

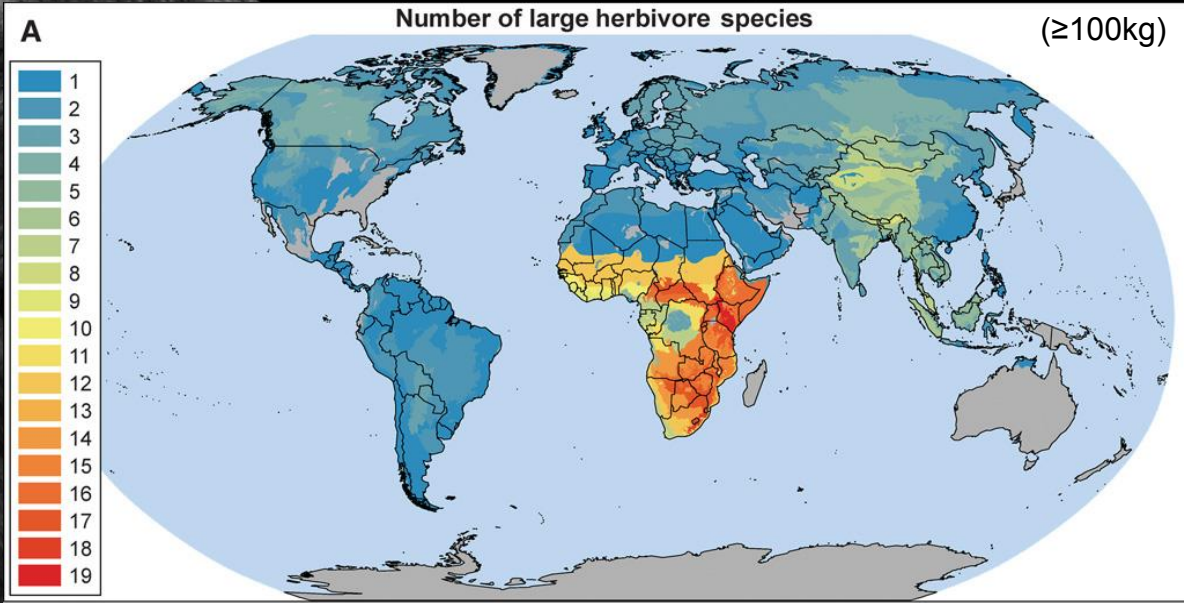
Evolutionary history of the African buffalo (*Syncerus caffer*) at continental scale based on mitochondrial and nuclear molecular markers



2th African Buffalo Symposium - 2016

Nathalie Smitz, Rasmus Heller, Pim Van Hooft, Daniel Cornélis, Philippe Chardonnet, Alexandre Caron, Michel de Garine-Wichatitsky, Johan Michaux

AFRICAN MEGAFAUNA



Ripple *et al.* 2015

Loxodonta africana



Hippopotamus amphibius



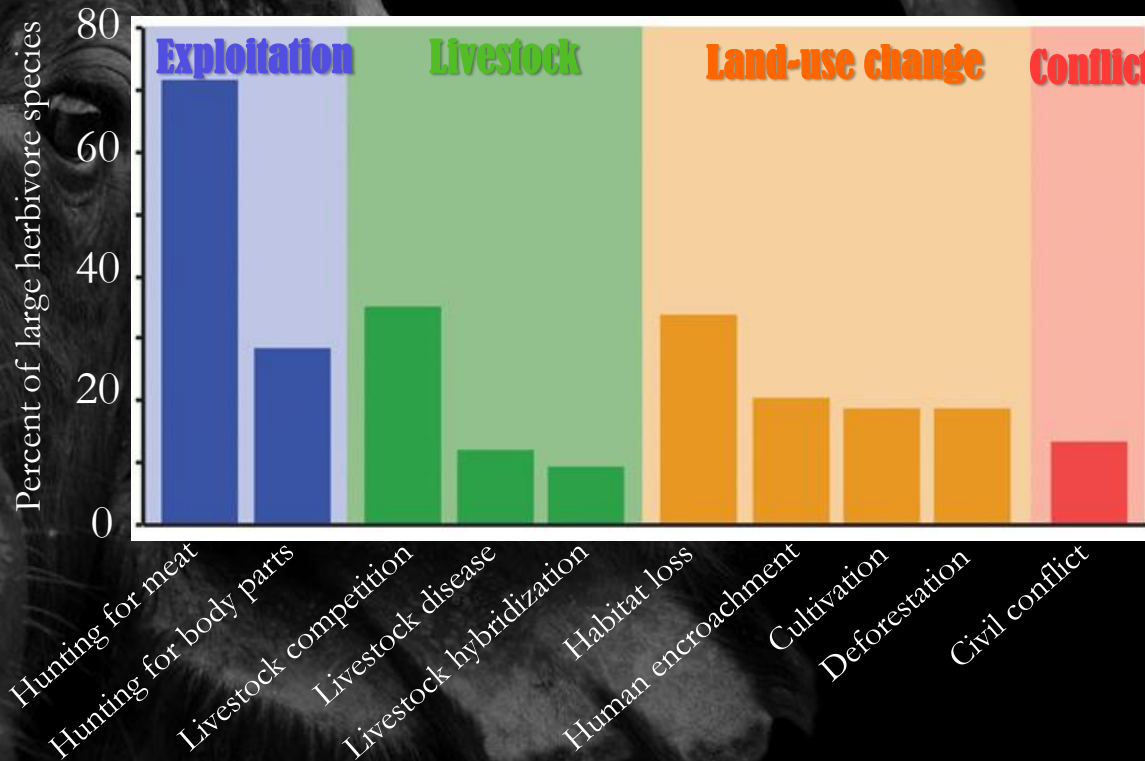
Ceratotherium simum



Diceros bicornis



Population size decreases



Ripple *et al.* 2015

➔ 55% of herbivores having body masses of 100 to 1000 kg are threatened (IUCN)

