


European Regional Focal Point for Animal Genetic Resources
Mediterranean Workshop, Working group Documentation and Information,
19th – 20th May 2026 Sassari, Sardinia, Italy

Conservation perspectives of native cattle breeds of Greece & Cyprus: Genetic background and insights into their adaptability



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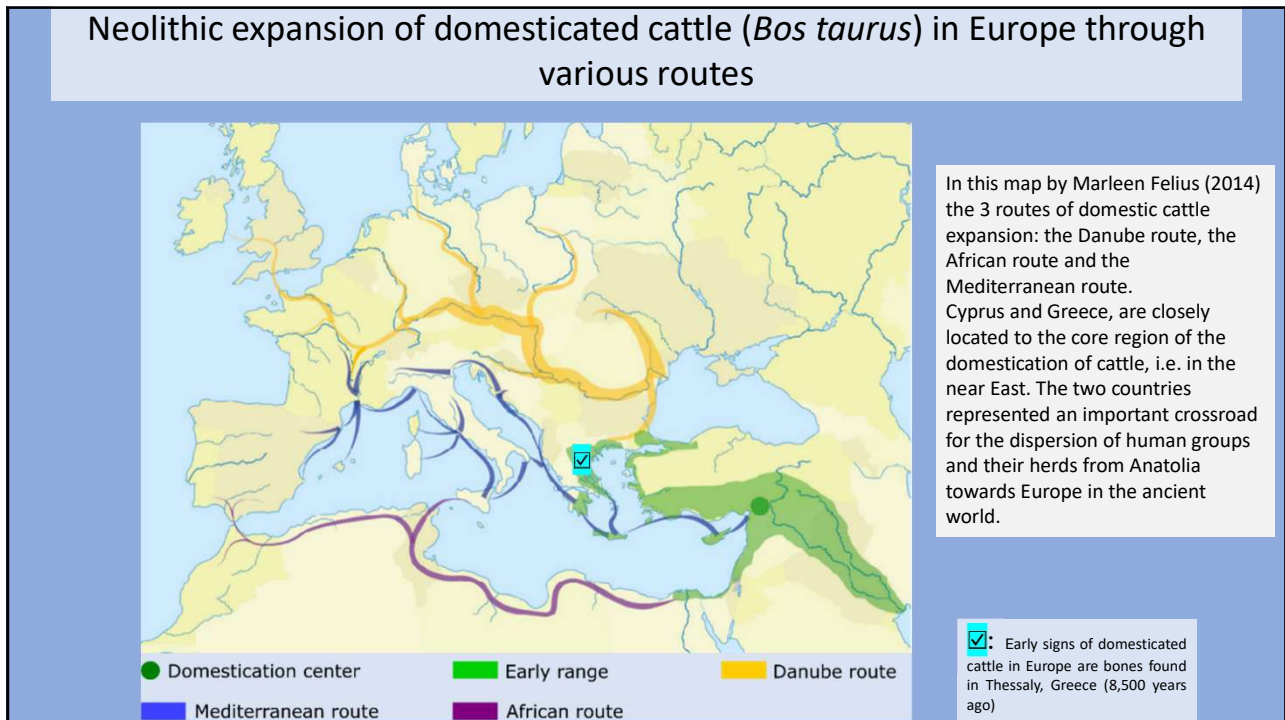
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Present situation

- The native breeds & populations are facing a severe **risk of extinction** due to socio-economic shifts
- Genetic erosion is accelerated by **crossbreeding** with commercial cosmopolitan breeds
- Represent **unique reservoirs** of genes adapted to harsh, marginal environments
- Urgent need for genome-wide analysis to define **objective conservation priorities**

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Southern Balkan peninsula

- From almost the Neolithic period throughout prehistoric times, the Antiquity, the Roman, Byzantine and Ottoman empires up to nearly 100 years ago, this area has been characterized by the **free movement of people and animals**
- Common breeding practices were followed by farmers throughout the Balkan region as the **seasonal movement of herds (transhumance)**
- Centuries of transhumance and isolation, natural selection and low selective breeding led to the formation of a significant number of well adapted local “strains”, of many native cattle breeds

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adapted local cattle “strains” / native cattle breeds

