

“Confounded variation”? Assessing the impact of intra-specific morphological variability on inter-species comparisons: a case study using petrous bones of extant and extinct suids (Mammalia, Artiodactyla)

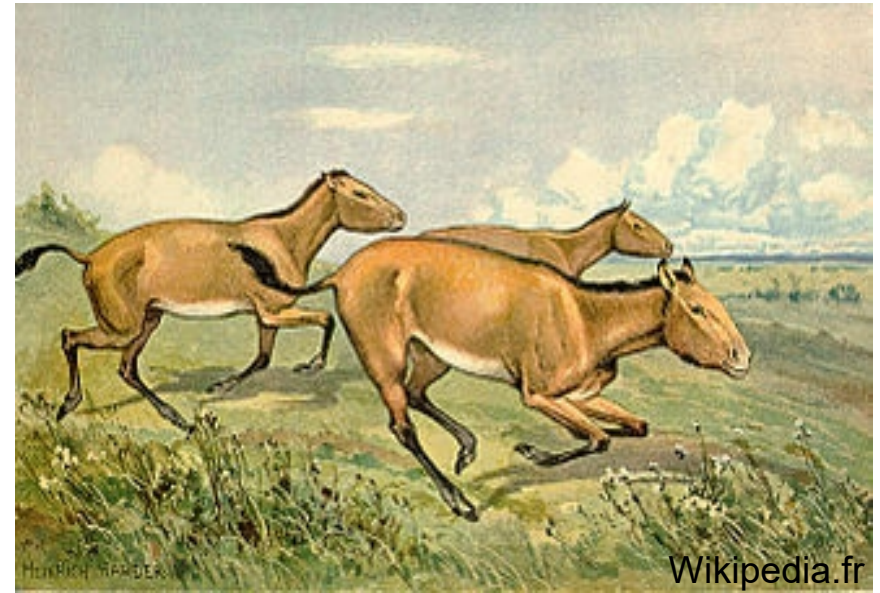
*Baltazart K., Santos F.,
Souron A., Guadelli J.-L.*



