Birthcoat Type And Fleece Shedding As Adaptative Traits For Extensively Managed Sheep: Genetic Variability And QTL Detection Experimental Design

D. Allain[1], D. Foulquié[2], D. Francois[1], B. Pena[1], P. Autran[2], B. Bibé[1] and J. Bouix[1].

Introduction

The French Romane breed (INRA401) was proposed as an interesting genetic strategy allowing good economical results in harsh areas such as permanent exposure outdoors in mountains areas. This breed is known to have a high productive potential and show a large variability in its fleece type leading to a high variable birthcoat type in lambs and seems to show some aptitude to fleece shedding in adults. For extensive managed sheep, it could be interesting to adapt the fleece in two ways. Firstly, it has been shown that birthcoat type had an impact on lamb survival in several breeds (Purser and Karam (1967); Jacquin et al. (2002); Hatcher (2009)). Then there is a renewed interest in Europe for shedding or hairsheep breed due to relative value of meat and wool, and increasing shearing costs. Thus aptitude to fleece shedding leading to a shedding sheep with seasonal moult could be an interesting opportunity to select. The aim of the present study was i) to characterize the coat of the lamb at birth and to quantify lamb survival in relation to the birthcoat type and its protective aptitude concerning heat loss, ii) to evaluate fleece shedding aptitude, and iii) to estimate genetic variability of these fleece adaptative traits in the French Romane breed raised under permanent exposure outdoors.

Material and methods

General experiment context, breeding system and lambing conditions. The experiment was conducted on the INRA farm of La Fage on the Causses-du-Larzac, a calcareous plateau in the South of France. As previously described (Bouix et al. (2002)) the main characteristics of this high-altitude territory (800 m) is arid conditions despite of an abundant annual rainfall of 1000 mm, due to an important permeability of the soil, which feeds deep subterranean rivers. Seasons are highly contrasted with cold winter due to the altitude, hot summer due to the southern latitude and intermediate seasons showing high variations in temperature, wind and rainfall. To take account of the between-year variability, and also to get a sufficient number of animals, the experiment was 11 years long from 1999 to 2009. The breeding system yet described (Bouix et al. (2002)) is characterized by a short lambing period in outdoors conditions from end-March to mid-April. Climate conditions at that period can abruptly vary from severe conditions of low temperature, wind and rain or snow to warm and sunny conditions. Annual shearing time for ewes is beginning of July.

[1] INRA, UR 631, Station d'Amélioration Génétique des Animaux, BP 52627, F-31326 Castanet Tolosan, France
[2] INRA, UE 321, Domaine de la Fage, Saint Jean et Saint Paul, 12250 Roquefort, France

Animals. The French Romane breed, a composite line of 50pcent Romanov (prolific breed) and 50pcent Berrichon du cher (meat breed), considered as a new breed at the 4th intercross generation (Ricordeau et al. (1992)) was used as experimental support with a flock of 350 ewes. Selection objectives of this breed are mostly maternal traits (prolificacy, growth of the lambs between 10 and 30 days) and meat production traits. This breed is known to have a high productive potential, shows a large variability in its fleece type leading to a high variable birthcoat type in lambs and some aptitude of fleece shedding.

Data recorded. At birth, within the first 12 hours, all lambs were weighted, sexed, assessed for birthcoat type (two grades: short woolly (SW) or hairy double (HD) coat according presence, density and length of guard hair over the body), measurements of coat surface temperature with an infrared thermometer (Jacquin et al. (2002)) and coat depth were made. Then lamb mortality was recorded at daily interval up to weaning (about 50 days of age) and lambs were weighted at 10, 30 and 50 days of age. Fleece shedding aptitude in adult was determined in female lambs, kept as ewe breeders, once a year at the end of June just before shearing time. In a first step, at farm level, the part of ewe body covered by wool was drawn on a standard figure of a sheep. Then this drawing figure was analysed using an image software for determining the percentage of the body surface covered by wool.

