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Estimation of genetic parameters and maternal effects for body weight at different ages in D'man sheep

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ABSTRACT

The objective of this study was to estimate the genetic parameters for birth weight (BW), weight at 30 days (W30), 90 days (W90) and 135 days (W135) of D'man sheep. Records used in the study were collected over a period of 25 years (1988–2012) from 4728 lambs that descended from 129 sires and 621 dams. (Co) variance components and genetic parameters were estimated with univariate and bivariate animal models using the restricted maximum likelihood (REML) procedure. Age of dam, type of birth, sex of lamb and period of birth showed significant effects on studied weights, so they were considered as in the analysis models. Twelve different animal models were fitted by including or excluding maternal additive genetic effects, maternal permanent environmental effect, maternal temporary environmental effect and covariance between direct-maternal additive genetic effects. The most appropriate model for each trait was determined based on Akaike's Information Criterion (AIC). Bivariate analysis was performed using the most appropriate models obtained in univariate analysis. Based on the best model, direct heritability estimates were 0.05 ± 0.02, 0.03 ± 0.02, 0.08 ± 0.03 and 0.12 ± 0.04 for BW, W30, W90 and W135, respectively. Maternal effects significantly influenced the growth traits. The maternal heritability for BW, W30 and W90 were 0.10 ± 0.02, 0.07 ± 0.03 and 0.07 ± 0.03, respectively. Direct-maternal additive genetic correlations were negative and medium ranging from −0.04 to −0.54 for BW, W90 and W135, but positive and medium to high for W30 (0.25–0.71). The maternal permanent environmental effects as a proportion of total variance were 0.10, 0.05 and 0.09 for W30, W90 and W135, respectively. The maternal temporary environmental effects were 0.18, 0.09, 0.08 and 0.07 for BW, W30, W90 and W135, respectively. The estimates of direct genetic correlation between BW–W30, BW–W90, BW–W135, W30–W90, W30–W135 and W90–W135 were 0.84 ± 0.23, 0.66 ± 0.24, 0.81 ± 0.15, 0.92 ± 0.09, 0.93 ± 0.05, 1.00 ± 0.01, respectively. The estimates of the phenotypic correlation among traits were positive and ranged from 0.31 for BW–W135 to 0.87 for W90–W135. In conclusion, maternal effects on weights of D'man sheep are important and need to be considered in any selection programme undertaken for this breed.

1. Introduction

The D'man is the sheep breed of South Moroccan oases. It is known for its high prolificacy, since its litter size at birth varies from 1 to 7 lambs, but also for its low lamb growth (Boujenane, 2006). This growth deficiency is a real obstacle for its large extension as a pure breed outside of its breeding area. Therefore, there is a crucial need for the improvement of growth potential of D'man sheep. To achieve this goal, a selection programme should be implemented for D'man sheep and genetic and non-genetic parameters of body weight at different ages need to be estimated.

The lamb's growth traits in particular until weaning age of prolific sheep are influenced by the genes of lamb inherited from its parents (sire and dam) and environmental factors as lambs suckling period, dam's milk yield and feeding management of sheep. The term maternal environmental effect refers to influences of the mother on her offspring other than through the genes she transmits to them. It incorporates both similarities between multiple lambs born in the same lambing and similarities between lambs born to the same ewe in different lambings (Snyman et al., 1995). Principally, these represent the dam's milk production and mothering ability, through effects of the uterine environment and extra-chromosomal inheritance may contribute (Meyer, 1992). A number of studies have demonstrated that the inclusion of mater-

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nal effects in animal models of maternally influenced traits has an important effect on the estimates of direct heritability (Boujenane and Kansari, 2002; Ekiz et al., 2004; Mandal et al., 2006a; Rashidi et al., 2008; Jafaroghli et al., 2010; Mohammadi et al., 2010; Savar-Sofla et al., 2011). Moreover, Ghafouri-Kesbi and Eskandarinasab (2008) demonstrated that animal models which ignore maternal effects might result in overestimation of direct heritability. A direct consequence of such parameter overestimation will be a similar upward bias in predicted responses to selection. Hence, to achieve optimum progress in a selection programme, both direct and maternal components should be taken into account, especially if an antagonistic relationship between them exists. It is generally assumed that the covariance between direct and maternal additive genetic effects on body weight is negative (Maria et al., 1993; Boujenane and Kansari, 2002; Mandal et al., 2006a; Kushwaha et al., 2009; Zishiri et al., 2014). However, a positive relationship has also been found (Yazdi et al., 1997; Ghafouri-Kesbi et al., 2008; Abbasi et al., 2012).