Geographic context



Location of the Ahl al Oughlam site

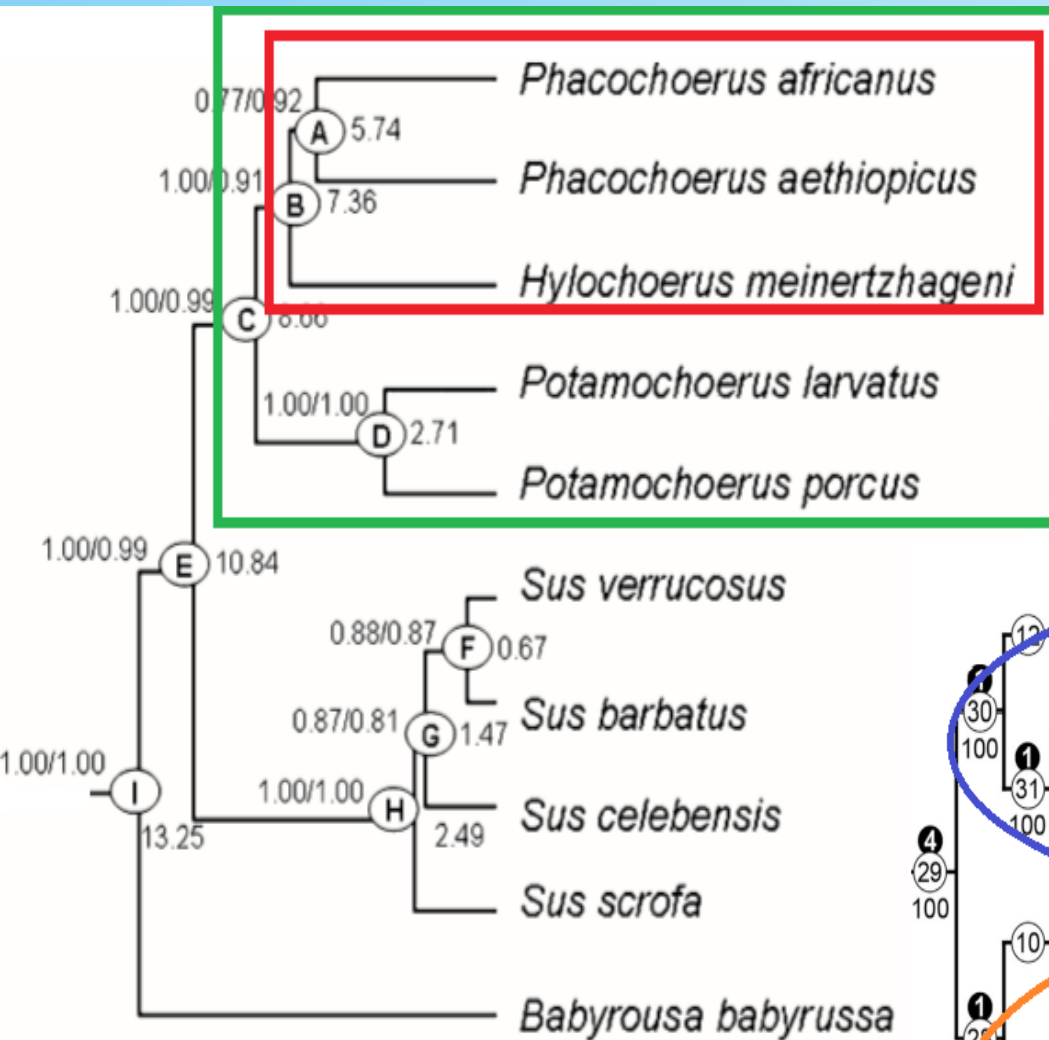


Artist view of genus *Hipparion*



Cranium belonging to the species
« *Kolpochoerus* » *phacochoeroides*.
Photo: Souron

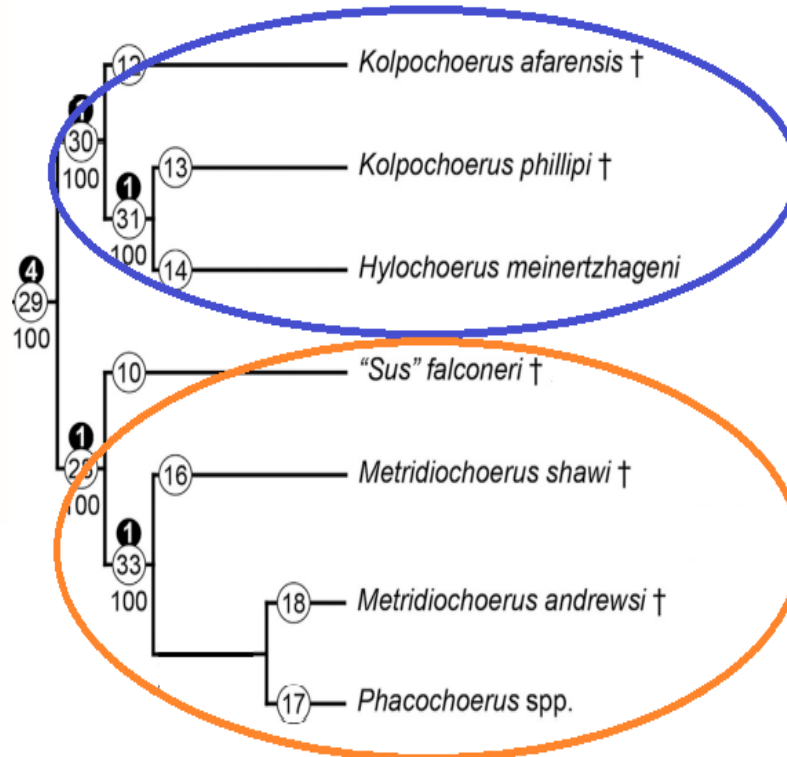
Phylogenetic context



Hylochoerus/Phacochoerus clade

Clade of African Suinae

Molecular tree based on 8 nuclear genes and 9 mitochondrial genes (Gongora *et al.*, 2011)



Kolpochoerus clade
(Geraads, 1993, 2004)



Ahl al Oughlam Suidae ?



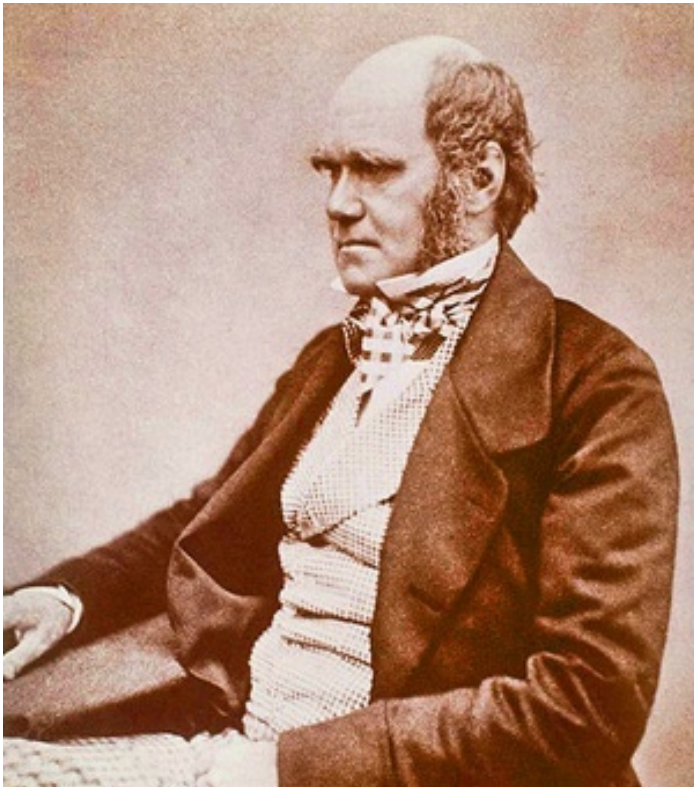
Metridiochoerus clade
(Souron, 2012, 2015 ;
Cherin *et al.*, 2018)