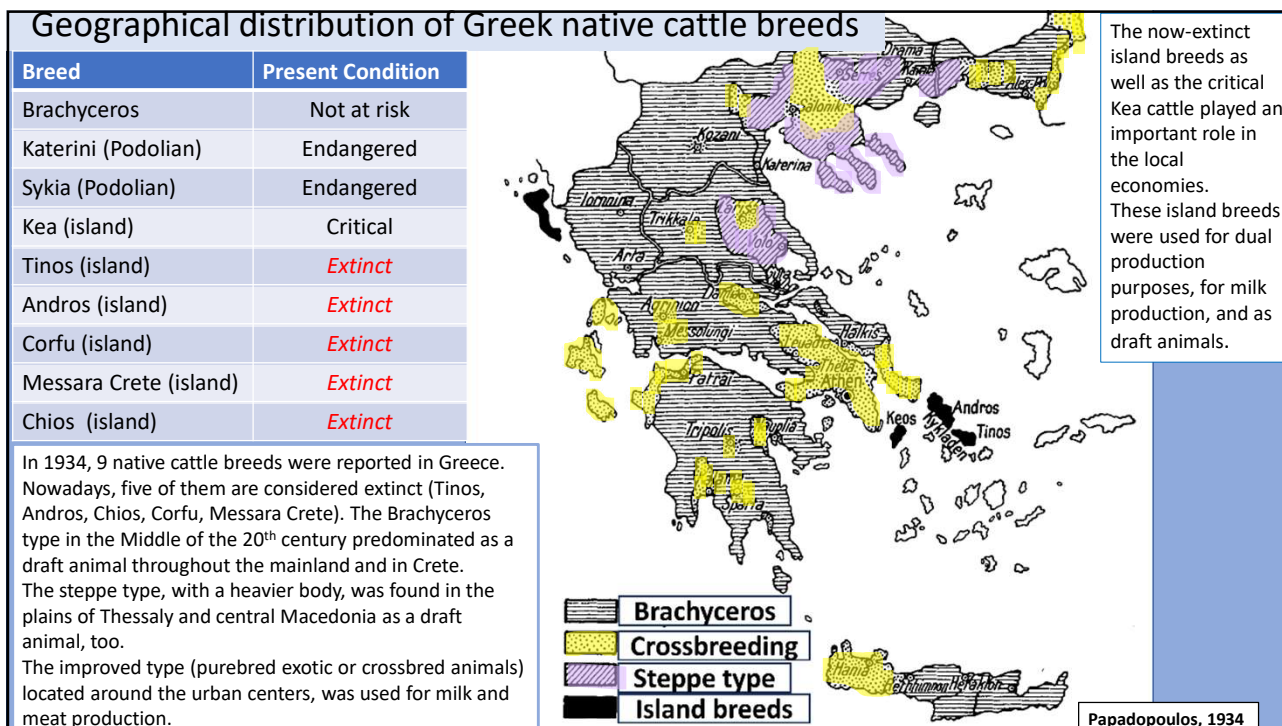
- The breeding and rearing practices associated with these local “strains” differ substantially from those of high-yield breeds:
 - (i) Relatively undifferentiated / very low artificial selection pressure
 - (ii) Pedigree records are incomplete or non-existent
 - (iii) Breeding associations either do not exist or were established recently and are focused on the conservation
 - (iv) No systematic and standardized records of breed characteristics
 - (v) the necessary infrastructure for such registration is rudimentary
 - (vi) Consequently, there are no classic breed standards, but a breed is usually defined by its origin.

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adapted local cattle “strains” / native cattle breeds

- Therefore, the local native cattle of Southeast Europe do not meet all the criteria to be classified as breeds.
- These local breeds have been at constant risk, particularly since the 1970s.
- In fact, in some extreme cases, the current population size of certain local breeds consists of only a few animals.
- This is a global trend that broadly reflects the situation of Greek & Cyprus native cattle.

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Demographic data of native cattle breeds from Greece & Cyprus (2023)						
Breed	total	males	females	Herds	Risk status	DAD-IS
Brachyceros	15758	3282	12476	173	Not at Risk (FAO - National level)	✓
Katerini	1618	469	1149	8	Endangered (FAO - National level)	✓
Sykia	1907	500	1407	14	Endangered (FAO - National level)	✓
Kea	27	2	25	1	Critical (FAO - National level)	✓
Rodope	~250			1	Endangered (Amalthia Network)	No data
Prespa	~150			2	Endangered (Amalthia Network)	No data
Crete Mountain	~35	7	28	6	Critical (Amalthia Network)	No data
Agathonisi	~32	4	28	3	Critical (Amalthia Network)	No data
Nisyros	~25	5	20	2	Critical (Amalthia Network)	No data
Kastelorizo	~16	6	10	3	Critical (Amalthia Network)	No data
Cyprus	1202	286	842	78	Endangered (FAO - National level)	✓

DAD-IS: Domestic Animal Diversity Information Systems

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2018: the start of a collaboration on native cattle populations of Greece and Cyprus among AUA, LMU, Amalthia-Network, SAVE-European Network & Breeders' Association of Greek Brachyceros

Papachristou et al. *Genet Sel Evol* (2020) 52:43
<https://doi.org/10.1186/s12711-020-00560-8>



RESEARCH ARTICLE

Open Access

Genomic diversity and population structure of the indigenous Greek and Cypriot cattle populations

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- LMU Munich: Population Genomics Group
- Amalthia - Network (Greek)
- SAVE - European network &
- Breeder's Association of Greek Brachyceros cattle

- The goal was the study of genomic diversity and population structure as a prerequisite for the conservation of native Cattle breeds and populations of Greece and Cyprus, due to the lack of pedigree data.