Furthermore, maternal environmental effect can be partitioned into permanent (factors consistent between each lambing of a dam but not genetic in origin) and common (factors specific to one litter of a dam; litter effect or temporary environmental effect) components. The former component was often included in the analysis models (Ekiz, 2005; Miraei-Ashtiani et al., 2007; Rashidi et al., 2008; Zamani and Mohammadi, 2008; Jafaroghli et al., 2010), whereas the latter, which is a source of variation among lambs born in the same litter, has been ignored in most genetic studies on growth traits, although Falconer and Mackay (1996) reported that offspring of the same litter share a common environment that contributes to the resemblance among them. During the recent years, some authors (van et al., 2003; Abegaz et al., 2005; Ekiz, 2005; Abbasi et al., 2012; Mohammadi et al., 2013) included the maternal temporary environmental effect in animal models and found it significant for growth traits of sheep. Moreover, it was reported (Snyman et al., 1995; Yazdi et al., 1997; Maniatis and Pollott, 2002; Safari et al., 2005; Kushwaha et al., 2009 Safari et al., 2005; Kushwaha et al., 2009) that maternal influences tend to decrease with age of lambs, but they never disappeared completely after weaning. Also, relationships could exist between the maternal genetic, maternal permanent environmental and maternal temporary environmental effects, emphasizing the need for estimating these effects and the relationships among them simultaneously in data of prolific sheep.

To our knowledge, information on genetic parameters for growth traits studies in the D'man breed are meagre. Boujenane and Kerfal (1990) estimated genetic parameters for growth traits of D'man sheep using a sire model. However, little or nothing is known about the influence of maternal effects on growth traits of D'man sheep using animal models. Therefore, the objective of the present study was to obtain estimates of genetic parameters for direct and maternal effects on growth traits of D'man sheep by fitting twelve animal models, attempting to separate direct genetic, maternal genetic, maternal permanent environmental and maternal temporary environmental effects. The information generated would be useful in designing selection programmes for D'man sheep breed in Morocco.

2. Material and methods

2.1. Site of study

The study was conducted in the research station at Errachidia, belonging to the Institut National de la Recherche Agronomique, located in south–east of Morocco (40°39′S, 62°54′W). The climate is arid. The maximum temperature recorded is about 50 °C in summer, while the temperature can drop to −4 °C in winter. The mean annual rainfall is 200 mm, mainly occurring during November–March.

2.2. Flock management

The station maintains a flock of about 80 breeding ewes under an accelerated reproduction system of three lambings in 2 years. Ewes were mated following a controlled breeding, with lambing either in spring (March–May), summer (June–August) or autumn (October–December) season. At each mating season, ewes were allocated at random to a mating group. A single sire mating system was practiced with a ratio of 20–25 ewes per ram for a service period covering two oestrous cycles. At each joining season, at least 3 rams were used for mating. Each sire was generally used during two joining periods and discarded once a male offspring was available for replacement. Ewes are generally culled at 7 years of age. However, if they fail to wean lambs during two successive lambing, show any health problem or exhibit extreme physical defects, they are culled before this age. Ewe lambs retained for breeding were selected on the basis of their birth type, health status and body conformation. They were first mated at about 12 months of age. One or two replacement rams were selected from each sire primarily upon weaning weight among lambs born and reared as multiples. After lambing, the ewe and its newly born lambs were separated from the rest of the flock and placed in an individual pen for a period of 2–3 days. Shortly after birth, lambs' navel cord was disinfected with an iodine solution. The ewes' udders were inspected to assess the milk yield. Excess lambs (i.e., more than two lambs) from multiple births were artificially reared, as were lambs that could not be reared by their own dams. A few days after parturition, ewes and their lambs were moved to a mixing pen with 15–20 other ewes and their lambs. Lambs remained with their dam until weaning at about 90 days of age. The animals were indoors all year, no grazing being allowed. They were housed according to their age, sex, physiological status and health status and maintained under intensive feeding system. Depending on the number of suckled lambs and lactation stage, lactating ewes were provided with 1–3 kg of alfalfa and 0.8–1.2 kg concentrate containing wheat bran, barley, sugar beet pulp, date residue and vitamin and mineral mix. Pregnant and non-pregnant ewes received less feed than suckling ewes. Animals were fed twice daily with two equal amounts. Moreover, water and mineralised salt blocks were supplied ad libitum to animals in the flock at all time. Suckling lambs were creep fed starting from the second month of age. They were provided with a mixture containing alfalfa hay, barley, sun flower meal and mineral and vitamin mix. After weaning, lambs were placed in separate sex groups and were offered about 500 g/day of the same feed for the first 2 months after weaning. Male lambs were not castrated.

Adult animals were vaccinated against enterotoxaemia and treated against internal and external parasites. Lambs were vaccinated against enterotoxaemia at 1 month of age, with a booster 1 month later. They were also treated against internal parasites at 90 days.

2.3. Studied traits

Newborn lambs were identified individually by an ear tag, and dam identification number, birth date, sex and type of birth were recorded within 18 h of birth. The lambs were weighed at birth and every 3 weeks until weaning. The weights at 30 days (W30), 90 days (W90) and 135 days (W135) were obtained by linear interpolation using the appropriate weightings. Thus, the studied lamb weights were BW, W30, W90 and W135.