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Distribution of litter sizes within flocks at different levels of fecundity

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ABSTRACT

Proportions of ewes having 1 to 4 lambs in 72 local breed flocks with mean litter sizes per ewe ranging from 1.07 to 2.30 were examined, and compared with the proportions recorded in 12 groups of Booroola and 8 groups of Finn type ewes. Below a mean litter size of 1.70, differences in litter size resulted from differences in the proportion of ewes having singles and twins. Mean litter sizes ranging from 1.70 to 2.30 were accompanied by changes in the proportions of ewes having singles and triplets, the proportion of ewes having twins or quadruplets showing no significant change. The proportions recorded in local breed flocks and groups of Finn-type sheep were similar over litter sizes of 1.70 to 2.30. Groups of ewes that carried 1 copy of the Booroola gene had more ewes with 1, 3 and 4 lambs, but fewer ewes with twins, than the local breed flocks.

Keywords Sheep; ewes; litter size; Booroola; Finn

INTRODUCTION

It has recently been established that the fecundity of Booroola type sheep is markedly influenced by a major gene (Piper and Bindon, 1982; Davis *et al.*, 1981; 1982). The criterion used to identify ewes carrying 1 copy of the Booroola gene has been the expression of at least 1 ovulation rate record ≥ 3 or a set of triplets in the ewe's lifetime performance. Consequently, in ewes carrying 1 copy of the gene there is an increase in the proportion of ewes having triplet litters. Changes in the distribution of birth ranks within a flock that accompany increases in litter size are important when considering flock management. It is pertinent therefore to examine the distribution of ewes having 1 to 4 lambs in flocks of Booroola type ewes to test whether this differs markedly from other breeds of sheep with similar litter sizes. This paper compares differences in the proportions of ewes having 1 to 4 lambs between flocks with 1 copy of the Booroola gene and high fecundity local breed (Romney and Coopworth), Finnish Landrace and Finn cross flocks within the same range of mean litter size (1.70 to 2.30). Additionally, changes in the distribution of the proportions with increasing mean litter size in flocks of various local breeds were studied over the range in mean litter size of 1.07 to 1.68.

MATERIALS AND METHODS

All lambing data are from ewes aged 2 years or older at lambing. The Booroola data were from 4 flocks of heterozygous (F +) Booroolas located at the Tara Hills High Country Research Station and Invermay Agricultural Research Centre, grouped according to age. The size of the 12 Booroola groups ranged from 36 to 92 with mean litter sizes in the range 1.70 to 2.30.

Data from the local breed flocks were obtained from 2 sources—a study of the reproductive performance of 2.5-year old ewes in commercial sheep flocks in 4 South Island districts using the records from the laparoscoped ewes (litter size 1.07 to 1.91; Kelly, 1982), and information from mixed age Coopworth ewes in commercial high fecundity flocks (litter size > 1.70) located in Otago and Southland. A total of 72 flocks ranging in size from 43 to 1096 were studied.

The Finn data were obtained from flocks run at the Agricultural Institute, Belclare, Ireland, and comprised 335 lambing records from Finn ewes, 686 from Fingalway (½ Finn ½ Galway) ewes and 448 from ¼ Finn (¼ Finn ¾ Galway) ewes. Ewes were grouped according to age resulting in 1 group of Finns, 5 of Fingalways and 2 of ¼ Finns with 81 to 335 lambing records per group and mean litter sizes in the range 1.70 to 2.30.

In comparing the distribution of the proportion of ewes having 1 to 4 lambs in Booroola flocks with local breed flocks over the common range of litter size, 1.70 to 2.30, it transpired that litter size was an important concomitant variable for singles and triplets, but not for twins and quadruplets. Accordingly, regression analyses were performed on singles and triplets and analyses of variance on twins and quadruplets.

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RESULTS

In the 28 local breed flocks with mean litter sizes in the range 1.07 to 1.44, differences in litter size resulted from differences in the proportion of ewes having singles and twins. The proportion of ewes having triplets never exceeded 0.01 in this litter size range.

For the 17 local breed flocks with a mean litter size ranging from 1.46 to 1.68, the proportion of ewes having triplets was low (0.00 to 0.03). Thus most of the change in lamb production in this litter size range was accomplished by the substitution of ewes having twins for singles.

