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Genetic parameters of two methods of scoring cow fighting ability

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ABSTRACT - In this study, two different methods of scoring were implemented and compared in reason to assign a correct phenotypic value to cow fighting ability, and the variance components of the trait were estimated. Moreover, it was investigated the correlation of the estimated breeding values (EBVs) for fighting with the EBVs for the linear type traits muscularity. A scoring method mainly based on position (PS) and a method considering opponents' performances (CPS) were compared and used in genetic analyses. A correlation of 0.75 between EBVs associated to PS and CPS was obtained, and ANOVAs considering alternatively PS and CPS indicated almost the same magnitude of the different sources of variation included (R^2=0.50 and 0.52 for PS and CPS, respectively). Heritability estimates with the REML method were 0.099 (S.E.=0.005) for PS and 0.034 (S.E.=0.007) for CPS. Pearson and Spearman correlations between both indexes and ranks were no significant. Finally, an evaluation of the fitness of the two models revealed that PS is the better system for scoring, although CPS was designed to account also for the opponents.

Key words: Genetic evaluation, Fighting ability, Score methods, Valdostana breed.

Introduction – A preliminary estimation of genetic components for fighting ability in Valdostana cows has already been studied (Mantovani *et al.*, 2007). Phenotypic information about the trait studied were based on the results of the "Batailles de Reines" (Rosset *et al.*, 1992), traditional contests in which cows fight in a grass arena contending a heap of earth perceived as resource. Couples of animals yearly duet divided for weight category in 20 knockout eliminatory battles to win access to a final match in Aosta, where the best fighters become the "Queens of the Year". The previous research was based on a pilot data set (7,157 results of fights belonged to 3,461 cows) with the aim of finding a system to assign scores to fighting cows based on the final position reached in the battle-board. Due to the great interest in studying the "Batailles", the investigation has continued and this paper aimed to report results of the further studies carried out on the topic. Using a recent data set the following parameters were estimated: i) another score methods accounting also for the competitor strength, ii) possible sources of variation affecting the score, iii) the genetic components of fighting ability, iv) the correlation between the estimated breeding values (EBVs) obtained for fighting and the EBVs of muscularity got from linear type evaluation of primiparous cows.

Material and methods – Data on fights between cows (20,075 fights disputed by 7,410 cows) from 2001 to 2006 were obtained from the local breeders association organizing the challenge (AREV). Data included information on all cows participant to the fight, their weights, the battle-tournament, the weight category, and the level of fighting within the battle board. AREV provided also data on herds where the cow was bred, whereas pedigree information and EBVs on muscularity were obtained from the national breeders association (ANABoRaVa). After the editing, each record corresponded to an individual performance within tournament-weight category, and it was retained a minimum of two observations per level for each variable, for an amount of 10,352 records. They represented the best position reached in each year of fighting for all 5,885 cows involved. On these data, two different approaches of score were applied. The first score system accounted the position reached by the individual in the tournament on the number of participants involved (from 16 to 153) and it represented a slight modification of the Placement Score (PS) developed in a previous work (Mantovani *et al.*, 2007). PS could be related to the formula $PS_{ijl}=k+T_i+d_j+2w_l$, with k=20 (starting constant value), T_i=different weights of battles (0 for eliminatories and 7 for the final struggle), d_j=difficulty coefficient related to the number of participants (d_j=-2, …,+2, depending on the size of the battle-board) and w_l=number of wins in the battle (w_l=0, …, 8). An alternative Competitive Placement Score (CPS) expanded the PS expressing the score as a function of the opponent strength. CPS was obtained from the expression: $CPS_{ijkm}=k+T_i+2d_j-2^b-(k-CPS_{ijka})$, with k=500 (starting constant value), T_i=0 for heats and 50 for playoff (i.e., Aosta final), d_j=the same as for PS, b=highest level of the battle achieved (b=0, …, 8) and CPS_{ijka}=last competitor's score. Fixed effects to include in the genetic analysis were tested using the GLM procedure (SAS, 1999). The models included the following effects: the year-battle-category (YBC, 369 levels), the herd-year (HY, 2,180 levels), the class of ages of participants (CA, 7 levels), and the individual weight as covariate within weight category (W*C, 3 levels). Genetic components were estimated through a single-trait REML method (Misztal *et al.*, 2002), using the previous fixed effects and random permanent environment (n=5,885, as the number of cows with data considered) and random animal effects (n=13,450 animals in the pedigree file, up to the 14th generation). Spearman and Pearson correlations (SAS, 1999) between EBVs for PS, CPS, and muscularity were estimated.

