Escuela Técnica Superior de Ingeniería Agronómica

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Abstract 32236

Potential of inbreeding depression in morphological traits of Pura Raza Español horse

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INTRODUCTION

Domestic species

Selection of breeding animals

Unequal contribution of reproducers

Inbreeding depression consequences

Reductions in animal fitness

- Loss of reproductive capacity
- Loss of physiological efficiency
- Any trait under selection

(Leroy, 2014)

Inbreeding depression

- Assuming INBREEDING COEFFICIENTS are linearly related to phenotypic values of the trait

Descendants of different founders may be differently affected

- Unevenly distributed recessive genetic load

Founder lines are exposed to variable amounts of selection

Large number of loci involved

(Latter & Roberson, 1962; Latter, 1998)

INTRODUCTION

PURA RAZA ESPAÑOL HORSE (PRE)

- One of the oldest European horse breed.
- More than 200,000 active individuals worldwide.
- Genealogical analyses in this breed have demonstrated that:
  - **Inbreeding levels** are significantly **high**.
    (Valera et al., 2005)
  - **Inbreeding depression** exist for type traits
    (Gómez et al., 2009)
- The **economic value** of a PRE, mostly used as a **riding horse** or in **Dressage** is directly related with **Conformation.**
- **<u>Breeding programme</u>** initiated in 2003.
  Main <u>objectives</u>: **morphology** and **functionality**.

(Sanchez-Guerrero et al., 2016)

Objective

To perform, for the first time in an equine breed, a genetic analysis of the potential of inbreeding load in seven morphological traits of breeding animals responsible for the increase of homozygosis in PRE offspring.

MATERIALS & METHODS

PURA RAZA ESPAÑOL HORSE (PRE)

Computing **partial inbreeding coefficients** (F_{ij}) allows to test the genetic load distributed heterogeneously among founder genomes

Negative

Neutral

Positive

(Casellas et al., 2009, 2011; Todd et al., 2018)

Active PRE horses F_{ij} were calculated

At least 4 offspring or more

A $F_{ij} \geq 6.25\%$ derived from the same ancestor

Type traits measured

639 horses were selected

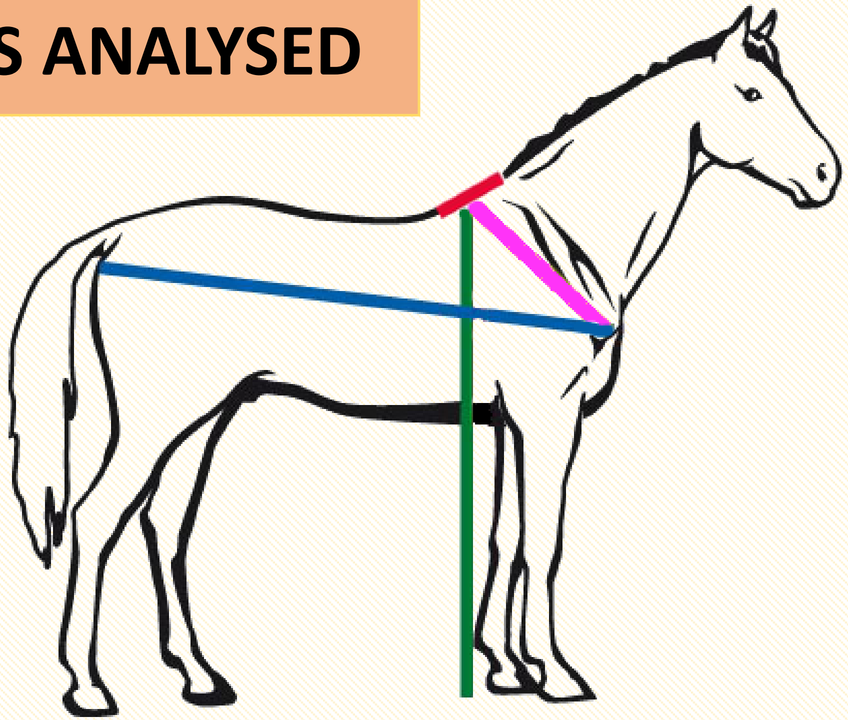
Pedigree with 5 generations
5,026 animals (1,662 stallions and 3,364 mares)

The final morphology database included records of 2,732 animals.

