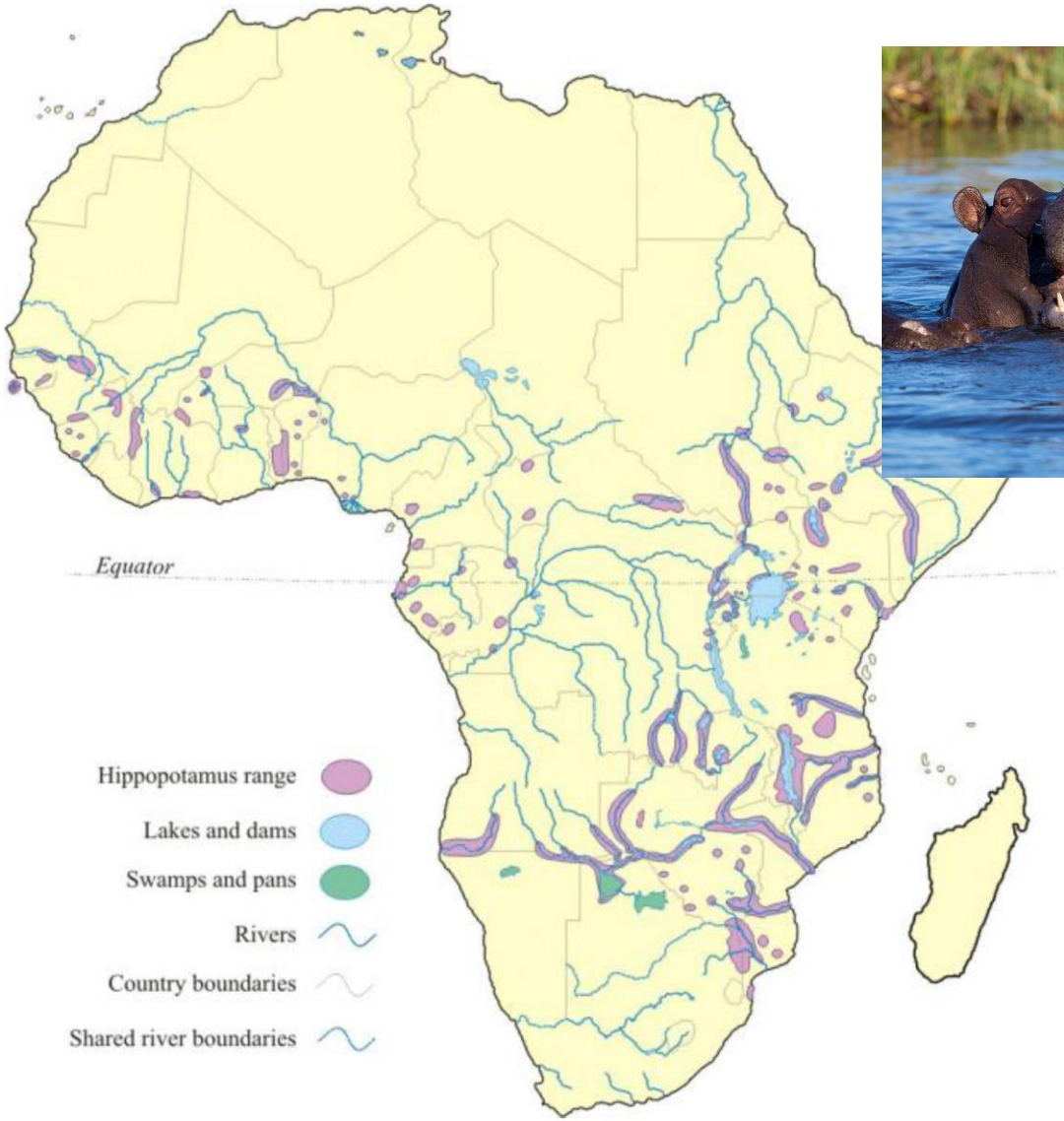
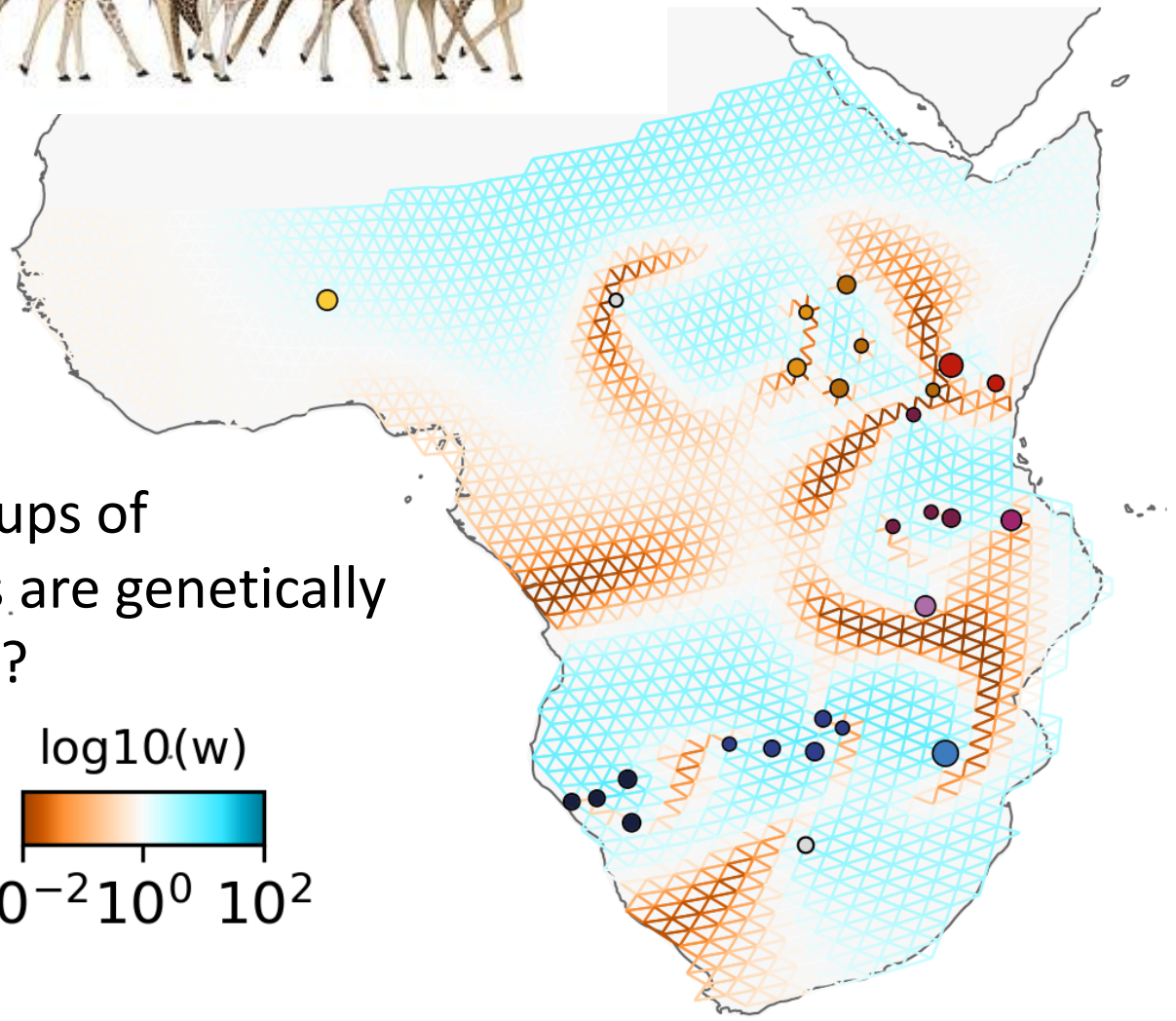
Population structure and why it matters