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Objectives of the Study of Greek & Cypriot native cattle breeds/populations based on SNPs

1. The estimation of the neutral genetic diversity
2. Assessment of the different sources of genetic variation, the level of genetic differentiation of native breeds
3. Prediction of the admixture patterns of the highly selected breeds with the not improved/heterogeneous native breeds from Greece and Cyprus
4. To build an **objective basis** for the implementation of **conservation programs** for breeders' associations and national and international organizations, as a perspective solution to the uncontrolled mating and interbreeding of certain native breeds at high risk of extinction



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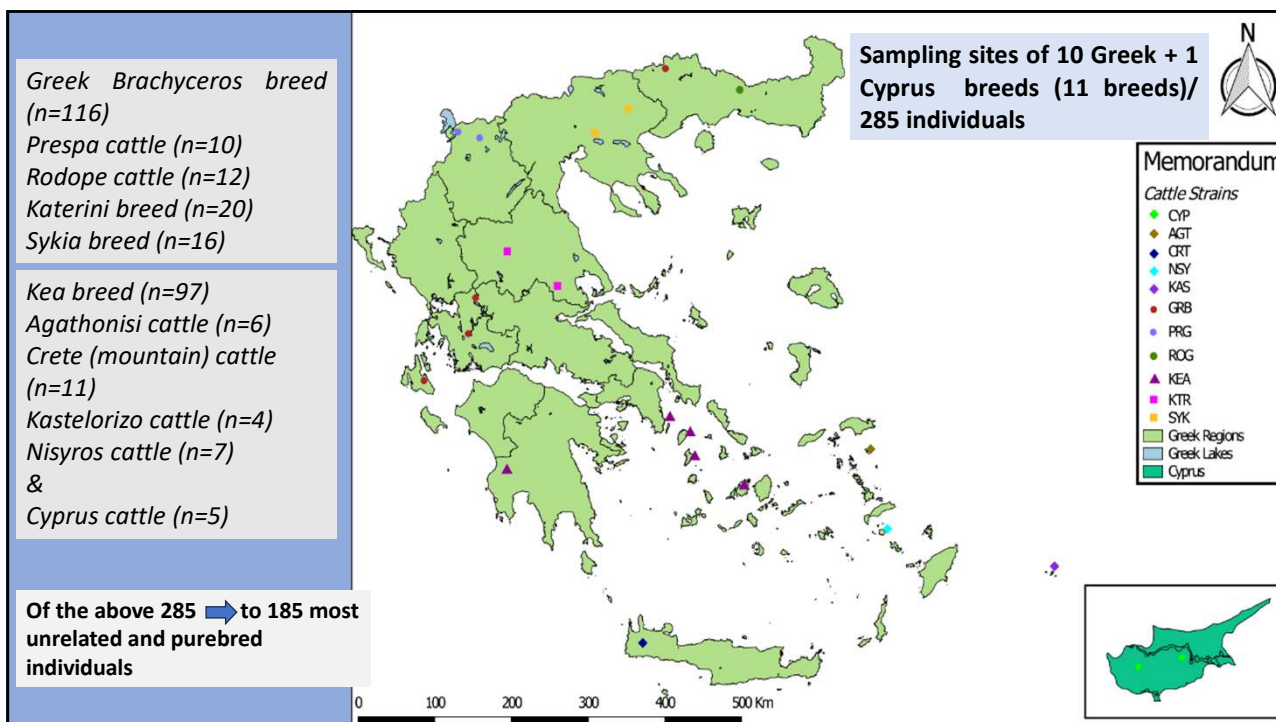