ANCCE

MATERIALS & METHODS

MORPHOLOGICAL TRAITS ANALYSED



Neutral to selection

- Height of withers
- Scapular-ischial length

Selection pressure

- Height at withers
- Length of shoulder

- Frontal angle of knee
- Ewe neck
- Cresty neck

Disqualifying defects

MATERIALS & METHODS

MIXED LINEAR MODEL

Random genetic effects

- **Standard breeding value**
- **Ancestors inbreeding load**

(Casellas,2018)

Reparameterization

Additive nature of the individual Inbreeding load (i)

(Varona et al., 2019; unpublished)

Bayesian approach

$$y = Xb + Zu + Ki + e$$

Where :

*u= vector of **infinitesimal additive genetic contribution***

*i= vector of **individual inbreeding load effects***

*b= vector of **systematic effects***

*e= vector of **residuals***

y= vector of observations (phenotypic values)

X= incidence matrix of systematic effects

Z= incidence matrix of additive genetic contribution

K= T(I-P)

T= lower triangular matrix where each nonzero element was a partial inbreeding coefficient

P= matrix with a 0 diagonal and 0.5 in the elements that links individual with its sire and dam

I= identity matrix

Systematic effects:

Sex (2 levels)

Age (6 levels)

Geographic stud zone (35, 37 or 39 levels)

RESULTS AND DISCUSSION

DESCRIPTIVE STATISTICS

	Males				Females			
	n	Mean	S.E.	CV	n	Mean	S.E.	CV
Height at withers	236	163.63^a	0.30	2.86	396	160.57^b	0.25	3.15
Height of withers	292	8.59^a	0.11	21.6	458	8.19^b	0.09	23.78
Length of shoulder	411	67.08^a	0.18	5.55	670	66.44^b	0.15	5.72
Scapular-ischial length	912	161.19^a	0.17	3.28	1800	160.18^b	0.12	3.3
Frontal angle of knee	299	5.38^a	0.04	12.58	458	5.24^b	0.03	12.05
Ewe neck	257	1.51^a	0.06	67.29	416	1.44^a	0.04	58.81
Cresty neck	257	1.46^a	0.06	66.5	416	1.33^a	0.04	56.95

Different letters indicate significant differences between genders $p<0.05$.

Gómez et al., 2009; Sánchez-Guerrero et al., 2016

RESULTS AND DISCUSSION

HERITABILITIES (h^2), INBREEDING DEPRESSION LOAD RATIOS (d^2) AND DIRECT ADDITIVE GENETIC (σ_a), INBREEDING DEPRESSION LOAD (σ_d) AND ERROR VARIANCES (σ_e)

			σ_a		σ_d		σ_e	
	h^2	d^2	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD	Median
Height at withers	0.80	0.06	1.84±0.27	1.85	0.12±0.30	0.012	0.32±0.19	0.30
Height of withers	0.10	0.26	0.05±0.03	0.04	0.12±0.12	0.09	0.29±0.03	0.29
Length of shoulder	0.12	0.40	0.25±0.08	0.24	0.80±0.57	0.79	1.00±0.08	1.00
Scapular-ischial length	0.34	0.30	1.20±0.11	1.20	1.06±0.46	1.03	1.30±0.08	1.30
Frontal angle of knee	0.05	0.04	0.00±0.00	0.00	0.00±0.00	0.00	0.04±0.00	0.04
Ewe neck	0.06	0.05	0.01±0.01	0.00	0.01±0.01	0.00	0.08±0.01	0.08
Cresty neck	0.08	0.04	0.01±0.01	0.01	0.01±0.01	0.00	0.06±0.01	0.07

h^2 →Sánchez-Guerrero et al. 2013, 2016

These results correspond with an inbreeding value of 10%.

