Investigating whole genome selection signatures in local Moroccan sheep

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Plan

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- Demographic history
- Selection signatures in Moroccan sheep breeds :
  - **Detecting intra breeds selection**
  - **Detecting inter breeds selection**
- Conclusion

Introduction

Introduction

Sheep is the main source of meat in Morocco and around the whole world.

- Decreasing genetic diversity in sheep populations (Taberlet *et al.*, 2008).
- Growing need for meat products both at national and international level.
- Climate change challenges.

→ Improvement and conservation

Introduction

Genomic data availability : NextGen European project (2010-2014)

WGS of 160 sheep covering most of Morocco and belonging to different local breeds. (Benjelloun 2015). Sampled in regions showing marked variation in environmental conditions.

Breed	Dman	Sardi	Timahdite	BeniGuil	OuledDjellal	Rahalya	Boujaâd	Undefined
Number of individuals	30	27	16	6	8	4	1	68

- High genetic diversity
- High adaptive potential.
- Low population structure (K le plus probable=1).

(Benjelloun 2015).

Valuable genetic resource for the conservation of the sheep species on a worldwide scale.

Objective ?

- Characterize diversity and demographic history in the main Moroccan sheep populations (Five breeds).

- Regions under selection, within and between those Moroccan sheep breeds, using entire genome data.

Demographic history

popsizeABC (Boitard *et al.*, 2016) : python and R scripts allowing to estimate population size histories from large samples of genome wide SNP data using approximate Bayesian computation (ABC).

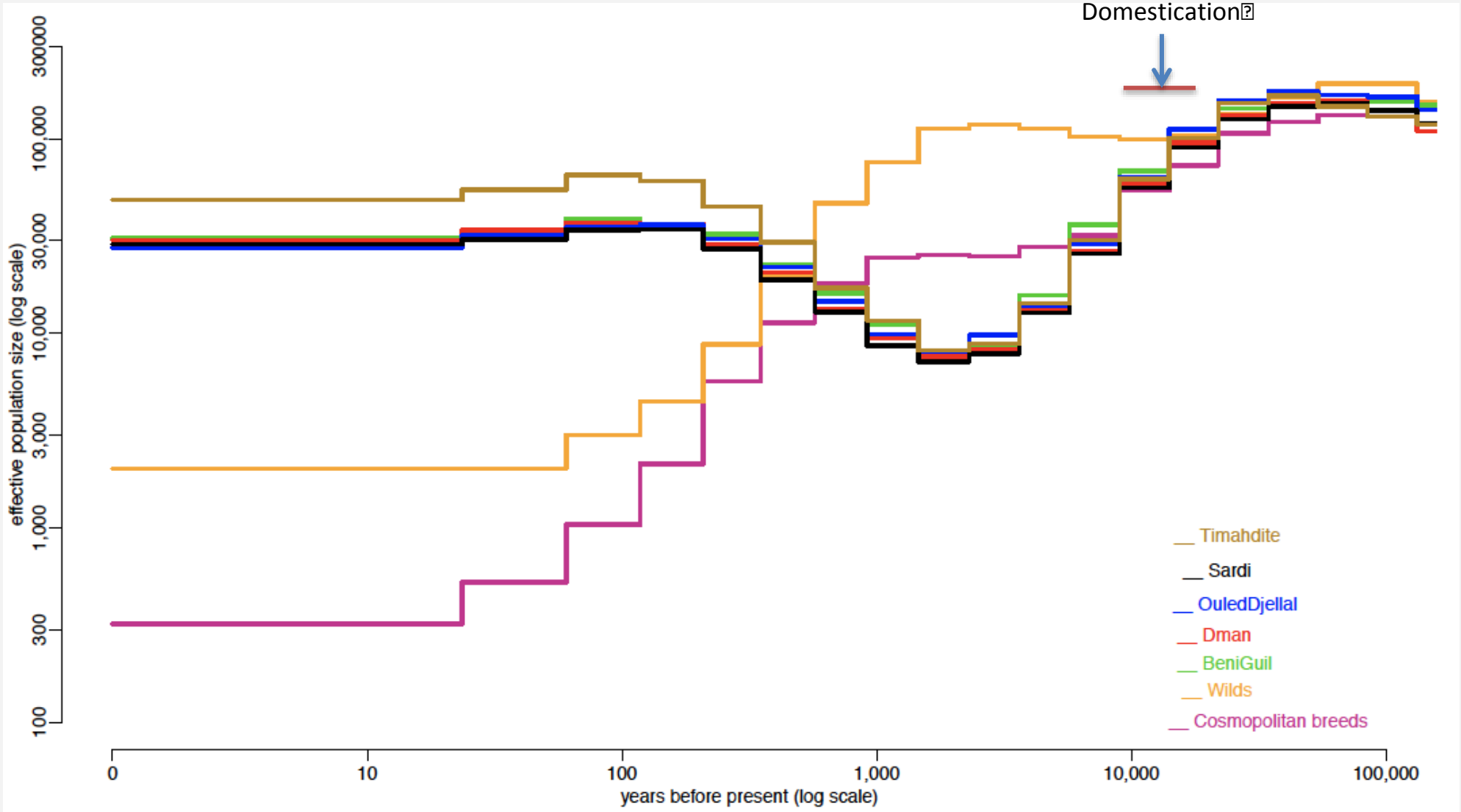
Summary statistics : allele frequency spectrum (AFS) and the average linkage disequilibrium (LD) at different bins of physical distance between SNPs.

