Genetic Parameters And Trends Of Growth Traits In A Conservation Herd Of The Colombian Creole Cattle Breed Blanco Orejinegro (BON)

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Introduction

Cattle herds in Colombia were initially composed of crossbred animals brought by the Spaniards in the 16th century (Jordan, 1993). However, during the first decades of the past century, these Creole breeds were indiscriminately crossbred with imported taurine breeds from temperate countries and also with zebuine breeds, which contributed to the genetic erosion of these important tropical cattle genetic resources (Hall and Ruane, 1993). Today, Creole cattle accounts for only 0.01% of the national bovine population, and this proportion experienced a 23% decrease from 1989 to 1999. Effective management of genetic diversity in a threatened breed is essential for its sustainable use in the future because a limited number of breeders will inevitably lead to increased inbreeding and thus to a reduction in additive genetic variance (Falconer and MacKay, 1996), and possibly to inbreeding depression (Burrow, 1993). As a consequence, controlling inbreeding and variation assessment for the genetic component over time are usually the major targets in conservation and selection programs (Meuwissen and Woolliams, 1994 ; Hill, 2000). The aim of this paper is to provide results of genetic parameters and their trends in a population of Colombian Creole cattle breed, Blanco Orejinegro, which has been maintained as genetic conservation herd.

Material and methods

The conservation of BON herd breed has been raised under extensive conditions, at the northeast mountainous region in Antioquia, at experimental center El Nus, Agricultural Research Colombian Corporation (CORPOICA). Although the conservation program began in 1994, the data set was constructed with animals born from 1980 onward; both parents of each animal entering the program had to be known. The pedigree information analyzed included parental animals (table 1.). The data consisted of records from 3376 animals, the progeny of 104 sires and 251 dams. Records were collected from 1980 to 2009. The total numbers of calf records in the data file for the four growth traits were 3376 for Birth Weight, 2642 for Weaning Weight (240-d), and 2509 for 480-d Weight (Table I).

The bovines were arranged in contemporary groups based on year, season, sex and birth number. The general linear model procedure of SAS (1998) was used to test the significance of fixed effects and testing of the models. The age of the dam was included as a covariate at all calf weights evaluated. Random effects considered in the model were direct and maternal effects and permanent environmental effect due to the dams. We established the variance components and heritability values to additive direct, maternal effects and permanent environmental effects due to the dams, initially since 1978 to 1990 and later annually were

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calculated the same parameters up to 2009. The (co)variance used to estimated the heritability values were obtained through an univariate model employing the Best Lineal Unbiased Predictor (BLUP), and with the derivative free restricted maximum likelihood DFREML software (Graser *et al*., 1987; Meyer, 1989), based on the mixed models equations of Henderson (1975):

Table 1. Structure of data set used for estimating of variance component and heritability values

Trait	Birth weight	Weaning Weight	480-d Weight
No. of animals with records	3.376	2.642	2.509
No. Of sires with progeny records	1.104	979	233
No. Of dams with progeny records	251	231	217
No. Of grand-sires w. Progeny records	695	593	550
No. Of grand-dams w. Progeny records	286	265	242

The model fitted in the analysis was a univariate animal model represented as follow:
$y = X\beta + Za + Zm + Zp + e$

where y= vector of observations, β= vector of fixed effects (year of birth, season, sex and covariate for age of dam) a= vector of random additive direct genetic effects, m = Vector of random maternal genetic effect, p = Vector of random permanent environmental effects due to the dams, e= vector of random residual effects and X,Z, are known incidence matrices relating records to the respective fixed and random effects. The (co)variance structure for random effects for the traits can be describe by:

$$\begin{array}{c} a \\ m \\ pe \\ e \end{array} = \begin{bmatrix} A\sigma^2 \\ A\sigma am \\ 0 \\ 0 \end{bmatrix} \begin{bmatrix} A\sigma am & 0 & 0 \\ A\sigma m & 0 & 0 \\ 0 & Ipe\sigma^2 pe & 0 \\ 0 & 0 & In\sigma^2 \end{bmatrix}$$

where:
$\sigma 2a$ is the direct additive genetic variance; $\sigma 2m$ and $\sigma 2pe$ are the maternal additive genetic and permanent environmental variances; σam is the covariance between additive direct and additive maternal genetic effects; $\sigma 2e$ is the residual variance. In this case, $\sigma 2te$, temporary environmental variance; Inc and In are identity matrices of order equal to the number of dams (nc) and to the total number of animals with records (n), respectively; and A is the additive numerator relationship matrix with order q.