CONSERVATION GENETICS

↘ Genetic variability
↗ Inbreeding
↗ Genetic drift
↘ Ability to adapt

Anthropogenic activities

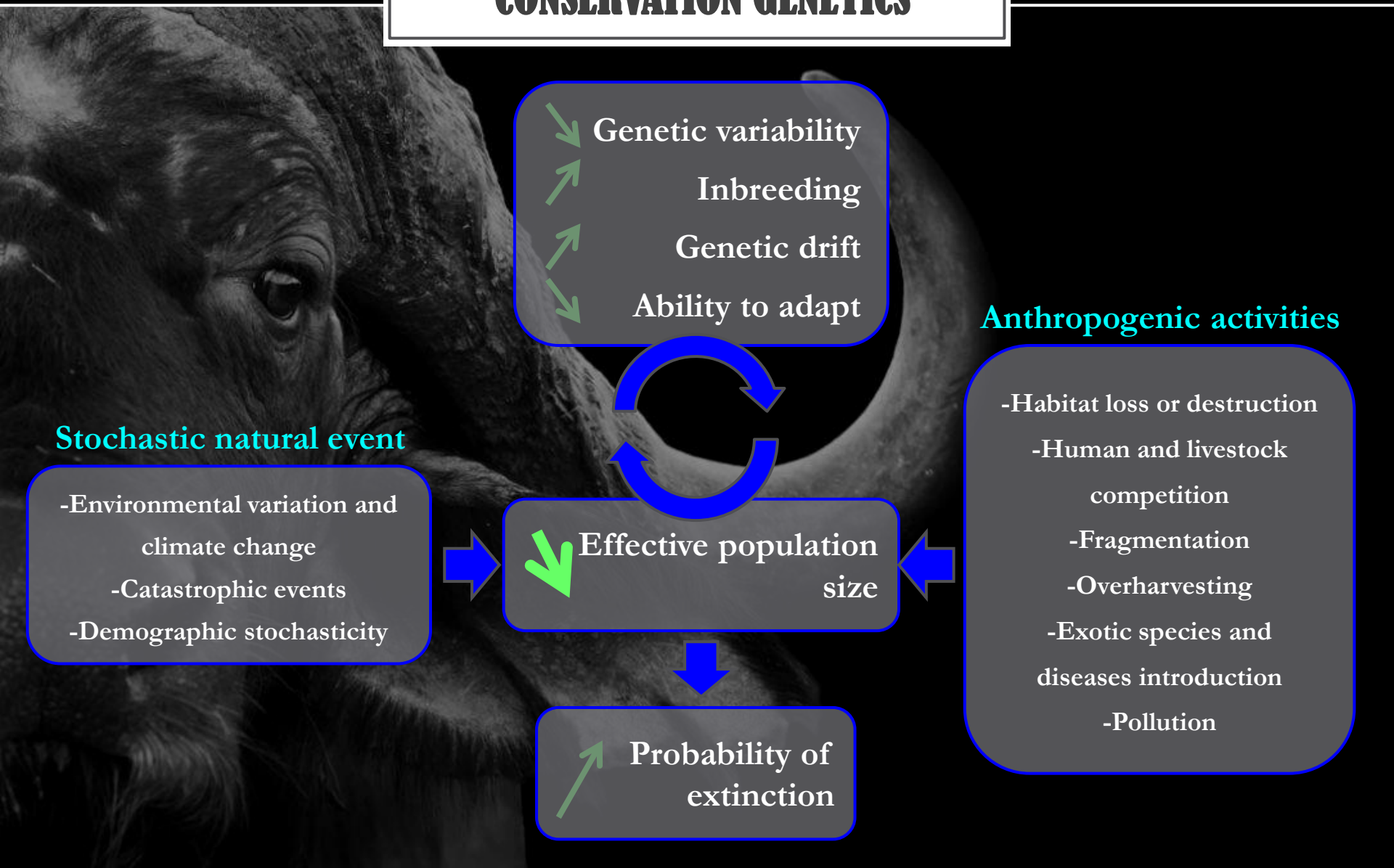
- Habitat loss or destruction
- Human and livestock competition
- Fragmentation
- Overharvesting
- Exotic species and diseases introduction
- Pollution

Stochastic natural event

- Environmental variation and climate change
- Catastrophic events
- Demographic stochasticity

↘ Effective population size

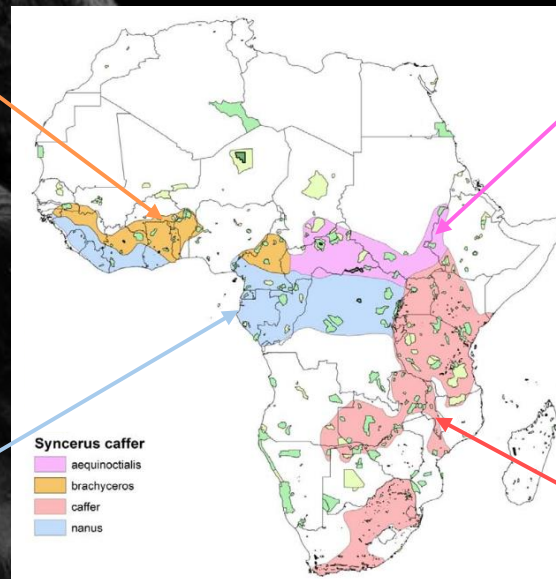
↗ Probability of extinction



AFRICAN BUFFALO

- Large continental distribution, wide range of habitats
- High morphological variability
- Economically important

75 % of the global population located within protected areas



Source: IUCN 2010/FAO report



SAMPLE COLLECTION



Material

776 samples
(tissue, blood, hair or faeces)

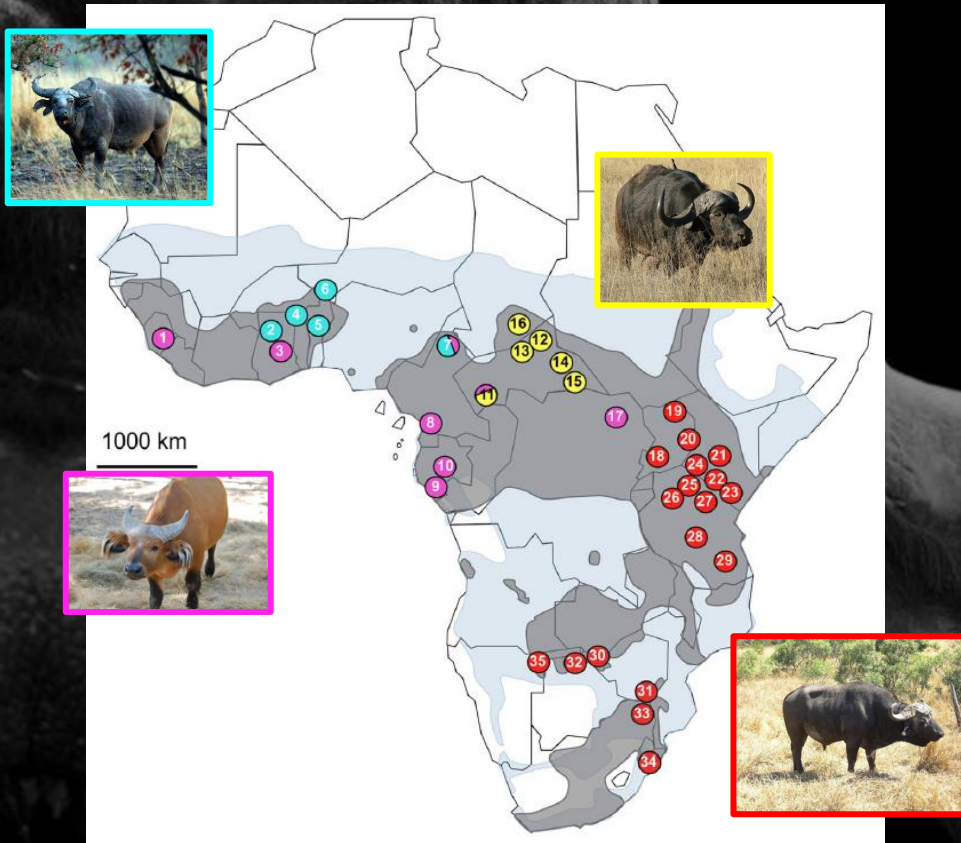
17 Countries

→ *S. c. caffer*

→ *S. c. nanus*

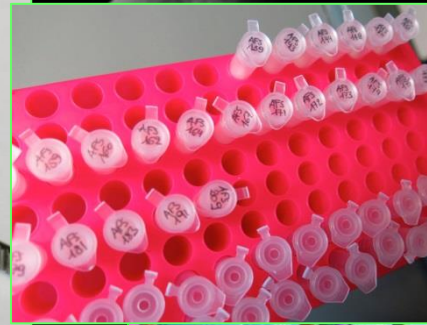
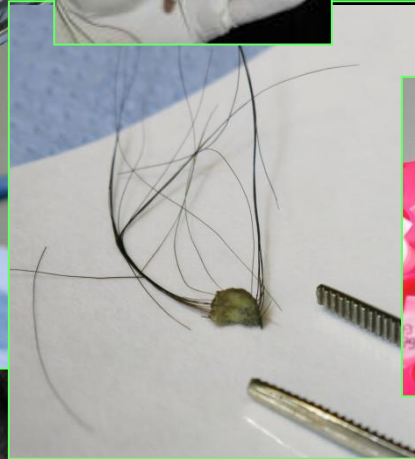
→ *S. c. brachyceros*