Clades within the African Suinae (modified after Cherin *et al.*, 2018)

Disentangle variability... A very old problem

« *Systematic work would be easy
were it not for this confounded variation* »

Darwin, 1849 (letter to Hooker)



Barnacles



Material



Sus scrofa



Babyrousa babyrussa



Sus domesticus



Microstonyx erymanthius



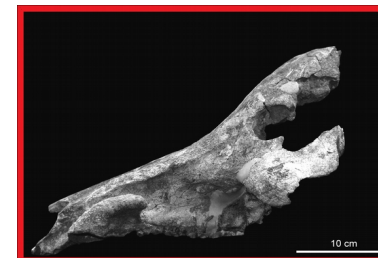
Hylchoerus meinertzhageni



Phacochoerus africanus



Potamochoerus porcus



Kolpochoerus phillipi

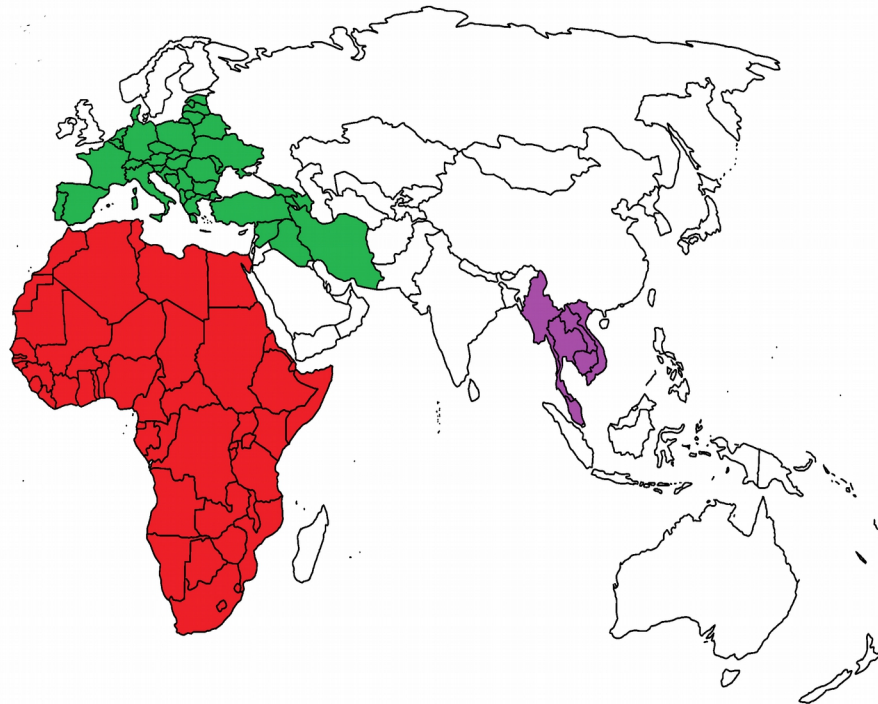


Ahl al Oughlam Suidae

Fossil species: *Kolpochoerus phillipi*, Ahl al Oughlam Suidae and *Microstonyx erymanthius*

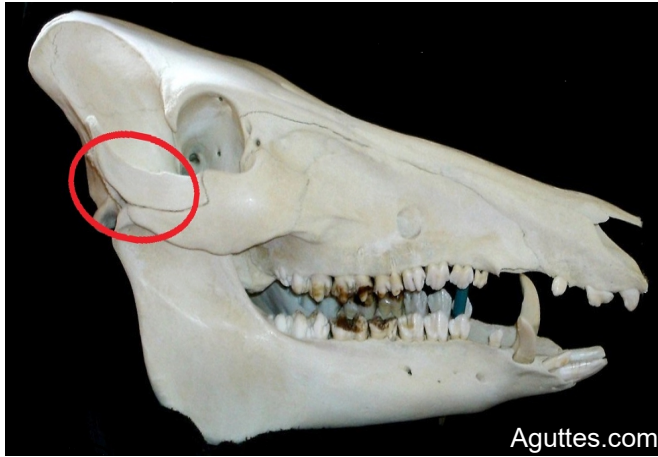
Total number of petrous bones: 72

Taxa represented by more than 20 individuals: *Sus scrofa* and Ahl al Oughlam Suidae