Data

Breed	Beni Guil	Dman	Ouled Jellal	Sardi	Timahdite	Mouflons asiatiques	cosmopolitans
Number of individuals	6	30	8	27	16	19	20

Demographic history of Moroccan Sheep breeds

Results



Evolution of effective population size in five Moroccan breeds in comparison with wild sheep and a group of cosmopolitans.

Demographic history of Moroccan Sheep breeds

Results

Demographic characteristics of the studied populations

Breed	Beni Guil	Dman	Ouled Jellal	Sardi	Timahdite	Mouflons asiatiques	20 cosmopolitans
Effective population size (Ne)	30921	29789	25811	28523	47097	2016	285

- **Exceptional adaptive potential of these Moroccan breeds.**
- **Threat by cosmopolitan breeds in their distribution and replacement of local breeds around the world.**

Selection Signatures in Moroccan Sheep breeds

Selection Signatures in Moroccan Sheep breeds

Objectives

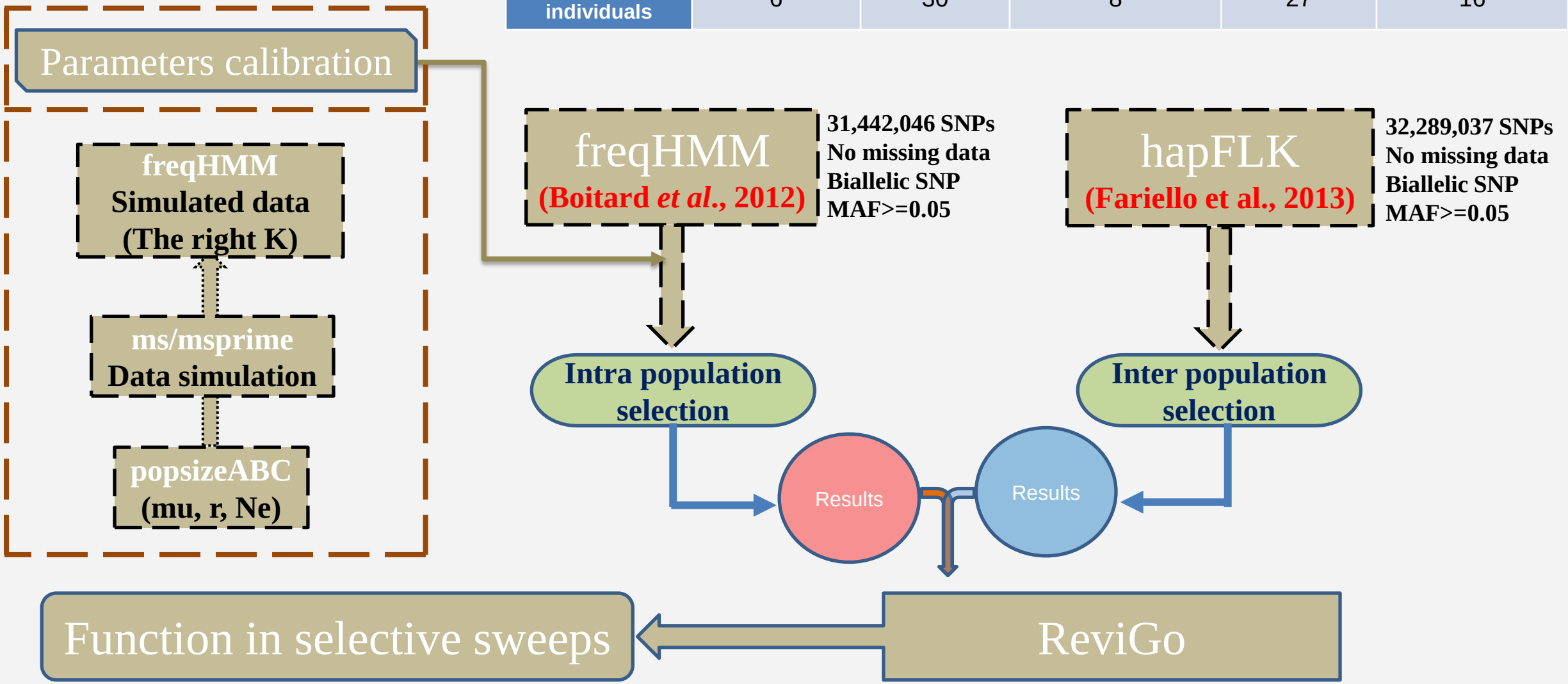
- Detecting selection : intra and inter population using two complementary methods using whole genome data from the main sheep breeds raised in Morocco.
  Putative selective sweeps ? what involved genes ?