→ *S. c. aequinoctialis*



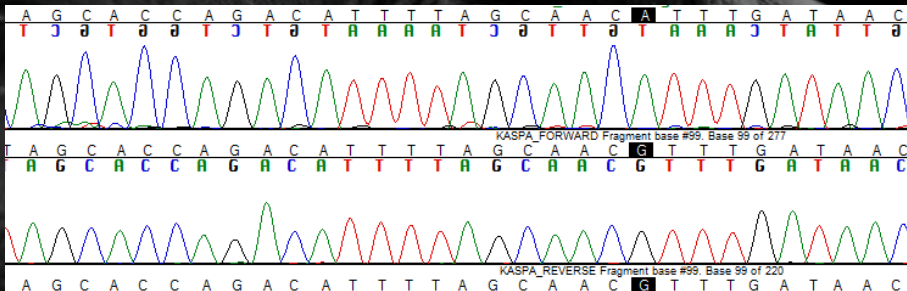
Geographical distribution of the African buffalo (IUCN)

DNA EXTRACTION



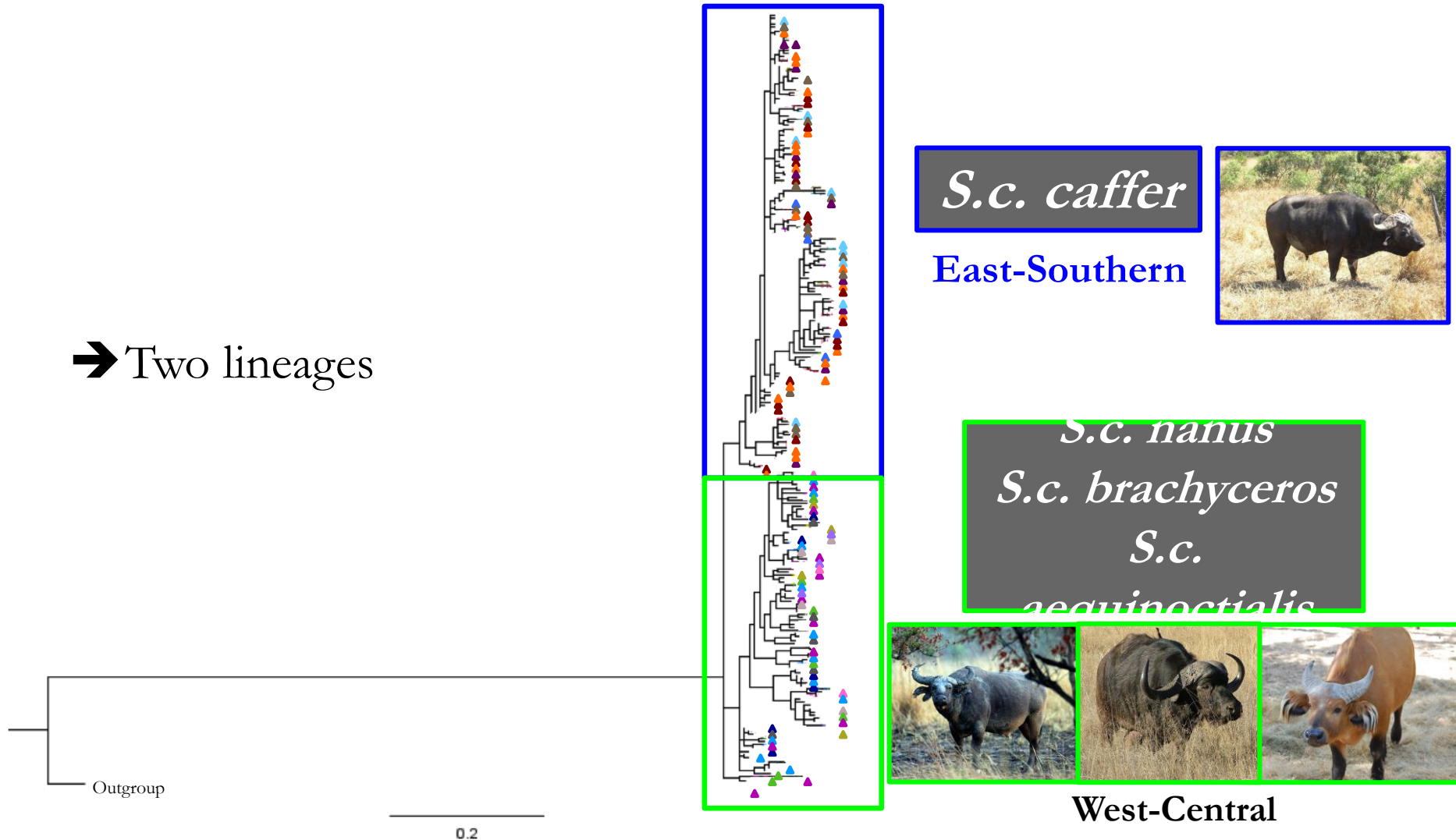
METHODS

→ mtDNA *D-Loop* sequences (Sanger Sequencing)



TREE RECONSTRUCTION

→ Two lineages



S.c. caffer

East-Southern



S.c. nanus
S.c. brachyceros
S.c. equinoctialis

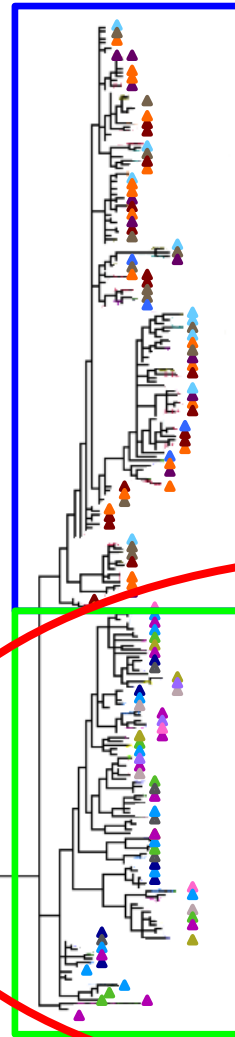


West-Central

0.2

TREE RECONSTRUCTION

➔ Absence of monophyly for the three West-Central subspecies



- ▲ Zimbabwe
- ▲ Uganda
- ▲ Tanzania
- ▲ Kenya
- ▲ Botswana
- ▲ South Africa

- ▲ Benin
- ▲ Cameroon
- ▲ Burkina Faso
- ▲ Ghana
- ▲ Sierra Leone
- ▲ Chad
- ▲ Namibia
- ▲ Gabon
- ▲ Niger
- ▲ Central African Republic

