GENETIC AND PHENOTYPIC RELATIONSHIPS OF HOGGET BODY WEIGHT AND OESTROUS ACTIVITY WITH REPRODUCTION IN NEW ZEALAND ROMNEY SHEEP

Relaciones genéticas y fenotípicas entre peso y actividad estral de burreegas con reproducción en Romney Neozelandés


NEW ZEALAND

INTRODUCTION

Relatively few estimates of genetic correlations between reproductive traits of ewes and other traits recorded early in life have been reported in sheep (Turner, 1969; Ch'ang and Rae, 1972).

This paper presents estimates of phenotypic and genetic correlations of several reproductive traits in ewes with a number of hogget traits recorded between 3 and 16 months of age. Ch'ang and Rae (1972) suggested that indirect selection, based on the measurement of yearling liveweight or number of hogget oestruses, could be more efficient in producing genetic gain in lamb production in New Zealand Romney sheep than direct selection. This question is also addressed here.

MATERIALS AND METHODS

The data in this study were collected during the establishment phase of an experimental selection programme conducted in collaboration with the New Zealand Lands and Survey Department on their Waikite block about 30 km south of Rotorua. The Waikite environment is typical of many North Island hill country properties.

Initially records were collected on ewe hoggets (animals aged between 3 and 16 months) born from 1969 to 1972 in two flocks, one of about 800 commercial Romney ewes and the other of 250 registered ewes. Genetic and phenotypic parameters among both ewe and ram hoggets traits were published by Baker, Clarke, Carter and Diprose (1979). Four traits recorded on these ewe hoggets are considered here, namely: live weight at weaning (3 months of age), yearling weight (13 months), number of hogget oestruses (recorded from about 8-10 months of age) and occurrence of oestrus, i.e. an all-or-none trait for ewe hoggets that did (code=1) or did not (code=0) show oestrus. Vasectomised rams (6-8) were joined with the ewe hoggets (400-500) in April each year and the occurrence of oestrus observed thereafter at 14 day intervals until about the end of June.

Reproductive performance of ewes born between 1969 and 1972 was recorded for their first four lambings between 1971 and 1977. Overall, 79% of those ewe hoggets alive as yearlings were randomly selected, within flock and sire group, to enter the ewe flock. Ewes were first joined at approximately 18 months of age, and then annually thereafter. Ewes were re-randomised for single-sire mating each year. After their fourth lambing the majority of the ewes in the flock were culled for age as 5 1/2-year olds. Over all four birth years a total of 1473 ewes were joined at 18-months of age and 626 (43%) survived to the fourth joining.

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Seven measures of ewe reproductive performance were studied. These included: fertility, ewes lambing per ewe joined (ELJ); prolificacy, lambs born per ewe lambing (LBL); lambs born per ewe joined (LBJ); lambs weaned per lamb born (LWB); lamb loss from birth to weaning (LB-1W); lambs weaned per ewe lambing (LWL); lambs weaned per ewe joined (LWJ). Ewes joined is defined here as ewes put to the ram.

A series of mixed models were fitted to the data. Within each lambing age a model was used which included the fixed effects of flock x year of birth (8 classes), birth-rearing rank of the ewe (3 classes), age of dam of the ewe (3 classes) and birthdate of the ewe and the random effect, sire of ewe nested within flock x year born (153 sires, 145 df). Analyses were also carried out across lambing ages and in this model age of the ewe (4 classes) was included as a fixed main effect. Components of variance and covariance were estimated using method 3 of Henderson (1953), and heritability and genetic correlation estimates derived from paternal half-sib correlations. When estimating correlations between hogget traits and lifetime reproductive performance, the 2-5 year records and 3-5 year records were the sum of deviations from flock x year born x lambing year subclass means.

RESULTS AND DISCUSSION

The heritability of all the reproductive traits except prolificacy were low (0-0.05) and not significantly different from zero. The heritability of prolificacy (LBL) was $0.10 + .03$ from the analysis over the four lambing records (2-5) and $0.14 + .08$ for the 2-year old record.

Estimates of the phenotypic and genetic correlations among the hogget and ewe reproductive traits are presented in Tables 1 and 2, respectively. Correlations of the four hogget traits with just three reproductive measures, ELJ, LBL, and LBJ are presented.