Day 3, Open Institute workshop, Kilifi, August 7th 2024

Assoc. Prof. Rasmus Heller, UCPH

Is there a single hippo population?





Which groups of individuals are genetically connected?

Why should we care about population structure?

- Tells us how many minimal evolutionary ”units” there are.
- Reveals the evolutionary history of the species.
- Reveals where there are natural (or unnatural) barriers to gene flow.
- Shows where we could/should maintain or restore migration.
- Influences how selection is affecting the species.
- Shows how far a species is on the road to evolving into new species.

Translocations- where from, where to?

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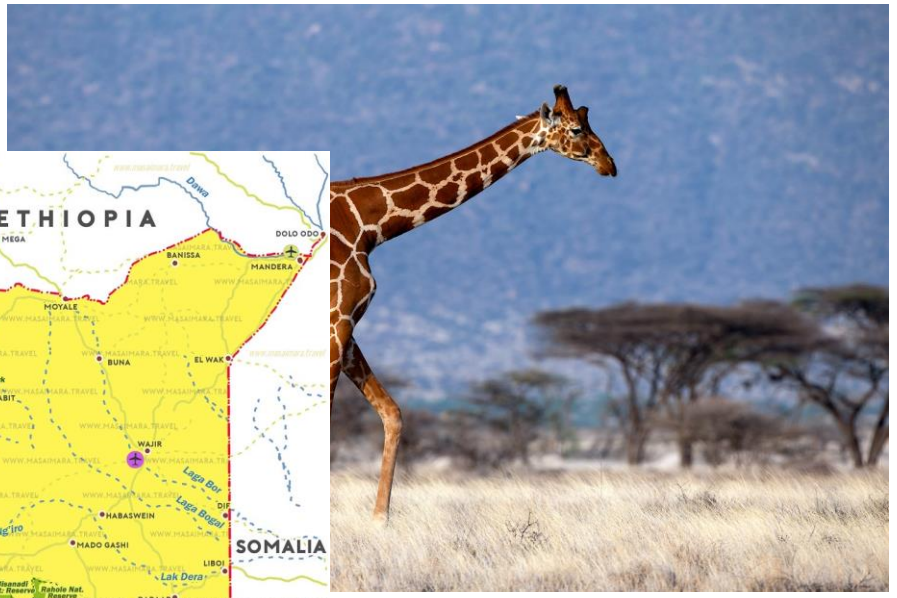
Masai giraffe – Maasai Mara

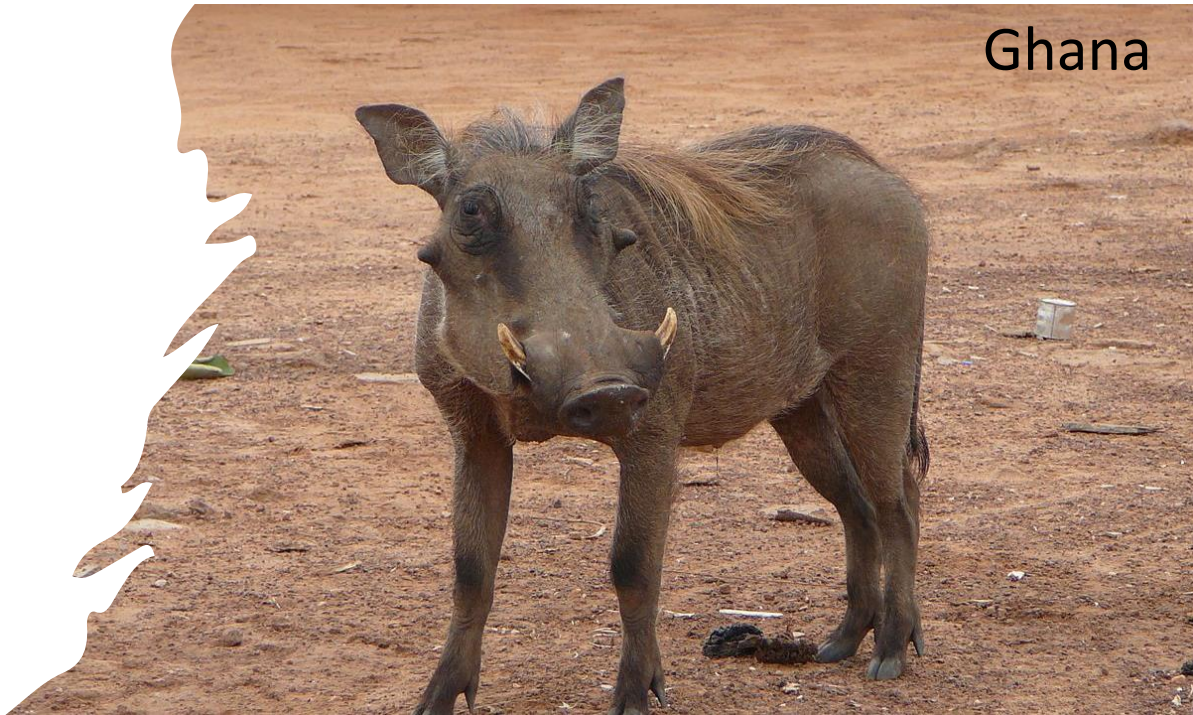
Reticulated giraffe – Samburu

Translocations- where from, where to?

