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# EFFECT OF MULTIPLE BIRTHS ON REPRODUCTION RATE IN A CONTROL FLOCK

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## Summary

A positive selection differential, in number of lambs born per ewe joined, has been demonstrated in a hypothetical control flock in which male and female replacements are chosen at random.

Annual genetic gains of 0.0129 and 0.0103 have been calculated for control flocks with 30% and 15% multiple births in which 16.7% of the ewes and half of the rams are replaced each year.

The increase in reproduction rate observed in a control flock of medium Peppin Merinos is discussed.

## I. INTRODUCTION

The possible sources of error in the use of a control group to estimate the genetic change in a selected population have been reviewed by Hill (1972). One source is a genetic trend in the control due to natural selection, Natural selection, operating through differences in reproduction rate among the parent individuals or in viability among their offspring, may cause changes in gene frequency between the parent individuals and the offspring generation (Falconer 1961).

If natural selection should operate in a control population by virtue of differences in number of lambs born among parent individuals, this could be a problem in the interpretation of a selection experiment in which number of lambs born is either under selection itself or is under observation for a correlated response with another character which is under selection.

A method of compensating for this effect of natural selection is described here.

## II. MATERIALS AND METHODS

### (a) Estimation of Natural Selection

Young and Turner (1965) gave theoretical consideration to the improvements in both number of lambs born and clean wool weight per head which might be expected from a number of selection schemes in Australian Merino sheep. In each of the schemes, both rams and ewes were selected on various criteria relating to reproduction or wool weight or both.

We have made the same assumptions as Young and Turner (1965), but all replacement rams and ewes have been selected at random. The assumptions made are set out below.

Ewes were 2-7 years of age at lambing, and 12% bore no lamb. At the two levels of twinning (30% and 15%), the numbers of lambs born per ewe joined ($L_{BJ}$) were 1.18 and 1.03 respectively.

Rams were joined at 3% of the number of ewes and were used in two consecutive years. The rams were 2 and 3 years old at the birth of their offspring.

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Of the single lambs 80% were assumed to survive until selection; of the twins, 60%.

No deaths in adult sheep were allowed for; one sixth (16.7%) of the breeding ewe flock and 50% of the working ram flock was replaced each year.

(b) Avoiding Natural Selection

The aim in avoiding natural selection is to establish a zero selection differential, in LBJ , for the rams and ewes chosen as replacements. Details of the calculations are shown in the results.

## III. RESULTS

### (a) Estimation of Natural Selection

Let P be the proportion of the flock replaced each year,

p the proportion of twins among the animals available at selection,

$L_{BJ}$ the original lambs born per ewe joined.

Then the selection differential in number of lambs born, that is, based on the dam's reproductive performance, is

$$\frac{2Pp + P(1-p)}{P} - L_{BJ}$$

$$= 1 + p - L_{BJ}$$

As p will be the same for each sex when replacements are chosen at random, the selection differentials calculated for rams and ewes are the same.

(i) 30% Multiple births

. The percentages of ewes bearing 0, 1 and 2 lambs are 12, 58 and 30 respectively. If all replacements are then selected at random, the expected percentages of twins and singles chosen would be 43.7 and 56.3.

The selection differential, in $L_{BJ}$, for the rams and ewes becomes

$$(1 + 0.437) - 1.18 = 0.257.$$

(ii) 15% Multiple births

The percentages of ewes bearing 0, 1 and 2 lambs are 12, 73 and 15 respectively. We would then expect 23.6% of twins and 76.4% of singles to be selected at random.

The selection differential, in $L_{BJ}$ , for the rams and ewes becomes

$$(1 + 0.236) - 1.03 = 0.206.$$

(iii) Genetic gains

The rate of genetic gain per generation in number of lambs born if ewes are chosen as twin-born, that is, if selection is based on the dam's reproduction rate, is

$$\Delta G = \bar{i}_{\varrho}\sigma_{\varrho} \quad (\tfrac{1}{2}h^2 \ell_3 \quad) \text{ (Turner and Young 1969)}$$

where $\bar{i}_\ell$ = average standardized selection differential of parents in reproduction (which depends on the proportion of ewes bearing 0, 1 or 2 lambs).

$\sigma_\ell$ = standard deviation of number of lambs born.

$h^2{}_{\ell_3}$ = heritability of the dam's 3 year-old lambing performance, since twin births are rare at 2 years.