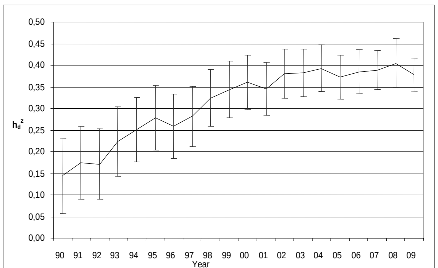
Results and Discussion

Birth weight: For the period between 1978 to 2009 , we found a high direct heritability ($h^2d = 0.37 \pm 0.03$), but low for the maternal heritability ($h^2m= 0.02 \pm 0.023$), for the birth weight (see table 2). For the permanent environmental effect, we observed a low value (0.072 ± 0.023); similar to found by Gallego, *et al*., (2006) in the same breed, or Mascioli, *et al* (1996), in Canchim breed. The heritability trends, from 1990 to 2009 for BW are shown in the figure 1. This parameter displayed to 1990 a value of $h^2d = 0.14 \pm 0.08$, with a increasing trend with the higher value in 2004 with $h^2\ d = 0.39 \pm 0.05$, changing 64% compared to 1990; possibly because to improvement in the calves management, that affect the environmental around the birth, which can be evidenced by standard deviation for this parameter at all study period than displayed a diminish trend, from 61% in 1990 to 10% in 2009. In low size populations or when the mating system have allowed significant increase of inbreeding values, the heritability can be drastically reduced (Falconer y Mackay 1996), but this genetic parameter can be affected by the variable environmental conditions, which diminish the heritability values and also tend to increase when the conditions are uniform.

Weaning weight: The weaning weight was adjusted at 240 days and the heritability values were calculated for the 1979 to 2008 period, finding an intermediate value for $h^2d = 0.18 \pm 0.056$, and a lower maternal heritability value $h^2m = 0.05 \pm 0.023$, similar to found by Martínez, *et al*., (2006a) in Colombian Creole cattle breed "Costeño con Cuernos" (0.21 ± 0.074 and 0.05 ± 0.038 for direct and maternal effects); but lower than found by Cuco, *et al*., (2009) in Braunvieh breed population in Brazil (h2d = 0.25± 0.050 and h2m = 0.15 ± 0.032), and also described by Orenge, *et al*., (2009), in Charolais and Hereford breeds (h2d = 0.23 y h2d = 0.13). The contribution of permanent environmental effect, showed a low value (C2 = 0.065 ± 0.023). In figure 2, we show the heritability trends for weaning weight, from 1990 to 2008, and found a slowly decrease annual trend for direct heritability (B1=-0.00025), meaning than the genetic variation for this trait was maintained over the study period; desirable situation in our conservation program. The additive maternal effect displayed a low value and decrease trend, similar to the permanent environmental effect, that showed a higher impact on the variation of weaning weight compared to the maternal component.

480-d Weight: The direct heritability for this trait has shown a intermediate value ($h^2d = 0.15 \pm 0.046$) but a low value for the maternal heritability ($h^2_m = 0.05 \pm 0.022$), similar to described in Colombian Creole Costeño con Cuernos breed, ($h^2_t = 0.192$, $h^2_d = 0.172 \pm 0.001$ and $h^2m = 0,04 \pm 0,001$) (Martínez, *et al*., 2006b), found lower values in Borah breed, in Kenya, to direct heritability ($h^2_d = 0.08$ and $h^2_d = 0.14$ for weight at 18 and 24 months respectively), but higher values was found for maternal heritability ($h^2_m = 0.34$ and $h^2_m = 0.11$ for weight at 18 and 24 months, respectively). This parameter has been measured since 1990 and was recalculated annually up to 2007.

Figure 1 : Birth weight heritability trend from 1990 to 2008 in the Blanco Orejinegro breed.
Figure 2: Weaning weight heritability trend from 1990 to 2008 in the Blanco Orejinegro breed.
Figure 3: 18m weight heritability trend from 1990 to 2008 in the Blanco Orejinegro breed.