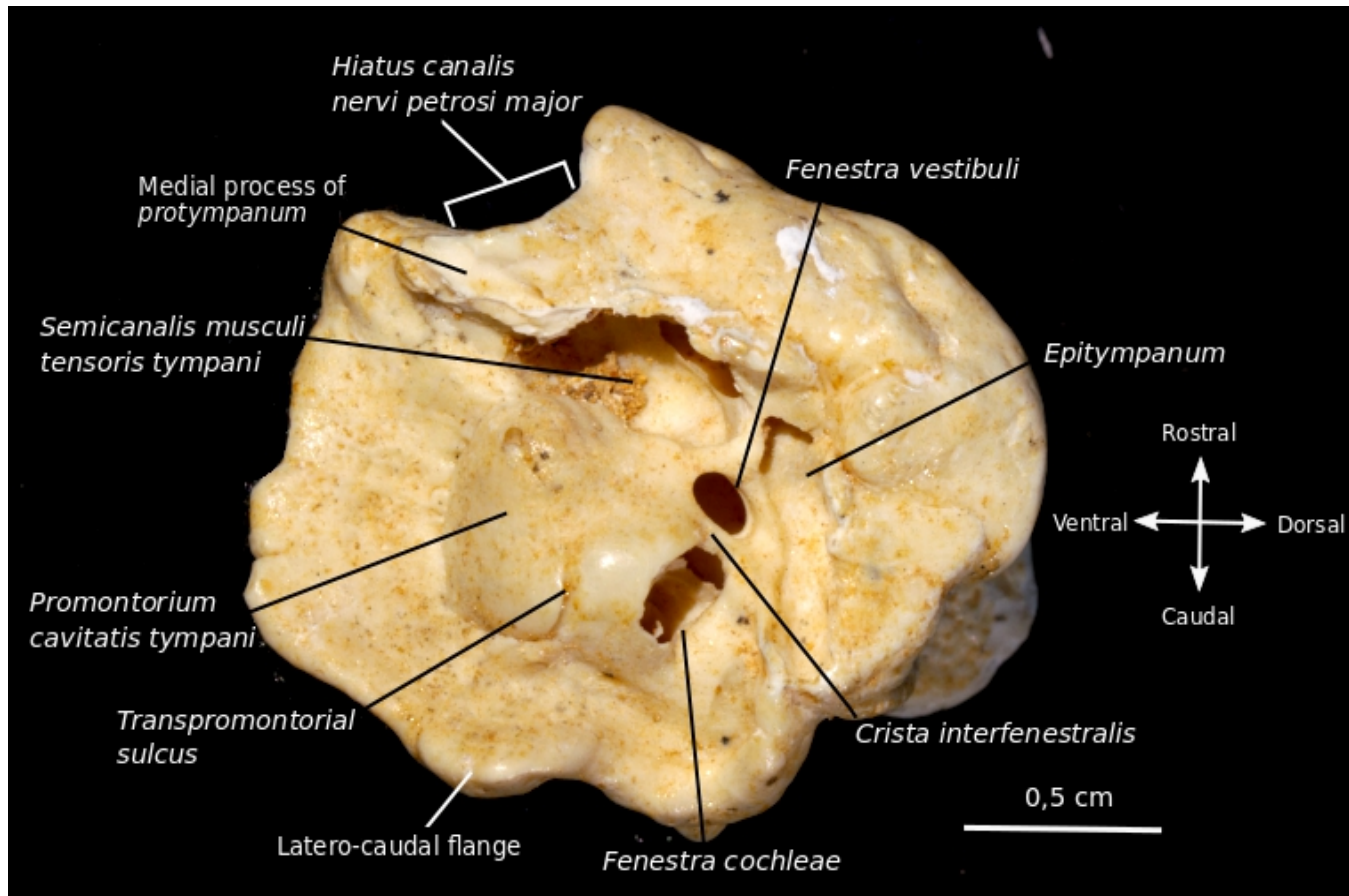
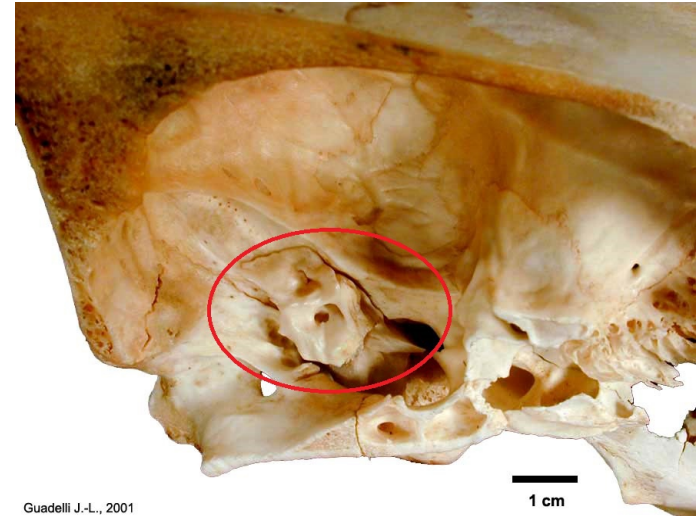


