# Analysing the genetic diversity of domestic and wild goats in Spain

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**and the Spanish Goat HapMap Consortium**

## Spain as an important reservoir of caprine biodiversity

1. With 2.9 millions heads, the goat census of Spain ranks 2nd (after Greece) in the EU.
2. Extraordinary ability to feed on poor pastures and excellent adaptability to low rainfall and extreme temperatures throughout the year.
3. So far, 22 goat breeds have been officially recognized in Spain, of which 17 have an endangered status.
4. Causes of breed regression or extinction: abandonment of low-income rural activities, competition with highly productive breeds and others.

## Goals and experimental design

1. The aim of the Goat Adaptmap Initiative is to characterize goat biodiversity at a worlwide scale as well as to understand the genetics of environmental adaptation.

2. Experimental design: to genotype (Goat 50K Chip) and phenotype (pictures and body measurements) a total of 7 Spanish caprine breeds (N=25 approx.). Data submission to the Goat AdaptMap database.

| ID animal | Sample ID | GPS info | date | sex | Breed | Birth date | Place | OWNER | Famacha Test (conjuntiva | | | | | Measurements | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | A(1) | B(2) | C(3) | D(4) | E(5) | CG | HW | BL | PB |
| ESPAÑA:CAN:13:101 | E1G1-PALMERA | lat : 28,749699 long : -17,739238 | ######## | H | Palmera | nov-06 | Puntallana (La Palma) | José Miguel Martín Pérez | | | | X | | 96 | 71,5 | 74 | 21 |
| ESPAÑA:CAN:13:102 | E1G2-PALMERA | | ######## | H | Palmera | nov-07 | | | | | | X | | 88 | 71 | 74 | 20 |
| ESPAÑA:CAN:13:103 | E1G3-PALMERA | | ######## | H | Palmera | nov-05 | | | | | | X | | 99 | 72 | 73 | 21 |
| ESPAÑA:CAN:13:104 | E1G4-PALMERA | | ######## | H | Palmera | nov-07 | | | | | | X | | 91 | 68 | 72 | 19 |
| ESPAÑA:CAN:13:105 | E1G5-PALMERA | | ######## | H | Palmera | nov-08 | | | | | | X | | 91 | 72 | 76 | 20 |



## Geographic distribution of the Spanish and foreign goat breeds genotyped with the 50K chip

**Europe**

- Saanen (Switzerland)
- Carpathian (Romania)

**North Spain**

- Rasquera
- Mallorquina
- Bermeya

**South Spain**

- Florida
- Malagueña
- Murciano-Granadina

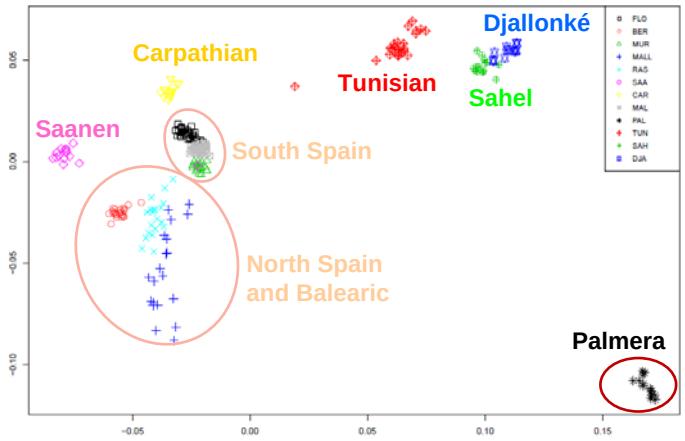
**Canary I.**

- Palmera

**Africa**

- Tunisian (Tunisia)
- Djallonké (Burkina-Faso)
- Sahelienne (Burkina-Faso)

## Multidimensional scaling plot of Spanish goat breeds

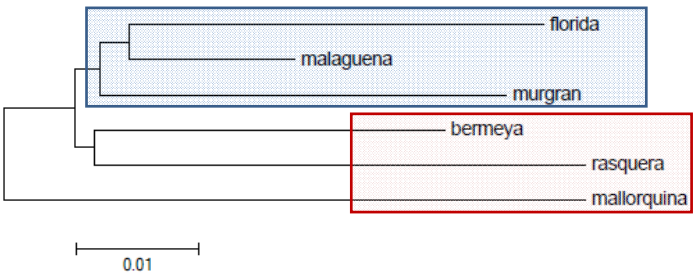



1. The Spanish breeds cluster with the European ones (but not with African goats).

2. The Canarian Palmera breed shows a high genetic differentiation.

3. Northern and Southern Spanish breeds form distinct subclusters (close affinity between Blanca de Rasquera and Mallorquina)

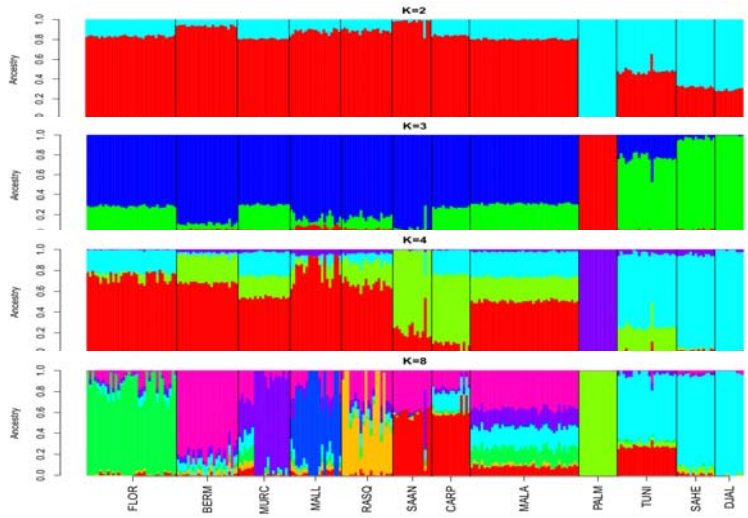
## Multidimensional scaling plot of Spanish goat breeds