RESULTS AND DISCUSSION

PEARSON'S CORRELATIONS BETWEEN ESTIMATED INBREEDING DEPRESSION LOAD

Height at withers	Frontal angle of knee	Scapular-ischial length	Length of shoulder	Ewe neck	Cresty neck	
0,29***	0,06***	0,38***	0,23***	-0,01	0,11***	**Height of withers**
	0.01	0.55***	0.17***	-0.15***	0.26***	**Height at withers**
		-0.10***	-0.22***	0.01	0.50***	**Frontal angle of knee**
			0.44***	-0.13***	-0.00	**Scapular-ischial length**
				-0.11***	-0.08***	**Length of shoulder**
					-0.01	**Ewe neck**

***significant at p<0.001.

These results implies that the inbreeding depression load does not affect all morphological traits equally.

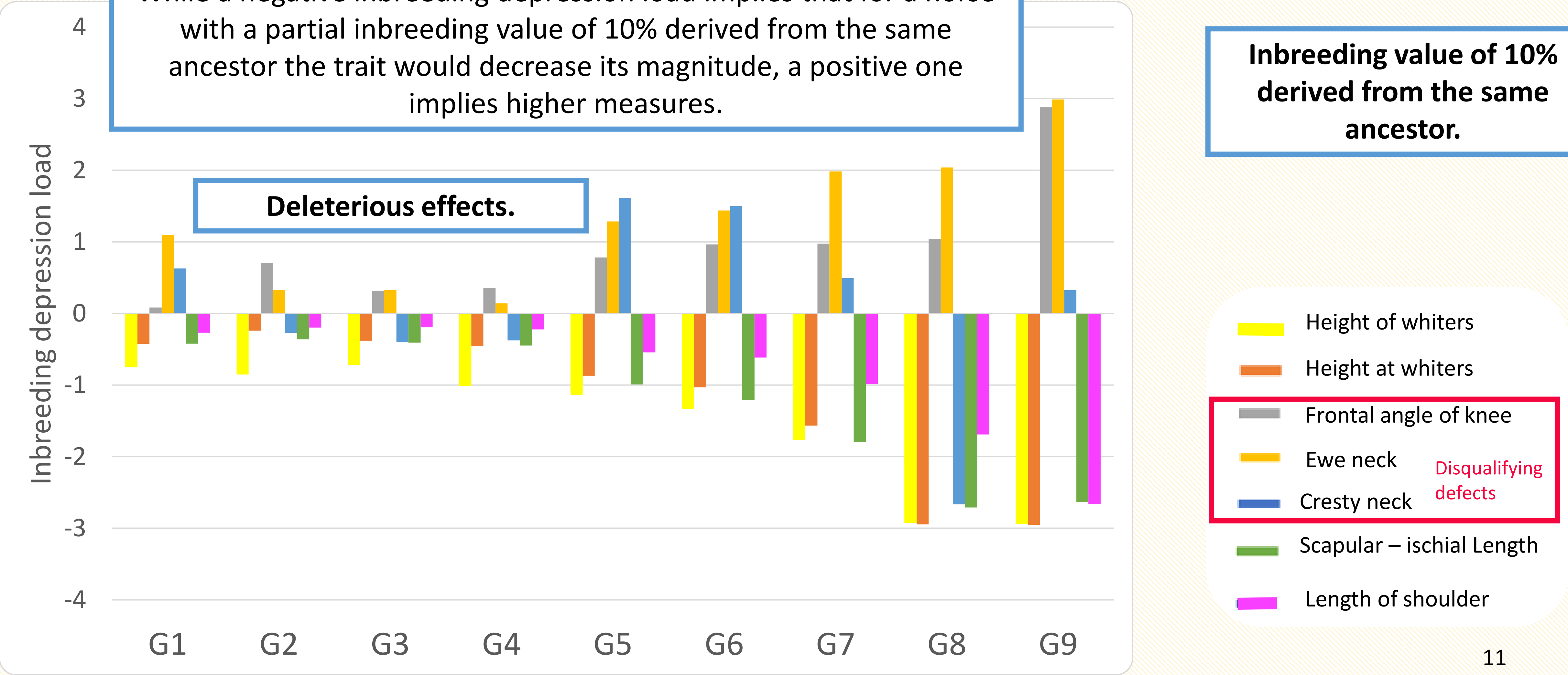
RESULTS AND DISCUSSION

AVERAGE OF INBREEDING DEPRESSION LOAD AND INBREEDING COEFFICIENTS (F, F3 AND F6) CHANGES FOR THE LAST 9 GENERATIONS

While a negative inbreeding depression load implies that for a horse with a partial inbreeding value of 10% derived from the same ancestor the trait would decrease its magnitude, a positive one implies higher measures.