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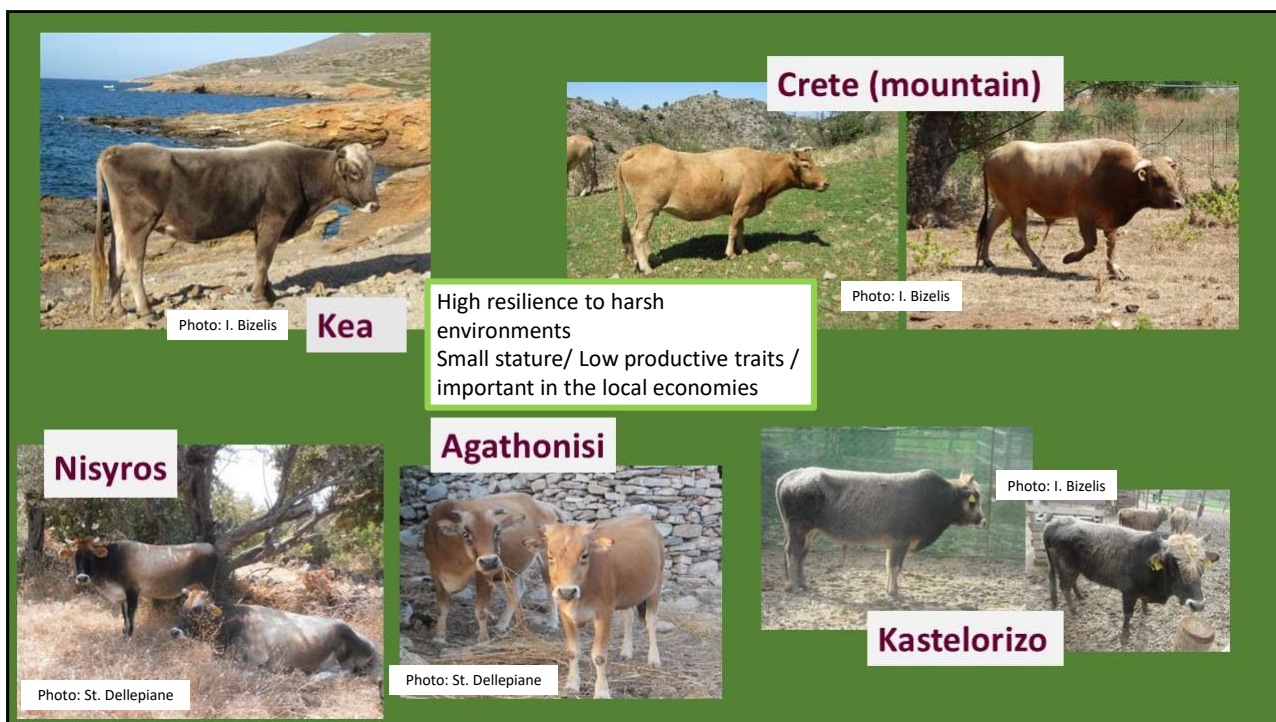
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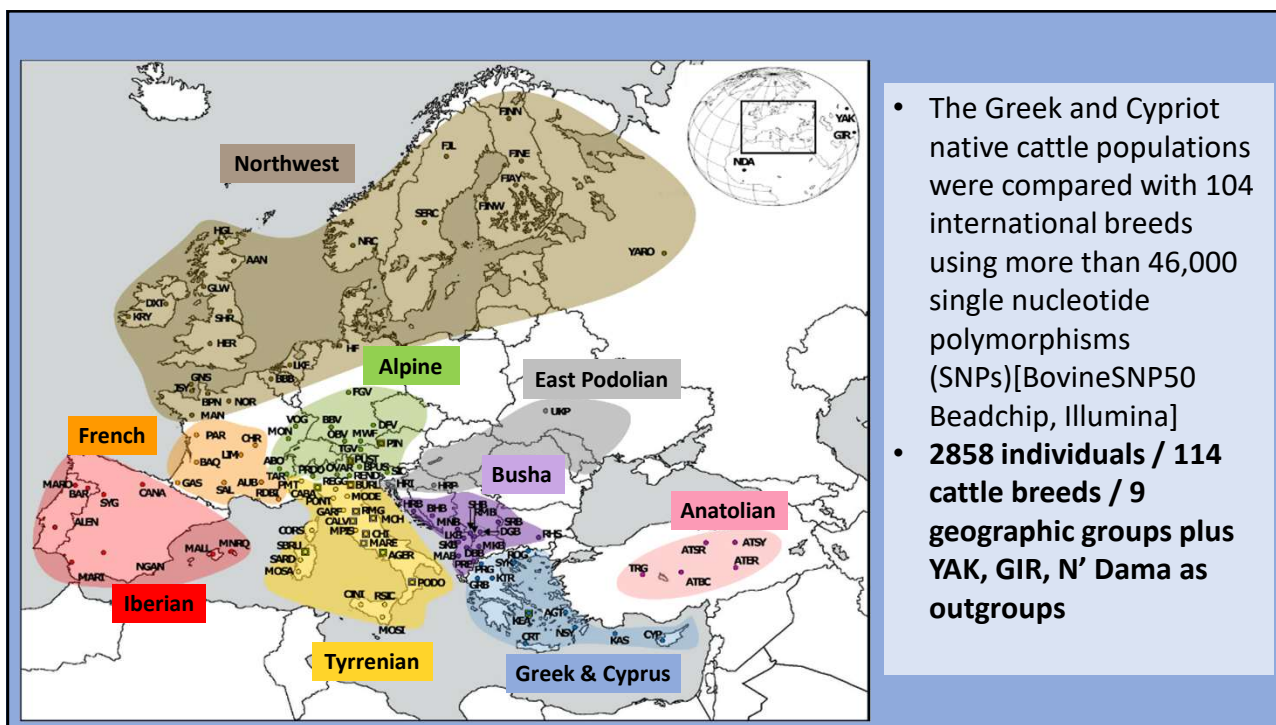