Outgroup

ECOTONE HYBRIDS

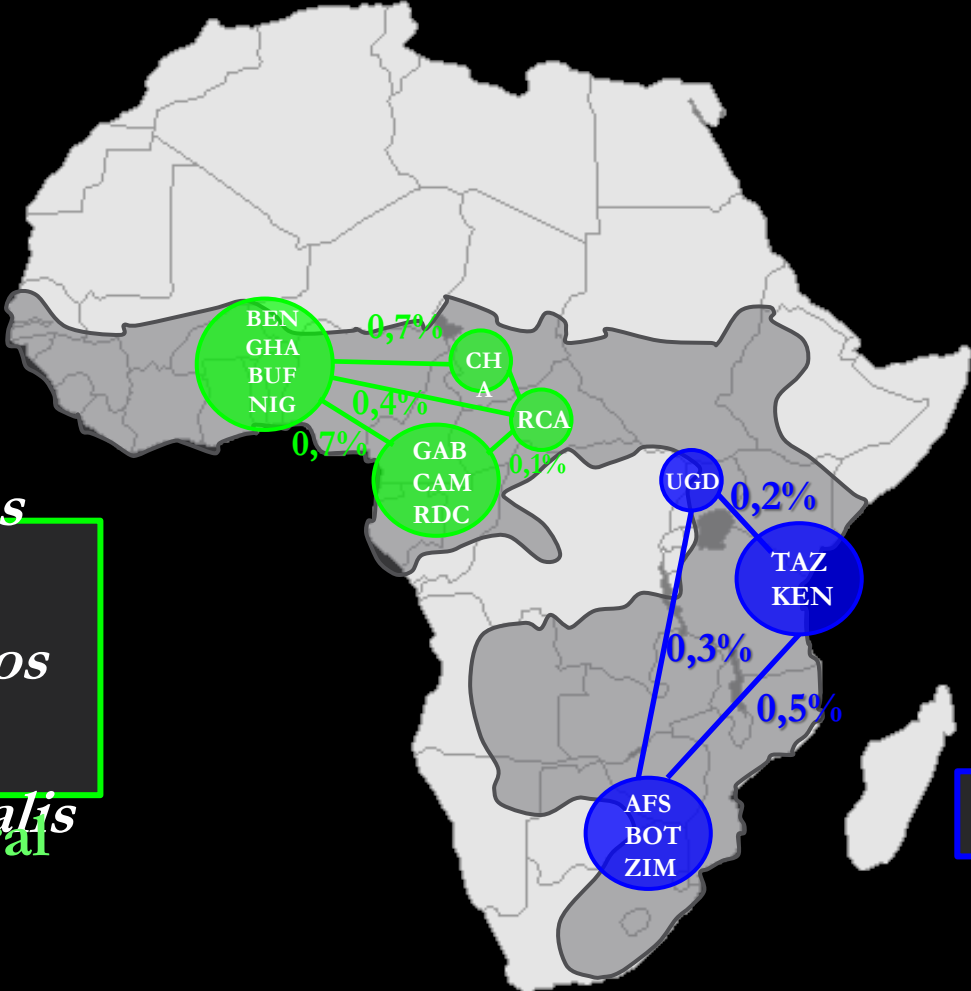


S.c.
brachyceros



S.c. nanus

GENETIC DISTANCES



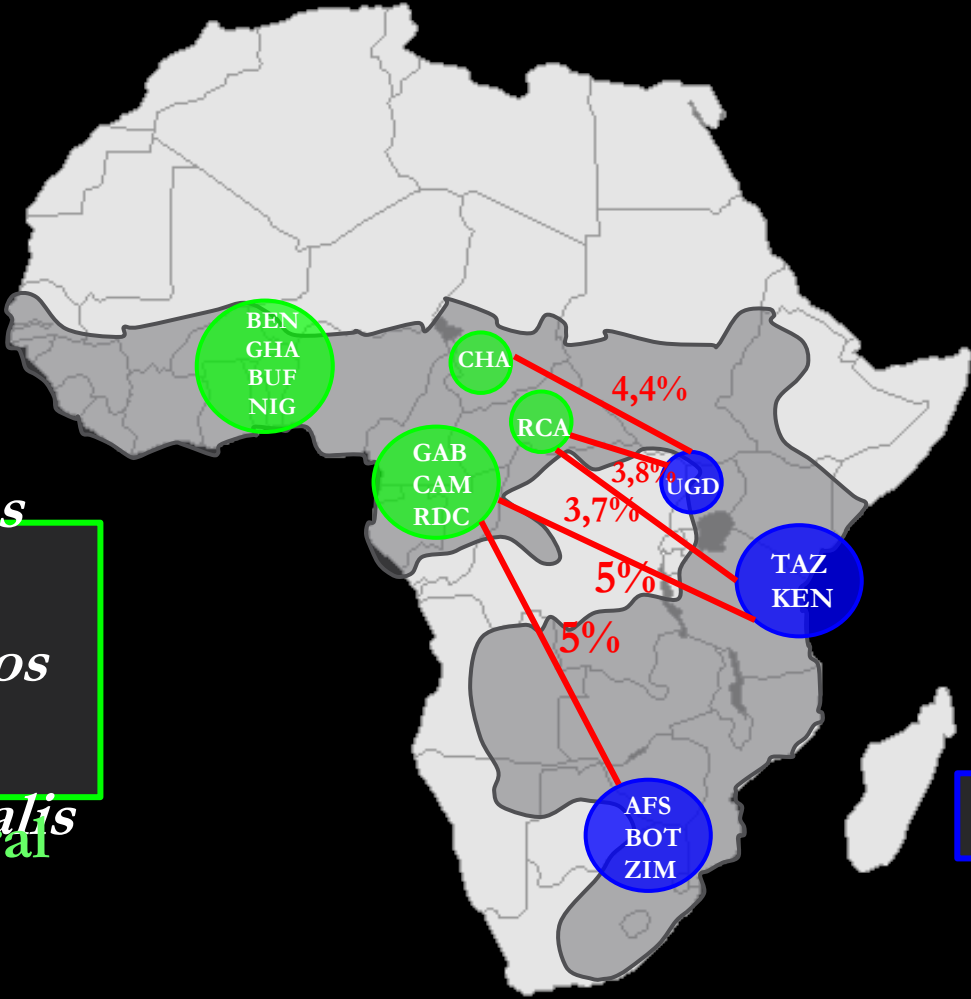
S.c. nanus
S.c. brachyceros
S.c.