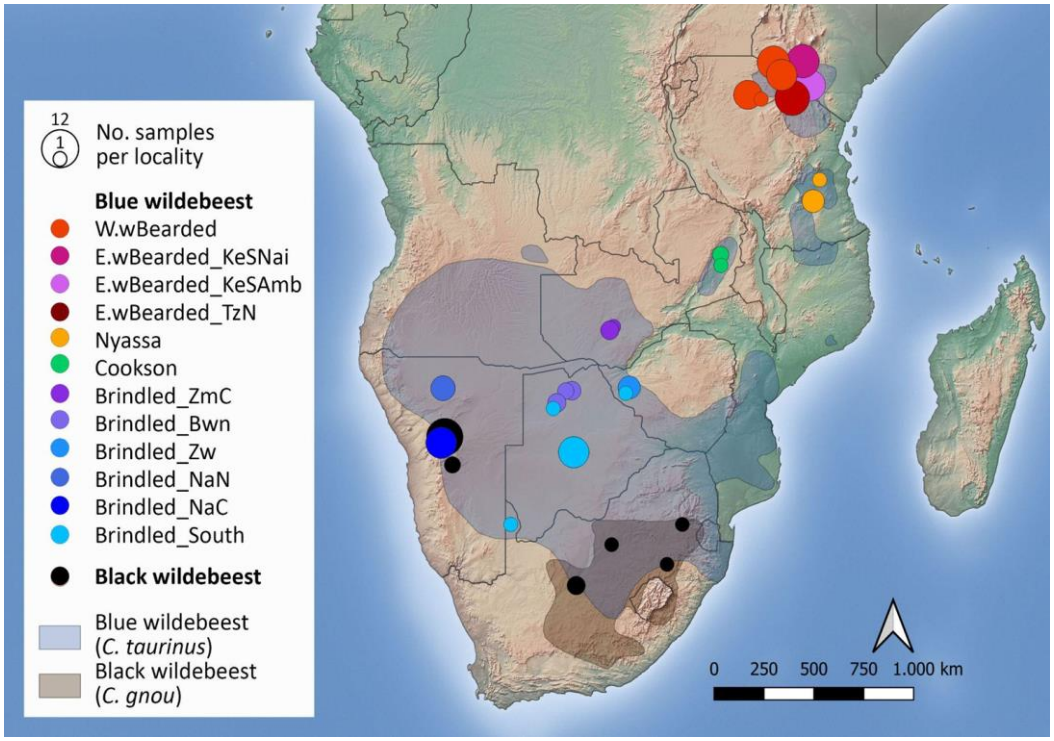


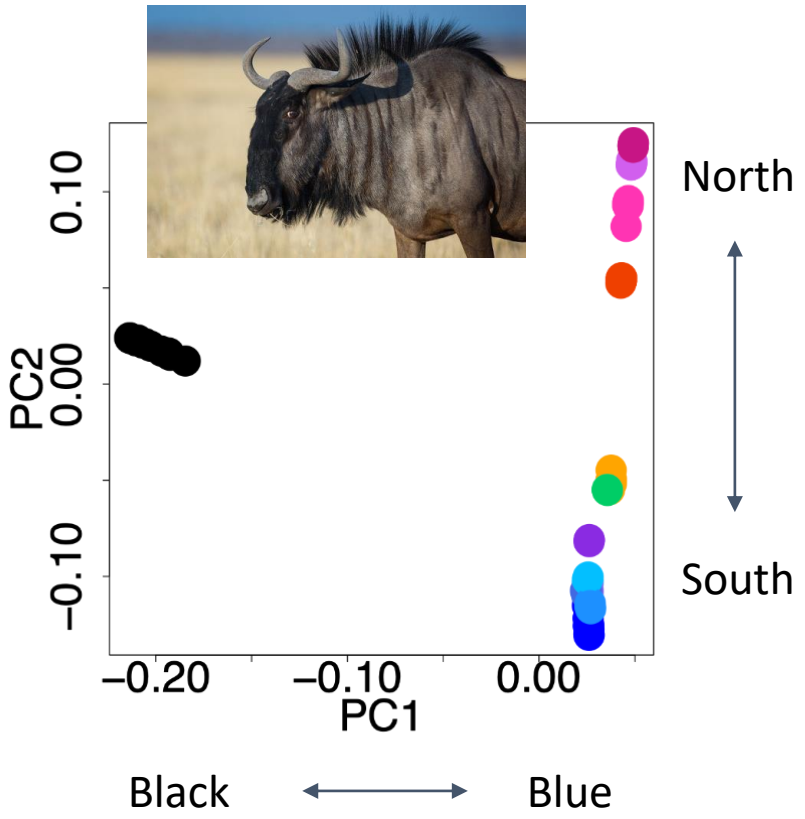
Masai giraffe – M d giraffe – Samburu

Translocations- where from, where to?



How do we measure population structure?





