PRELIMINARY RESULTS IN A DIVERGENT SELECTION EXPERIMENT ON VARIANCE OF LITTER SIZE IN RABBITS. II. RESPONSE TO SELECTION

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ABSTRACT

A divergent selection experiment on phenotypic variance of litter size was carried out in rabbits. Selection was based on phenotypic variance of litter size for each doe after correcting litter size for the fixed effects of year-season and lactation status (PVc). Selection pressure on does was approximately 30% in each line. Males were chosen within sire families in order to avoid the increase of inbreeding. The total number of records for litter size and PVc were 1929 and 534, respectively. Results of the first generation of selection were analyzed using Bayesian methods. The High line showed a higher PVc than the Low line in the first generation of selection. The difference between lines (D) was 0.73 (P(D>0)=96%). This difference in PVc was associated with an increase in the phenotypic variance of litter size (D=1.49, P(D>0)=100%) and a decrease in litter size in the High line (D=-0.38 kits, P(D>0)=93%). The first preliminary results of this study suggest that the variance of litter size seems to be under genetic control.

Keys words: Selection, Variance, Litter size, Bayesian methods.

INTRODUCTION

Selection on litter size has had a lower than expected success as a consequence of its low heritability (see review by Baselga, 2004). 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 of costs. SanCristobal-Gaudy *et al.* (1998) proposed a quantitative genetic model that supposes a genetic control of environmental variance. Recent studies have reported evidences for an additive genetic control of environmental variance on litter size (Sorensen and Waagepetersen, 2003, in pigs; Gutiérrez *et al.*, 2006, in mice) and in uterine capacity (Ibañez-Escriche *et al.*, 2007, in rabbits), and in litter weight at birth (Garreau *et al.*, 2004, in rabbits).

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

MATERIALS AND METHODS

Animals

Rabbits used in this study came from a divergent selection experiment on phenotypic variance of litter size. The animals of the base population of this experiment were chosen at random between offspring of an F2 population derived from lines divergently selected for uterine capacity (see more details about foundation of this F2 in Peiró *et al.*, 2007). They were bred at the farm of the Universidad Miguel Hernández de Elche. Does 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 2.5 parities per doe.

Selection was based on phenotypic variance of litter size for each doe after correcting litter size for the fixed effects of year-season and lactation status (PVc). The effect of year-season included seven levels and the effect of lactation status included three levels (nulliparous, lactating and nonlactating does with more than one parity). PVc 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 year-season and lactation status and n is the number of parities of each doe (n varying from 2 to 6). Selection pressure on does was approximately 30% in each line. Males were chosen within sire families in order to avoid an increase in inbreeding.

Data from the base population and the first generation of selection were included in the analysis. The total number of records for litter size and PVc were 1929 and 534, respectively. The number of does was 265 in base population, 141 in High line and 128 in Low line.

Traits

The following traits were analyzed: total number of kits born (LS) and PVc described above.

Statistical Analyses

Differences between the lines of High and Low variance of litter size: All analyses were based on Bayesian methods. PVc and phenotypic variance of litter size $\left(\sigma^2_{LS}\right)$ were analyzed using a model with only the effect of line (with three levels: base generation, High and Low lines). The model used to analyze LS included the effects of line, year-season, lactation status (with three levels: nulliparous does, lactating or nonlactating does with more than one parity), 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 **0** and variance $\mathbf{I}\sigma^2_p$, where **I** is a unity matrix, and σ^2_p is the variance of the doe. Residuals were normally distributed with mean **0** and variance $\mathbf{I}\sigma^2_e$. 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 DISCUSION

Table 1 shows raw means and standard deviations for phenotypic variance of litter size within doe after correcting for year-season and lactation status (PVc), phenotypic variance of litter size $\left(\sigma^2_{LS}\right)$ and total number of kits born (LS) in the does of our divergent selection experiment on variance for litter size. Values obtained for LS and σ^2_{LS} were slightly lower than those published by Blasco *et al.* (1994) and Santacreu *et al.* (2005).

Table 1: Number of data (N), mean, standard deviation (SD) for phenotypic variance of litter size within doe after corrected for year-season and lactation status (PVc), phenotypic variance of litter size $\left(\sigma^2_{LS}\right)$ and total number of kits born (LS)

Traits	N	Mean	SD
PVc	534	3.36	3.32
$\boldsymbol{\sigma^2_{LS}}$	534	6.51	6.29
LS	1929	8.27	2.56

Features of the estimated marginal posterior distributions of the differences (D) between the High and Low lines of variance for litter size are presented in Table 2. Marginal posterior distributions were approximately normal, therefore only the posterior mean of the difference is shown. The High line showed a higher PVc than the Low line in the first generation of selection (D=0.73, P(D>0)=96%, Table 2). This difference in PVc was associated with an increase in the phenotypic variance of litter size (D=1.49, P(D>0)=100%) and a decrease in litter size in the High line (D=-0.38 kits, P(D>0)=93%). This result agrees with the negative correlation between environmental variance of litter size and litter size (-0.75) reported by Ibañez-Escriche *et al.* (2008) in this population.

Table 2: Features of the marginal posterior distributions of the differences between the High and Low lines in phenotypic variance of litter size within doe after correction for year-season and lactation status (PVc), phenotypic variance of litter size $\left(\sigma^2_{LS}\right)$ and total number of kits born (LS)

Traits	D	$HPD_{95\%}$	P (%)
PVc	0.73	-0.11, 1.51	96
$\boldsymbol{\sigma^2_{LS}}$	1.49	0.02, 2.97	100
LS	-0.38	-0.86, 0.12	93

D: posterior mean of the difference between the High and Low lines. $HPD_{95\%}$: highest posterior density region at 95%. P: P(D>0) when D>0 and P(D<0) when D<0

CONCLUSIONS

The first preliminary results of this study suggest that environmental variance of litter size seems to be under genetic control.

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