aequinoctialis
West-Central

S.c. caffer

South-East

GENETIC DISTANCES

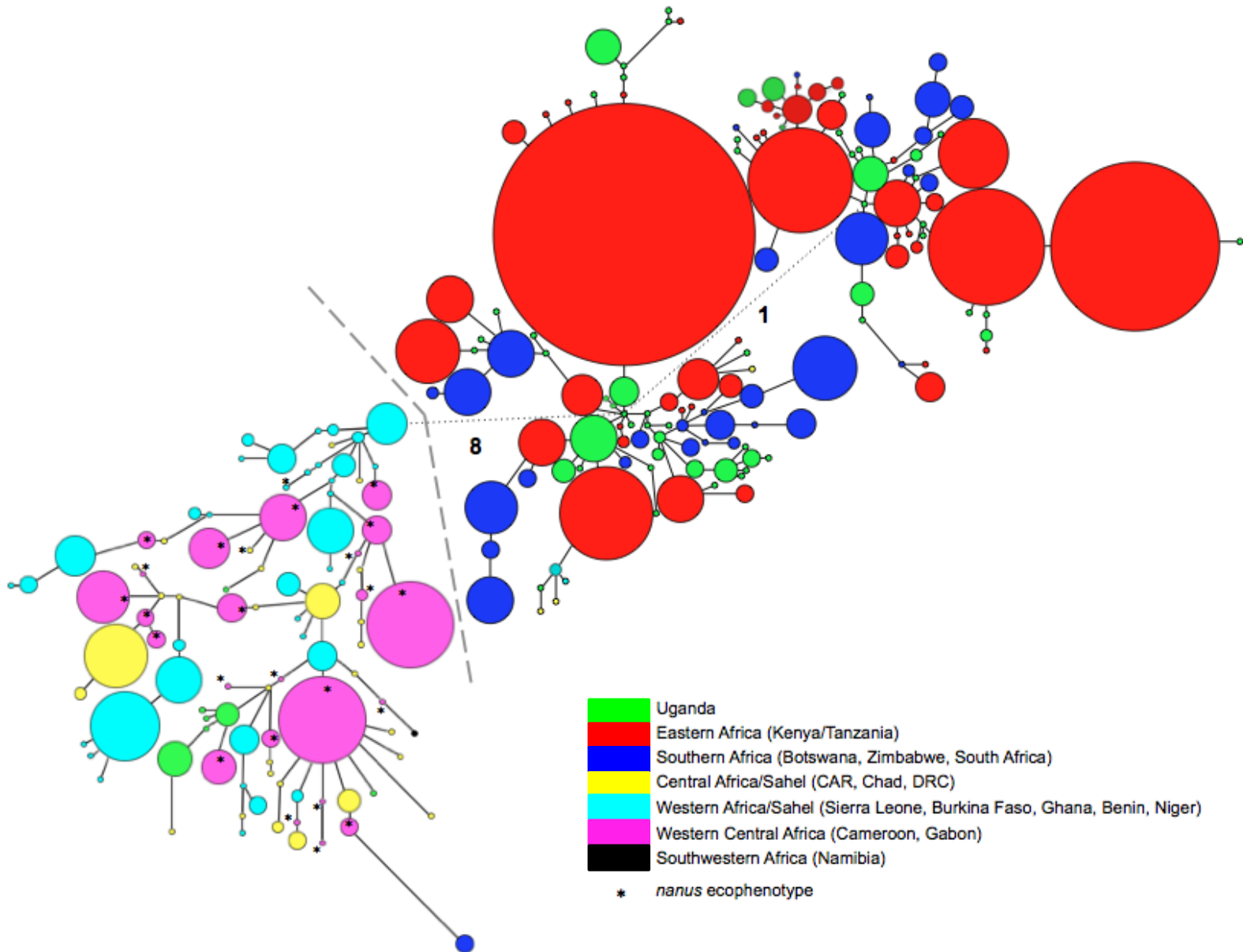


S.c. nanus
S.c.
brachyceros
S.c.
aequinoctialis
West-Central

S.c. caffer

South-East

NETWORK RECONSTRUCTION



Nucleotide and haplotype diversities:

(Arlequin, DNaSP)

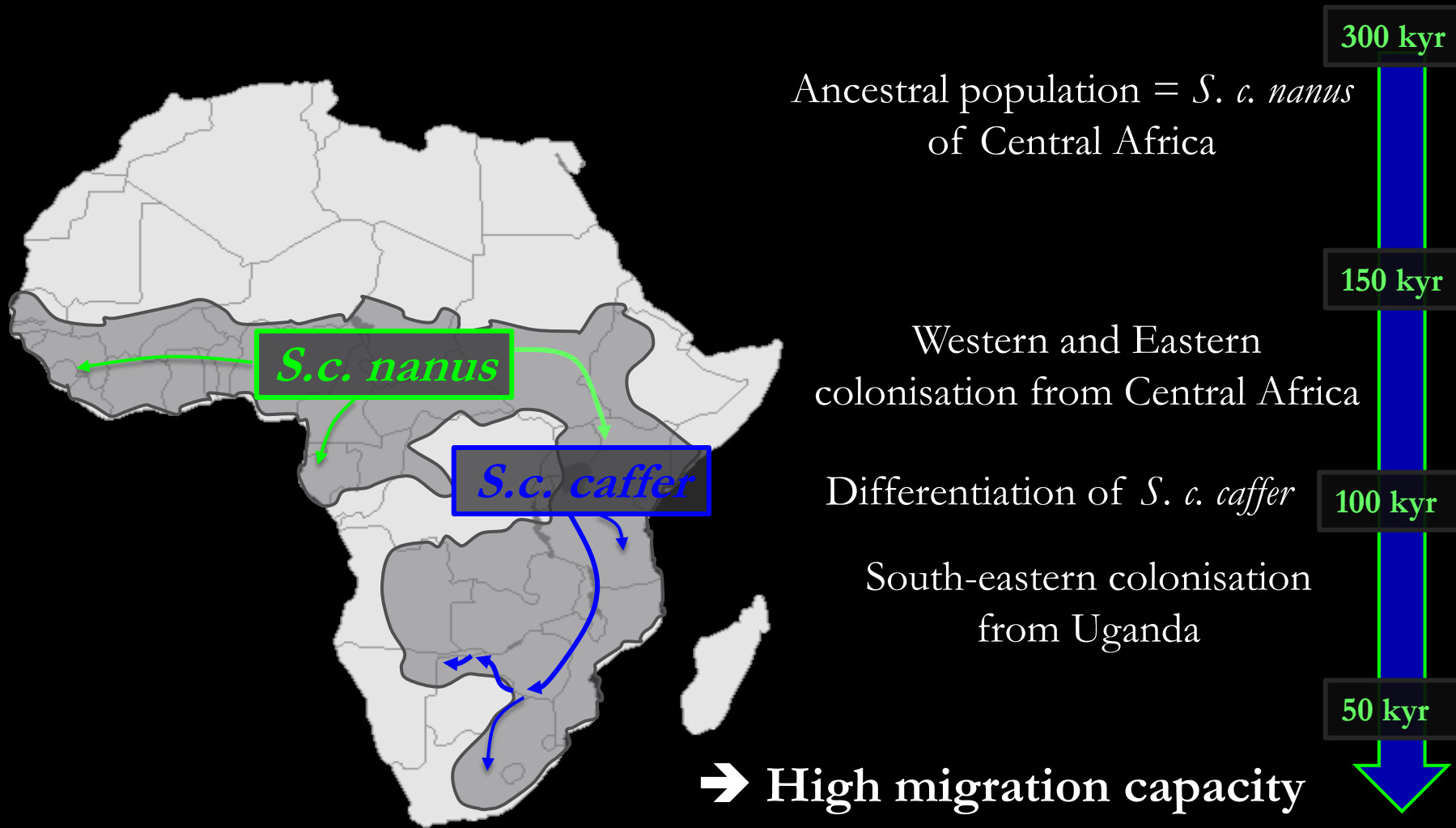


	h (SD)	π (SD)
South-Eastern lineage	0.980 (0.002)	4.58 (0.001)
West-Central lineage	0.981 (0.002)	6.42 (0.002)