Deleterious effects.

Inbreeding value of 10% derived from the same ancestor.



RESULTS AND DISCUSSION

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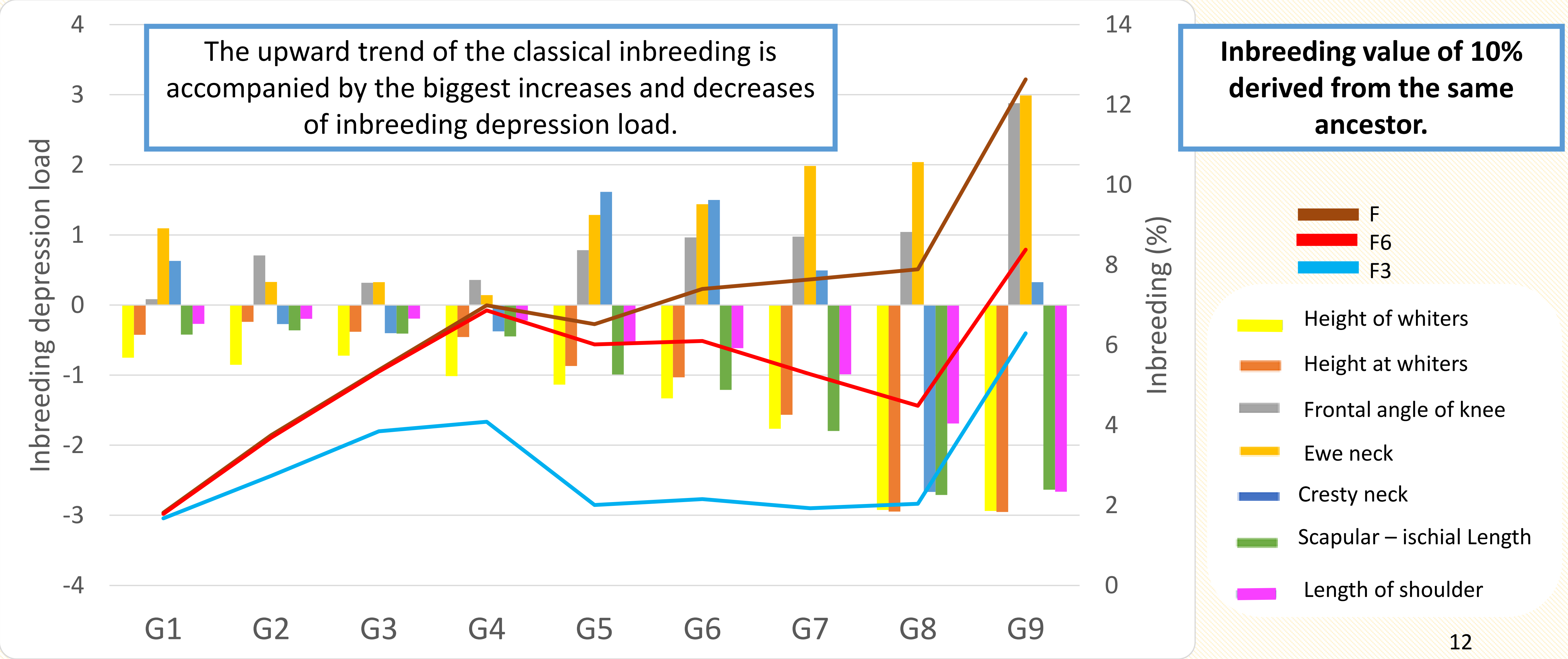


