HERITABILITY OF FAECAL WORM EGG COUNT AT DIFFERENT TIMES OF THE YEAR IN A MEDITERRANEAN ENVIRONMENT

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SUMMARY

The heritability of Faecal Worm Egg Counts (FWEC) at different times of the year was estimated in July born Merino lambs in a mediterranean environment. Large differences were found between the estimates calculated with a sire model, and those estimated with an animal model. A heritability estimate of 0.21 • 0.06 was found for FWEC at weaning at three months of age which decreased to approximately 0.08 • 0.04 the following month, and stayed low until after the break of the season in June the following year. It is suggested that the drop in heritability might be related to stress associated factors, such as the weaning process and/or an increased worm burden coupled to a decline in the quantity and quality of feed available. The increase in heritability in June coincided with the growth of pasture and the hatching of parasite eggs after the first rains. This indicates that the optimum time to measure FWEC for selection purposes in a Mediterranean environment is sometime after the break of the season from June to September. These results emphasise the importance of designing breeding programs to select for worm resistance that are appropriate to a particular region.

INTRODUCTION

There is an increasing amount of scientific evidence that indicates genetic variation exists both between, and within sheep breeds for resistance to internal parasites. This can be exploited to increase the level of parasite resistance in sheep populations (Gray and Woolaston, 1992). Mediterranean environments are characterised by large seasonal fluctuations in rainfall and temperature and this affects the parasite population on the pasture dramatically at different times of the year. Normally, larvae numbers on the pasture increase sharply after the first rainfall in autumn and reach a peak in October after which it declines until the next rainfall in the following autumn. This leads to different parasite burdens during the year which are reflected in faecal worm egg counts (FWEC). The aim of this paper is to determine the optimal time(s) to test sheep for FWEC for selection purposes in a Mediterranean enviroment.

EXPERIMENTAL PROCEDURES

Flock and mating information

Eight hundred ewes were donated to the Rylington Merino project in 1987 of which 700 were allocated to a selection line for low FWEC and 100 to an unselected control flock. In 1988 the selection line was mated to rams from three populations (two rams from the CSIRO "High Responder line", four rams from the "Bakers Hill Natural Selected line" of CSIRO and four rams from the University of New England (UNE) line). The rams from the UNE line were descendants from a highly resistant ram ((50% related) from the UNE flock, which was described by Albers *et al.* (1987). In 1989 the selection line was mated to the four UNE rams used in 1988, and also by artificial insemination to three new rams (by AI) from the CSIRO "High Responder" line, four new rams from the "Bakers Hill Natural Selected" line and to three rams from the CSIRO "Increased Resistance to *Haemonchus*" (IRH) line. In 1990, 12 new sires, selected from within this flock, were used as well as the three IRH sires used in 1989. From 1991 onwards, 14 new sires were used with two reference sires from the previous year to generate genetic links between years. Mating took place in February each year and ewes lambed in July over a six week period. Full sire and dam pedigrees were recorded from 1989 (Karlsson *et al* 1992).

From 1989 until 1990, all the lambs were subjected to a natural worm challenge and were not drenched until 15 months of age. Faecal samples were collected on a monthly basis from weaning in October until September the following year, and the number of nematode parasite eggs per gram of faeces (FWEC) counted. No samples were collected in October 1989 and no samples were collected in January during the entire experiment. Lambs born in 1991 to 1993 were subjected to a natural challenge from birth until December. From 1991 the lambs were drenched in December and again in March. The sheep were then exposed to a second cycle of natural challenge following the break of the season and FWEC determined monthly until September when the sheep were approximately 15 months of age. Selection of rams was based on the lowest average FWEC over the 10 or 11 monthly measurements.

Data

The first dataset consisted of 676 monthly FWEC from lambs born in 1989 and 1990 from 25 sires. These were measured monthly from weaning in November until September the following year. October FWEC was not available in the first dataset and a second data set which comprised 1738 records of FWEC of progeny from 54 sires from 1990 until 1993, was generated to determine the genetic variation and genetic relationship between FWEC collected in October, November and December under a natural challenge. To obtain an improved heritability estimate for May, June, July, August and September, different datasets using the available records were generated.

Statistical analysis

Initial genetic parameters for FWEC were estimated from a half sib (HS) analysis by the method of least squares (Harvey, 1987). The FWEC data were transformed to cubes as suggested by Woolaston (personal communication). Lamb birth year, birth type, sex and dam age were included in the model as fixed effects, whereas sire was treated as a random effect. All two-way interactions were initially included but were left out of the model if not significant. The data were finally analysed with an univariate animal model with the DFREML computer program of Meyer (1989). Environmental factors that tested significant in the first analysis were included in the model.

RESULTS

Environmental factors

Figure 1 indicates the untransformed mean FWEC for the lambs born in 1989 and 1990. Data was collected from weaning at approximately 3 of age until 13 months of age (Dataset 1). It is clear that there were large variations between months within years, and also between years, with the average monthly FWEC significantly ($P<0.01$) higher in 1990 than in 1989.

Figure 2 shows the average untransformed FWEC for October, November and December for lambs born from 1990 to 1993. Significant differences ($P<0.01$) were again found between years and also between months within years. It is clear that FWEC varied dramatically from year to year and also between months within years. Except for 1992, FWEC tended to increase from October to December.

The average untransformed FWEC from June to September for lambs born in 1989, 1990 and 1992 are indicated in Figure 3. FWEC for the 1989 born lambs was very low ($P<0.01$) but higher for the 1991 and 1993 born lambs. It reached a peak in July ($P<0.05$) after which it started to decline.