Geographical origin of taxa

Material



Petrous bone
in the skull
of a *Sus scrofa*

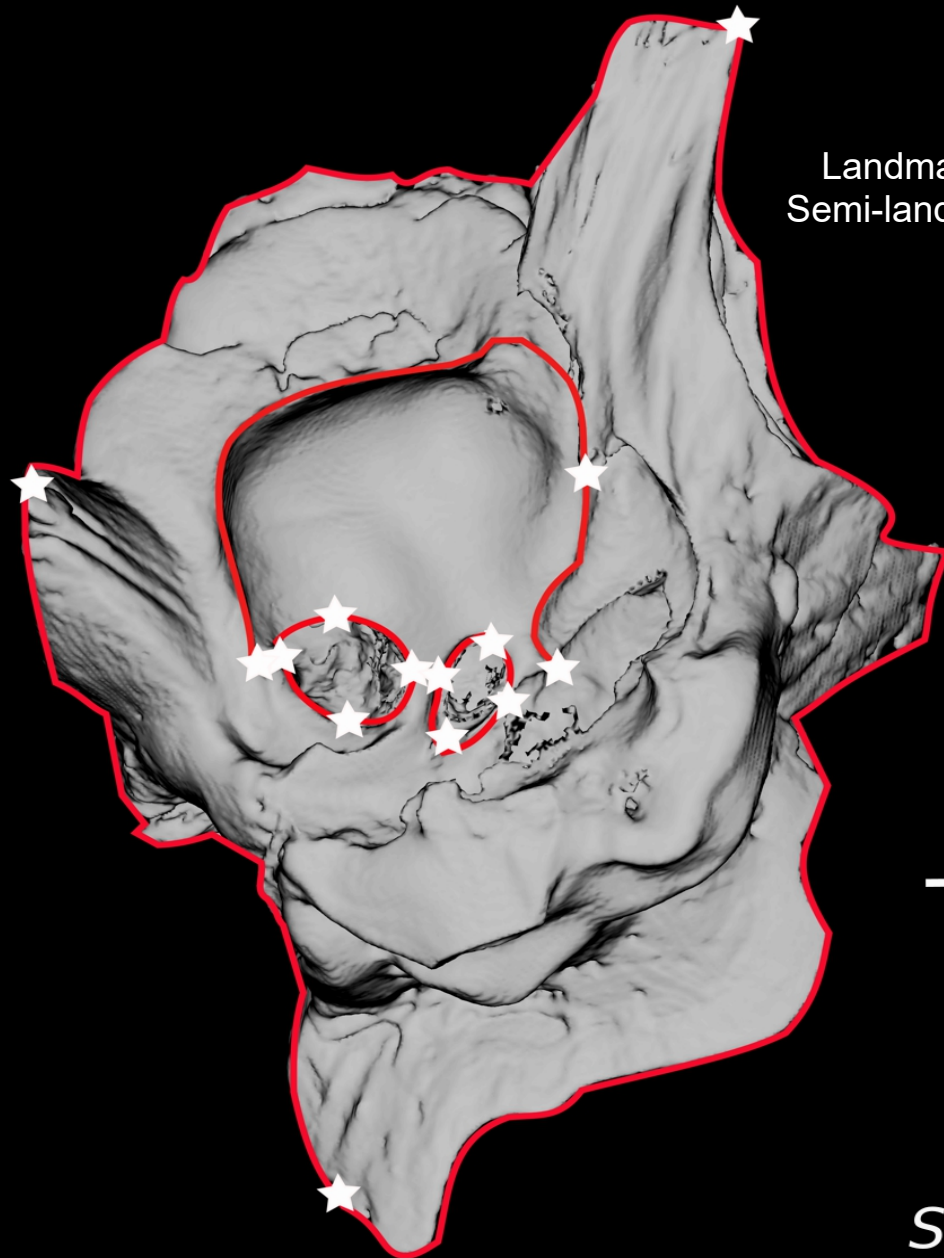


Petrous bone, site of hearing and balance in mammals

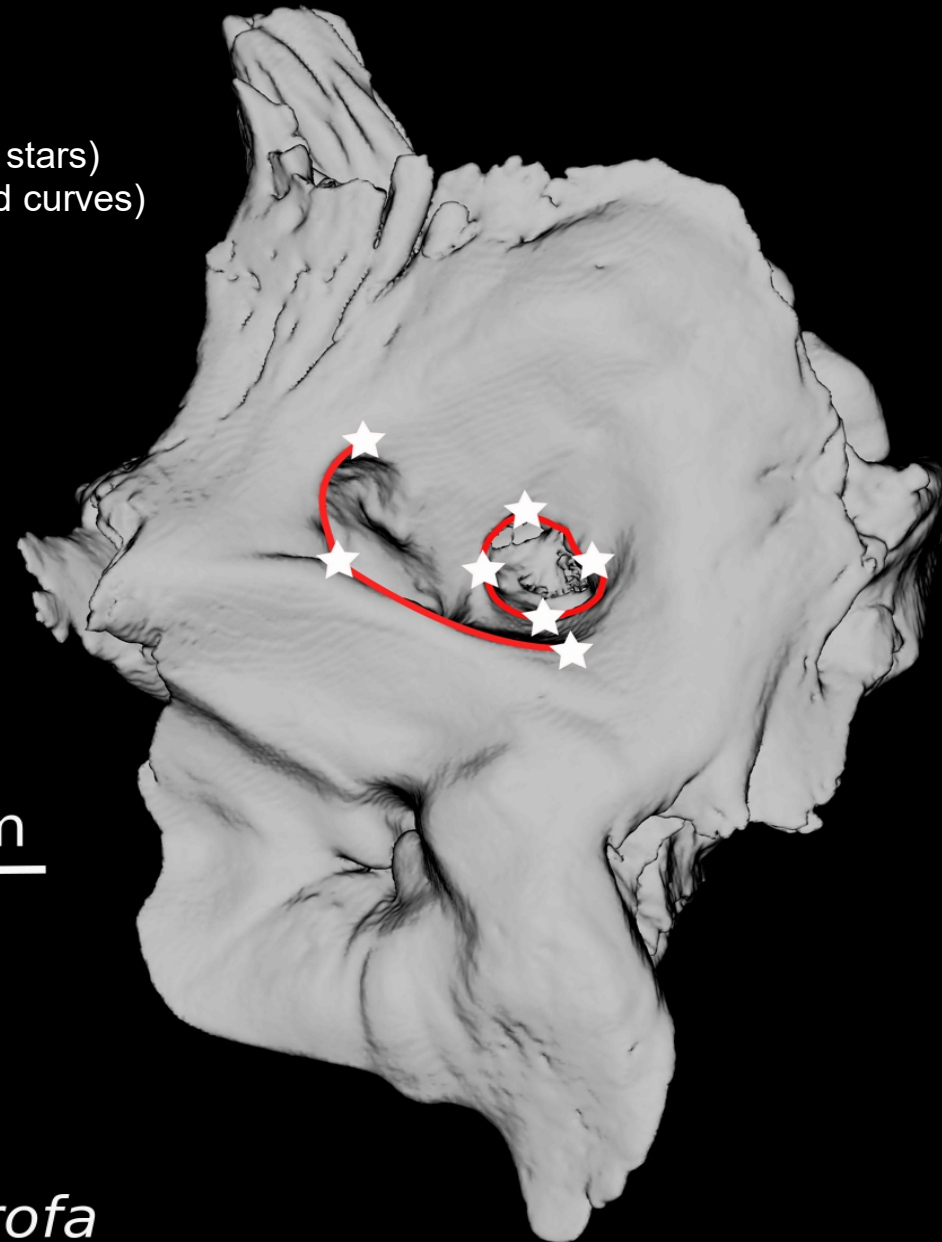
First step : to digitize landmarks

Lateral face

