



Με τη χρηματοδότηση
της Ευρωπαϊκής Ένωσης
NextGenerationEU



Κυπριακή Δημοκρατία



ΥΠΟΥΡΓΕΙΟ ΓΕΩΡΓΙΑΣ
ΑΓΡΟΤΙΚΗΣ ΑΝΑΠΤΥΞΗΣ
ΚΑΙ ΠΕΡΙΒΑΛΛΟΝΤΟΣ

How to use Genomic information for Breed Assignment: A pilot study on Cyprus Chios Sheep

Maimaris Giannis, Andreas C. Dimitriou, & Georgia Hadjipavlou

Giannis Maimaris, PhD
Agricultural Research institute, Nicosia, Cyprus



EAAP Annual Meeting 2023, Lyon, France
Session 25, 28th August 2023





World-Class Centre to conduct *high-throughput Agricultural Genomic* studies in order to support the advancement and sustainability of the livestock and feed production sectors in Cyprus



Funding scheme targeting local farmers aiming to improve data collection infrastructure (milk volume, genealogies, milk qualitative characteristics) and animal welfare

Cyprus_____tomorrow

RECOVERY AND RESILIENCE PLAN



**Funded by the
European Union**
NextGenerationEU

Genetic Improvement of Cyprus local breeds Chios Sheep and Damascus Goats

Cyprus Chios Sheep and Halloumi

- Sheep and Goat milk is used mainly for cheese production (Hallumi)
- Hallumi is the third biggest source of income from exports
- Recently registered as Protected Designation of Origin product
- High composition of goat-sheep milk
 - Goal (2029) → >50%
- Breeds in focus
 - Cyprus Chios Sheep
 - Cyprus Damascus Goats
- Improvement of milk production and milk composition (fat and protein) by genetic selection



Questions

What is the admixture of Cyprus Chios Sheep in comparison to other breeds in order to maximize the effect of the genetic improvement towards commercial dairy traits

Is there a **quick** and **cost effective** method to differentiate genomically the Cyprus Chios Sheep from the admixture population in local farmers' livestock in order to maximize the effect of the genetic improvement program?

Genotypic Data

1. 200 blood samples from ARI and ACH (CNBS)
OvineSNP50v3 (63K) Illumina SNP microarrays



2. Mediterranean orientated breeds
ISGC HapMap Illumina OvineSNP50 (49k)



| Sheep Breed | Location |
|---------------------------|----------|
| Black Headed Mountain | Spain |
| Castellana | Spain |
| Rasaaragonesa | Spain |
| Comisana | Spain |
| Milk/Meat Lacaune | France |
| Rambouillet | France |
| Sardinian Ancestral Black | Italy |
| Altamura | Italy |
| Leccese | Italy |
| Chios Greece | Greece |
| Chios Turkey (Sakiz) | Turkey |
| Karakas | Turkey |
| Improved/Local Awassi | Lebanon |
| AfecAssaf | Israel |
| Egyptian_Barki | Egypt |
| Chios Cyprus | Cyprus |
| Cyprus Fat Tail | Cyprus |

Methodology

Dataset enrichment

- merging
- keeping the common SNPs
- 942 animals

Filtering

- 1. call rate <90% removed
- 2. individuals missing genotype data
- 3. SNPs missing genotype rate

PCA analysis

- 1. entire SNP set
- 2. 1000 most contributing SNPs
500 PC1 and 500 PC2

Random Forest

- ntree: 100k, best mtry:88
- selection of the 100 most informative SNPs

STRUCTURE

Burn in:100000, MCMC:400000, rep:20 based on **100 SNPs** for Mediterranean or Chios Sheep breeds

