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(Co)Variance components and genetic parameter estimates for growth traits in Moghani sheep

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ABSTRACT

Genetic parameters were estimated for birth weight (BW), weaning weight (WW), yearling weight (YW), average daily gain from birth to weaning (ADG1) and average daily gain from weaning to yearling (ADG2) in Moghani sheep. Maximum number of data was 4237 at birth, but only 1389 records at yearling were investigated. The data was collected from 1995 to 2007 at the Breeding Station of Moghani sheep in Jafarabad, Moghan, Iran. (Co)Variance components and genetic parameters were estimated with different models which including direct effects, with and without maternal additive genetic effects as well as maternal permanent environmental effects using restricted maximum likelihood (REML) method. The most appropriate model for each trait was determined based on likelihood ratio tests and Akaike's Information Criterion (AIC). Maternal effects were important only for preweaning traits. Direct heritability estimates for BW, ADG1, WW, ADG2 and YW were 0.07, 0.08, 0.09, 0.09 and 0.17, respectively. Fractions of variance due to maternal permanent environmental effects on phenotypic variance were 0.08 for ADG1. Maternal heritability estimates for BW and WW were 0.18 and 0.06, respectively. Multivariate analysis was performed using the most appropriate models obtained in univariate analysis. Direct genetic correlations among studied traits were positive and ranged from 0.37 for BW–ADG2 to 0.85 for ADG1–YW. Maternal genetic correlation estimate between BW and WW was 0.33. Phenotypic and environmental correlation estimates were generally lower than those of genetic correlation. Low direct heritability estimates imply that mass selection for these traits results in slow genetic gain.

1. Introduction

Moghani sheep breed is one of the most important meat type breeds among Iranian local sheep, numbering about 5.5 million heads, and well known for their large body size, tolerance and capability to produce heavy lambs (Nosrati, 1998). The breed is polled in both sexes, fat-tailed, predominantly white with brown face, legs and feet. Moghani breed raise with a traditional migratory system, summer in the mountainous areas and winter in the flat areas and pastures.

Maternal effects constitute a sizeable source of variation in growth traits of mammalian species, particularly in young ones (Maniatis and Pollott, 2002; Ligda et al., 2000). These effects mainly represent the dam's milk production and mothering ability as well as intrauterine circumstances and may be influenced by both genetic and environmental factors (Maniatis and Pollott, 2002; Matika et al., 2003). Several studies have shown that growth traits of sheep are affected not only by the animals genetic potential for growth but also by maternal effects including maternal genetic and permanent environmental effects (Snyman et

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Table 1
Description of data set.

Item	Traits[a]				
	BW	ADG1	WW	ADG2	YW
No. of records	4237	3782	3782	1389	1389
No. of sires	204	204	204	185	185
No. of dams	1173	1103	1103	782	782
No. of dams with own records	624	547	547	218	218
Average no. of progeny per dam	3.61	3.42	3.42	1.77	1.77
No. of sires with own records	100	99	99	64	64
Average no. of progeny per sire	20.76	18.54	18.54	7.51	7.51
Mean (kg)	4.575	0.195	22.943	0.052	38.205
C.V. (%)	16.96	24.10	22.29	44.23	15.27

[a] BW, birth weight; WW, weaning weight; YW, yearling weight; ADG1, average daily gain from birth to weaning; ADG2, average daily gain from weaning to yearling.

al., 1995; Ligda et al., 2000; Duguma et al., 2002; Maniatis and Pollott, 2002; Ekiz et al., 2004; Miraei-Ashtiani et al., 2007; Rashidi et al., 2008; Mokhtari et al., 2008).

Body weight of lambs at different ages can be considered as selection criteria in breeding programs (Ozcan et al., 2005). Inclusion of growth traits in any sheep breeding programs need to take into account both direct and maternal effects to obtain optimum genetic gain. Therefore, accurate estimation of genetic parameters for direct and maternal effects is of primary importance for designing an efficient improvement program and genetic evaluation system in any sheep breeding scheme.

Few studies have been conducted on the estimation of genetic parameters for growth traits of Moghani sheep. Rashidi et al. (1998) estimated genetic parameters for growth traits of Moghani sheep breed using sire and dam models. Little is known about the influence of maternal effects, maternal genetic and maternal permanent environmental effects on growth traits of Moghani sheep using animal models. Therefore, the main objective of the present research is to investigate the importance of maternal effects and estimation of genetic parameters for some growth traits of Moghani sheep, fitting different combination of direct additive effects and maternal effects including both maternal genetic and maternal permanent environmental effects. Moreover, genetic, phenotypic and environmental correlations among studied traits were estimated.

