Preliminary Results In A Divergent Selection Experiment On Variance For Litter Size In Rabbits

M.J. Argente*, M.L. García*, R. Muelas*, M.A. Santacreu† and A. Blasco†

Introduction

Litter size is one of the most important traits in pig and rabbit production. However, selection on litter size has had a lower response than expected as a consequence of its low heritability (see reviews by Rothschild and Bidanel, 1998, in pigs and Baselga et al., 2004, in rabbits). A reduction in the environmental variance of litter size would increase the heritability and consequently its response to selection. Besides, homogeneity in litter size reduces cross-fostering, facilitating management with a consequent reduction in costs. Recent studies have reported evidences for an additive genetic control of environmental variance on litter size (SanCristobal-Gaudy et al., 2001, in sheeps; Sorensen and Waagepetersen, 2003, in pigs; Gutiérrez et al., 2006, in mice) in uterine capacity (Ibañez-Escriche et al., 2008a, in rabbits), and in body weight (Rowe et al., 2006, and Mulder et al., 2009, in broilers; Garreau et al., 2008, in rabbits; Ibañez-Escriche et al., 2008b in mice). A better biological understanding of the genetics of environmental variance could help to propose new selection strategies in order to improve efficiency of selection schemes at the commercial population.

The objective of this study is to estimate response to selection in a divergent selection experiment on phenotypic variance of litter size within doe in rabbits.

Material and methods

Animals. Animals came from a line originally selected for litter size. Reproduction was organized in discrete generations. Each divergent line had approximately 100 females and 25 males per generation. All animals were bred at the farm of the Universidad Miguel Hernández de Elche. They were under a constant photoperiod of 16:8 h and controlled ventilation. The females were first mated at 18 wk of age thereafter 10 d after parturition, producing an average of 4 parities. Selection was based on phenotypic variance of litter size within doe after correcting litter size for the fixed effects of year-season and lactation status (Vc). The effect of year-season included fifteen levels and the effect of lactation status included three levels (nulliparous, lactating and nonlactating does). Vc within doe was calculated as

\[
\frac{1}{n+1} \sum_{i=1}^{n} (e_i - \bar{e})^2
\]

where e is the phenotypic litter size after correcting for

* Departamento de Tecnología Agroalimentaria. Universidad Miguel Hernández de Elche. Ctra de Beniel Km 3.2. 03312 Orihuela, Spain
† Institute for Animal Science and Technology. Universidad Politécnica de Valencia, P.O. Box 22012. 46071 Valencia, Spain
year-season and lactation status and n is the number of parities of each doe (n varying from 2 to 8). Selection pressure on does was approximately 30% in each line. Males were chosen within sire families in order to avoid an increase of inbreeding. Three generations of selection were performed. Data came from 1030 does. Table 1 shows the number of does and records in litter size per generation and line.

Table 1. Number of does (ND) and records in litter size (NR) per generation and selected line.

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>ND</td>
<td>269</td>
<td>135</td>
<td>159</td>
<td>135</td>
</tr>
<tr>
<td>NR</td>
<td>1012</td>
<td>621</td>
<td>703</td>
<td>605</td>
</tr>
</tbody>
</table>


Traits. The following traits were analyzed: the total number of kits born (LS), phenotypic variance of litter size within doe (Vp), estimated as \( \frac{1}{n+1} \sum_{i=1}^{n} (x_i - \bar{x})^2 \) where \( x \) is the phenotypic litter size and \( n \) is the number of parities of each doe (n varying from 2 to 8), and phenotypic variance of litter size within doe after correcting for year-season and lactation status (Vc).

Statistical analyses. All analyses were performed using Bayesian methodology. Both Vp and Vc were analyzed using a model with only the effect of line-generation (with seven levels: base generation, High and Low lines of first generation, High and Low lines of second generation and High and Low lines of third generation). The model used to analyze LS included the effects of line-generation, year-season (with fifteen levels), lactation status (with three levels: nulliparous does, lactating or nonlactating does), and an effect of the doe. Bounded uniform priors were used for all unknowns with the exception of the doe effect, which was considered normally distributed with mean \( \mathbf{0} \) and variance \( I \sigma_d^2 \), where \( I \) is a unity matrix, and \( \sigma_d^2 \) is the variance of the doe. Residuals were normally distributed with mean \( \mathbf{0} \) and variance \( I \sigma_e^2 \). The priors for the variances were also bounded uniform.

Features of the marginal posterior distribution of differences between lines were estimated using Gibbs sampling. After some exploratory analyses, we used a chain of 120,000 samples each, with a burn-in period of 20,000. Only one of every 50 samples was saved for inferences. Convergence was tested using the Z criterion of Geweke (Sorensen and Gianola, 2002) and Monte Carlo sampling errors were computed using time-series procedures described in Geyer (1992).
Results and discussion

Table 2 shows raw means for phenotypic variance of litter size within doe after correcting for year-season and lactation status (Vc), phenotypic variance of litter size within doe (Vp) and total number of kits born (LS) in the base generation of our divergent selection experiment for phenotypic variance of litter size and features of the estimated marginal posterior distributions of the differences (D) between the High and Low lines in the first three generations of selection. Marginal posterior distributions were approximately normal, thus mode, mean and median were similar, and only the posterior median of the difference is shown.

A large difference between the High and Low lines was found for the selected trait (Vc) in the first generation of selection (D=0.62, P(D>0)=93%, table 2). This difference seems to increase slightly after the second generation of selection. Selection on Vc showed a positive correlated response on phenotypic variance of litter size within doe (Vp) (D=0.59, P(D>0)=87% in the first generation, D=0.54, P(D>0)=85% in the second generation and D=0.90, P(D>0)=94% in the third generation, table 2). Besides, selection on Vc seems to be negatively correlated with litter size. Thus, the differences on litter size between the High and Low lines were -0.32 kits (P(D<0)=92%) in the first generation, -0.27 kits (P(D<0)=88%) in the second generation and -0.72 kits (P(D<0)=98%) in the third generation (table 2). This result agrees with the negative correlation between environmental variance of litter size and litter size (-0.75) reported in a previous study by Ibañez-Escriche et al. (2008c) in this population. Beside, other authors have found a negative correlation between litter size and its environmental variance (Sorensen and Waagepetersen, 2003, in pigs; Gutiérrez et al., 2006, in mice).

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>D</td>
<td>HPD&lt;sub&gt;95%&lt;/sub&gt;</td>
</tr>
<tr>
<td>Vc</td>
<td>3.83</td>
<td>0.62</td>
<td>-0.17, 1.42</td>
</tr>
<tr>
<td>Vp</td>
<td>5.15</td>
<td>0.59</td>
<td>-0.41, 1.60</td>
</tr>
<tr>
<td>LS</td>
<td>8.69</td>
<td>-0.32</td>
<td>-0.76, 0.12</td>
</tr>
</tbody>
</table>

D: posterior median of the difference between the High and Low lines. HPD<sub>95%</sub>: highest posterior density region at 95%. P(%): P(D>0) when D>0 and P(D<0) when D<0.

Conclusion

The preliminary results of this study suggest that environmental variance of litter size seems to be under genetic control, moreover environmental variance seems to be negatively correlated with litter size.
Acknowledgements
This experiment has been supported by project MCYT AGL2008-05514-C02-02 and ACOMP09/2009/172.

References