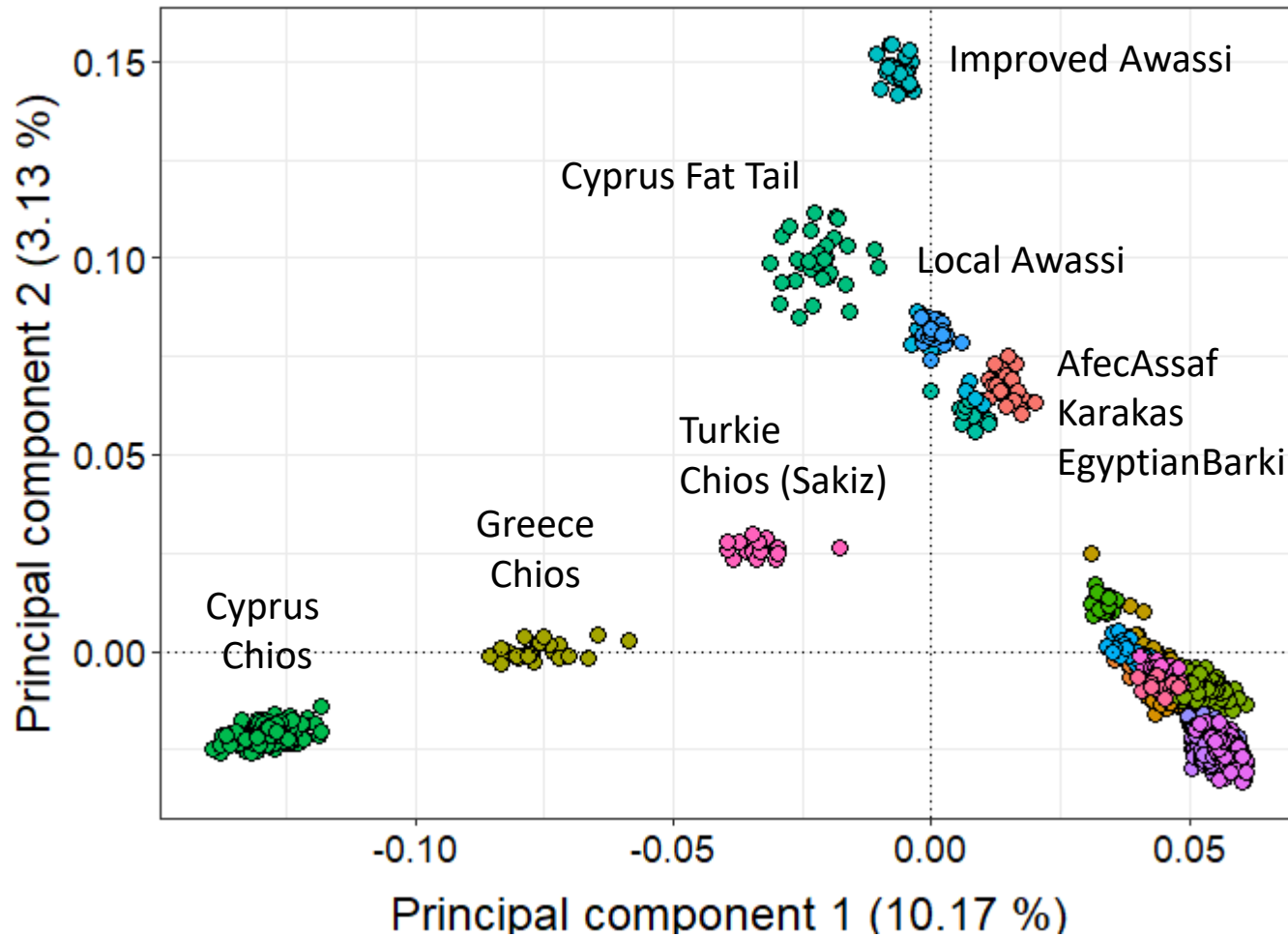
Maximum likelihood phylogenetic reconstruction clustering based on **1000 SNPs**

Softwares/algorithms:

1. Plink
2. Random forest
3. Structure
4. IQ-tree web server

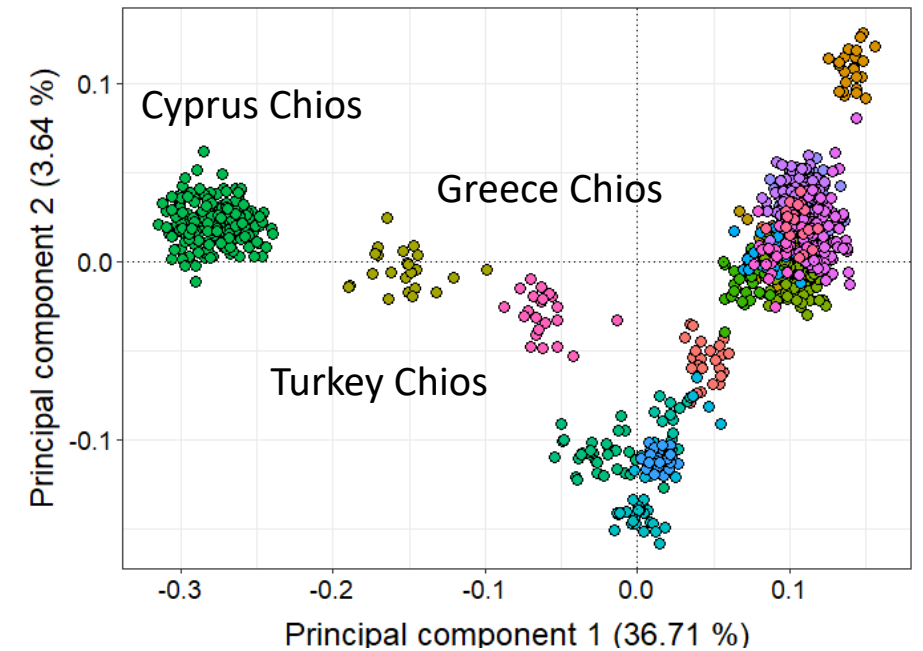
PCA analysis Mediterranean sheep breeds – all SNPs set (47k) - 942 animals

PCA of Mediterranean Sheep pops



500 most contributing SNPs for PC1 and PC2 were selected

PCA for Mediterranean breed pops for 1000 SNPs set



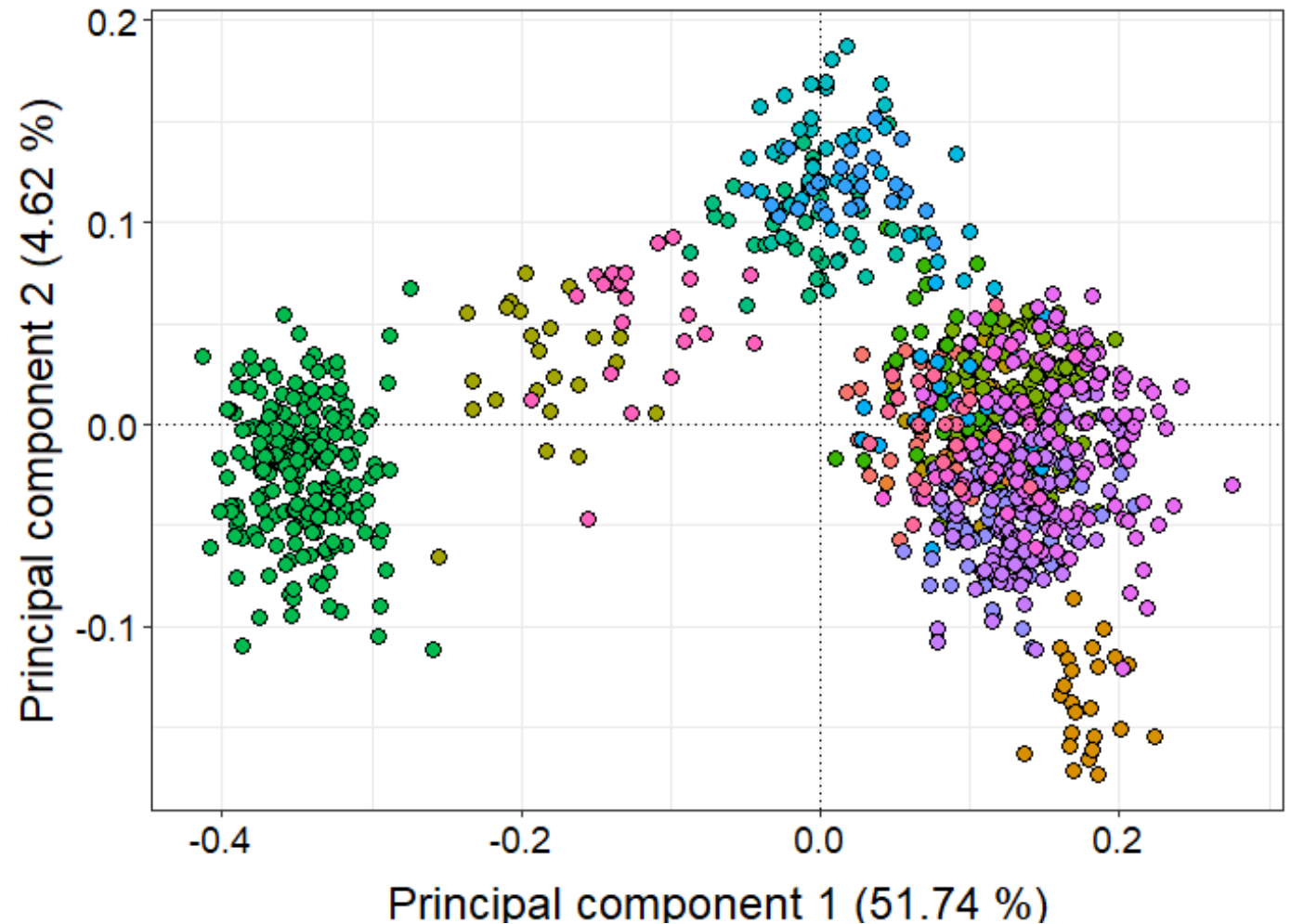
Random Forests analysis for the Mediterranean breed populations based on 1000 SNPs set