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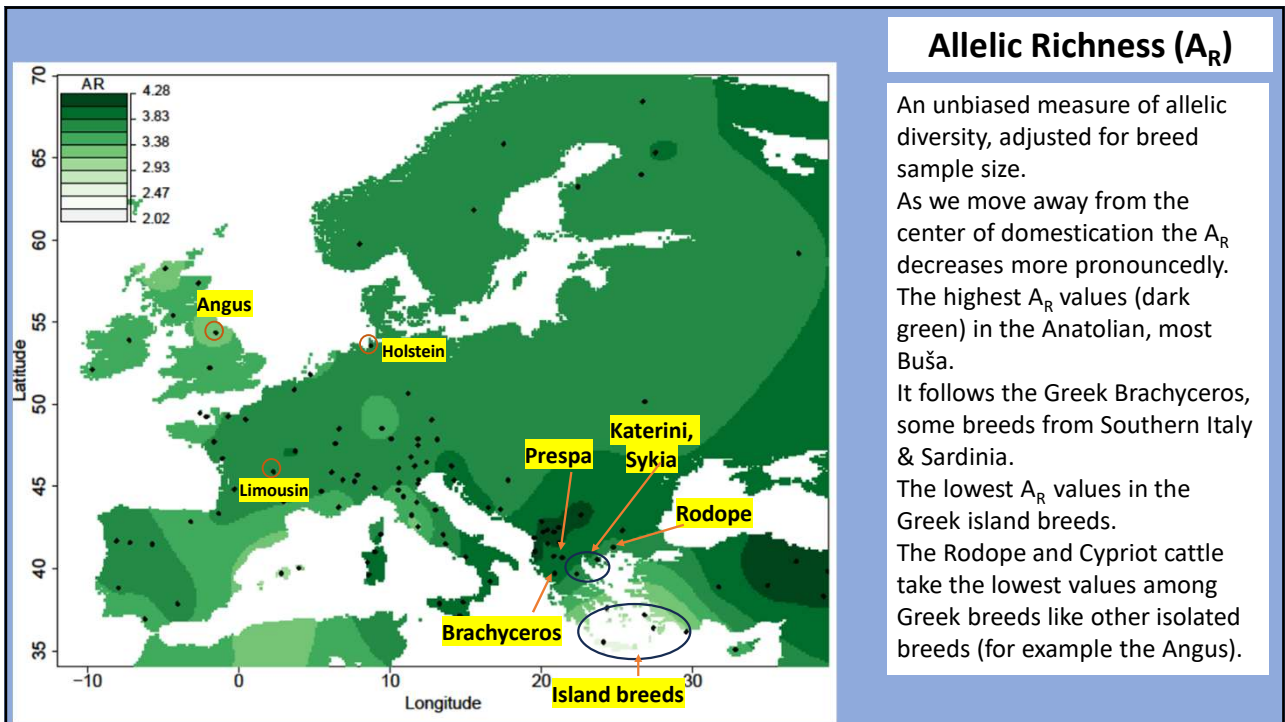
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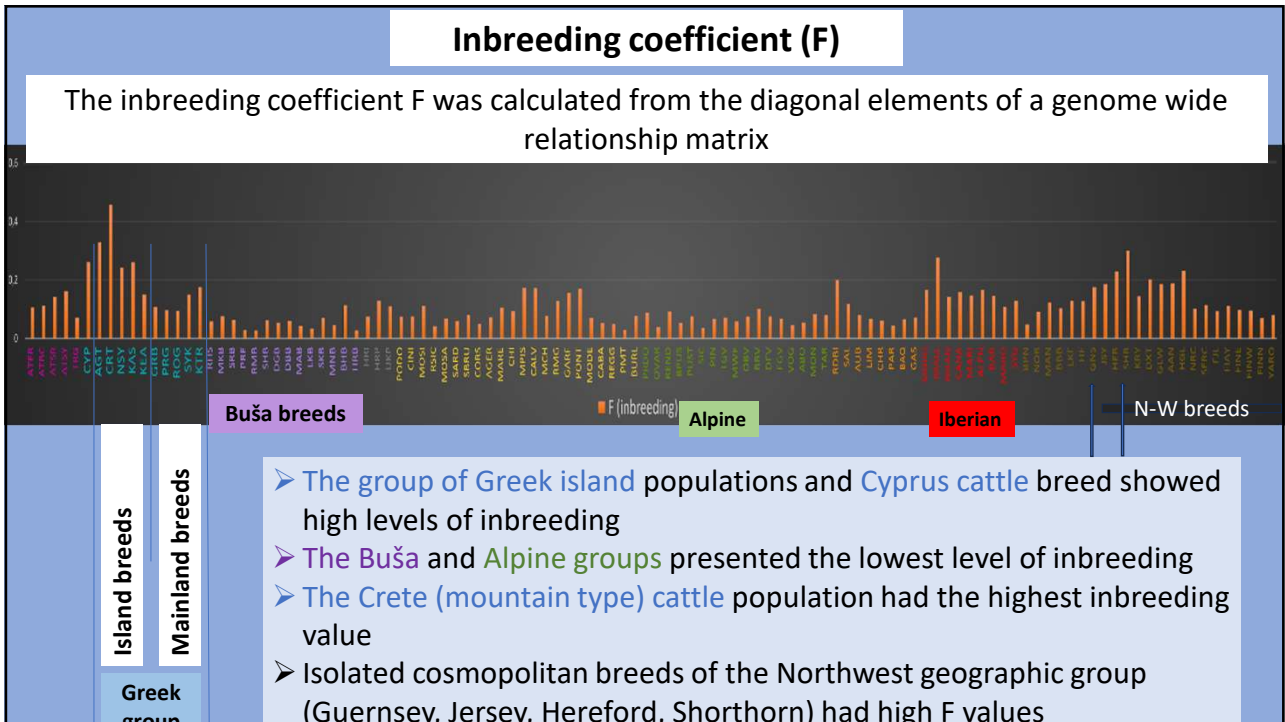