Diversity of Spanish breeds

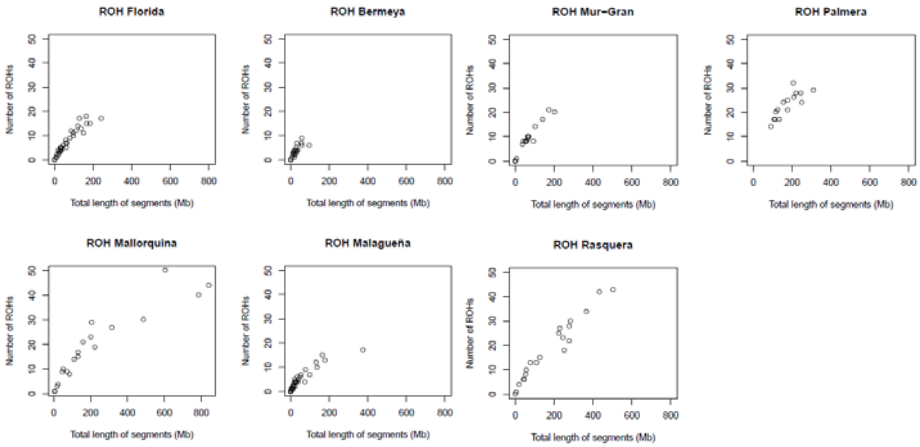
| Population | Ho | He |
|---|---|---|
| Florida | 0.409 | 0.390 |
| Bermeya | 0.407 | 0.397 |
| Mallorquina | 0.369 | 0.372 |
| Malagueña | 0.418 | 0.413 |
| Murciano-Granadina | 0.405 | 0.394 |
| Palmera | 0.295 | 0.285 |
| Rasquera | 0.381 | 0.383 |

## Admixture analysis of Spanish goat breeds



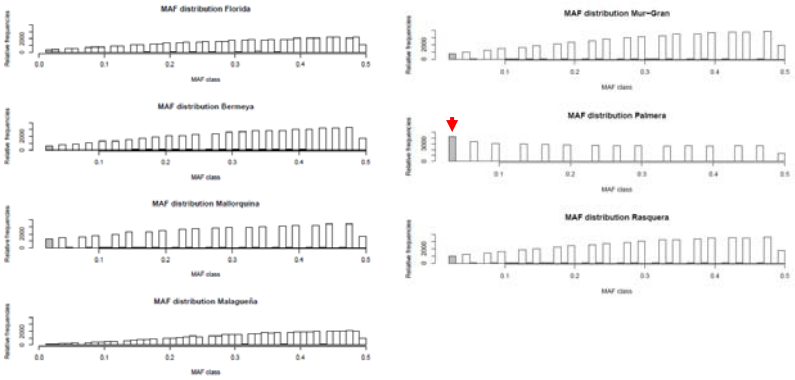

Some presence of putative African alleles (in green, K=3) in Southern Spanish breeds, suggesting an introgression event. However, this African pattern is also observed in the Carpathian breed from Romania, a finding that is very puzzling.

## Detection of regions of homozygosity in Spanish goat breeds




- Runs of homozygosity (ROH): long stretches of consecutive homozygous genotypes. Caused by inbreeding, population size reduction, and natural selection.
- Prevalent in populations with small (Mallorquina) or declining census (Rasquera) or that have suffered strong founder effects (Palmera).

## Allele frequency spectrum of Spanish goat breeds




The high frequency of rare alleles in the Palmera breed may be indicative of population growth.However, ascertainment bias may also produce such pattern.

## Footprints of artificial selection in the genomes of Spanish goats

**MEAT BREEDS**

→ Growth traits

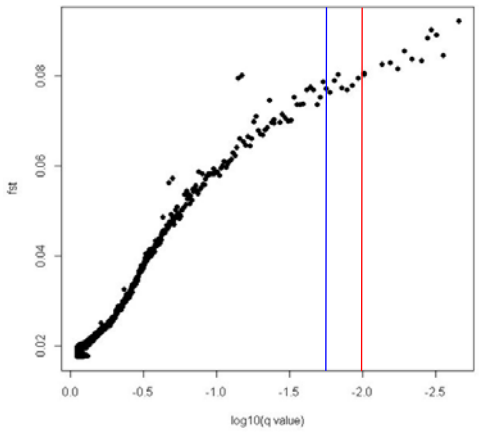
**Blanca de Rasquera** | **Mallorquina** | **Bermeya**

**DAIRY BREEDS**

→ Milk yield

**Florida** | **Murciano Granadina** | **Malagueña**

## Footprints of artificial selection in the genomes of Spanish goats




A total of X SNPs appear to be under selection when we compare meat vs dairy goats

BayeScan (Foll and Gaggiotti 2008): $F_{ST}$ coefficients are partitioned into a population-specific component (β), common to all loci, and a locus-specific component (α) shared by all the populations

## Acknowledgments


Arianna Manunza
Antonia Noce
Armand Sànchez
Àngela Cànovas

Juan Manuel Serradilla
Amparo Martínez
Juan Vicente Delgado
Antonio Molina
Vincenzo Landi
Eva Muñoz

Félix Goyache

Raul Tonda
Sergi Beltrán

Jordi Jordana

Juan Capote

Valentin Balteanu

Amadou Traoré

Agueda Pons

Oriol Vidal

Montse Villilla

Research partially funded by project “Genetics of tolerance to heat stress in dairy ruminants" (RTA 2011-00108-C02-02).