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Genetic Parameters for Birth Weight, Growth and Litter Size for Danish Texel and Shropshire

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Abstract

Texel and Shropshire are the most common sheep breeds in Denmark. In this study, heritabilities and (co)variance components of birth weight (BW), average daily gain from birth until two months (ADG2) and litter size (LS) were estimated. Data from 1990 to 2004 were extracted from the sheep recording database at the Danish Agricultural Advisory Centre. Average values for BW, ADG2, LS were 4.55 kg, 318 g, 1.38 for Texel and 4.20 kg, 281 g and 1.36 for Shropshire, respectively. Direct and maternal heritability for Texel were both 0.19 for BW and 0.14 and 0.10 for ADG2, respectively. For Shropshire the direct and maternal heritability were both 0.18 for BW and 0.21 and 0.14 for ADG2. The heritability for LS were 0.06 for both breeds. The direct genetic correlations between BW and ADG2 were 0.27 for Texel and 0.46 for Shropshire. Genetic correlations between LS and direct and maternal effects of BW were 0.04 and 0.16 for Texel and 0.14 and 0.34 for Shropshire. Genetic correlations between LS and direct and maternal effects of ADG2 were positive, ranging from 0.07 to 0.26 for Texel and Shropshire.

Introduction

In Denmark sheep breeding is taking place in about 6000 herds, where 400 of these are participating in an intensive registration programme. A total of 22 breeds are registered in the Danish sheep recording system. Texel and Shropshire are the most widespread breeds. 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.

The objective of this study was to estimate heritabilities and genetic correlations between growth and reproduction traits in Danish Texel, and Danish Shropshire.

Materials and methods

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 two months (ADG2) and litter size (LS). Birth weight was defined as the live weight of lamb measured at latest 24 hours after birth. ADG2 was defined as the average daily gain from birth until two months (weight at two months was measured within ± 15 days). Litter size was recorded on the day of lambing and as lambs born alive. The characteristics of the data used in the analyses are presented in Table 1.

Table 1

	Animals in pedigree	BW	ADG2	LS
Texel				
no	65 292	51 699	41 464	44 570
Means (S.D.)		4.55 (0.82)	318.4 (66.4)	1.38 (0.64)
Shropshire				
no	48 570	37 035	26 633	31 908
Means (S.D.)		4.20 (0.82)	281.4 (64.0)	1.36 (0.62)

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 followed:

$BW_{ijklnop} = S_i + HY_j + LM_k + NB_l + P_n + a\mathit{dir}_o + a\mathit{mat}_p + pe_p + c_q + e_{ijklnop}$
$ADG2_{ijklmnop} = S_i + HY_j + LM_k + NB_l + NA30_m + P_n + a\mathit{dir}_o + a\mathit{mat}_p + pe_p + c_q + e_{ijklmnop}$
$LS_{jkno} = HY_j + LM_k + P_n + a\mathit{dir}_o + pe_o + e_{jklo}$
where;
$BW_{ijklnop}$ = birth weight of animal *o*;
$ADG2_{ijklmnop}$ = daily gain of animal *o*;
LS_{jkno} = litter size of animal *o*;
S_i = fixed effect of sex;
HY_j = fixed effect of herd-year class;
LM_k = fixed effect of lambing month of ewe (grouped by month, but month 7-11 are pooled);
NB_l = number of offspring born in litter;
$NB30_m$ = number of offspring in litter after 30 days;
P_n = parity of ewe;
$a\mathit{dir}_o$ = direct additive genetic effect of animal *o*;
$a\mathit{mat}_p$ = maternal additive genetic effect of animal *p*;
pe_p = permanent environmental effect;
c_q = random effect of common litter;
$e_{ijklmnop}$ = random residual.

Homogeneous residual variance was assumed for all models. Estimation of (co)variance components for all models was carried out with the AI-REML algorithm using the DMU-package (Madsen & Jensen, 2004), and heritabilities were calculated based on these estimates. Due to computational limitations, genetic correlations where estimated from bivariate models.