= 0.35 (Young, Turner and Dolling 1963).

If actual selection differentials are used, $\bar{i}\sigma_\ell = I\ell$. With 30% multiple births $\Delta G = 0.257 \times \frac{0.35}{2} = 0.0450$ for both the ewes and rams. For 15% multiple births, $\Delta G = 0.0361$ for each set of parents. The annual genetic gains for reproduction rate in number of lambs born are then $\frac{0.0900}{7} = 0.0129$ and $\frac{0.0722}{7} = 0.0103$. For replacements chosen at random the annual genetic gains are $\frac{0.0129}{0.042} = 30.7\%$ and $\frac{0.0103}{0.039} = 26.4\%$ of the maximum values calculated by Young and Turner (1965) for the two levels of twinning.

(b) Avoiding Natural Selection

Given the flock replacement rate, the mean reproduction rate $L_{BJ}$, and the number of sheep of each sex and birth type surviving to selection, the percentage of twin and single replacements required to achieve a zero selection differential can be calculated for a control flock.

From the formula $\Delta G = \bar{i}_\ell \sigma_\ell (\frac{1}{2} h^2{}_{\ell_3})$, as the selection differential $I\ell$ approaches 0, $\Delta G$ will also approach 0.

We have shown earlier that the selection differential $I\ell$ is $1 + p - L_{BJ}$, where p is the proportion of twins among the animals available at selection, The selection differential will be zero when $p = L_{BJ} - 1$. Thus with 30% multiple births, $p = 1.18 - 1 = 0.18$ and so 18% of the 16.7% ewe replacements required in the theoretical flock are twins and 82% are singles. Similarly for 15% multiple births, $p = 1.03 - 1 = 0.03$ and 3% of the 16.7% ewe replacements required are twins and 97% are singles. The percentages of twin and single ram replacements needed are the same as the ewe percentages required at each level of multiple births.

IV. DISCUSSION

The reproduction rate in a control flock of medium Peppin Merinos (Turner, McKay and Quinane 1972) is characterised by an increase in the number of lambs born per ewe lambing ($L_{BP}$) for ewes from 3 to 8 years of age at lambing. The lambings covered were those from 1950 to 1966 inclusive; the increase in $L_{BP}$ was evident in 1959 and later years.

The percentage chance of choosing a twin from the weaners available each year has been calculated (Table 1); the 7 lambs born as triplets have been bulked with the twins in the 2,105 weaned lambs considered.

It is seen from Table 1 that there is a general increase in the probability that twin-born sheep would be chosen as replacements in this control flock. Should, in fact, twins have been selected, the increase in $L_{BP}$ described by Turner, McKay and Guinane (1972) could have resulted from natural selection for reproduction rate as described in this paper.

Differences in favour of singles have been observed by Dun and Grewal (1963) for weaning weight, 18 month body weight, and greasy fleece weight. Turner (1961) has shown a difference of 0.154 kg clean wool between handicapped (twins and the progeny of young ewes) and unhandicapped (singles, the progeny of adult ewes) sheep. Inclusion of more twins could, therefore, result in an over-estimation of the response to selection involving these characters, when measured as percentage deviations from the control, unless the numbers of twins and singles in the control flock and the flock under selection were the same or type of birth adjustments were made.

The increase in $^{L}BJ$, described for a random control flock, would be expected to occur in commercial flocks. If this has not occurred, it could be because handicapped animals are generally not identified at selection, as a result of which they are selected against with a resultant lowering of the twinning rate (Turner 1961).

TABLE 1

Percentage chance of choosing a twin from weaned lambs available each year in the control flock of Turner, McKay and Guinane (1972)

| Year of lambing | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 |
|---|---|---|---|---|---|---|---|
| Males | 7.8* | 4.3 | 6.1 | 15.9 | 23.6 | 21.6 | 14.8 |
| Females | 8.6 | 5.9 | 5.3 | 10.8 | 14.3 | 16.8 | 20.3 |

| Year of lambing | 1957 | 1959 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|
| Males | 5.9 | 37.2 | 34.1 | 22.0 | 31.5 | 23.9 |
| Females | 18.6 | 40.2 | 31.5 | 27.7 | 20.0 | 22.8 |

* Percentage chance of choosing a twin from weaned lambs available

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