QTL experimental design. An experimental design was initiated in 2004 using a Romane breed population comprising 10 sires families of 100 halfsibs/sire) for QTL detection of birthcoat type, fleece shedding and maternal behaviour traits (Boissy et al. (2007)).

Data analysis. A total of 6343 lambs at birth and 1359 adult ewes from 89 sires including animals born within the QTL experimental design described above were recorded. Data were analysed by ANOVA with the GLM procedure of the SAS package. For lamb traits, the considered fixed effects were the birthcoat type, sex, rearing*birth type, age of dam and year of production, with a simple additive model. The GENMOD procedure was used for analysing the survival rate of lambs. Coat surface temperature was analysed by including surface temperature of a control material as covariate in the model. For fleece shedding aptitude in adult ewes, the considered fixed effects were year of observation, age, litter size and number of suckling lamb. Genetic parameters between birthcoat type and coat depth in lamb and fleece shedding aptitude in adult ewe were estimated using a TM (Threshold Model) program[3] using a Bayesian analysis and performing numerical integration through the Gibbs sampler. Estimates were made according two analysis models considering birthcoat type as either a continuous or a binary trait, fleece shedding aptitude being considered as a continuous trait[4].

Results and discussion

Number of records measured in lambs from birth to weaning and distribution of birth coat type in the French Romane breed were shown on Table 1. About 2/3 of Romane lambs had a hairy double coat at birth characterised by a higher coat depth (table 2).
Lamb survival, coat surface temperature and coat depth (table 3) and live body weight 10 days of age were clearly affected by birthcoat type. Lambs bearing a short woolly coat

[3] Available at http://snp.toulouse.inra.fr/~legarra or upon request to the author at: andres.legarra@toulouse.inra.fr
[4] Authors thank Andres Legarra for help to use the TM program.

survived less than others, the difference is highly significant from birth up to 50 days of age. Such an association between birthcoat type and survival rate was correlated to significant differences in coat surface temperature at birth indicating that lambs bearing a short woolly coat had larger heat losses than lambs having a hairy double fleece. Similar results were reported in different breeds (Purser et Karam (1967); Jacquin et al. (2002)).

Table 1: Distribution of birthcoat type in French Romane lambs.

Number of lambs	Short woolly (SW)	Hairy double (HD)
6343	36.8%	63.2%

Table 2: Means, residual standard deviation, tests of significance and lsmeans for different traits in relation to birthcoat type (Survival rate, CST: coat surface temperature, coat depth and live body weight) in French Romane lambs.

	Survival rate (%) at				CST (°C)	Coat depth (mm)	Live body weight (kg)	
	2 days	10 days	30 days	50 days	at birth	at birth	at birth	at 10 days
Means	91.8	88.2	84.8	83.4	23.3	17.1	3.62	6.17
Residual sd					2.7	5.6	0.67	1.03
Sex	NS	NS	NS	NS	NS	*	***	***
Rearing type	***	***	***	***	*	***	***	***
Age of dam	***	***	***	***	*	***	***	***
Birthcoat	***	***	***	***	***	***	NS	*
- HD	92.8	89.6	87.0	86.2	21.2	23.1	3.74	6.41
- SW	89.8	85.5	82.6	82.3	26.3	8.3	3.70	6.35

NS: p>0.05; * p<0.05; ** p<0.01; *** p<0.001

Table 3: Fleece shedding aptitude categorized by percentage of body surface without wool in adult ewes (3051 records from 1359 ewes) of the French roman Breed.

	Classes of body surface without wool						
	<5%	5-25%	25-35%	35-45%	45-65%	65-85%	> 85%
% of records	56.8	3.4	13.7	14.1	5.5	3.7	2.8

Table 3 shows fleece shedding aptitude observed once a year in 1359 adult Romane ewes (3051 records). Some ewes (1.4%) shed all fleece and a total of 43.2% of adult ewes shed at least partly their fleece once a year during spring. The Romane breed being a composite line of 50pcent Romanov and 50pcent Berrichon du cher, gene pool involved in fleece shedding aptitude is probably originated from the Romanov breed where fibre shedding have been yet reported (Bykova (1973)) while no fleece shedding has ever been reported in the Berrichon du Cher breed.