Results and discussion

Means and standard deviations of the traits are given in Table 1. Overall means of BW were 4.20 kg for Shropshire and 4.55 kg for Texel. Average daily gain at 2 months were lower for Shropshire (281 g) compare to Texel (318 g). Litter size ranged from 1.36 for Shropshire to 1.38 for Texel.

Heritabilities (in bold on the diagonal) and genetic correlations (below the diagonal), with standard error in parenthesis are presented in Table 2.

Table 2

	BW_d[1]	BW_m[2]	$ADG2_d$[1]	$ADG2_m$[2]	LS
Texel					
BW_d	**0.19** (0.02)				
BW_m	-0.26 (0.05)	**0.19** (0.01)			
$ADG2_d$	0.27 (0.08)	0.00 (0.07)	**0.14** (0.02)		
$ADG2_m$	-0.04 (0.08)	0.32 (0.07)	-0.47 (0.07)	**0.10** (0.01)	
LS	0.04 (0.07)	0.16 (0.06)	0.07 (0.09)	0.21 (0.08)	**0.06** (0.01)
Shropshire					
BW_d	**0.18** (0.02)				
BW_m	-0.17 (0.07)	**0.18** (0.02)			
$ADG2_d$	0.46 (0.08)	-0.16 (0.07)	**0.21** (0.03)		
$ADG2_m$	-0.13 (0.09)	0.45 (0.07)	-0.41 (0.07)	**0.14** (0.02)	
LS	0.14 (0.09)	0.34 (0.06)	0.14 (0.09)	0.26 (0.08)	**0.06** (0.01)

1= 'd' in subscript denotes direct additive genetic effect
2= 'm' in subscript denotes maternal genetic effect

Both direct and maternal heritability for BW were 0.19 for Texel and 0.18 for Shropshire. The direct heritabilities were similar to those presented for meat breeds (0.15) in a comprehensive review by Safari et al. (2005). The maternal heritabilities for BW were in agreement with what found for crossbreeds (0.17) by Mousa et al. (1999), and for Belgian Texel (0.15) by Janssens et al. (2000).

The direct heritability of ADG2 was 0.14 for Texel and 0.21 for Shropshire. The estimates are in agreement with Larsgard and Olesen (1998) and Matika et al. (2003). The maternal heritability for ADG2 was 0.10 for Texel and 0.14 for Shropshire.

The heritability of LS was estimated for lambs born alive, and were 0.06 for both Texel and Shropshire. Safari et al. (2005) reported the average heritability for LS to be 0.10 for lambs born alive. Van Haandel and Visscher (1995) estimated the heritability for litter size 24 hours after birth for crosses between Isle de France and Finnish Landrace to be 0.08.

The correlation between direct and maternal genetic effects on BW in this study was negative for both breeds; -0.17 for Shropshire and -0.26 for Texel. Robinson (1972) proposed that environmental circumstances can induce negative correlations between direct and maternal effects, especially when field data is analysed. Genetic correlations between direct and maternal genetic effects for ADG2 were -0.41 and -0.47 for Shropshire and Texel, respectively. Negative correlations between direct and maternal genetic effects for average daily gain were also found by Hassen et al. (2003) and Ozcan et al. (2005).

Genetic correlations between the direct effects on BW and ADG2 were as expected positive and ranged from 0.27 to 0.46. Maternal genetic correlations between BW and ADG2 were 0.32 for Texel and 0.45 for Suffolk. The genetic correlations between direct genetic effect on BW and maternal genetic effect on ADG2 and between maternal genetic effect on BW and direct genetic effects on ADG2 were negative, but not significant different from zero.

The direct genetic correlations between BW and LS were positive but not significant different from zero. Genetic correlations between the direct effects on ADG2 and LS were positive and low for both breeds. However, the estimates were not significant different from zero. The genetic correlations between maternal genetic effect on ADG2 and LS were 0.21 for Texel and 0.26 for Shropshire.

Conclusion

The estimated heritabilities for birth weight, average daily gain until two months and litter size for Texel and Shropshire sheep in Denmark were within the range reported in the literature. The positive genetic correlation obtained in this study between BW and LS indicate that selection for increased LS may not have a negative genetic effect on BW, and vice versa.

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