The analysis was built on the 1000 SNPs set

- ntree 100 000
- mtry 88 (best mtry)

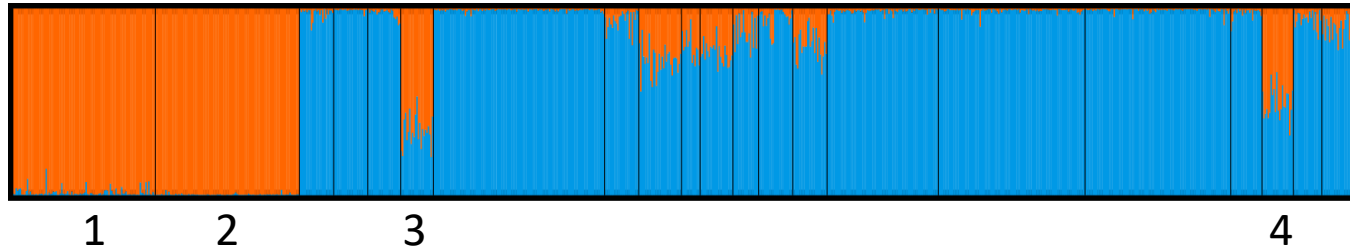
Based on the MDGI for these SNPs,
the 100 most informative were selected

PCA for Mediterranean breed pops
for 100 SNPs set



STRUCTURE analysis

Mediterranean Sheep pops.



**100 SNPs set can assign
the individuals to the
predicted groups**

Chios Sheep pops.