Estimates of phenotypic correlations were low (0.02-0.10) and somewhat lower than comparable correlations presented by Ch'ang and Rae (1972) for Romneys, which ranged from 0.13 to 0.23. A positive phenotypic association of hogget or ewe liveweights with both fertility and prolificacy has also been found in Romney, Merino and half-bred flocks in New Zealand (reviewed by Dalton and Rae, 1978). There is now general agreement from both New Zealand (Ch'ang and Rae, 1972; Hight and Jury 1976; Clarke, 1980) and U.S.A. studies (Hulet et al., 1969; Levine et al. 1978) of a small positive association of ewe hogget oestrus activity and subsequent lamb production.

Relatively few estimates of genetic correlations among hogget characters and reproductive traits are available in sheep. Those presented in Table 2 have high sampling errors and none are significantly different from zero. This is presumably a function of insufficient sire progeny groups, the relatively small number of ewes per sire (Table 2) and the discrete nature of the ewe reproductive traits and hogget oestrous measures (discussed by Ch'ang and Dunlop, 1974), the combination of which lead to imprecise estimates of genetic parameters.

The generally negative or small positive genetic correlations between liveweights (weaning or yearling) and reproductive traits in Table 2 are in marked contrast to the same correlations presented by Ch'ang and Rae (1972), which were positive and ranged from 0.32 to 0.81. Ch'ang and Rae (1972) did not present standard errors for their genetic correlation estimates. They did
TABLE 1

Estimates of phenotypic correlations among some hogget traits and reproductive traits of ewes recorded from 2 to 5 years of age

<table>
<thead>
<tr>
<th>Hogget traits</th>
<th>ELJ 2</th>
<th>LBL 2</th>
<th>LBJ 3-5</th>
<th>LBJ 2-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning wt.</td>
<td>0.02</td>
<td>0.06*</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Yearling wt.</td>
<td>0.06*</td>
<td>0.09**</td>
<td>0.10**</td>
<td>0.06</td>
</tr>
<tr>
<td>N. hogget oestrous</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06*</td>
<td>0.09*</td>
</tr>
<tr>
<td>Occurrence of oestrus</td>
<td>0.02</td>
<td>0.06*</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>1279</td>
<td>1001</td>
<td>1279</td>
<td>452</td>
</tr>
</tbody>
</table>

*P < .05  
**P < .01

TABLE 2

Estimates of genetic correlations + standard errors among some hogget traits and reproductive traits of ewes recorded from 2 to 5 years of age

<table>
<thead>
<tr>
<th>Hogget traits</th>
<th>ELJ 2</th>
<th>LBL 2</th>
<th>LBJ 3-5</th>
<th>LBJ 2-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning wt.</td>
<td>-.46+.41</td>
<td>-.20+.33</td>
<td>-.61+.78</td>
<td>0.19+.16</td>
</tr>
<tr>
<td>Yearling wt.</td>
<td>-.34+.32</td>
<td>0.13+.27</td>
<td>-.37+.56</td>
<td>0.52+.25</td>
</tr>
<tr>
<td>N. hogget oestruses</td>
<td>0.04+.35</td>
<td>-.38+.34</td>
<td>-.47+.65</td>
<td>-2.6+11.0</td>
</tr>
<tr>
<td>Occurrence of oestrus</td>
<td>0.23+.39</td>
<td>-.36+.36</td>
<td>-.18+.62</td>
<td>-3.4+17.5</td>
</tr>
<tr>
<td>Degrees of freedom-sires</td>
<td>145</td>
<td>145</td>
<td>145</td>
<td>142</td>
</tr>
<tr>
<td>Ave. no. ewes per sire</td>
<td>9.3</td>
<td>7.5</td>
<td>9.3</td>
<td>4.0</td>
</tr>
</tbody>
</table>

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state, however, that sampling errors were relatively large and that accuracy of several genetic correlations, particularly those involving reproductive performance of the ewe, were less than satisfactory. The evidence from a number of other different sources would all suggest that yearling liveweight or ewe liveweights and ewe’s reproductive performance have a small positive genetic correlation ranging from -0.11 to 0.23 (Shelton and Menzies, 1968; Young, Turner and Dolling, 1963; Forrest and Bichard, 1974; Eikje, 1975; Martin, Nicholson, Smith and Sales, 1981).