Results and conclusions – All factors included in the model resulted statistically significant (Table 1), with the only exception of the age effect for CPS analysis. In both traits, factors included explained about half of the overall variance (R^2=0.50 for PS and 0.52 for CPS). In Mantovani *et al.* (2007) the model used accounted only for the 25% of the total variance. The introduction of the fixed factor of herd-year probably explained the better fitting of the present model. The behavioral background of any individual, and its hierarchical position within the group of herd mates would probably influence the final results in battles (Parker, 1974). The phenotypic correlation estimated between PS and CPS was 0.75. The level of heritability (Table 2) resulted generally low (h^2=0.099, S.E.=0.005 for PS and 0.034, S.E.=0.007 for CPS) in agreement with literature values for behavioural traits (Hohenboken, 1986; Mosseau and Roff, 1987). Higher values of heritability for fighting ability in Valdostana cows were found in Mantovani *et al.* (2007) using different expressions of fighting traits. Comparing the two methods of scoring, PS and CPS, the heritability is much lower in CPS than in PS score, although CPS score presents higher accuracy due to the inclusion of the competitor effect. The main effect observed when CPS is used is the transfer of part of the genetic variance to the residual, while the ratio of permanent environmental variance on the phenotypic variance does not change (Table 2). Therefore, the analysis based on CPS resulted also less powerful than that performed with PS, as the logarithm of the likelihood (logL) confirmed. As lower values of logL (expressed as -2logL, Misztal *et al.*, 2002) correspond to better fittings, model with CPS fitted worse than model with PS, that resulted the best method for genetic analysis (Meyer, 1991). These results indicate that the worth of opponents in fight studies could be probably better considered introducing directly the competitor effect in the model instead of using it in the score, as the recent "competitive models" based on REML methods allows (Arango *et al.*, 2005). A further step in studying the fighting behaviour of Valdostana cows will be the implementation of this analysis. High Pearson and Spearman correlations were found between PS and CPS EBVs (Table 3), but the correlations between these EBVs and EBVs for muscularity were very low. Despite this correlation does not indicate any actual genetic relationships between muscularity and fighting ability, it seems that the improvement made by selection for muscularity, and therefore for body mass, did not affect fighting ability. However, the importance of weight in social dominance and fighting performance has been recognised (Parker, 1974) and further studies in this direction have to be addressed, since Valdostana breed is required to be selected for both dual purpose and fighting ability. In this regard, a better knowledge also with other economically important traits (i.e., milk) is necessary. The low but present h^2, otherwise, proves that a selection for fighting ability in this breed could be possible.

Table 1. Results of ANOVA for the fixed factors included in the model.

Fixed factors	Type of score			
	PS		CPS	
	Variance	P	Variance	P
Year-Battle-Category	17,994	<0.001	1,631,948	<0.001
Herd-Year	21,895	<0.001	1,682,718	<0.001
Age class	379	<0.001	6,803	0.07
Weight (Category)	1,134	<0.001	42,852	<0.001
[1]MSE	2.78		24.04	
[2]R^2	0.50		0.52	

[1]MSE: Mean Square Error; [2]R^2: Coefficient of determination.

Table 2. Variance components, heritability, repeatability and model -2log of likelihood (L).

Item	Type of score	
	PS	CPS
Additive genetic variance (V_A)	0.760	19.5
Permanent environment variance(V_{Pe})	1.203	93.5
Residual variance (V_r)	5.732	466.8
Phenotypic variance (V_P)	7.695	579.8
Heritability (h^2)	0.099	0.034
Repeatability	0.255	0.195
-2logL	54,887.00	122,600.00

Table 3. Spearman and Pearson correlation values between EBV for fighting ability scores (PS and CPS) and muscularity.

		Index correlation		Rank correlation	
Level of comparison	No.	PS & MUSC	CPS & MUSC	PS & MUSC	CPS & MUSC
Fighting cows	5,343	0.033*	0.074**	0.029*	0.071**
Dams	3,046	-0.010 n.s.	0.074**	-0.037*	0.058**
Sires	852	0.107**	0.126**	0.087*	0.103**

*n.s. = not significant difference of the correlation coefficient from 0; * = P<0.05; ** = P<0.01.*

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