- Identifying the genomic regions/genes involved in local adaptation and those related to zootechnical performances characterizing each breed.
  Enrichment for some regions undergoing selection ?

Selection Signatures in Moroccan Sheep breeds

Methods

Breed	Beni Guil	Dman	Ouled Jellal	Sardi	Timahdite
Number of individuals	6	30	8	27	16



Selection Signatures in Moroccan Sheep breeds

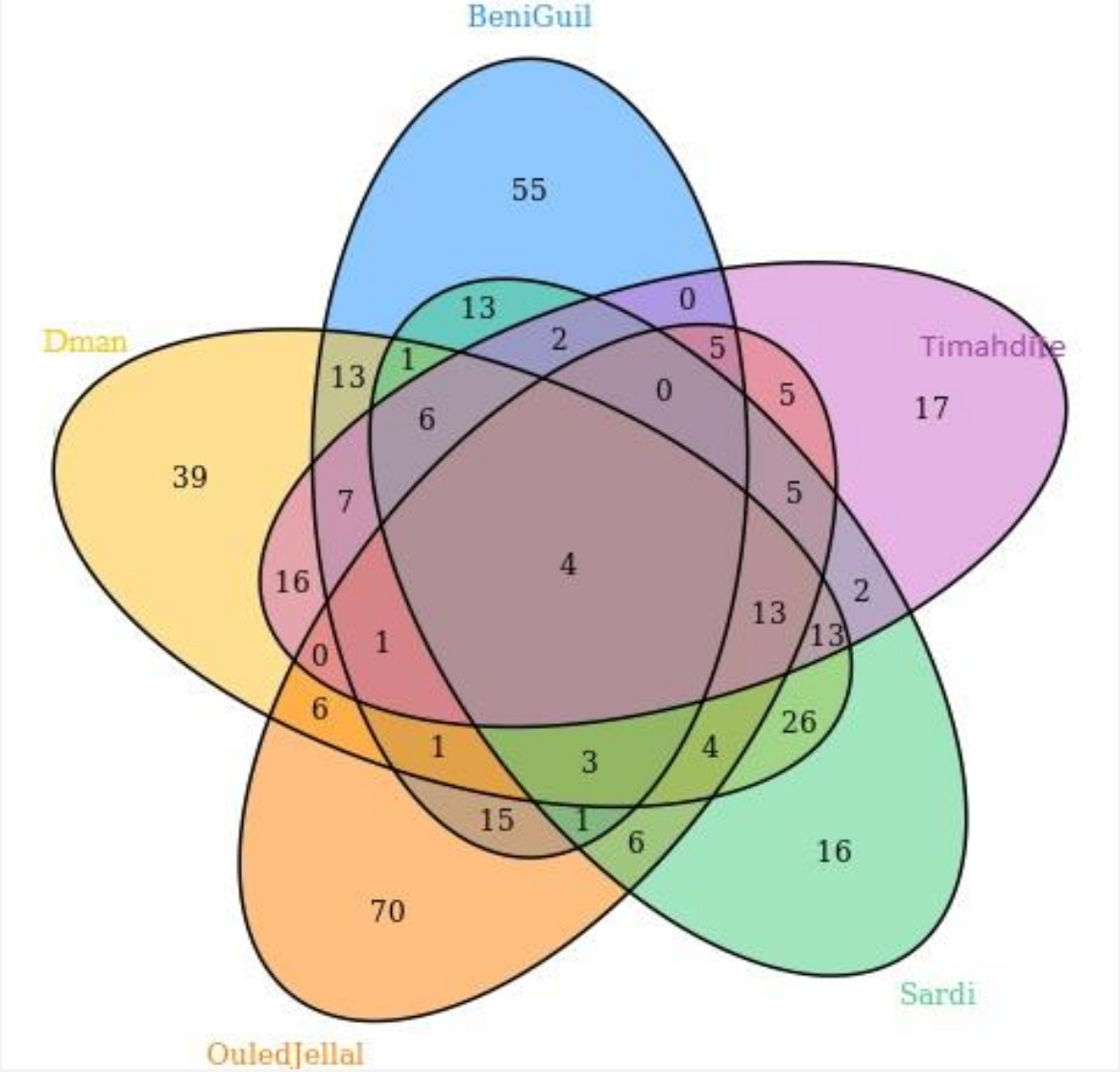
Detecting intra breeds selection

Results

Number of selected SNPs and selected genes (by freqHMM) common to each two sheep breeds

Breed	Beni Guil	Dman	Ouled Jellal	Sardi	Timahdite
Beni Guil	-	8.180	5.307	6.311	5.880
Dman	36	-	5.795	14.568	9.436
Ouled Jellal	30	32	-	8.238	6.846
Sardi	30	70	36	-	9.708
Timahdite	25	60	33	45	-

Variants commonly selected are associated with 4 genes: *HMGA2, RCOR1, SBF2* and *U6*.