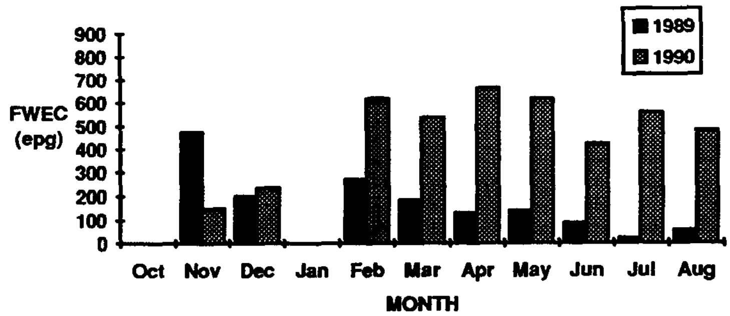

Figure 1. Average FWEC for 1989 and 1990 under a natural challenge.

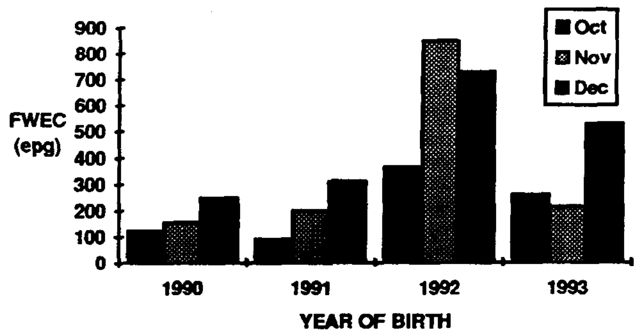

Figure 2. Average FWEC of lambs measured in October, November and December.

Figure 3: Average FWEC from June to September for 1989, 1990 and 1992.

<u>Heritabilities</u>

The heritabilities of FWEC for naturally challenged lambs during different times of the year were estimated with a half sib as well as a REML analysis from the different datasets. Results are shown in Table 1.

Heritability estimates from dataset 1 were very low for the late spring and summer period. It increased to 0.17 • 0.09 in May and reached a peak of 0.25 • 0.11 in June after which it declined again. The heritabilities of FWEC for November and December estimated from dataset 2, were similar to the estimates of dataset 1 and were also very low despite the fact that FWEC generally increased (except for 1992) from November until December (Figure 2). A relatively high heritability of 0.21 • 0.06 was found at weaning in October in spite of the low FWEC during this time compared to November and December. Analysing dataset 2 with an animal model with DFREML (Meyer, 1989), gave essentially the same results.

Table 1. Heritability of FWEC in different months under a natural challenging regime and estimated using different procedures (halfsib estimates above, and REML estimates below).

Month	**h^2 • se**		
	Dataset 1 HS analysis	**Dataset 2** (HS analysis) (REML)	**Available data** (HS analysis) (REML)
October	-	0.21 • 0.06 0.18 • 0.05	
November	0.08 • 0.07	0.07 • 0.04 0.08 • 0.04	
December	0.03 • 0.05	0.07 • 0.04 0.08 • 0.04	
February	0.03 • 0.05	-	
March	0.02 • 0.05	-	
April	0.00 • 0.05	-	
May	0.17 • 0.09	-	0.00 • 0.04 ---
June	0.25 • 0.11	-	0.22 • 0.07 0.43 • 0.06
July	0.04 • 0.06	-	0.28 • 0.07 0.51 • 0.04
August	0.13 • 0.08	-	0.20 • 0.08 0.38 • 0.05
September	0.09 • 0.07	-	0.23 • 0.06 0.32 • 0.04

Dataset 1: 676 records from 25 sires sampled in 1989 and 1990.
Dataset 2: 1738 records from 54 sires sampled in 1989 until 1993.
All available data.

Heritability estimates (column 3) from May to September with a half sib (above) and REML analysis (below) show large differences in heritability estimates between the two estimation methods. Analysing the data with REML increased the half sib heritability estimates dramatically. The REML estimates were nearly double that of the half sib estimates. This indicates that REML extracts more information from a dataset than the conventional least squares means method.

DISCUSSION

The differences in heritability estimates between the two methods of estimation may be due to the fact that in the one case a sire model was used, while in the other case an animal model was used. With full animal models, maternal and non-additive effects may be important. However, in spite of the small dataset, a separate analysis found maternal effects to be unimportant. This aspect needs to be investigated further.

A reasonable heritability estimate of 0.21 • 0.06 was found for FWEC at weaning. This estimate was recently confirmed with a heritability of 0.22 • 0.07 from a dataset consisting of 1380 records from 72 sires in the GSARI Base Flock at Katanning. This flock was described by Lewer *et al* (1992). The average FWEC in this flock was also quite low (250 epg) with a high proportion of zero counts. This raises the interesting possibility of culling individuals with a high FWEC at weaning to reduce the contamination level of pastures. Measurements of FWEC in the following June (at 10 months) could be combined with this early measurement to improve the accuracy of selection.

The drop in heritability between October and November/December might be related to stress associated factors, such as the weaning process, and/or an increased worm burden coupled to a decline in the quantity and quality of feed available. Kelly and Gray (this conference) stated that "Increased levels of nutrition usually increase the ability of mammals to mount an immune response at cellular and molecular levels". It is well known that a nutritional stress suppresses immunity (Bundy and Golden, 1987; Roberts and Adams, 1990), which in turn may affect the expression of resistance, leading to low heritabilities.

The increase in heritability in June coincided with the growth of pasture and the hatching of parasite eggs after the first rains. This trend supports the idea that resistant genes are expressed when sheep are being stimulated by the intake of larvae following the break of the season (May to June in Western Australia). These results indicate that the optimum time to measure FWEC for selection purposes in a Mediterranean environment is sometime after the break of the season from June to September. This emphasises the importance of designing breeding programs to select for worm resistance that are appropriate to a particular region.

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