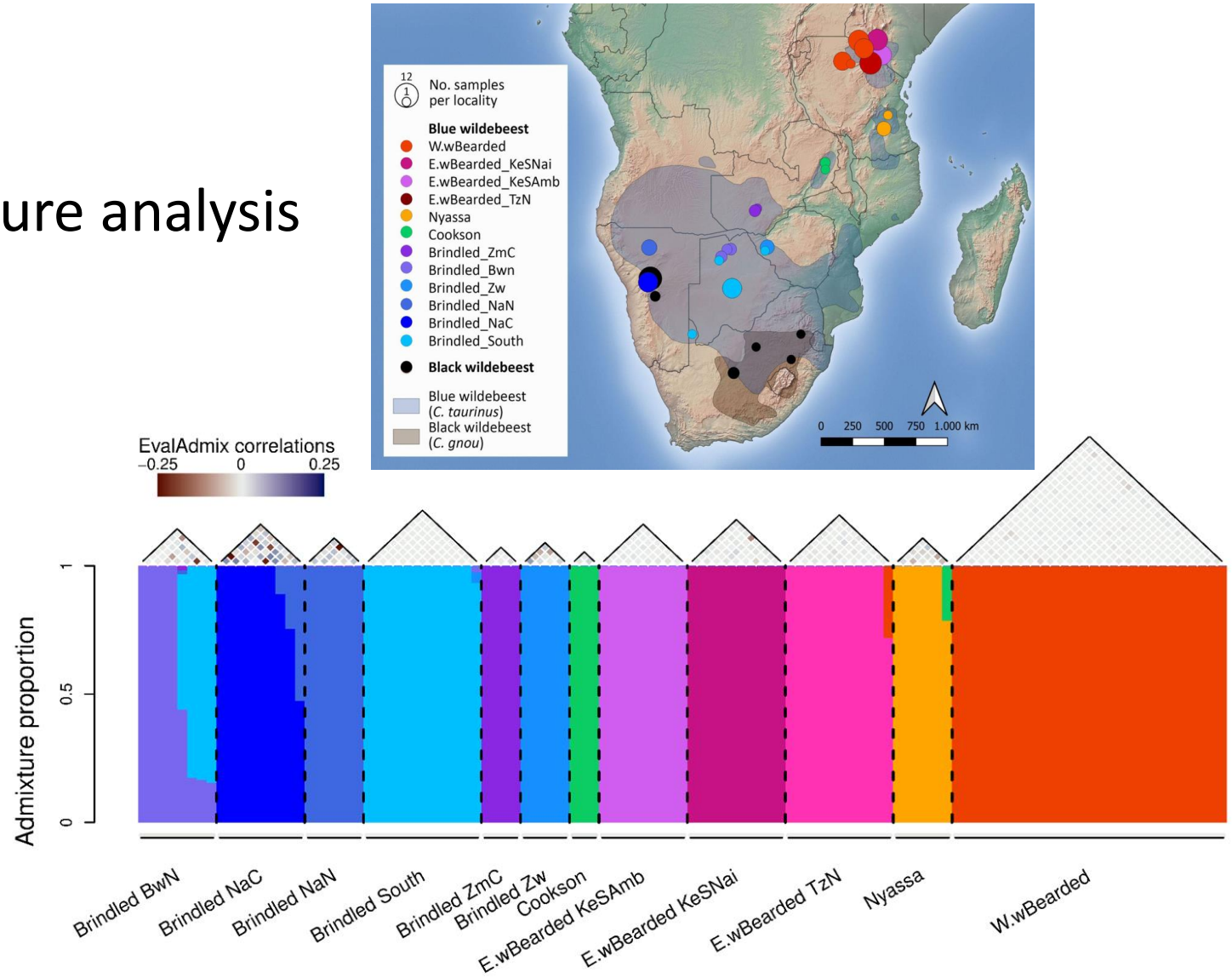
Principal Component Analysis
(PCA)

How do we measure population structure?

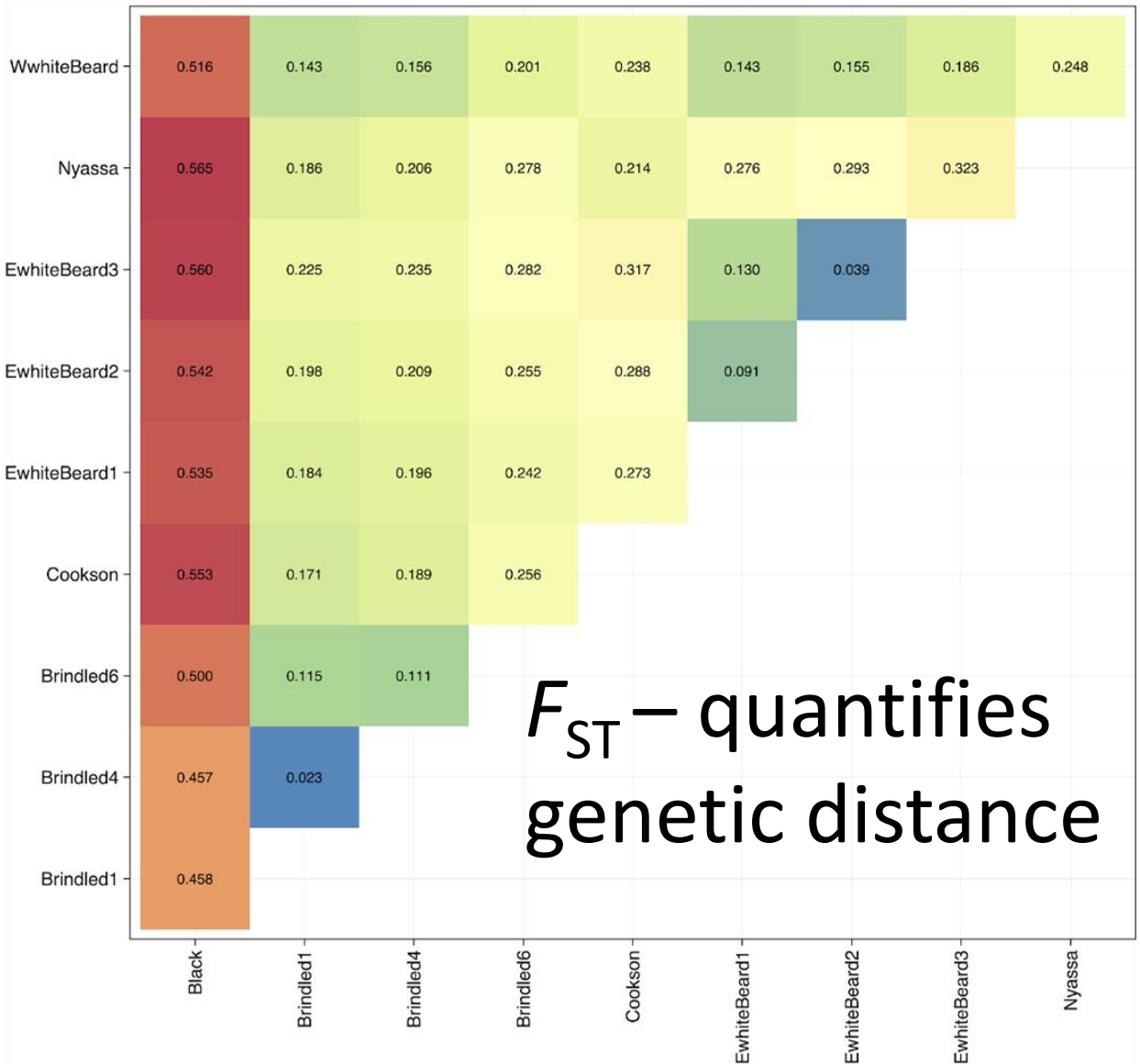
A phylogenetic tree

How do we measure population structure?

An admixture analysis



How do we measure population structure?



