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# Genetic parameters for growth traits and litter size in Danish Texel, Shropshire, Oxford Down and Suffolk

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**Abstract**

In this study, heritabilities and (co)variance components for birth weight (BW), average daily gain from birth until 2 months (ADG2) and litter size (LS) were estimated in Danish Texel, Shropshire, Oxford Down and Suffolk. Data from 1990 to 2004 were extracted from the sheep recording database at the Danish Agricultural Advisory Centre. A multivariate animal model was used to estimate genetic parameters, including both direct and maternal additive genetic effects, common litter effects and permanent environmental effects. Average values ranged from 4.20 to 4.68 kg for BW, from 281 to 333 g for ADG2 and from 1.36 to 1.55 lambs for LS. Direct and maternal heritabilities for BW for all breeds were in the range from 0.16 to 0.19 and from 0.15 to 0.20. Direct and maternal heritabilities for ADG2 ranged from 0.14 to 0.30 and from 0.09 to 0.16. The heritability for LS ranged from 0.04 to 0.06. Both direct genetic correlations between BW and ADG2, and maternal genetic correlations between BW and ADG2 were positive for all breeds. Genetic correlations between LS and direct genetic effects on BW were not significant different from zero, but the genetic correlation between LS and maternal genetic effects on BW were positive and favourable.


*Keywords:* Sheep; Growth traits; Reproduction; Genetic parameters

## 1. Introduction

In Denmark sheep breeding is taking place in about 6000 herds, where 400 of these are participating in an intensive registration programme. The programme was initiated at the beginning of the 1980s, and based on the database for sheep registrations. A system for estimation of breeding values was developed in 1991–1992. A total of 22 breeds are registered in the Danish sheep recording system. Shropshire, Texel, Suffolk and Oxford Down are the most common breeds, accounting for about 70% of the flocks and about 77% of the purebred ewes (Holmenlund, 2003).

Knowledge on genetic parameters and heritabilities are crucial for the genetic evaluation and for choosing the best selection schemes. In Denmark, sheep breeding programs are currently based on values from the literature, so there is a need for estimating these parameters based on Danish data. Possibilities for simultaneous improvement in growth traits and litter size are dependent on the genetic correlation between the traits. Numerous studies have evaluated genetic parameters for growth traits in sheep (Tosh and Kemp, 1994; Notter, 1998; Mousa

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et al., 1999; Neser et al., 2001), but there are few studies describing genetic correlation between growth and reproduction traits for meat sheep breeds.

The objective of this study was to estimate heritabilities and genetic correlations between growth and reproduction traits in four meat sheep breeds in Denmark; Texel, Shropshire, Oxford Down and Suffolk.

## 2. Materials and methods

### 2.1. Data

Data were collected in the period from 1980 to 2004 by the Danish Agricultural Advisory Centre. Data from 1990 to 2004 were included in this analysis. The traits studied were birth weight (BW), average daily gain between birth and 2 months (ADG2) and litter size (LS). Birth weight was defined as the live weight of lamb measured at latest 24 h after birth. ADG2 was defined as the average daily gain from birth until 2 months (weight at 2 months was measured within ±15 days). Litter size was recorded on the day of lambing as lambs born alive. The characteristics of the data used in the analyses are presented in Table 1. Only animals belonging to a herd-year class with six or more animals were included.

### 2.2. Statistical methods

A multivariate animal model was used for estimation of genetic parameters, including both direct and maternal additive genetic effects, common litter effects and permanent environmental effects due to repeated observations. Effects included in the model differed for the three traits, and they were as follows:

$$\mathrm{BW}_{ijklnopq} = S_i + \mathrm{HY}_j + \mathrm{LM}_k + \mathrm{NB}_l + P_n + \mathrm{adir}_o + \mathrm{amat}_p + \mathrm{pe}_p + c_q + e_{ijklnopq},$$

$$\mathrm{ADG2}_{ijklmnopq} = S_i + \mathrm{HY}_j + \mathrm{LM}_k + \mathrm{NB}_l + \mathrm{NA30}_m + P_n + \mathrm{adir}_o + \mathrm{amat}_p + \mathrm{pe}_p + c_q + e_{ijklmnopq},$$

$$\mathrm{LS}_{jkno} = \mathrm{HY}_j + \mathrm{LM}_k + P_n + \mathrm{adir}_o + \mathrm{pe}_o + e_{ijkno}$$

where $\mathrm{BW}_{ijklnopq}$ is the birth weight of animal $o$; $\mathrm{ADG2}_{ijklmnopq}$ the daily gain of animal $o$; $\mathrm{LS}_{jkno}$ the litter size of animal $o$; $S_i$ the fixed effect of sex; $\mathrm{HY}_j$ the fixed effect of herd-year class; $\mathrm{LM}_k$ the fixed effect of lambing month of ewe (grouped by month, but months 7–11 are pooled); $\mathrm{NB}_l$ the number of offspring born in litter; $\mathrm{NA30}_m$ the number of offspring in litter after 30 days; $P_n$ the fixed effect of parity of ewe; $\mathrm{adir}_o$ the random direct additive genetic effect of animal $o$; $\mathrm{amat}_p$ the random maternal additive genetic effect of animal $p$; $\mathrm{pe}_p$ the random permanent environmental effect of ewe on lambs BW and ADG2; $\mathrm{pe}_o$ the random permanent environmental effect on litter size; $c_q$ the random effect of common litter; $e_{ijklmnopq}$ is the random residual.

Homogeneous residual variance was assumed for all models. Estimation of (co)variance components for all models was carried out with an AI-REML algorithm (Madsen et al., 1994; Johnson and Thompson, 1995)

Table 1
Number of records and means (with S.D. in parenthesis) for each trait and breed

| | Texel | Shropshire | Oxford Down | Suffolk |
|---|---|---|---|---|
| Animals in pedigree | 65292 | 48570 | 36944 | 14932 |
| Sires with offspring | 2353 | 1526 | 1317 | 482 |
| Average no. sire per hyc[a] | 7.8 | 6.9 | 6.1 | 7.5 |
| Average no. hyc per sire | 7.4 | 8.3 | 7.1 | 7.2 |
| Average no. offspring per sire | 43 | 48 | 41 | 42 |
| Average no. animals in hyc | 47 | 42 | 38 | 44 |
| Birth weight (kg) | | | | |
| No. | 51699 | 37035 | 26549 | 10550 |
| Means | 4.55(0.82) | 4.20(0.82) | 4.41(0.86) | 4.68(0.90) |
| Average daily gain[b] (g) | | | | |
| No. | 41464 | 26633 | 20887 | 7970 |
| Means | 318(66) | 281(64) | 333(72) | 324(74) |
| Litter size[c] | | | | |
| No. | 44570 | 31908 | 22567 | 8015 |
| Means | 1.38(0.64) | 1.36(0.62) | 1.55(0.73) | 1.48(0.67) |

[a] Herd-year class.
[b] Weighed at 2 months ±15 days, and adjusted for age.
[c] Number of lambs born alive.