Medial face



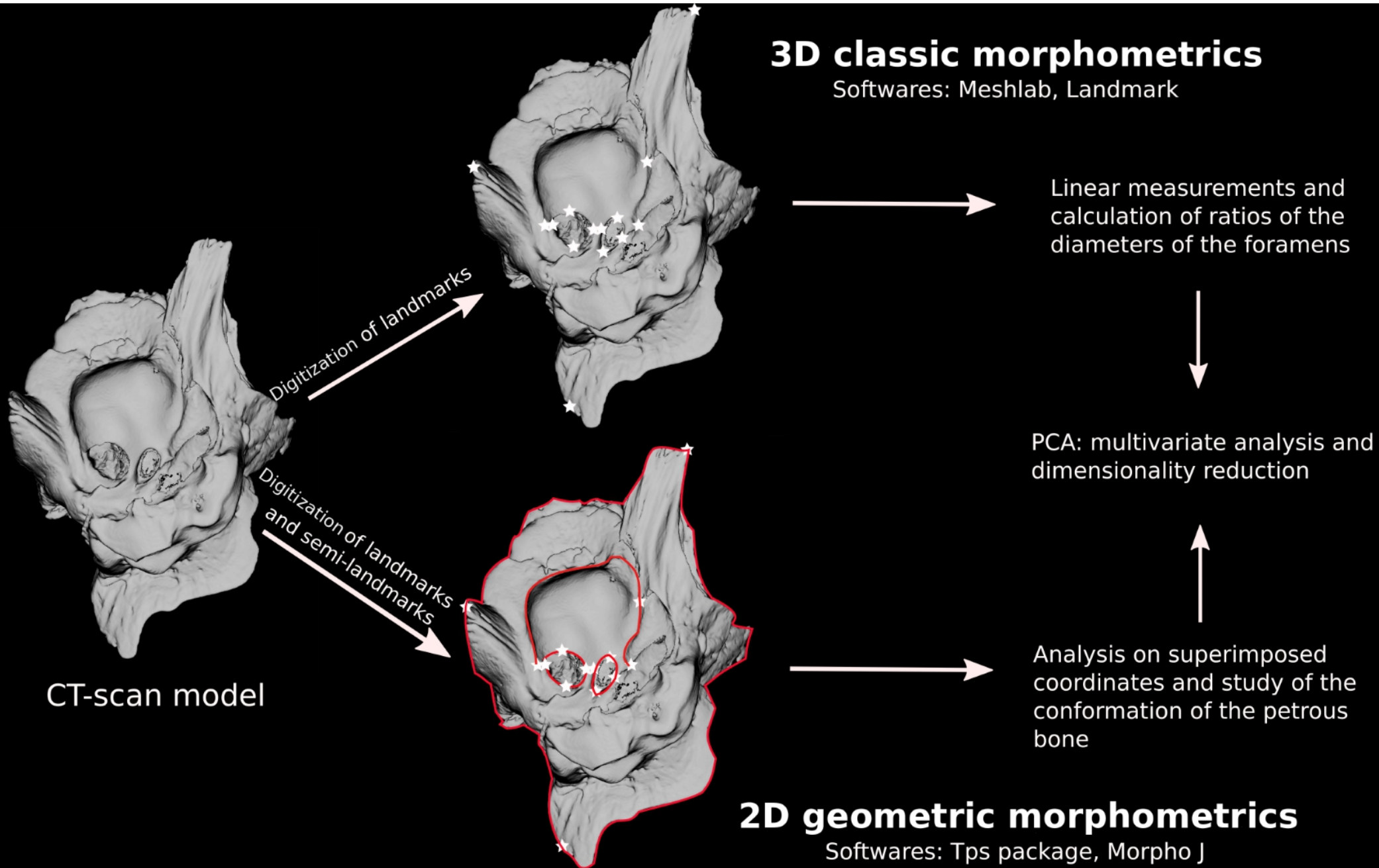
Landmarks (white stars)
Semi-landmarks (red curves)



0.5 cm

Sus scrofa

Second step : Principal component analysis (PCA)



Third step : Multivariate statistical analysis (MFA)

- **MFA : 15 variables of PC scores including :**
 - The five main axes of PCA outline



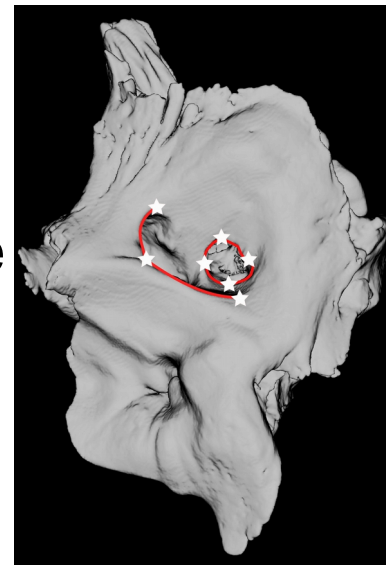
Third step : Multivariate statistical analysis (MFA)

- **MFA : 15 variables of PC scores including :**
 - The five main axes of PCA outline
 - The five main axes of PCA lateral face