The genetic correlation of either measure of hogget oestrous activity with the reproductive traits were mostly negative and several had extremely high sampling errors. The consistently negative genetic correlations with LBJ are also contrasted with the positive estimates for comparable correlations reported by Ch'ang and Rae (1972), which ranged from 0.44 to 0.56. Ch'ang and Dunlop (1974) further investigated the relationship between number of hogget oestruses and ewe reproduction by re-examining in more detail the data analyzed by Ch'ang and Rae (1972). Two measures of reproductive performance were examined; fertility (ELJ) and prolificacy (LBL). There was a positive genetic correlation of number of hogget oestruses with fertility (0.86) but with prolificacy the value was about zero (-0.06). Comparable estimates from Table 2 were 0.04 and -0.38 which suggests in both cases, at least, that the genetic correlation with fertility is higher than that with prolificacy. To our knowledge these are the only published estimates of the genetic correlation between hogget oestrus activity and ewe reproduction. Thus we must agree with Ch'ang and Dunlop (1974) that further work in this area is required to clarify this relationship.

On the basis of the fairly high positive genetic correlations they found, Ch'ang and Rae (1972), investigated the merit of using liveweights or hogget oestrus activity as indirect selection criteria to improve reproductive improvement in sheep. Their results were encouraging with both hogget liveweight and number of hogget oestruses giving at least as much response and up 2.5 times greater response for genetic gain in reproduction than direct selection.

Using what we consider are more realistic estimates of average genetic parameters (heritability, genetic correlation with reproduction) from the literature, for hogget liveweight (0.35, 0.20), number of hogget oestruses (0.30, 0.10) and a heritability for "lifetime" LBJ of 0.10, then the relative efficiencies of indirect selection are now only 0.37 for hogget liveweight and 0.17 for number of hogget oestruses.

We therefore question the conclusion of Ch'ang and Rae (1972) that selection for hogget liveweight or number of hogget oestruses is expected to result in greater genetic gains for reproductive performance in sheep than direct selection for LBJ or LBL. It is suggested, however, that the selection index approach to breeding value estimation, incorporating both direct and indirect pathways of the genetic relationships among traits of economic importance in sheep, is the best way to utilise these hogget traits. This is what is presently being done in the New Zealand national flock recording programme – Sheeplan (Clarke and Rae, 1977; Clarke, 1979).
Information was available on 1,473 ewes born 1969-72, sired by 153 rams, with 4,005 joinings recorded between 1971 and 1977, and ewes lambing at 2, 3, 4 and 5 years of age. Seven measures of ewe reproductive performance were studied. Genetic and phenotypic correlations of three of these reproductive measures with some hogget characters, specifically weaning weight and yearling weight and hogget oestrus activity were estimated. Phenotypic correlations estimates were low (0.02 to 0.10). The genetic correlation for one reproductive trait, lambs born per ewe joined, pooled over the four lambing ages, with yearling liveweight was 0.06. This is considerably lower than previous New Zealand estimates of this correlation (0.32-0.81) but compatible with the average value of all such published estimates in sheep of about 0.1 to 0.2. The genetic correlation of number of hogget oestruses with all reproductive traits was fairly consistently negative. This is in marked contrast to the only other known published values of this correlation from New Zealand work which were positive and moderately high (0.44 to 0.56). Based on these results the validity of using either of these hogget characters as indirect selection criteria to improve reproductive performance in sheep, is seriously questioned.

SUMMARY

RESUMEN

Se dispone información sobre 1,473 ovejas nacidas entre 1969 y 1972, cruzadas con 153 carneros, con 4,005 registros de monta entre 1971 y 1977, pariendo las ovejas a los años de edad de 2, 3, 4 y 5. Se estudiaron siete medidas del rendimiento reproductor de la oveja. Se estimaron también las correlaciones genéticas fenotípicas de tres de estas medidas reproductivas con algunos caracteres tales como el peso al destete y el peso al año o la actividad del estro en las corderas primerizas. La correlación genética para un carácter de la reproducción, el de los corderos nacidos por oveja cubierta, estimada sobre los cuatro años de parto, con el peso vivo de los recién nacidos fue de 0,06. Ello es considerablemente más bajo que las estimaciones previas de Nueva Zelanda sobre esta correlación (0,32-0,81) pero compatible con el valor medio de todas las estimaciones publicadas en las ovejas de alrededor de 0,1 a 0,2. La correlación genética del número de estros de las primerizas con todos los caracteres de reproducción fue de una manera débil consistentemente negativa. Existe un marcado contraste para solamente otros valores publicados conocidos de esta correlación en nueva Zelanda, que fueron positiva y moderadamente altos (0,44 a 0,56). Basándose en estos resultados, la validez de usar estos caracteres de las primerizas como criterio indirecto de selección a fin de mejorar los rendimientos de la producción en la oveja se pone seriamente en duda.
REFERENCES