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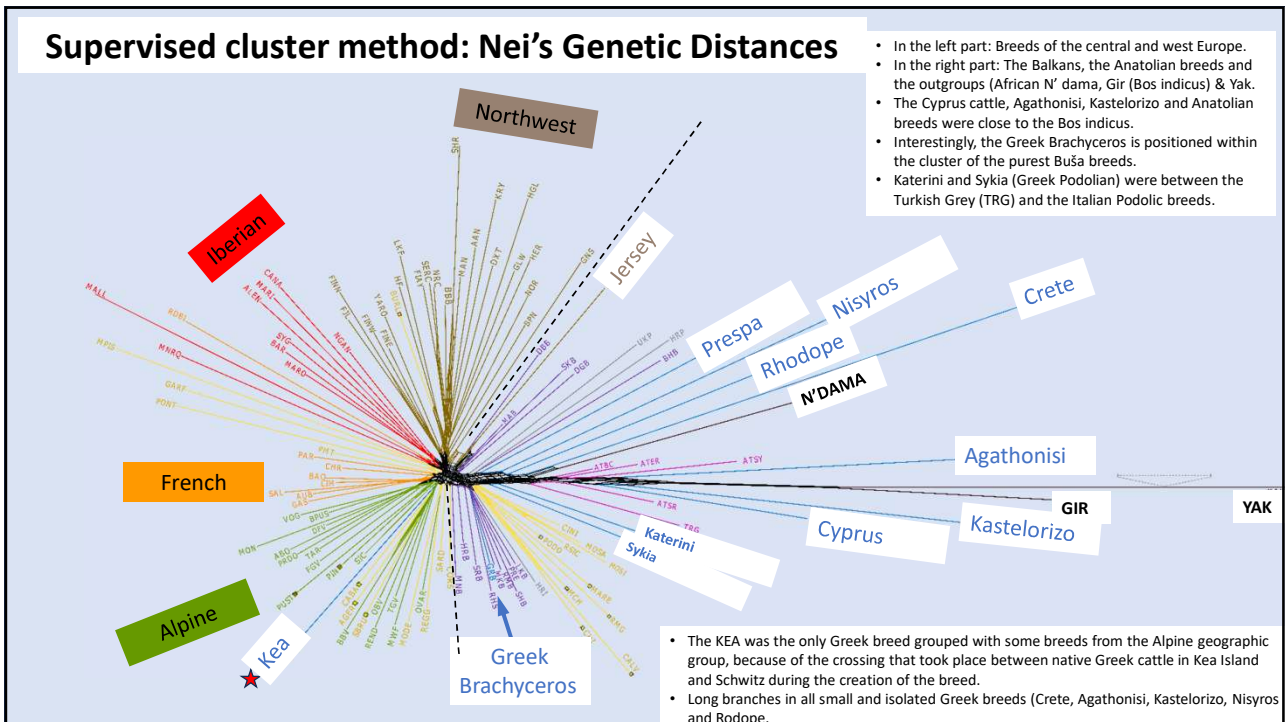
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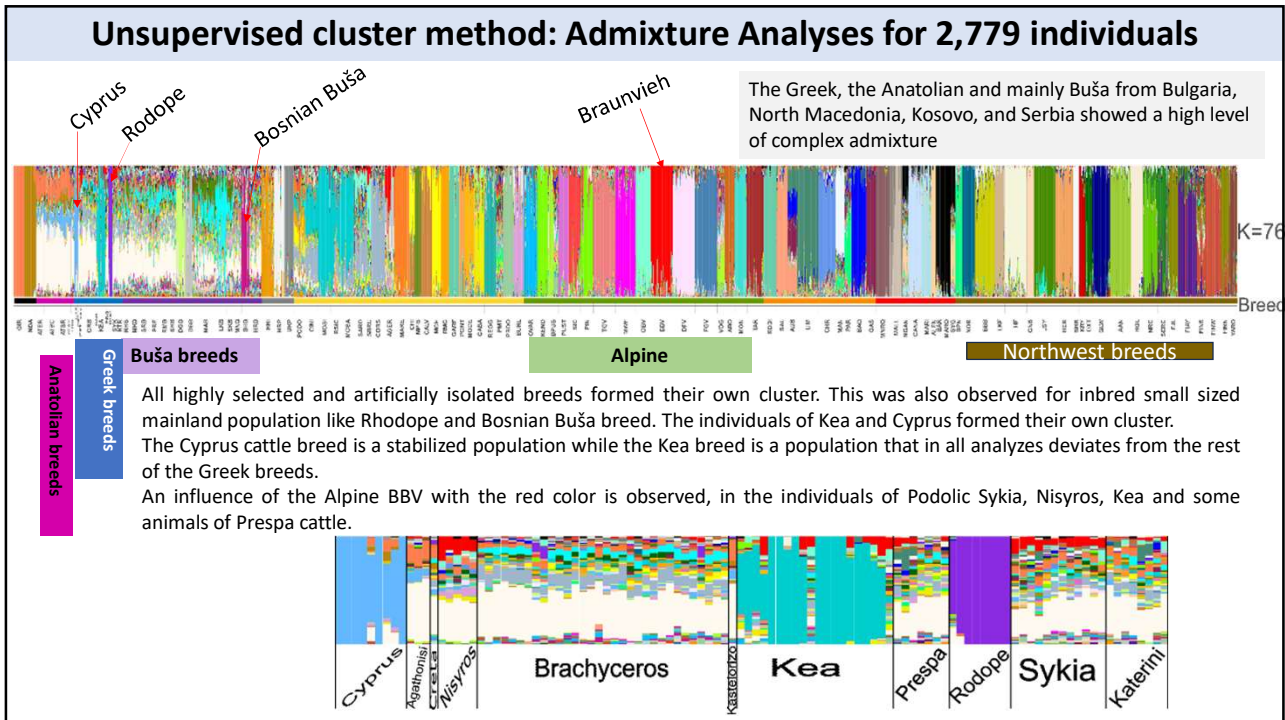