Good genetic diversity

EVOLUTIONARY HISTORY OF THE AFRICAN BUFFALO BASED ON BAYESIAN ANALYSES

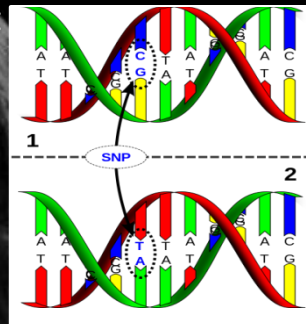


NUCLEAR MARKERS

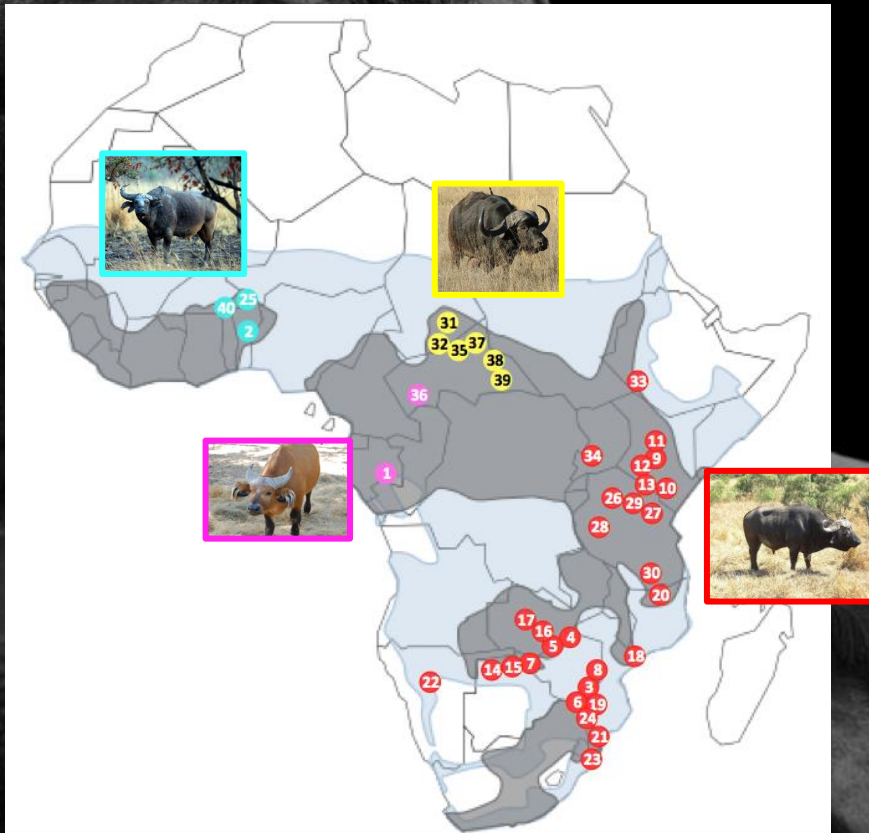
Compared results obtained by studying the genetic variation

- Single Nucleotide Polymorphisms (SNP):
→ Genotyping-By-Sequencing (GBS/NGS)

Ex:



GBS SAMPLING



Geographical distribution of the African buffalo (IUCN)

319 samples
(tissue and hair)

16 Countries

→ *S. c. caffer*

→ *S. c. nanus*

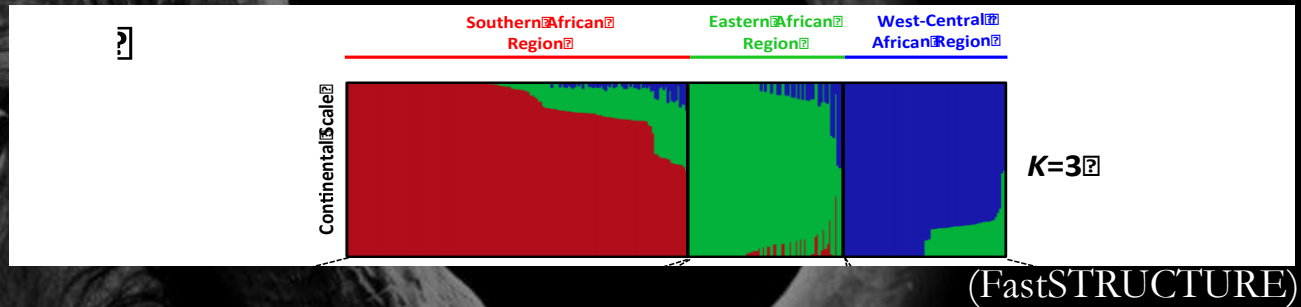
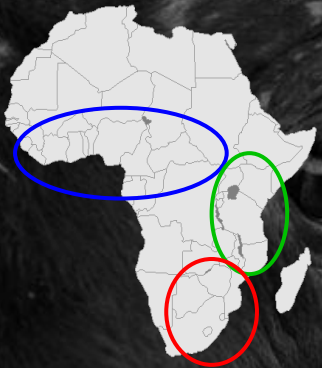
→ *S. c. brachyceros*

→ *S. c. aequinoctialis*

→ 42,643 Single Nucleotide
Polymorphism

CLUSTERING ANALYSES

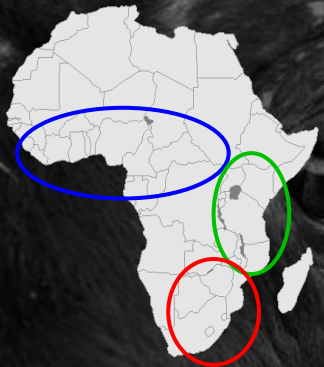
→ Three main identified populations



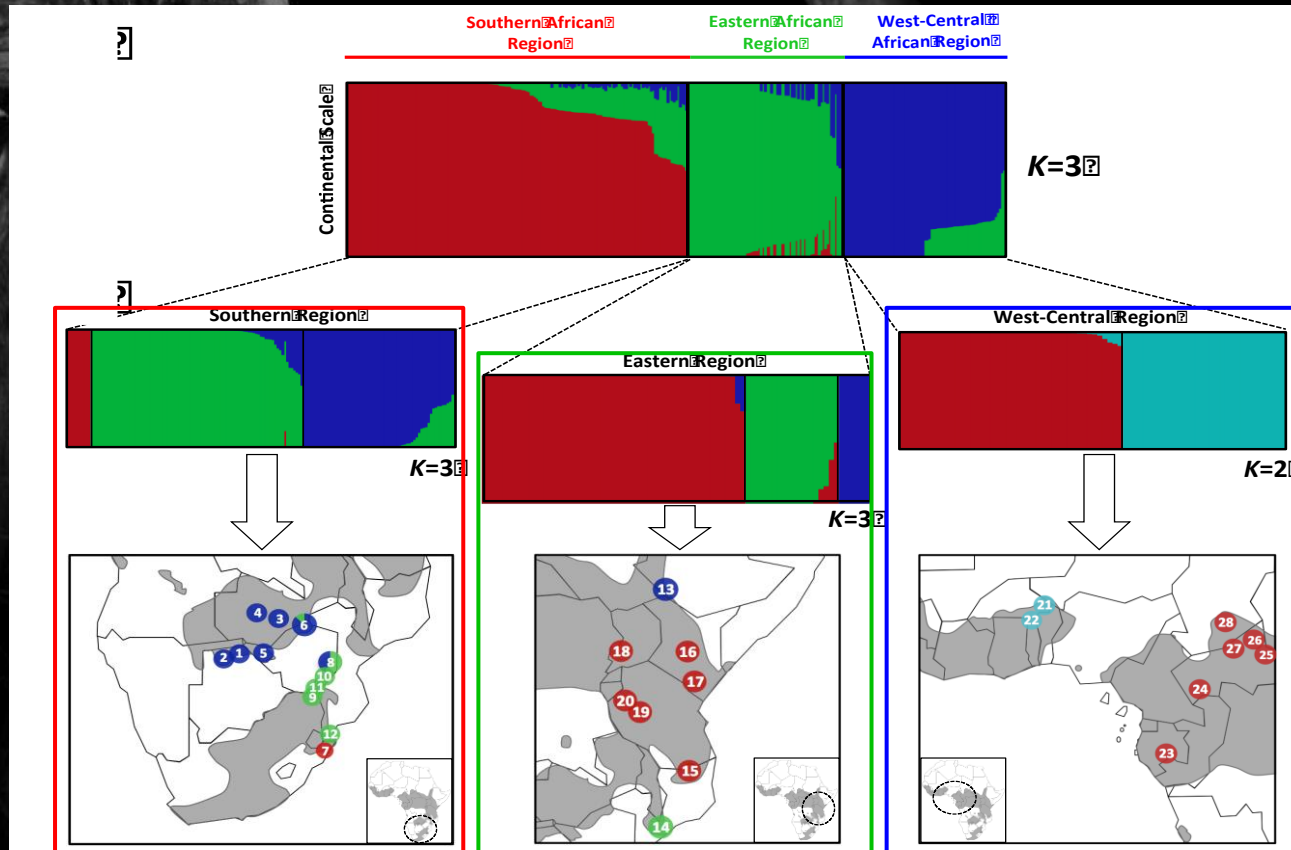
Mean F_{ST} between West-Central Pop
and South-Eastern Pop = 0.20