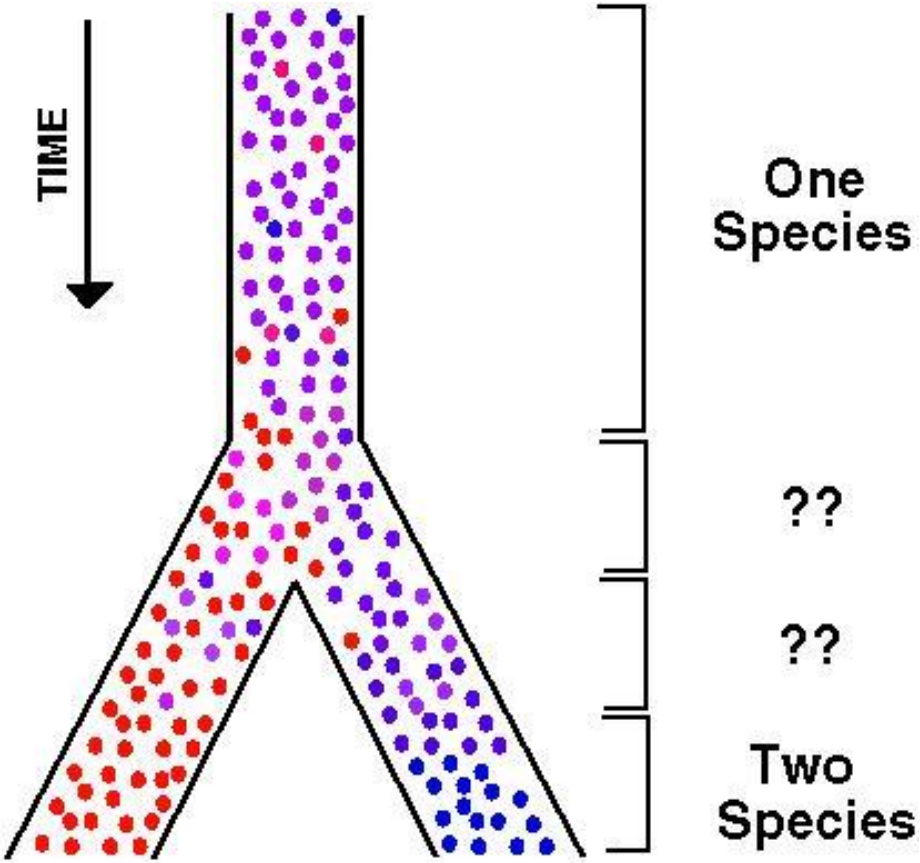
F_{ST} – quantifies genetic distance

How many populations are there?

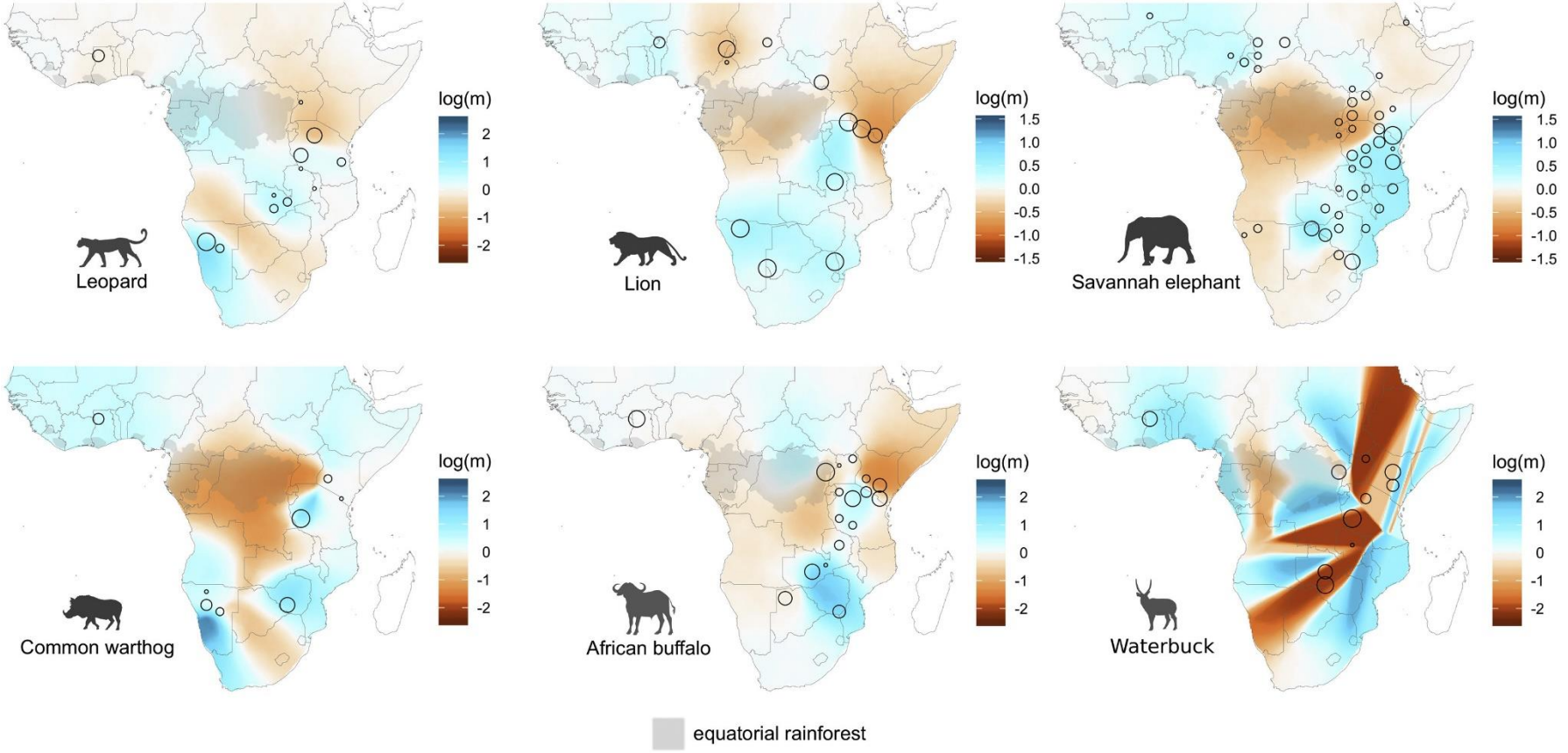
Population structure is often **hierarchical**

What happens when populations diverge?