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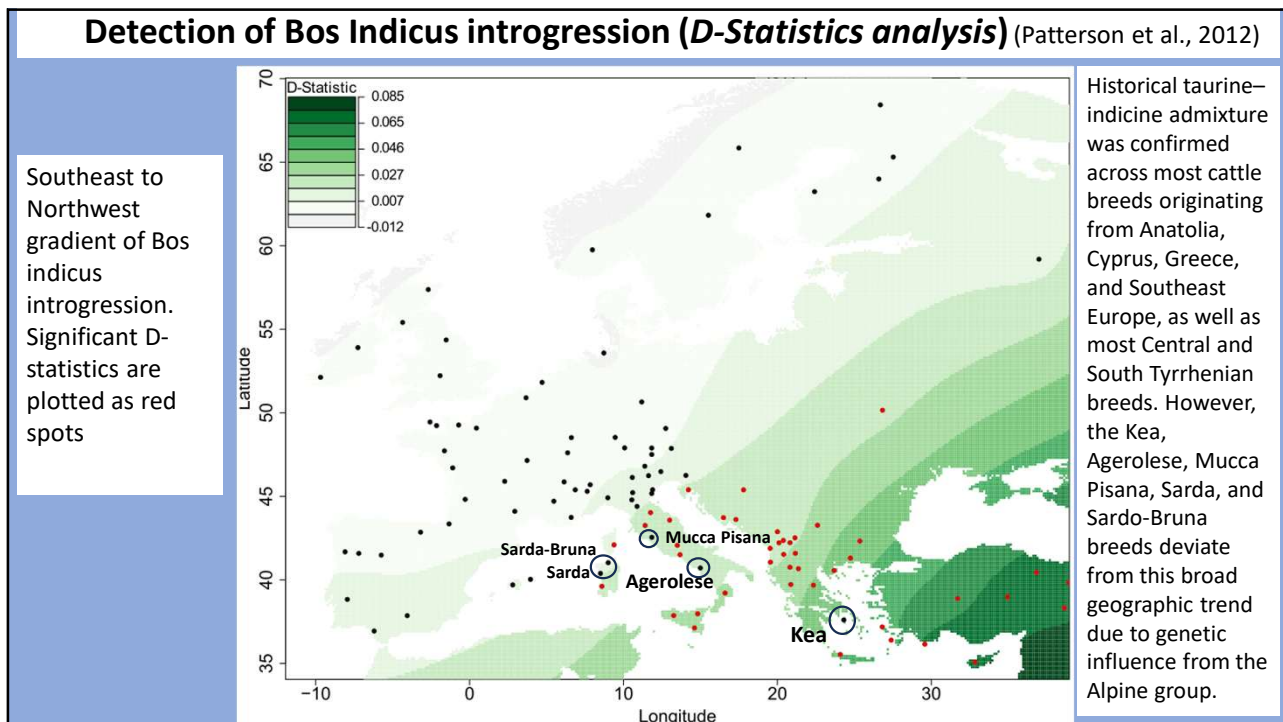
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Main results of genomic analyses

