was significantly higher by 9.1±1.6% in the High than Low lines ($P<0.001$), and the corresponding figure for EFW was 10.9±1.3% ($P<0.001$), also in favour of the High lines. All results summarised in Table 1 were derived from pairs of High and Low lines grazed together. Results from flocks grazed separately are discussed below.

DISCUSSION

Selection lines grazing together

Results show convincingly that when animals from High and Low FEC selection lines graze together, lower FEC is associated with a reduction in YFW and EFW in both New Zealand Romneys and Perendales. The conclusion is consistent with FEC levels in the converse Romney selection lines (i.e. lines selected for high YFW compared with unselected controls) at Massey University (Howse *et al.*, 1992), and at AgResearch (both the Woodlands and Hight lines; Morris *et al.*, 1996). Thus, in all experiments with Romney selection lines where the genetic correlation has been tested, it has been found to be positive in sign. The same was reported by McEwan *et al.* (1995) from paternal half-sib analyses of Romneys. In contrast, Eady *et al.* (1994) were unable to show the same correlation in Merino selection lines, and the Coopworth genetic correlation from McEwan *et al.* (1995) was not significantly different from zero. The reason for the inconsistency across breeds is at present unclear.

Selection lines grazing apart

Despite the apparently unfavourable relationships between FEC and fleece weight shown above, it has been suggested that the true benefits of selecting for low FEC may only become apparent when selection lines graze apart (Bisset and Morris, 1996).

At Wallaceville, there were two birth years (1990 and 1991) when female lambs from the selection lines grazed apart (n = 153 records), and under these conditions the High line mean for YFW was not significantly different from the Low line mean (+1.9±3.6%; Morris *et al.*, 1997). Pasture larval counts were on average 2.6 to 2.9 times higher in the High line than in the Low line pastures.

Similarly in the Perendales, the 1995-born selection line lambs grazed apart (n = 138 records; both sexes), and again the High line mean for YFW was not significantly different from the Low line mean (-3.7±2.8%). For the Perendale ewes, selection lines were separated and grazed apart from September 1995, and were shorn in November 1995. EFW data recorded in November 1996 therefore represented 12 months of fleece production in selection lines grazed apart (n=176 records). In this case the High line mean was 7.9% above the Low line mean (not significant when testing against the replicate mean square). The replicates (but not the selection lines) differed signifi-

TABLE 1: Fleece weights in the High (H) and Low (L) faecal egg count selection lines when grazed together

Flock/Breed	Class[A]	Years[A]	Records	(H-L)/L,(%)	Significance[B]
Wallaceville (Romney)	Y	1992-94	293	14.6±3.0	***
	E (2 to 5+yo)	1995-96	579	14.9±1.7	***
Ruakura (Romney)	Y	1991-92	212	7.9±2.4	**
	E (2 & 3yo)	1991-92	91	-3.2±3.8	n.s.
Ruakura (Perendale)	Y	1992-93	181	5.3±3.1	†
	E (2 to 5+yo)	1995	199	8.0±2.7	**

[A] Y = yearling; E = breeding ewe; years of birth for yearlings, years of shearing for ewes.

[B] *** = $P<0.001$; ** = $P<0.01$; † = $P<0.10$; n.s. = not significant.

cantly in ewe live weight, but adjusting EFW for live weight still left non-significant line differences. Nevertheless, the Low line ewes had significantly lower dag weights in November 1996 than High line ewes (158 g versus 206 g, respectively; $P<0.01$), indicating that there were epidemiological benefits derived by the low FEC line as a result of separate grazing. The Perendale EFW results in 1997 will provide the first data on ewes where selection lines grazed apart from birth.

The relative performance of selection lines when grazed together and when grazed apart is still under intensive study, using experimental sheep and also population models. Results could influence advice to ram breeders as selection progress in industry flocks continues.

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