GENETIC AND ENVIRONMENTAL INFLUENCES ON WORM EGG COUNTS OF GOATS IN THE HUMID TROPICS

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SUMMARY

Faecal egg counts (FECs) were recorded in Fijian goats, after drenching and allowing natural worm infections to develop. Neither age of the animal nor dam age significantly affected log-transformed FEC in weaners, but birth status and sire were both significant in one out of seven groups of cohorts, and sex effects (confounded with paddock effects) were frequently significant, but in an inconsistent manner. The heritability of log FEC was not significantly different from zero in 1513 weaners (h^2=0.04±0.03), or in 789 adult goats (h^2=0.08±0.06). Repeated measures in adults, recorded a year apart, indicated no permanant environmental effect on log FEC. These results offer little promise for within-flock improvement of resistance to nematode parasites of goats in the humid tropics using FEC as a selection criterion.

INTRODUCTION

Over recent years, several Pacific Island governments have encouraged an expansion of sheep and goat populations in an attempt to increase domestic meat production. Small ruminants appear to be well suited to the high islands provided they are given adequate nutrition and protection from dog attack (Banks et al. 1990). However, as the intensity of grazing increases, internal parasites, particularly *Haemonchus contortus* and *Trichostrongylus colubriformis*, can cause heavy mortalities and loss of production. Frequent anthelmintic treatments have promoted the development of resistant worm strains. This problem, together with the high cost of chemicals, has led to a thrust for the small ruminant industries to move away from total dependence on drugs for worm control (Walkden-Brown and Singh 1986).

The Fijian Ministry of Primary Industries' (MPI) goat breeding program aims to produce an improved, tropically-adapted meat goat. Genetic improvement is disseminated to the islands' stock-owners through the sale of improved bucks. Preliminary investigations revealed a significant sire effect on faecal egg counts (FECs) of kids born in 1986 and 1987 (L.R. Piper, unpublished). As only a small number of sires were involved, a larger study was initiated to investigate the feasibility of breeding goats for improved worm resistance. In this paper, we report a study of identifiable factors affecting FEC in MPI goat herds in Fiji.

MATERIALS AND METHODS

Between 1988 and 1992, faecal egg counts were recorded in Fijian goats (described by Hussain et al. 1983), which included 1513 weaners and 951 adults. Of the adults, 162 were repeat sampled, in successive years. Data were available from two herds- one at Sigatoka Reseach Station in the south-west of Viti Levu (average rainfall 1800 mm) and the other at Seaqaqa Research Station on the north-western side of Vanua Levu (also 1800 mm). At Sigatoka, the breeding herd comprised approximately 400 adult does. The herd

at Seaqaqa was smaller (about 170 adult does) and with close genetic links with the Sigatoka herd through the transfer of bucks from Sigatoka. Management of the herds was similar at both stations. Two cycles of hand mating were used in February/March, followed by backup sires. Kids were housed for the first few weeks after birth, before exposure to pasture. At weaning, kids were separated according to sex. Prior to sampling, the two groups of weaners were run in similar paddocks, but in all instances, sex effects were confounded with paddock effects. Males were left entire. The Seaqaqa breeding herd was managed as one unit, but the Sigatoka herd was broken into four groups, for ease of management.

Faecal samples were collected in December of 1988 and 1989 and February of 1991 and 1992. Weaner goats (defined as <365 days old) were only sampled at Sigatoka in 1988, but at both stations in subsequent years. The mean age of weaners was 185 days, with a considerable range (S.D.=52 days). Adult goats (>365 days old) were sampled at both stations in 1989, 1991 and 1992, but in the last year, only adults less than 2 years of age were sampled. Most adults sampled were does (n=749), but 40 bucks were also included. The mean age of adult goats sampled was 3.0 years (range from 1 to 7 years). In all years, existing parasite burdens were terminated with ivermectin at the start of the observation period, then FECs allowed to build up over 4-6 weeks. In order to minimise the number of zero FECs, sampling was deferred until it was felt the welfare of the goats was being compromised. However, because samples were sent to a distant laboratory, the inevitable delay in obtaining results tended to precipitate a conservative approach, and FECs were often lower than considered optimal for detecting genetic differences (Eady and Woolaston, these proceedings). Approximately one month prior to sampling in 1991 and 1992, goats were also drenched with closantel, to selectively remove *H. contortus* during the monitoring and sampling periods. This was to remove possible variation due to between-animal differences in the ratio of *H. contortus* to *T. colubriformis*, which are known to differ considerably in their egg output (Reinecke 1983).

For any given group of cohorts, a logarithmic transformation was found to be best for normalising FEC data. The means and variances of weaners and adults differed markedly, and for most analyses FECs in the two age groups were considered as separate traits. Using least squares, preliminary statistical analyses were carried out on various sub-sets of the data to determine significant sources of variation in log-transformed FEC. Effects tested for weaners included sex/paddock, birth status, dam age, interactions and age at testing (as a linear and higher order regression). For adults, effects tested were sex/paddock, management group and age in years. Genetic analyses were carried out using DFREML (Meyer 1989), by fitting a full animal model with a combined location-year-sex effect and any fixed effects identified as potentially important by the least squares analyses. Data were again log-transformed, but standardised to a common residual variance. The same pedigree file was employed for all analyses, containing 2730 unique identities. Of these, 232 were single-link parents and subsequently treated as unknown, leaving 2498 animals in the model: 127 sires, 579 dams and 1792 non-parents. Following Woolaston et al. (1991), maternal genetic effects were assumed to be unimportant and therefore ignored.