- Migration of cattle from Southwest Asia to Northwest Europe resulted to a clear decline of autosomal diversity & of *Bos Indicus* introgression
- Diversity reduction is more severe in island breeds than mainland ones
- The Greek *Brachyceros* breed maintains high levels of genetic diversity
- The Podolic or Steppe breeds (*Katerini* and *Sykia*) retain significant levels of allelic richness despite their small size
- A substantial proportion of the genetic diversity observed across all Greek and Cypriot cattle breeds can be directly attributed to historical *Bos indicus* introgression.

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Conclusions of the study

- The Cypriot & Greek breeds show historical and recent admixture events — linking them to Near Eastern domestication routes
- Island breeds suffer from **severe loss of genetic diversity** due to declining population size, bottleneck effect, genetic drift and inbreeding
- Despite crossbreeding pressure, some **native breeds maintain** remarkably **high genetic diversity** compared to commercial continental breeds
- This genetic diversity makes them promising candidates for sustainable farming in marginal environments under future climate change scenarios

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How the above genomic findings could be used in a conservation plan for the native breeds ? What are the basic conservation steps?

- ❖ **Identification** of the **crossbred** individuals (at different levels)
[here we refer to crossbreeding with animals from geographically distant, high-yielding breeds, rather than crossbreeding with animals of other native breeds (historically related and geographically neighboring)]
- ❖ **Exclusion of admixed animals** from the breeding plan
- ❖ Estimation of **inbreeding coefficient** of the population
- ❖ Manage a plan of matings to **avoid breeding between relatives**, to keep inbreeding levels as low as possible

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❖ **Identification of the crossbred individuals** (at different levels)

- Admixed individuals can be identified using a **multivariate outlier test**
- Admixture signatures (outliers) involve 5 variables (*mvoutlier* algorithm):
 1. The genetic distance between everyone with the remaining individuals within its breed
 2. The maximum genetic relatedness value (UAR) with an animal of a different (exotic) breed
 3. The second-highest UAR value with an animal of a different breed
 4. The maximum average UAR value of everyone with all the animals of a different breed (total)
 5. The number of connections with animals from a different breed in the graph of closest individuals

This procedure was performed in 97 individuals of the Kea island breed and in 145 individuals of the Greek Brachyceros (unpublished data).

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Conclusion

- The native breeds of Greece and Cyprus are living archives representing thousands of years of co-evolution with Mediterranean landscapes
- Their genetic diversity is a strategic asset for future food security and climate adaptation
- Urgent, targeted conservation action is needed for island and fragmented mainland breeds
- There are genetic and genomic tools to manage the native breeds
- There are policy tools (subsidies) provided for years to support native breeds; however, the non recognized officially populations / breeds are gradually disappearing
- There is a need of awareness
- There is a need to take more action on the native breeds / populations due to the valuable genes they hold

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Thank you for
your attention

Clash of the Titans, Brachyceros cattle, Aetohori, Pindos Mountains; Painter: Jason Roberts

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