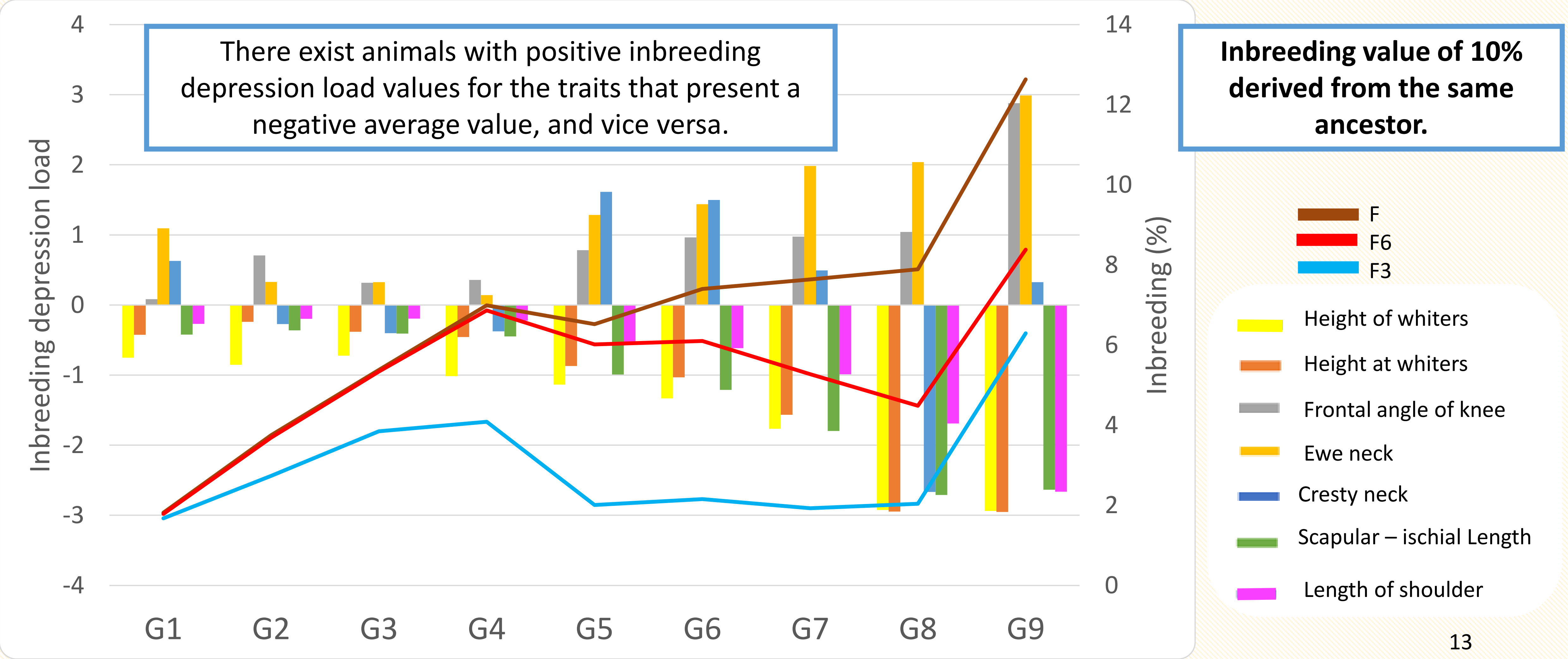
Inbreeding value of 10% derived from the same ancestor.

RESULTS AND DISCUSSION

AVERAGE OF INBREEDING DEPRESSION LOAD AND INBREEDING COEFFICIENTS (F, F3 AND F6) CHANGES FOR THE LAST 9 GENERATIONS

There exist animals with positive inbreeding depression load values for the traits that present a negative average value, and vice versa.

Inbreeding value of 10% derived from the same ancestor.



CONCLUSIONS

1. **There is no relationship between the variables on which a greater or lesser selection pressure has been exerted and the heritability and inbreeding depression load ratios of the traits.**

2. **The result of matings of inbred animals with the aim of increasing or decreasing a character or defect depends on their own partial inbreeding and inbreeding depression potential.**

3. **The knowledge of inbreeding depression load for a trait on individual breeding animals, instead of the whole population, is of high interest for breeding programmes.**

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Thank you!

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