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Alleles survival from Portuguese and Spanish strains in a population of Iberian pig

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SUMMARY - This work is an application of several techniques of genealogical analysis to the line *Torbiscal*, produced by blending four old strains of Iberian pigs from Alemtejo (Portugal) and Extremadura (Spain). The complete genealogy, with 3489 breeding animals descending from 116 founders, was used to estimate the recorded changes in the period 1963-97, for the following parameters: (i) genetic contributions of the founder strains, with present values 26.9, 14.5, 23.4 and 35.2%; (ii) expected number of founder alleles of these strains, with present values 2.6, 1.7, 2.3 and 3.4 survival alleles; and (iii) partial inbreeding coefficients ascribable to every strain, with mean present values 3.9, 1.7, 3.4 and 5.3%, for a total mean inbreeding of 14.4%. The highest values are found in the strains belonging to types practically extinguished (*Ervideira,* the golden pig from Alemtejo or *Puebla,* the hairless black pig from Guadiana valley), which points out the interest of *Torbiscal* line as a reservoir of the genetic legacy of Iberian pig.

Key words: Alleles survival, genetic contributions, partial inbreeding, Iberian pig.

RESUME - *"Survivance d'allèles des souches portugaise et espagnole chez une population de porcs Ibériques". Ce travail est une application des diverses techniques d'analyse généalogique à la lignée* Torbiscal*, issue de la fusion de quatre anciennes souches de porcs ibériques de l'Alentejo et de l'Extrémadure. On a utilisé la généalogie complète de 3 489 reproducteurs, descendants des 116 animaux fondateurs, pour le calcul des changements enregistrés pendant la période 1963-97 sur les paramètres suivants : (i) contributions génétiques des souches fondatrices, avec des valeurs actuelles de 26,9, 14,5, 23,4 et 35,2% ; (ii) le nombre espéré d'allèles fondateurs de ces souches, avec des valeurs actuelles de 2,6, 1,7, 2,3 et 3,4 allèles survivants ; et (iii) coefficients de consanguinité partielle attribuables à chaque souche, avec des valeurs actuelles de 3,9, 1,7, 3,4 et 5,3%, pour une consanguinité totale moyenne de 14,4%. Les plus hautes valeurs correspondent aux souches appartenant aux types des animaux pratiquement disparus (*Ervideira*, le porc doré de l'Alentejo ou* Puebla*, noir sans poil de la rive du Guadiana), ce qui reflète l'intérêt de la lignée* Torbiscal *comme réservoir du patrimoine génétique du porc ibérique.*

Mots-clés : *Survivance d'allèles, contributions génétiques, consanguinité partielle, porc ibérique.*

Introduction

The genealogical analysis of a population allows the evaluation of the genetic contribution of differentiated groups of founder animals and the survival probability of their alleles (Gandini *et al.*, 1997). It also makes feasible to carry out a partition of the inbreeding coefficient into components ascribable to every founder group (Rodrigáñez *et al.*, 1998).

This work is an application of these techniques to the analysis of a line of Iberian pig, *Torbiscal*, obtained in 1963 by blending four old strains of Iberian pigs, which were maintained since 1944-45 in the experimental herd of *El Dehesón del Encinar* (Oropesa, Toledo, Spain). Two out of these four strains were reddish and came from Portugal: the golden type from the Alemtejo, from the herd of the Count of *Ervideira* (Evora), and the chestnut type from the herd of Mr. Picao *Caldeira* (Elvas). The others, both black coated, came from Extremadura (Spain): the bald pig of La Serena from the herd of the Donoso brothers (*Campanario*), and the Guadiana valley hairless type from the herd of Mr. Fabián Lozano (*Puebla* de la Calzada) (Odriozola, 1976).

A founder is defined, for genealogical analysis purpose, as an animal with no known genetic relationship to any other animal in the pedigree except for its own descendants. Only 71 out of 116 founders actually contributed to the build up of *Torbiscal*. The pedigree information is summarized in Table 1. Breeding animals born between 1945 and 1997 were grouped into triennial cohorts, according to its birth date.