In the litter size range 1.70 to 2.30 for 27 local breed and 12 Booroola flocks the proportion of ewes having singles decreased as litter size increased while the proportion of ewes having triplets increased. The proportion of ewes with twins and quadruplets showed no significant change. Breed differences were evident in this litter size range. At the mean litter size of 1.98 for the 39 flocks the Booroolas had a greater proportion of ewes with single lambs than local breeds (0.290 *v* 0.209, SED = 0.014), fewer twins (0.460 *v* 0.617, SED = 0.027), more triplets (0.213 *v* 0.174, SED = 0.012), and more quadruplets (0.027 *v* 0.005, SED = 0.006). Thus for 100 lambs born to F + Booroola ewes there will be 4 more born as singles, 15 less as twins and 11 more as triplets and quadruplets compared with 100 lambs born from local breed ewes at the same mean litter size.

The distribution of proportions of ewes having 1 to 4 lambs within the Finn and Finn cross flocks was very similar to the local breeds. Distributions in all flocks in the mean litter size range 1.70 to 2.30 are shown in Fig. 1.

DISCUSSION

Differences in mean litter size below 1.70 in local breed flocks were almost entirely accountable by differences in the proportions of ewes having 1 or 2 lambs, but litter sizes ranging between 1.70 to 2.30 primarily resulted from differences in the proportion of ewes having 1 or 3 lambs, there being little change in the proportion of ewes having twins (mean value = 0.62). In fact the highest incidence of ewes with twins observed in any of the flocks was 0.75. The high lambing performances of the local breed flocks have undoubtedly been achieved through both genetic (ram and ewe selection) and environmental (live weight) methods. Therefore any farmers seeking increases in fecundity of their flocks beyond 1.70 through similar techniques can expect an increased proportion of triplet bearing ewes, and therefore