Diverged populations are what ultimately becomes different species



Gene flow and barriers



Genetic differentiation

Wright's F_{ST} quantifies the amount of genetic differentiation between two or more populations.

$$0 \leq F_{ST} \leq 1$$

where:

$F_{ST} = 0$: **no** differentiation

$F_{ST} = 1$: **maximum** differentiation

F_{ST} can be defined in many ways

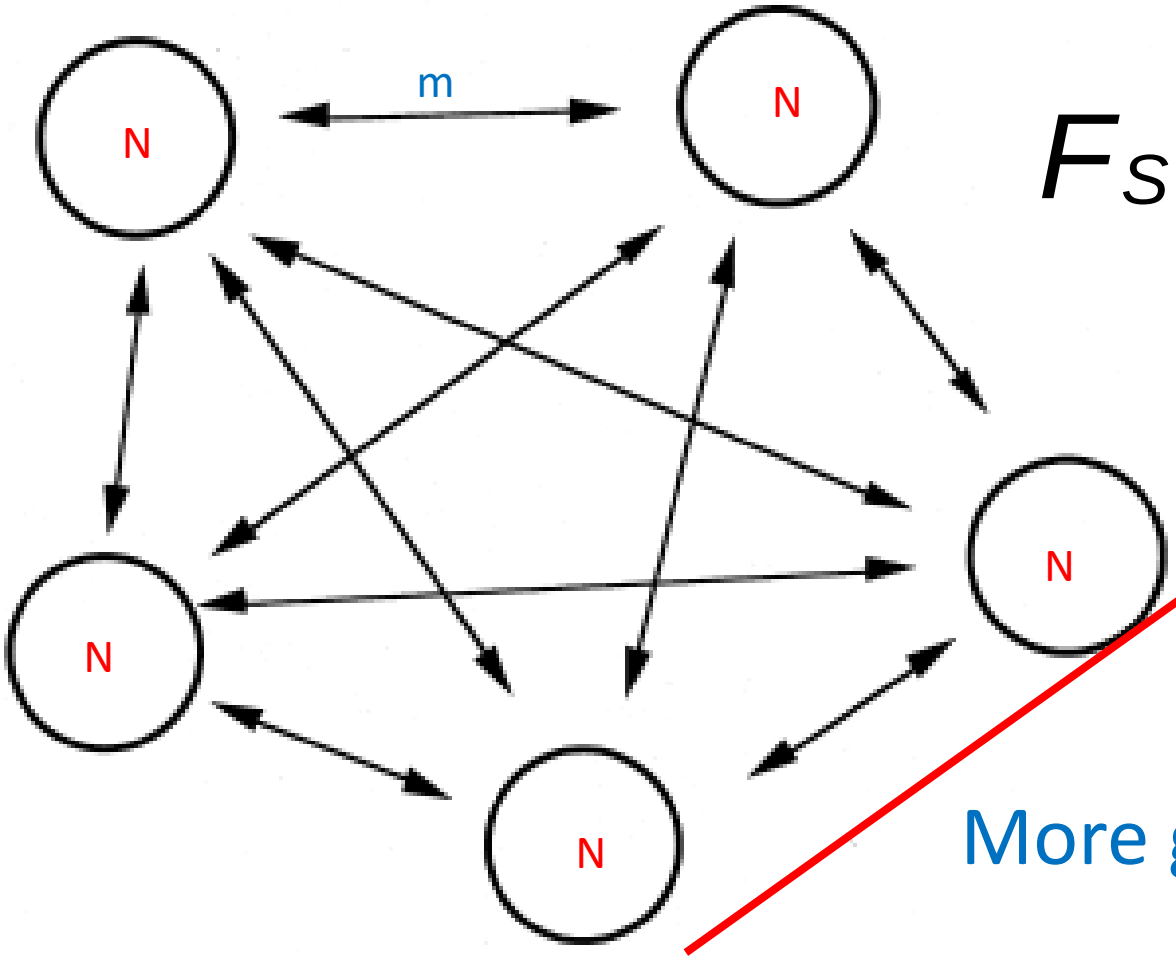
Can be defined by Hardy Weinberg expectations:

$$F_{ST} = (H_{E(total)} - H_{O(total)}) / H_{E(total)}$$

Can be defined by within (W) and between (B) population differences:

$$F_{ST} = 1 - \frac{H_W}{H_B}$$

Wright's island model



$$F_{ST} = \frac{1}{1 + 4Nm}$$

More gene flow, lower F_{ST}

Larger populations, lower F_{ST}

Gene flow and drift

$$F_{ST} = \frac{1}{1 + 4Nm}$$

Number of migrants ($N \times m$) determines differentiation between populations.

The One-Migrant-per-Generation Rule in Conservation and Management

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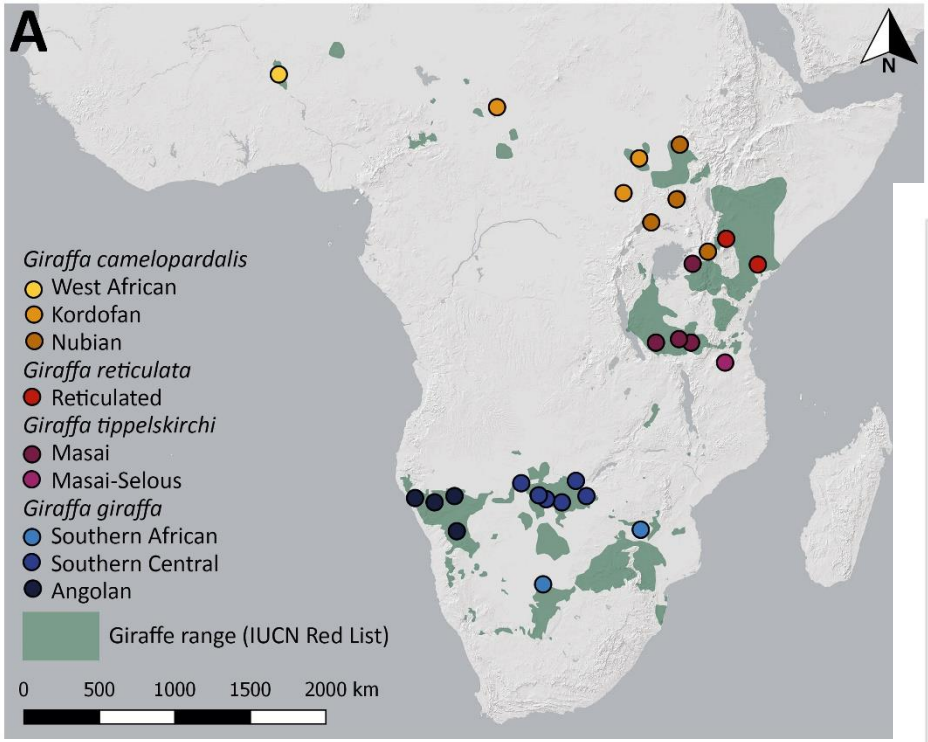
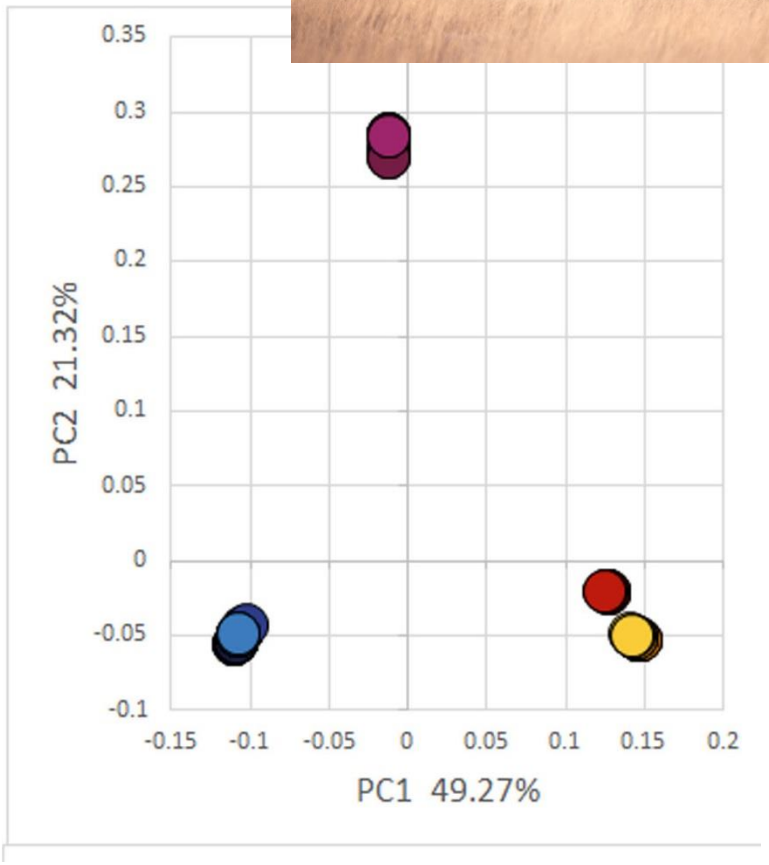
1. Clustered