CLUSTERING ANALYSES

→ 8 identified subpopulations

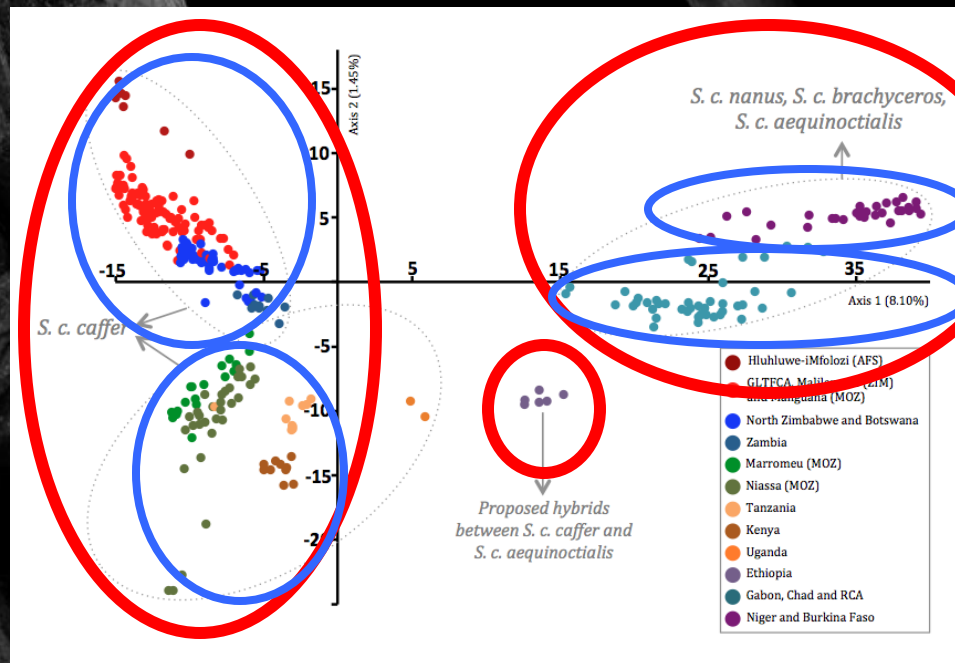


$$F_{CT} = 0.106$$



(FastSTRUCTURE)

CLUSTERING ANALYSES



Principal Component Analysis (Tassel)



Main conclusions

- Evidence of two main genetic lineages for the African Buffalo at the continental scale. Differentiation : 100 000 years ago.
- African buffalo would need of a taxonomic revision : two subspecies : *S. c. caffer* and *S. c. nanus*.
- Evidence of sub structures within each lineage : East/South and Central/West populations. Differentiation : 10 000 years ago

On the management point of view : avoid to mix animals from the different lineages to maintain their genetic identities and to avoid outbreeding depression risks (decrease of local adaptations).

The future of the African buffalo

- Considered as at “least concern” by the IUCN.
- Good levels of genetic diversity on the studied populations.
- However, more than 3 millions animals in the 19th.
Today, N : ~ 500 000 individuals.
- 75 % of the global population located within protected area.
- Fragmented populations : risks of genetic drifts and long term decrease of genetic diversity.



The future of the African buffalo

→ We preconize the re-establishment of ancestral connectivity between populations of the same genetic lineages through dispersal corridor and/or translocation

BUT Africa has the world's highest projected growth rates of human population and livestock production

Aknowledgements



M. Bourgarel

M. Melletti

F. Jori

A. Caron

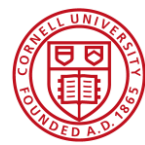
P. Chardonnet M. de Garine-

K. Kanapeckas C. Lopes

D.



And all the other!

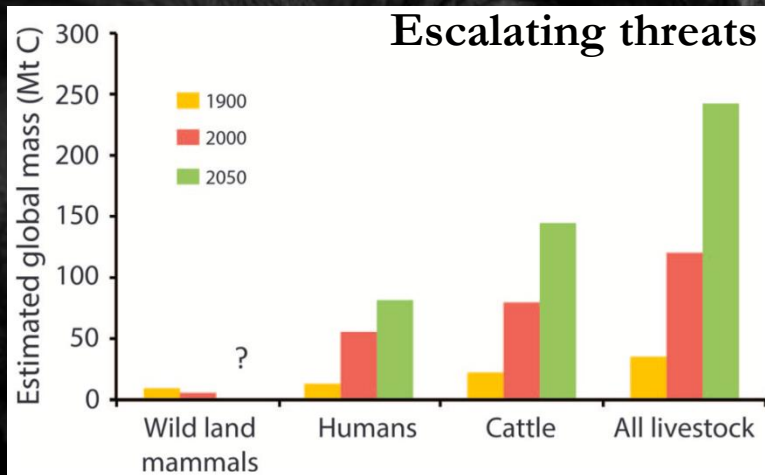


POPULATION MANAGEMENT

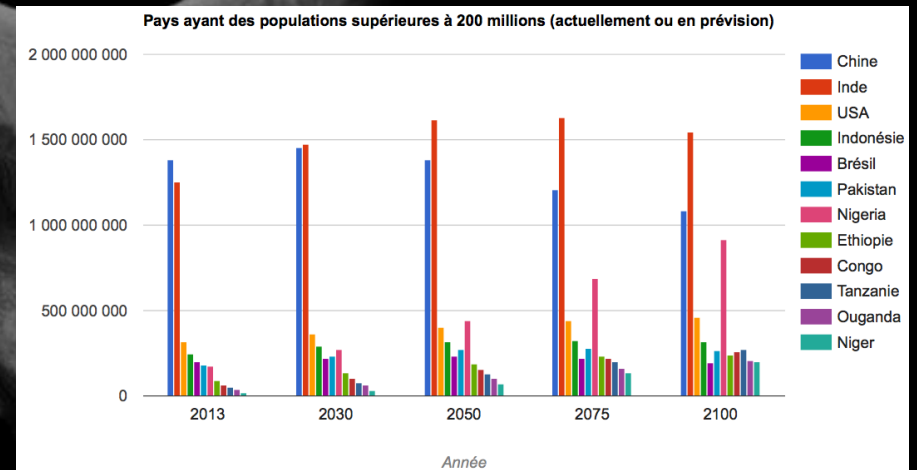
Currently, Africa:

- Has the most diversified mega-herbivore community
- Has the lowest endangerment rates

BUT: Has also the world's highest projected growth rates of human population and livestock production



Ripple *et al.* 2015



Source: worldometers

“In wildness is the preservation of the world...”