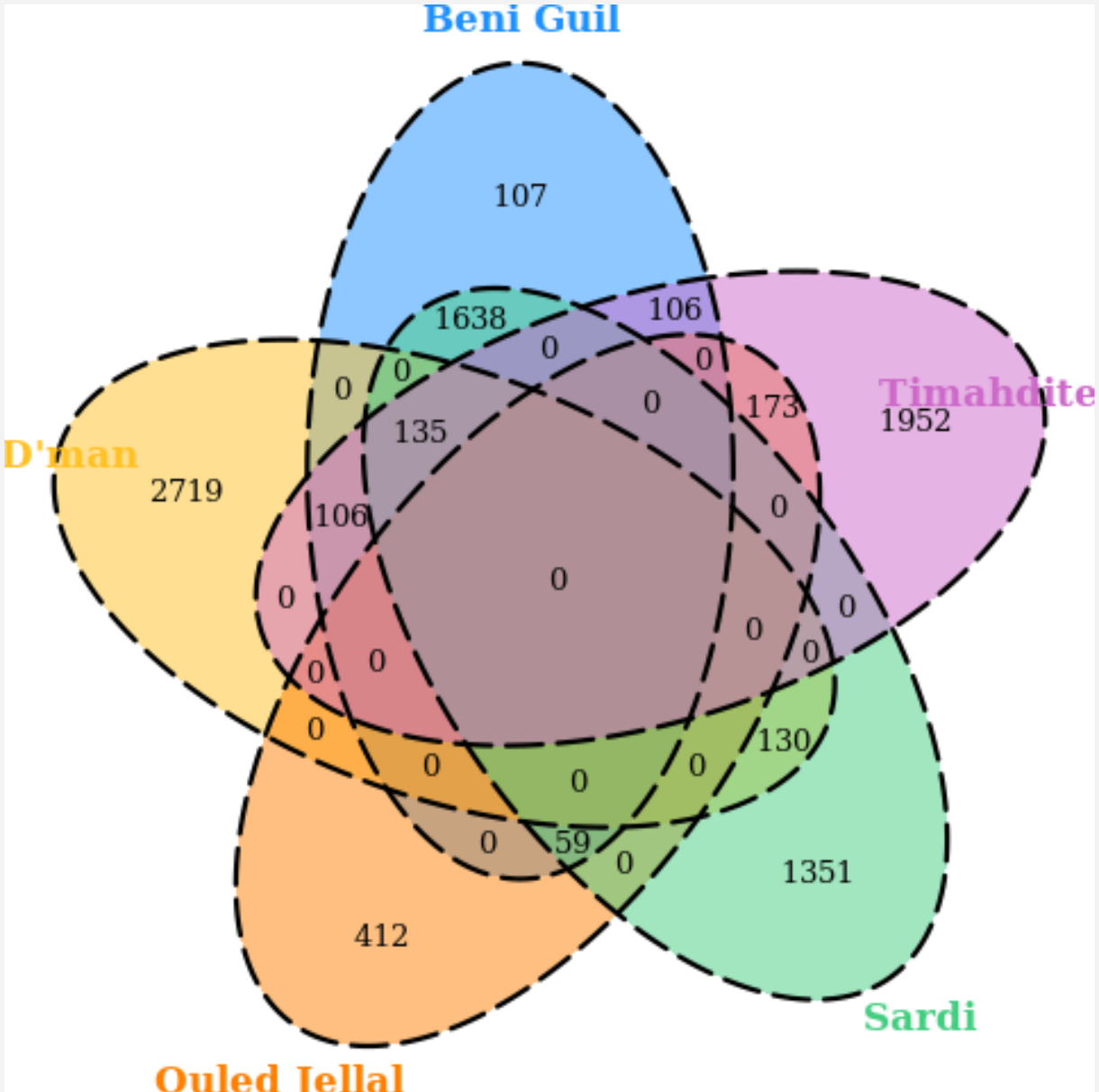


Venn diagram illustrating the number of genes selected commonly in five local sheep breeds and those exclusively selected in each breed