**Greece
Chios (3)**

**Cyprus Chios
Achelia (1)**

**Cyprus Chios
ARI (2)**

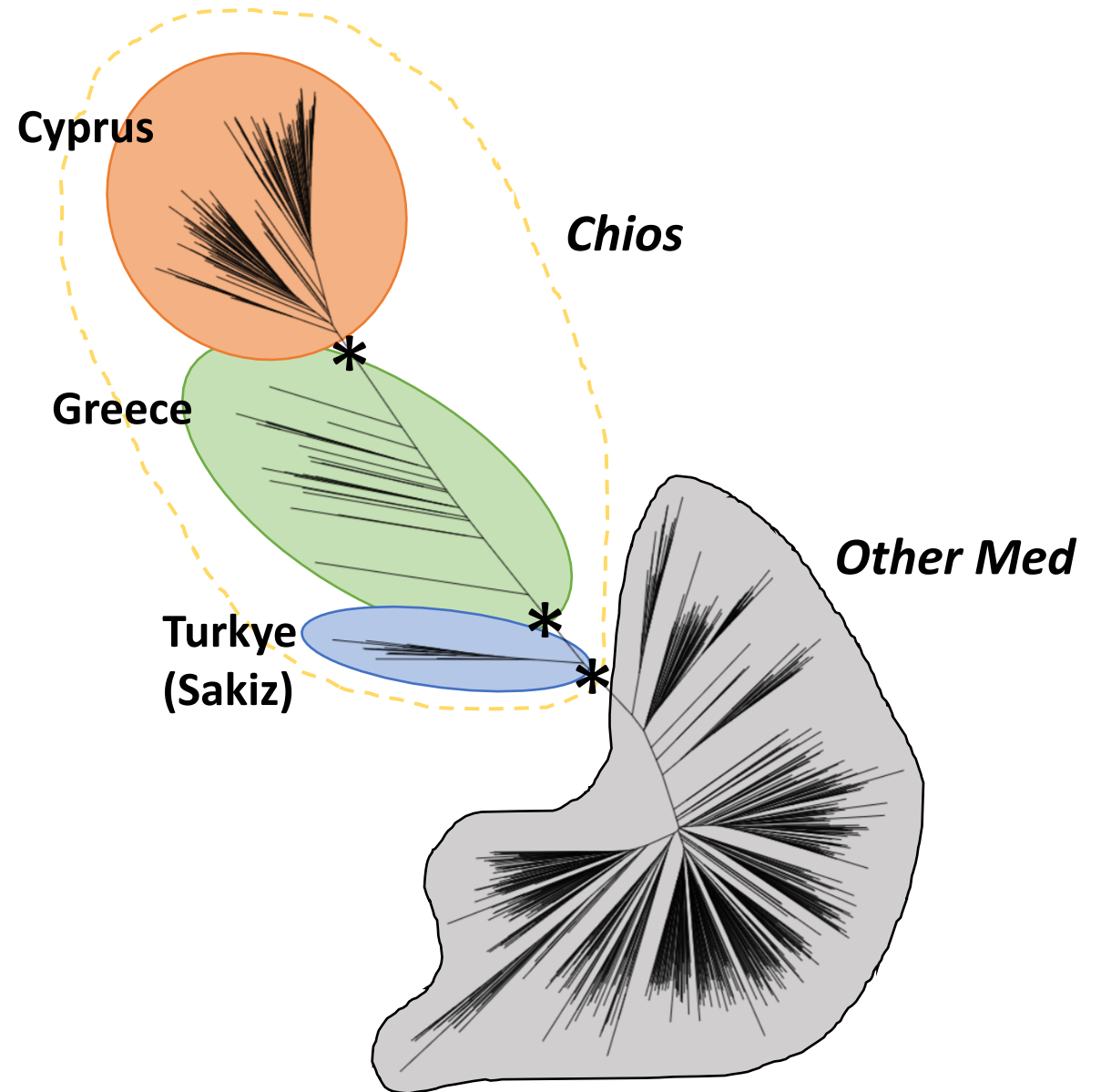
**Turkey Chios
(Sakiz) (4)**

- Burn in: 100k
- MCMC: 400k
- rep: 20 based on 100 SNPs for Mediterranean or Chios Sheep breeds

Maximum likelihood phylogenetic reconstruction/clustering

- 1000SNPs set
- Mediterranean breed pops
- IQ-tree web server
- 1000 Bootstraps

**Regarding Cyprus Chios sheep
1000SNPs dataset it is adequate for
phylogenetic clustering at breed level**



Conclusions 1.

- PCA analysis sensitivity identifies the divergence between chios sheep and other breeds included in our analysis based on the full SNPs ataset
- PCA analysis sensitivity identifies the divergence between chios sheep and other breeds included in our analysis based on the 1000 SNPs set
- Solely based on selected 100 SNPs Population Structure analysis assigns the individuals to the predicted groups with high statistical confidence
- 1000 SNPs set appears to by adequate for phylogenetic clustering at breed level regarding Cyprus Chios sheep
- Chios sheep are genetically distinct from all other Mediterranean sheep breeds

Conclusions 2.

- Cyprus Chios sheep are grouped together forming a statistically well supported taxonomic entity
- Chios sheep from Greece appear to be genetically more similar to Cypriot breed followed by those of Turkey (Sakiz)
- More individuals will be genotyped aiming to assess in a reliable way within-breed diversification and characterization of Cyprus sheep
- Generated data could be used for a cost and time effective assignment of individuals to the respective breeds on the island
- The proven breed diversification can support our project goal Genetic Improvement of Cyprus Chios Sheep

Acknowledgments

ARI Team

- Dr. Georgia Hadjipavlou
- Dr Andreas Dimitriou
- Andrea Georgiou
- Savanna Andreou
- Lola koniali
- Dr Stavria Panayidou
- Dr Theodoulakis Christofi
- Panayiota Markou

ARlans



Κυπριακή Δημοκρατία



ΥΠΟΥΡΓΕΙΟ ΓΕΩΡΓΙΑΣ
ΑΓΡΟΤΙΚΗΣ ΑΝΑΠΤΥΞΗΣ
ΚΑΙ ΠΕΡΙΒΑΛΛΟΝΤΟΣ



Με τη χρηματοδότηση
της Ευρωπαϊκής Ένωσης
NextGenerationEU

Thank you!