Henry David Thoreau

Thank you for your attention!

AFRICAN BUFFALO



S. c. nanus

Size : 1,8-2,2m

High : 1-1,3m

Weight : 256-320kg

Dress : orange

Central African rainforest



S. c. brachyceros

Size : 2,4m

High : 1,5m

Weight : 500-700kg

Dress : orange-brown

West African savanna



S. c. caffer

Size : 2,4-3,4m

High : 1,4-1,6m

Weight : 500-700kg

Dress : black to brown

East-South African savanna



S. c. aequinoctialis

Size : 2m

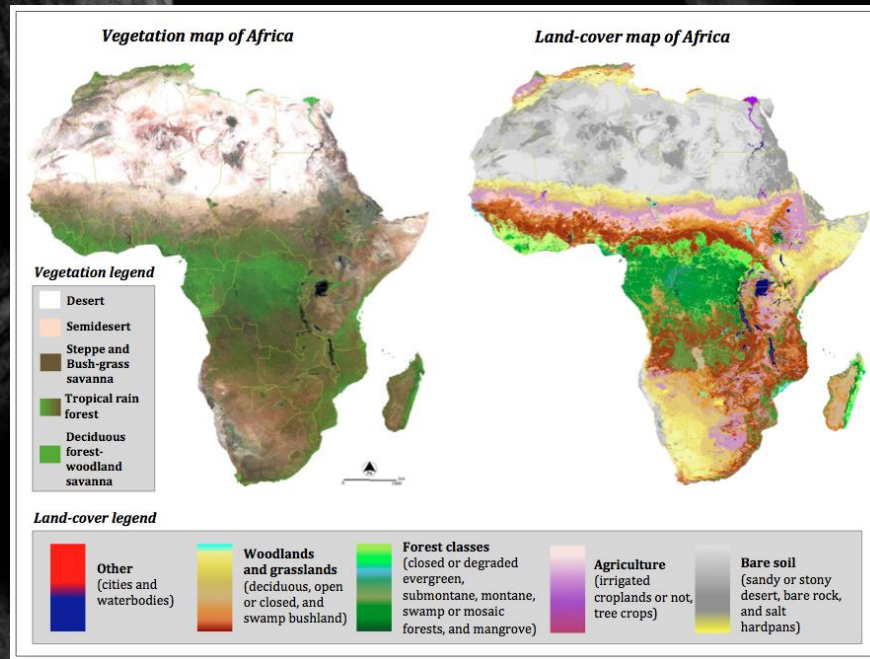
High : 1,4m

Weight : 750kg

Dress : dark brown

Central African savanna

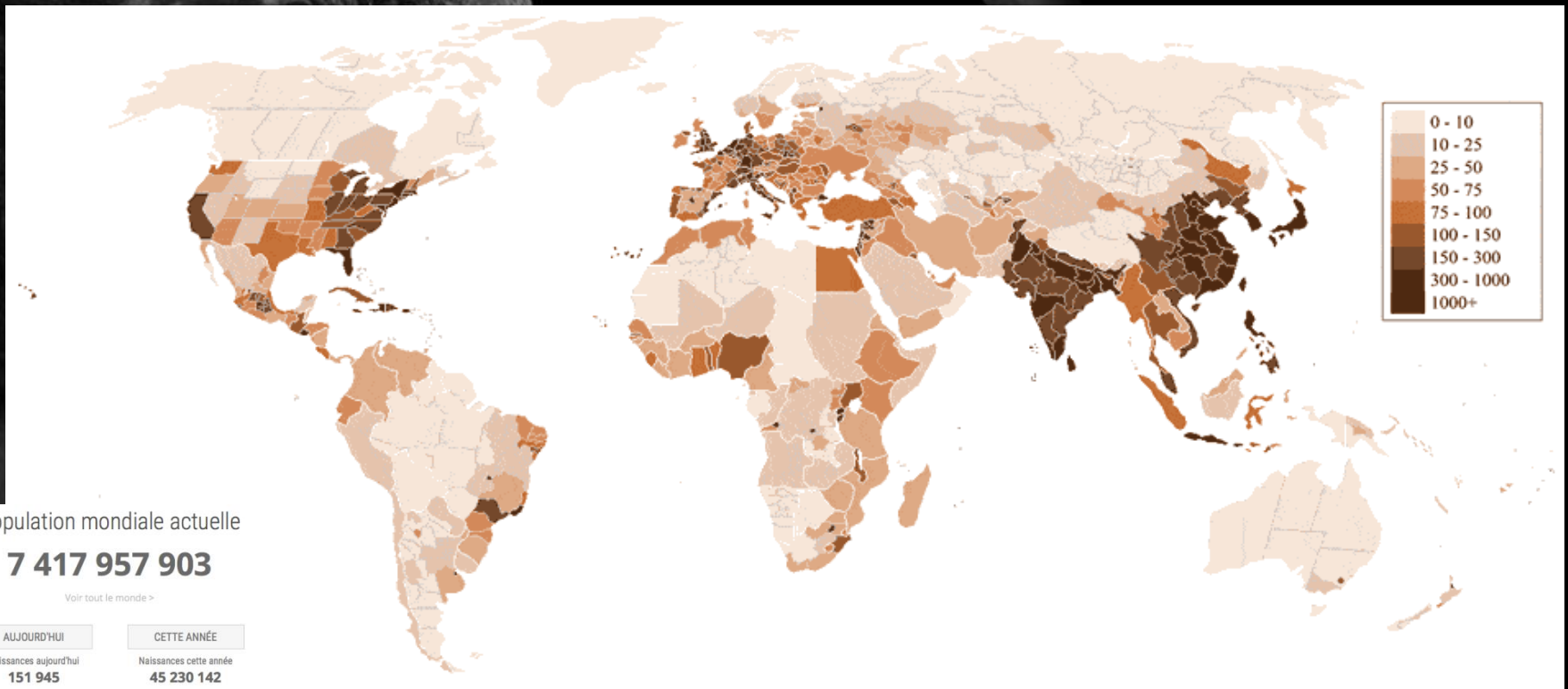
LAND-COVER OF AFRICA



P. Mayaux *et al.* 2004

HUMAN POPULATION DENSITY

Human population density (hab/km²)



Population mondiale actuelle

7 417 957 903

[Voir tout le monde >](#)

AUJOURD'HUI

Naissances aujourd'hui
151 945

CETTE ANNÉE

Naissances cette année
45 230 142

Décès aujourd'hui
63 630

Décès cette année
18 941 149

Croissance aujourd'hui
88 315

Croissance cette année
26 288 993

Source: Junuux at en.wikipedia