Table 1. Pedigree Information: founders, cohorts and breeding animals

Number of animals in the pedigree	3489
Number of founders (contributing to *Torbiscal*)	116 (71)
# *Ervideira*	31 (24)
# *Campanario*	28 (16)
# *Caldeira*	25 (17)
# *Puebla*	32 (14)
Cohorts (1945-1962)	1 to 6
Breeding animals (1945-1962)	1393
Cohorts (1963-1997)	7 to 18
Torbiscal breeding animals (1963-1997)	1980

Results and discussion

Genetic contributions

Expected genetic contribution of each founder to any animal is measured by means of coancestry coefficients between animal and founders (James, 1972). The proportional genetic contribution of each founder to a specific cohort is

$$p_i = \sum_{j=1}^{N} a_{ij} \,/\, N$$

where a_{ij} is the additive relationship coefficient between founder i and animal j, being N the number of animals in the cohort. The extension to the calculus of contributions of each one of the founder populations (E) is immediate by means of

$$\sum_{i \in E} p_i$$

referred to the founders belonging to each one. The values of these contributions at the beginning of *Torbiscal* were 31.0% (*Ervideira*), 14.6% (*Campanario*), 24.8% (*Caldeira*) and 29.6% (*Puebla*). As shown in Fig. 1, they kept stabilized since 1984 (cohort 14) with values close to the present ones: 26.9, 14.5, 23.4 and 35.2% respectively.

The number of equally contributed founders or effective number of founders

$$N_{fe} = \sum_{i=1}^{116} p_i^2 \quad \text{(Lacy, 1989)}$$

switched in *Torbiscal* from 38.04 to 35.53 in the last cohort, as a consequence of the recorded changes in the founder contributions.

Alleles survival

Due to the finite number of descendants of each breeding animal, there is a risk of gene extinction in the transmission from parents to offspring. The proportion of alleles from each founder (r_i) that have been retained within every cohort has been estimated by means of the gene dropping technique (MacCluer *et al.*, 1986). Two distinct alleles were assigned to every founder and the genotypes of all descendants along the actual pedigree have been generated through Monte-Carlo simulation, following the mendelian segregation rules. The procedure has been repeated 250000 times and the information from the genotypes of the different cohorts allows to calculate the expected number of alleles from each founder individual $2r_i$ or founder population

$$\sum_{i \in E} 2r_i$$

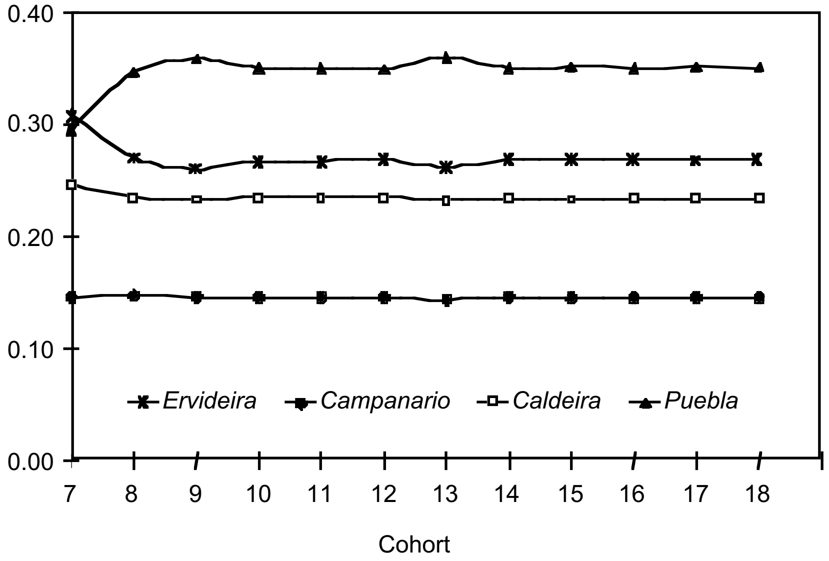

Fig. 1. Contribution of the founder strains of Iberian pigs to the cohorts in *Torbiscal*.

Figure 2 shows how these values have decreased along the existence of *Torbiscal*, with the expected number of alleles from *Ervideira*, *Campanario*, *Caldeira* and *Puebla* reduced from 6.0, 4.5, 5.1 and 6.5 at the beginning to 2.6, 1.7, 2.3 and 3.4 alleles in the last cohort.