Estimates of genetic parameters of birthcoat type and fleece shedding aptitude in ewes are shown in table 4. High heritability estimates were observed for both birthcoat type and fleece shedding aptitude with a low genetic correlation between these two fleece traits. No estimates of genetic parameters for fleece shedding aptitude have been earlier reported. The high fleece shedding aptitude observed in the adult ewe offers opportunities for selection

leading to a moulting sheep requiring no shearing. Heritability estimates for birthcoat type was very high (0.58 and 0.85 when analysed as a continuous or a binary trait respectively) and in agreement with previous work (Allain et al. (2009)). Previous studies suggested that birthcoat hairiness in the New Zealand Romney sheep is under the control of major genes (Dry (1956); Dry (1958)). Furthermore QTL' affecting staple length and coat structure have been reported in the Romane lamb (Allain et al. (1998); Ponz et al. (2001)). Animals of the QTL experimental design (Boissy et al. (2007)) have been genotyped with the OvineSNP50 bead chip (Moreno et al. (2009)), analyses being in progress to detect QTL and then to fine map relevant genes controlling birthcoat type and fleece shedding aptitude.

Table 4: Estimates of genetic parameters for fleece traits in the French Romane breed[α]

Trait analysis model	Both continuous		Continuous	Binary
Traits	FSA	LBT	FSA	LBT
Fleece shedding adult (FSA)	0.46±0.05	0.12±0.08	0.47±0.06	0.14±0.09
Lamb birthcoat type (LBT)	0.13±0.16	0.58±0.06	0.08±0.06	0.85±0.07

[α]Within each analysis model heritabilities (±s.e.) on the diagonal, phenotypic and genetic correlations below and above the diagonal, respectively.

Conclusion

In the French Romane breed there is a high potential for any selection program leading to a sheep bearing a fleece well adapted to extensive management under permanent exposure outdoors in mountains areas with a lamb bearing at birth a hairy double coat and having aptitude to shed all fleece in the adult. If selection for a hairy birthcoat could be easily achieved alone, it could be more complex to achieve both goals without gene introgression from a hairsheep breed and use of molecular information.

References

Allain, D., Lantier, I., Elsen, J. M. *et al* (1998). In *Proc 6th WCGALP*, 24**:** 51-54.

Allain, D., Foulquié, D. François, D. *et al* (2009). In *Proc 60th EAAP meeting*: 257.

Boissy, A., Ligout, S., Foulquié, D. *et al* (2007). *Renc. Rech. Rum.,* 14, 301-304.

Bouix, J., Jacquin M., Foulquié, D. *et al* (2002). In *Proc 7th WCGALP,* com. no: 02-02.

Bykova, L.G. (1973). *Trud. Yaros. Nauchno-Issledov. Inst.Zhivot. Kormop.,* 3:43-53.

Dry, F. W. (1956). *Proc NZ Soc. Anim. Prod.* 16: 130-140.

Dry, F. W. (1958). *Aust. J. Agric. Res.* 9: 348-360.

Jacquin, M., Allain, D. Bouix, J. *et al* (2002). In *Proc 7th WCGALP,* com. no: 18-13.

Moreno, C., Servin, B., Faraut, T. *et al* (2009). *Renc. Rech. Rum.,* 16, 420.

Purser, A.F. and Karam, H.A. (1967). *Anim. Prod.* 9 (1):75-85.

Ponz, R., Moreno, C., Allain, D. *et al* (2001). *Mammal. Genome* 12(7): 569-572

Ricordeau, G. (1992). *Prod. Anim, hors série: "Eléments de génétique quantitative et application aux populations animales":* 255-262.