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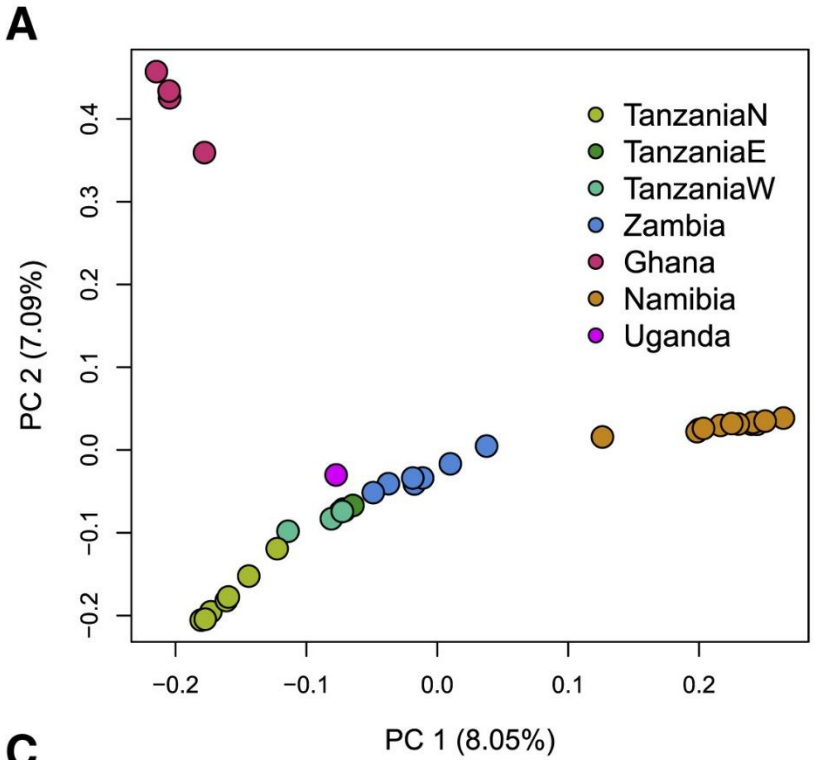
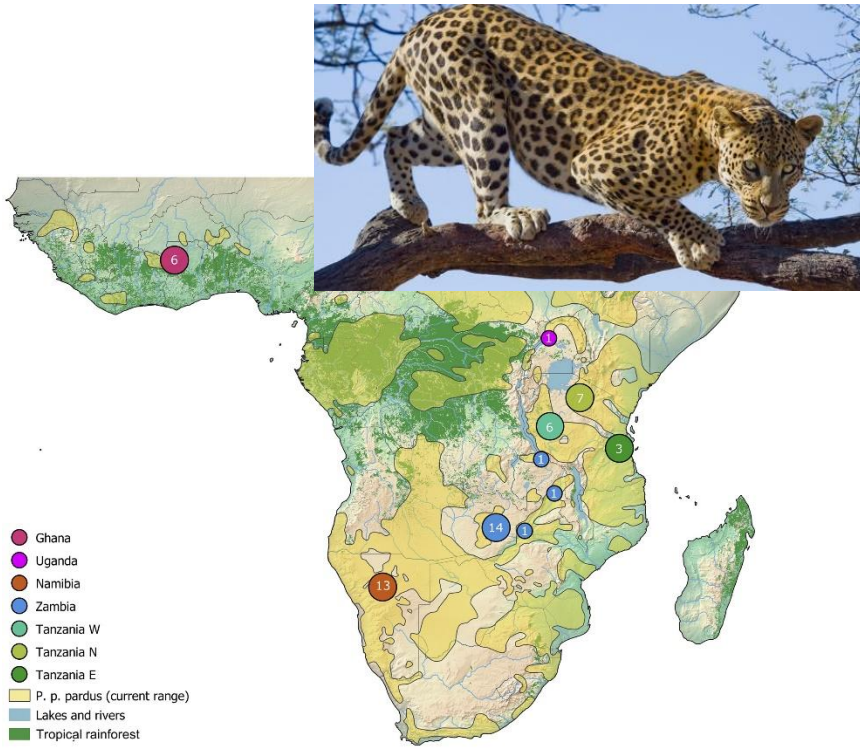
2. Scattered