RESULTS

The arithmetic mean (±S.D.) FEC of weaners was 1385±1922 epg, compared with 508±893 epg in adults. In all contemporary comparisons of weaners and adults, weaner FECs were higher, although they were always grazed separately. Classified by year, mean FECs of weaners ranged from 336 epg (43% zeros) in 1988 to 2412 epg (1% zeros) in 1989; and in adults ranged from 373 epg (43% zeros) in 1991 to 722 epg (14% zeros) in 1989. A summary of analyses of variance of weaner FECs at each location is shown in Table 1. Sire effects were significant (P<0.01) among 1991 born weaners at Seaqaqa, but in no other case. In only two instances were the estimates of the sire component of variance positive, in weaners born at either Sigatoka in 1990 or Seaqaqa in 1991. Sex/paddock significantly affected log-transformed FEC in

5 of the 7 data sets (Table 1), but there was no consistency of ranking, with males having significantly lower epg in 2 cases and significantly higher epg in 3 cases. The effects of dam age and age at testing failed to reach significance in any instance (Table 1), but birth status was significant in 1991-born weaners at Seaqaqa, when twins and triplets had higher FECs than singles. None of the effects tested in adults were a significant source of variation, but sex/paddock effects approached significance (bucks higher than does, P=0.07, not tabulated).

Table 1. Means and summary of analyses of variance of weaner FECs at each location, in each year.

				Mean Squares (epg^2)					
Location	Birth Yr	No[1]	Mean	Sire	Sex/ Paddock	Birth Status	Dam age	Age (linear)	Error
Sigatoka	1988	164	345	1.38	2.51	1.54	na	0.36	1.74
	1989	234	2467	0.18	2.50**	0.09	0.01	0.16	1.75
	1990	286	1371	0.49	0.68	0.10	0.00	1.27	0.47
	1991	232	1239	0.60	45.91**	0.10	0.03	0.62	0.73
Seaqaqa	1989	131	1820	2.55**	3.34*	0.86	0.00	0.09	0.71
	1990	114	1137	0.13	4.63**	0.81	0.76	0.36	0.62
	1991	173	787	0.24	18.16**	1.97*	0.35	0.16	0.62

[1] Excludes animals with unknown sires, so involves fewer animals than REML analyses

*P<0.05 ** P<0.01

Heritability estimates using REML were not significantly different from zero in weaners (h^2=0.04±0.03) or adults (0.08±0.06). In adult goats, the estimate of a permanent environmental effect was zero (0.00±0.11), indicating the repeatability of log-FECs between years to be no greater than the heritability. Different groupings were made of the animals according to age. For 981 goats aged 6-18 months, the heritability estimate was the same as that for weaners. For 188 goats aged 12-24 months, the estimate was 0.25±0.38. Combining data from goats of all ages utilised repeat records on 361 animals, which resulted in a heritability estimate of 0.04±0.02, and again, a permanent environmental effect of zero (0.00±0.05).

DISCUSSION

Although weaner and adult goats were grazed separately in this study, the data strongly suggest that like sheep, weaners are more susceptible to worms than adults. However, within any broad age group, no linear effect due to age was discernable. Sex effects in weaners were inconsistent, reflecting the confounding with management group effects and suggesting that if sex effects on FEC do exist in weaner goats, as they often do in sheep (Woolaston and Gray 1991), then they are probably not as important as paddock effects. In the one instance where there was an effect due to birth status, it was in the direction often found in sheep, with multiples tending to have a higher FEC (Woolaston and Gray 1991).

Breed effects on FECs in goats have been reported in Kenya (Preston and Allonby 1978) and France (Richard et al. 1990), indicating that genetic variation exists among hosts in their resistance to nematode infections. However, the results reported here indicate very little scope for within-flock genetic improvement in resistance of goats to nematode parasites in the humid tropics, using FEC as a selection criterion. Families were not optimally structured for the estimation of genetic parameters, but unlike sheep in Australia and New Zealand, where the heritability of FEC is moderately high (Woolaston and Gray 1991), very little significant genetic variation in FEC could be found. Furthermore, the low repeatability of FEC offers little promise for the use of repeated measures as an aid to selection. It is not clear why a

highly significant sire effect was found in only one instance (Seaqaqa in 1989-born weaners). Although the mean FEC was relatively high in this group (1820 epg), it was lower than the 1989-born weaners at Sigatoka, when there was no indication of a sire effect. Treating the sheep to control *H. contortus* in 1991 and 1992 did not increase sire effects on FECs (Table 1), but as the species were not differentiated in earlier years, it is unclear the extent to which differences in composition of the worm populations were important. It is however, worth noting that Baker et al. (1990) reported significant sire effects in New Zealand Romneys when mixed infections of *T. colubriformis* and *H. contortus* were present.

The only age group in which further work may be justified is the yearlings, which were not well represented in this study but yielded the highest heritability estimate, albeit with an even higher standard error. FECs in this age group may possibly be mediated by acquired immunity but not yet complicated by parturition. To our knowledge, no other heritability estimates for resistance of goats to nematode parasites have been published, so it is not clear whether the disparity between these results and those reported for sheep in Australia and New Zealand is due to the different host species or to a feature of the tropical environment. The relatively high proportions of zero readings were not optimal conditions for detecting genetic differences, but they were the best that could be achieved in the absence of on-site facilities for counting worm eggs.

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