Graphic 1: $yh^2_d = 0.0132x + 0.1739$ $R^2 = 0.8751$

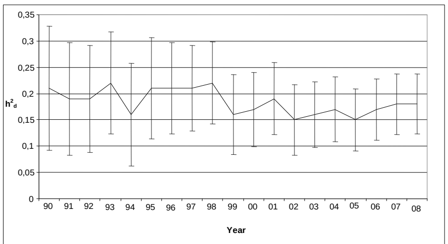


Figure 2: $yh^2_d = -0.0025x + 0.2132$; $R^2 = 0.3295$

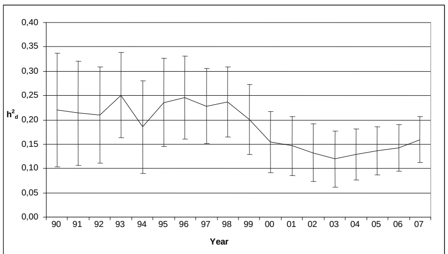


Figure 3: $yh^2_d = -0.0067x + 0.2494$; $R^2 = 0.6107$

The analysis of heritability trend has shown the higher value in 1993 ($h^2_d = 0.25 \pm 0.087$) and the lower value in 2003 ($h^2_d = 0.11 \pm 0.057$); this trait showed a slight decrease over the study period (B1= - 0.0067), probably due to the temporal environmental effects, more than to the permanent effects, as can be observed in figure 3. Is noteworthy the reduction of the standard deviation for direct and maternal heritability from 52% in 1990 to values near to 30% in 2007 year. Similarly, the maternal heritability showed an insignificant decrease trend (B1=-0.0007) ($R^2 = 0.0717$). But for the permanent environmental effects was observed a slight increase (B1=0.0003), however were found a highly variable values from 1990 to 2000, with more stable values since 2000 to 2007.

Conclusion

The heritability values for birth weight in the last 18 years have shown an increasing behavior, but the other traits evaluated, were found with a stable trend over the years, without change in the annual

average, but with a decrease of standard deviation, possibly due to the uniform conditions of management, nutrition, health and mating system and also because this is a conservation herd, which has not been object of genetic selection. The maintenance of the genetic variation in this population can be reflected in the intermediate to high heritability values and trends near to stability over the years, but it is important provide a more adequate environment to the cows, to diminish the environmental variance that negatively affect the maternal effect and the permanent environmental effect.

References

Burrow, H. M. (1993). *Anim. Breed. Abstr*. 61:737–751.

Cucco, D.C., Ferraz JB, Pinto LF, *et al.* (2009). *Genet. Mol. Res*.;8(1):291-8.

Falconer, D.S., & Mackay T.F.C. (1996). Editorial Acribia., pp 469.

Gallego, J., Martínez R., Moreno F. (2006). *Rev. Corpoica*. 7(1):16-24.

Graser, H.-U., S. P. Smith, & B. Tier. (1987). *J. Anim. Sci.* 64:1362–1370

Hall, S.J. and Ruane, J., (1993). *Conservation Biology.* 7, 815-825

Henderson, C. R. (1975). Biometrics 31: 423.

Hill, W. G. (2000). *Livest. Prod. Sci.* 63:99–109.

Jordan, T. G. (1993). University of New Mexico, Albuquerque.

Martínez, R., Pérez J. & Herazo T. (2006a). Rev. Corpoica. 7(2):12-20.

Martínez, R., Pérez J.,& Herazo T. (2006b). *Proceedings of 8th WCGALP*,

Martínez, R., Pérez J. (2007). *Genet. Mol. Res.* 6 (3):482 – 491.

Mascioli, A., M.N. Alencar y F.P. Barbosa. (1996). *Rev. Soc. Bras. Zootec.* 25(1): 72.

Meuwissen, T. H. E., & J. A. Woolliams. (1994). *Theor. Appl. Genet.* 89:1019–1026.

Meyer, K. O. (1989). *Genet. Sel. Evol.* 21:317.

Orenge, J.S., Ilatsia ED, Kosgey IS. (2009). *Trop. Anim. Health Prod*. 41(5):767-74