Selection Signatures in Moroccan Sheep breeds

Detecting inter breeds selection

Results

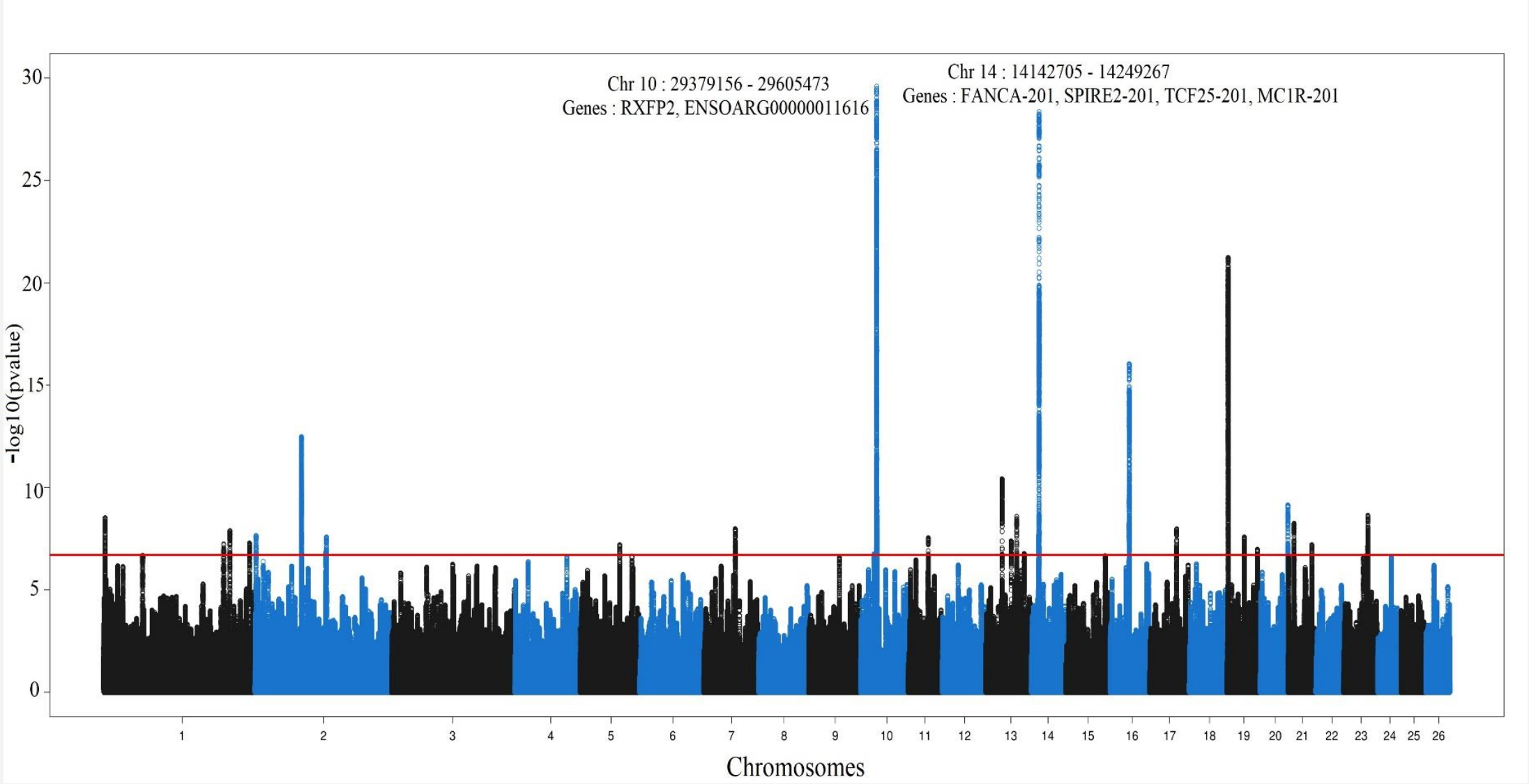


Venn diagram illustrating the number of variants selected commonly between the local sheep breeds and those exclusively selected in each breed

Selection Signatures in Moroccan Sheep breeds

Detecting inter breeds selection

Results



Manhattan plot depicting hapFLK scores in five Moroccan sheep breeds along their genome.
Each point represents a SNP. The horizontal red line represents the 5% Bonferroni threshold of significance.

Enrichment of some selected genes of high significance and that are specific to each breed

	GO term	Biological process	Adjusted p-value (FDR)	Associated genes
Beni Guil	GO:0070344	regulation of fat cell proliferation	0.0000688058	PID1
	GO:0098743	cell aggregation	0.0000688058	COL11A1
D'man	GO:0007292	Female gamete generation	0.0000741624	FSHR
	GO:0048469	Cell maturation	0.0000741624	RXFP2
Ouled Jellal	GO:0009650	UV protection	0.0000667761	SDF4
	GO:0043112	receptor metabolic process	0.0000667761	- SH3GLB1 - LMBRD1
Sardi	GO:0098659	inorganic cation import into cell	0.0003397750	SLC9A3
	GO:1901568	fatty acid derivative metabolic process	0,0000679420	- FADS1 - PLA2G10
Timahdite	GO:0043586	Tongue development	0,0000692810	BNC2
	GO:0007631	feeding behavior	0,0000692810	MRAP2

Conclusion

❑ **Are there a putative regions under selection ? what candidate genes ?**

freqHMM : ***HMGA2, RCOR1, SBF2, U6,…etc.***
hapFLK : ***RXFP2, FANCA-201, MC1R-201,… etc.***

❑ **Is there Enrichment for functions of candidate genes selection ?**

Specific to a breed : Female gamete generation, tongue development, fatty acid derivative metabolic process, regulation of fat cell proliferation…

More informations provided on the main Moroccan sheep breeds in term of identifying genes involved in local adaptation and those related to zootechnical performances:

Determine the breeds that carries the wanted features to exploit in term of conservation against upcoming changes and improvement of this species.

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