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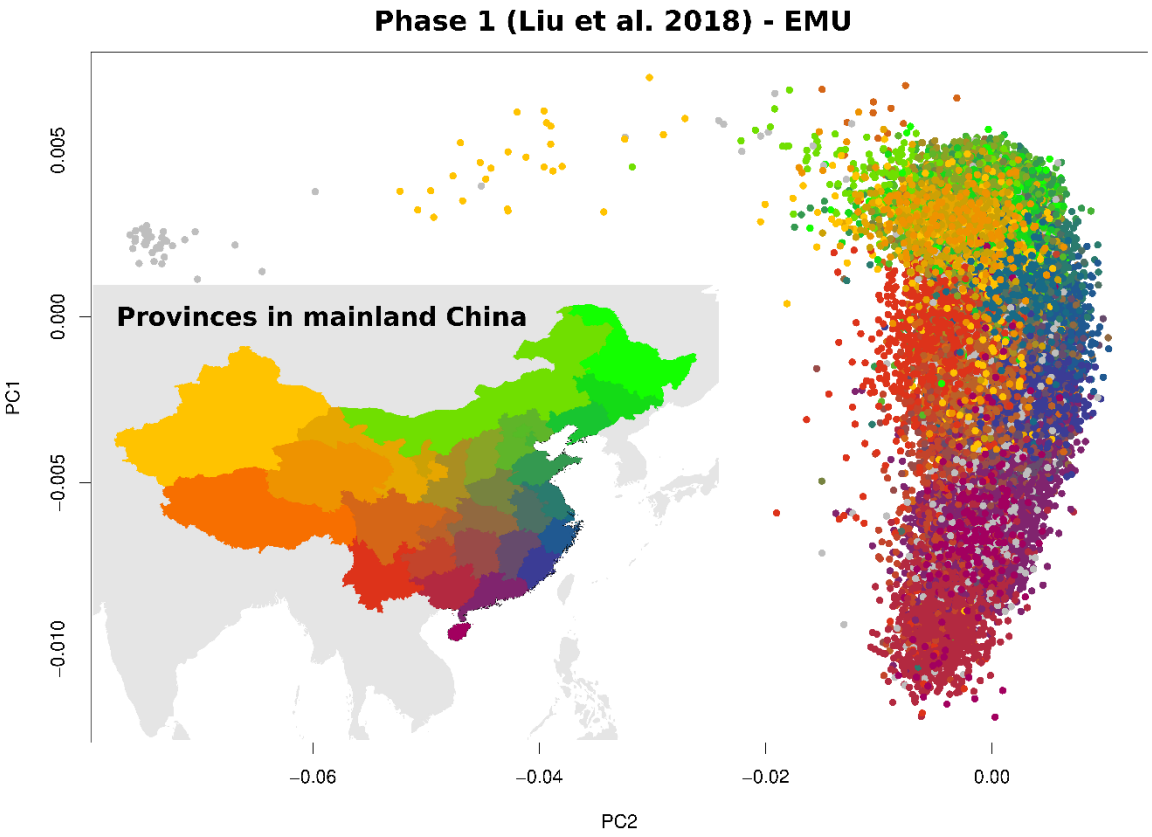
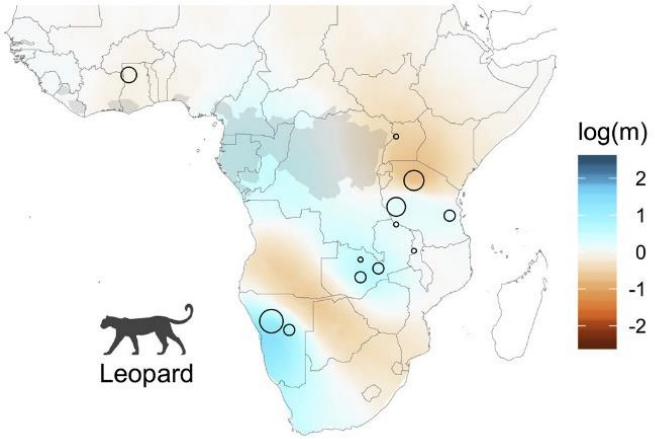
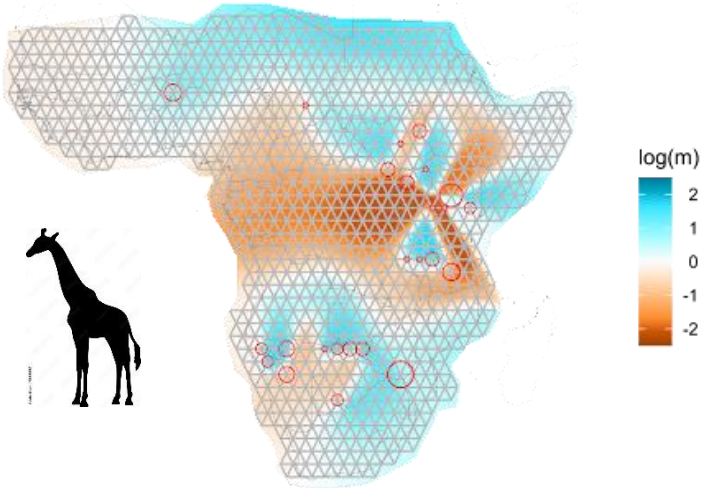
3. Continuous



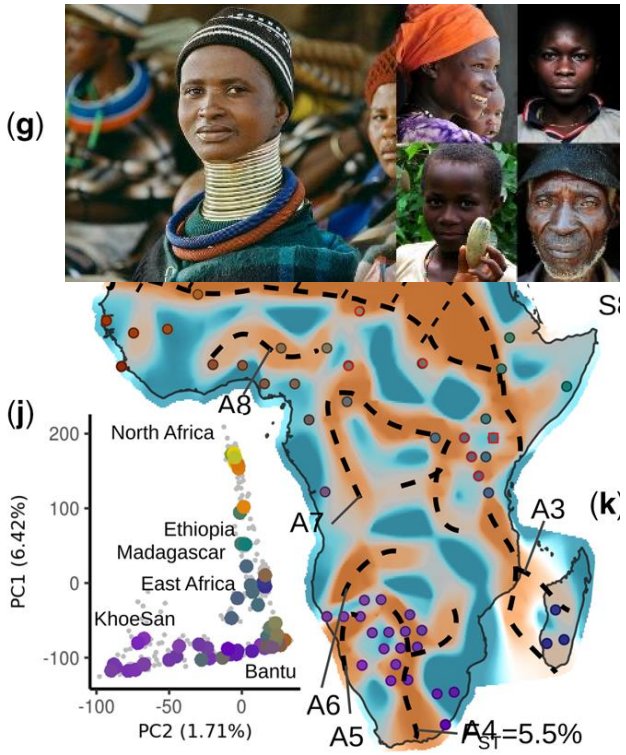
F_{ST} across Africa

F_{ST} = 0.17





F_{ST} = 0.71



F_{ST} = 0.03!!