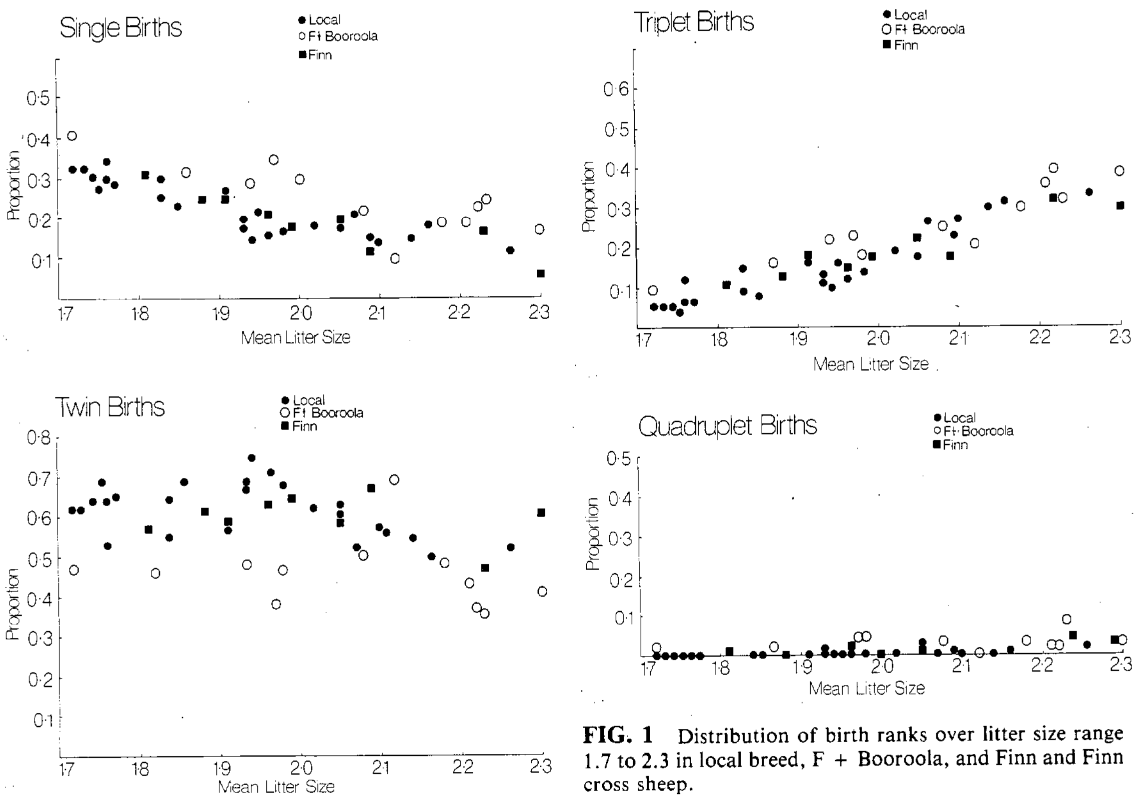

FIG. 1 Distribution of birth ranks over litter size range 1.7 to 2.3 in local breed, F + Booroola, and Finn and Finn cross sheep.

must be prepared to manage their flocks accordingly. In this respect, the data from Finn and Finn cross flocks suggest that similar distribution in birth ranks could also be expected from cross breeding with local breeds.

In contrast, the heterozygous Booroola flocks have a different birth rank distribution from that observed in local breed flocks in the litter size range 1.70 to 2.30. The basis of this difference does not appear to lie in differences in embryonic survival of multiple ovulating ewes, since for ewes with 2 to 4 corpora lutea embryonic survival in heterozygous Booroola ewes (G. H. Davis and R. W. Kelly, unpublished data) is similar to the values found in Finn and Galway breeds (Hanrahan, 1980). Rather, a comparison of ovulation rates between heterozygous Booroola and Fingalway ewes suggests that the differences arise from a breed difference in the distribution of ovulations. Some caution is necessary in interpreting these results because the observations reported here are only on a limited number of flocks, and they are largely on flocks generated from heterozygous Booroola rams in which the first cross ewe progeny have been classified as carriers using the criterion of at least 1 record of ovulation rate ≥ 3 (Davis *et al.*, 1982). It is possible that some ewes that failed to reach an ovulation rate ≥ 3 were in fact heterozygous animals and thus the proportion of ewes with twins in a heterozygous Booroola flock has been underestimated. However it is unlikely that such misclassification would account for all of the observed differences.

Given the observed differences in distribution of birth ranks in Booroola flocks, with fewer twin bearing ewes and correspondingly more singles, triplets and quadruplets, higher lamb mortalities and lower lamb growth rates can be expected in comparison with local breed flocks of similar mean litter size. More importantly, as at present most Booroola rams used in industry are heterozygous and therefore progeny will consist of approximately equal numbers of carrier and non-carrier animals, differences in birth rank distribution at common mean litter sizes for a flock will be even more marked.

Table 1 shows the theoretical distribution of proportion of ewes having 1 to 4 lambs in a Booroola flock with a mean litter size of 1.80 that is comprised of 50% heterozygous ewes (litter size = 2.30) and 50% non-carrier ewes (litter size = 1.30), compared with that for a local breed flock with the same mean litter size. A Booroola flock of 100 ewes generated from a heterozygous ram would have 12.5, 10.5 and 1 more ewes having 1, 3 and 4 lambs respectively, and 24 fewer ewes having twins. As only half these ewes carry the Booroola gene, the Booroola breed affect described previously results in 4, 2 and 1 more ewes having 1, 3 and 4 lambs respectively and 8 fewer having twins. Therefore the differences are primarily due to the combination of 2 sub-populations with widely differing prolificacy. Nevertheless they indicate potentially greater difficulties in feed management if farmers wish to preferentially feed multiple bearing and rearing ewes, and highlight a need for the farmer to be able to use homozygous Booroola rams so that Booroola ewes of known genotype can be produced.

TABLE 1 Predicted birth rank distribution in F + and + + Booroolas differing in litter size by 1.0, a Booroola flock comprised of equal numbers of both genotypes and a local breed flock.

	Litter size	Birth rank 1	2	3	4
Booroola (F +)	2.30	0.13	0.46	0.39	0.02
Booroola (+ +)	1.30	0.70	0.30		
Booroola (F + and + +)	1.80	0.415	0.38	0.195	0.01
Local breed	1.80	0.29	0.62	0.09	

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