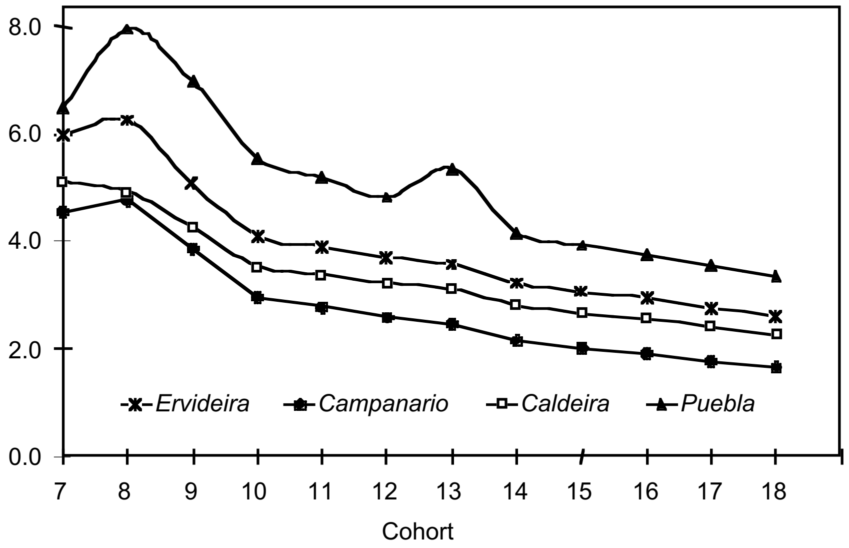

Fig. 2. Expected number of alleles from the founder strains of Iberian pigs in *Torbiscal*.

The founder genome equivalent is the number of equally contributed founder genomes that would produce the same genetic diversity if no genes had been lost by random drift:

$$N_{ge} = \sum_{i=1}^{110} p_i^2 / r_i$$ (Lacy, 1989)

This parameter had a parallel reduction from 10.55 to 4.92 founder genomes.

Partial inbreeding

To examine whether the alleles contributing to inbreeding were descendent or not from specific founders, the inbreeding coefficient can be partitioned into components due to each founder

$$F = \sum_{i=1}^{116} F_i$$

that measures, for any individual, the probabilities of being homozygous for a gene coming from each founder. These coefficients, calculated by using a modification of the classical method (Lacy *et al.*, 1996), have been grouped into four components ascribable to the founder strains,

$$\sum_{i \in E} F_i$$

sums of coefficients with respect to founder individuals belonging to each founder population. Their mean values for the successive cohorts are shown in Fig. 3. Partial inbreeding of *Torbiscal* ascribable to the strains *Ervideira*, *Campanario, Caldeira* y *Puebla* increased from the initial values 0.11, 0.20, 0.09 and 1.39% to the respective ones of 3.88, 1.74, 3.40 and 5.35% for the last cohort. The value of total inbreeding coefficient increased in the same period in *Torbiscal* from 1.79 to 14.37%.

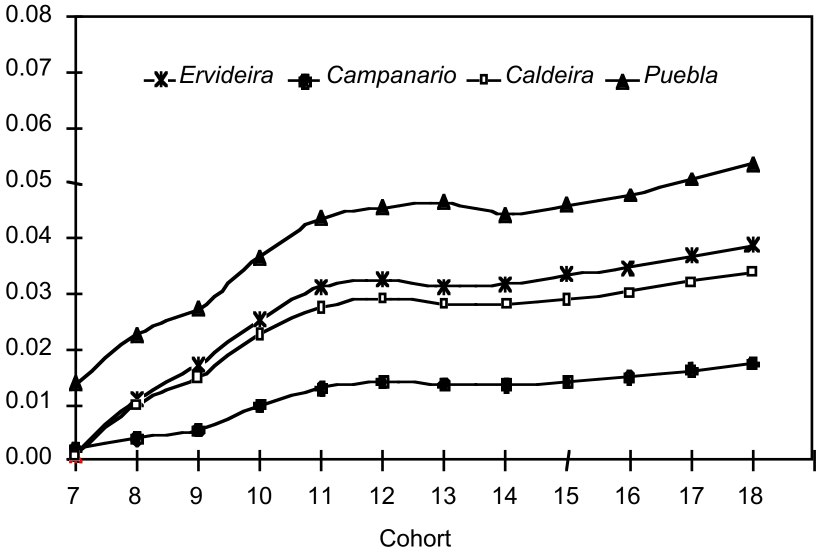

Fig. 3. Components of inbreeding in *Torbiscal* ascribable to founder strains.

Final remarks

The founder strains represent the most important types of Iberian pigs existing in Spain and Portugal sixty years ago. The previous results clarify the relative contribution to the population *Torbiscal* of these four old herds from it comes, as well as the recorded changes in the preserved genetic diversity. The better represented origins (*Puebla* y *Ervideira*) corresponds to types practically extinguished, as the black hairless from the Guadiana and the golden pig from Alemtejo. Besides being a live genetic reservoir, *Torbiscal* is a productive population with superior performances in growth and carcass traits than other lines of Iberian pigs (Benito *et al.*, 1998).

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