2. Materials and methods

2.1. Location, flock structure and management

Moghani breeding station is located in a plain area named as Moghan plain, having an areas extend of about 30,000 ha of lands in the north of Ardabil province and west of Caspian Sea, as the main place for rearing of Moghani sheep. The area has a semi-tropical weather with hot and relatively dry summers. Temperature varies from 1.7 to 35 °C and average annual rainfall ranges from 250 to 600 mm. These conditions make Moghan plain very suitable for keeping sheep during the winter season and cold days.

The flock stayed in summer range from May to October and in winter pastures during November–April. In general, the main feeding source is grazing pasture grasses, however some barley might be provided for breeding animals about 2 weeks prior to the beginning of breeding season, during the last month of pregnancy and the first month of lactation. Breeding season started from August and lasted to October. There was a controlled mating system so that the identification of sire and dam of each lamb was known. Ewe lambs and ram lambs were bred at 18 months of age. Rams were used only for 1 year, while ewes may be used for up to 8 years. Lambs were weaned at approximately 3 months of age. Male and female lambs were kept in separate flocks from the age of 6 months onwards. Breeding animals were selected in July, primarily based on the general appearance and coat color of animals. Lambing period ranged from January to February.

2.2. Studied traits

The data set and pedigree information used in the present research were body weight and growth rate of Moghani sheep collected from 1995 to 2007 in Breeding Station of Moghani sheep, located in Jafarabad, Moghan, Iran. Investigated traits were birth weight (BW), weaning weight (WW), yearling weight (YW), average daily gain from birth to weaning (ADG1) and average daily gain from weaning to yearling age (ADG2). All lambs were weighted at the same day, but not necessarily at the same age. The structure of data set which is used in the current research is presented in Table 1.

2.3. Genetic analysis

The fixed effects, considered in the analytical model after testing of significance, included sex of lamb in 2 classes (male and female), year of birth in 13 classes (1995–2007), age of dam at lambing in 7 classes (2, 3, 4, 5, 6, 7 and 8 years old), type of birth in 3 classes (single, twin and triplet) for pre-weaning traits and 2 classes (single and twin) for post-weaning traits, and age of lamb at 3 and 12 months (in days) as a covariate for WW and YW, respectively. Least square analysis was accomplished using the general linear model (GLM) procedure by the SAS software package (SAS Institute, 1989). The interactions between fixed effects were not significant and therefore excluded.

(Co)Variance components and corresponding genetic parameters for the studied traits were achieved by restricted maximum likelihood (REML) method fitting an animal model using DFREML 3.1 computer program (Meyer, 2000). Initially, six univariate animal models were used for genetic analysis as below.

$$y = Xb + Z_1a + e \qquad \text{Model 1}$$
$$y = Xb + Z_1a + Z_3pe + e \qquad \text{Model 2}$$
$$y = Xb + Z_1a + Z_2m + e \qquad cov(a, m) = 0 \qquad \text{Model 3}$$
$$y = Xb + Z_1a + Z_2m + e \qquad cov(a, m) = A\sigma_{am} \qquad \text{Model 4}$$
$$y = Xb + Z_1a + Z_2m + Z_3pe + e \qquad cov(a, m) = 0 \qquad \text{Model 5}$$
$$y = Xb + Z_1a + Z_2m + Z_3pe + e \qquad cov(a, m) = A\sigma_{am} \qquad \text{Model 6}$$

Where y is a vector of observations in the studied traits; b, a, m, pe and e are vectors of fixed effects, direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and the residual effects, respectively. X, Z_1, Z_2 and Z_3 are corresponding design matrices related to the fixed effects, direct additive genetic effects, maternal additive genetic effects and maternal permanent environmental effects to vector y.

It is assumed that direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and residual effects are normally distributed with the mean of 0 and variances $A\sigma_a^2$, $A\sigma_m^2$, $I_d\sigma_{pe}^2$, and $I_n\sigma_e^2$, respectively. Also, σ_a^2, σ_m^2, σ_{pe}^2, and σ_e^2 are direct additive genetic variance, maternal additive genetic variance, maternal