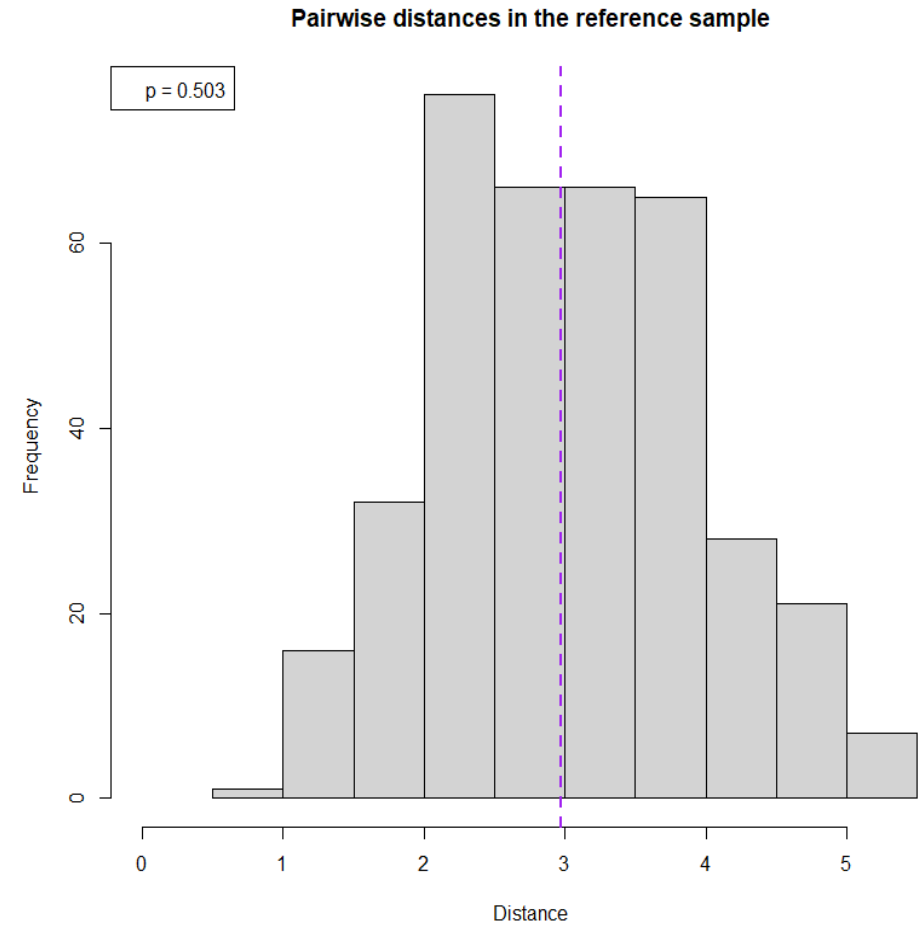
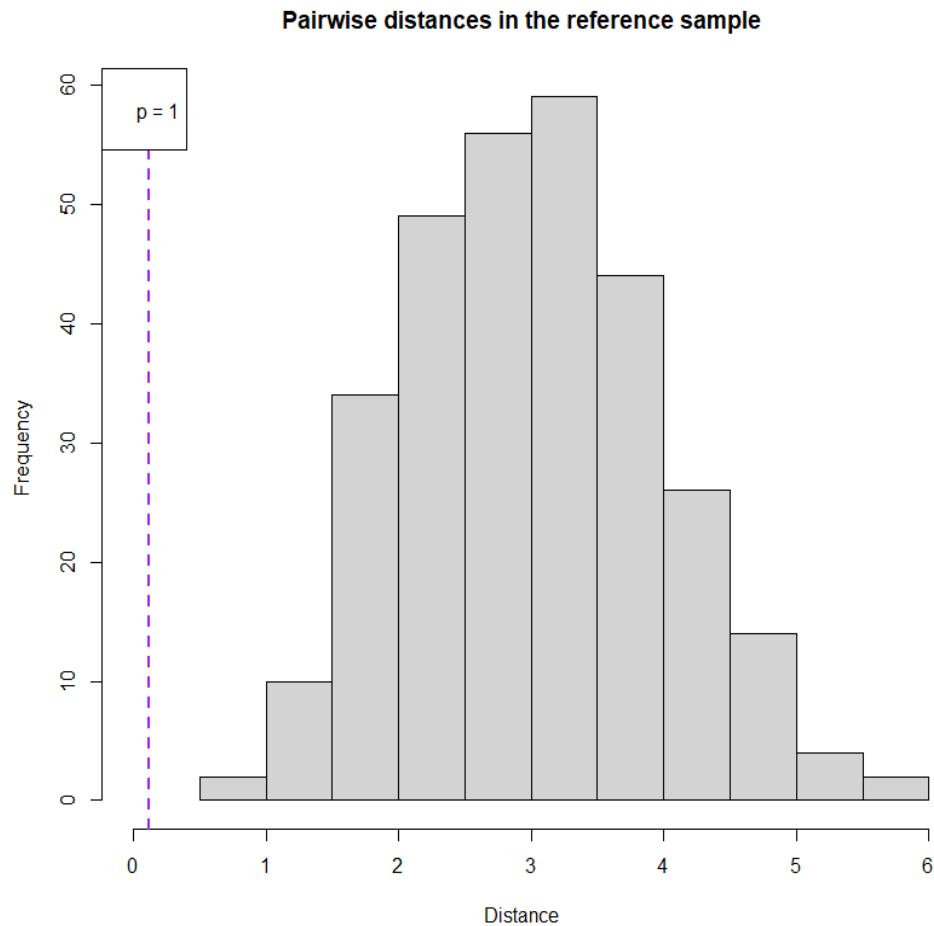
Third step : Multivariate statistical analysis (MFA)

- **MFA : 15 variables of PC scores including :**
 - The five main axes of PCA outline
 - The five main axes of PCA lateral face
 - The five main axes of PCA medial face



Final step : Coding the comparison function

Baltazart et *al.*, in prep.



Mahalanobis distances usually observed between two *Sus scrofa* specimens on the AFM factorial plane (left) and on the outline data (right).

Comparison function : results

Baltazart et *al.*, in prep.

1) Study of intraspecific variability

Median p-values	Outline data	MFA factorial design data
<i>Sus scrofa</i>	0.51	0.5
Suidae from Ahl al Oughlam	0.34	0.38
<i>Sus domesticus</i>	0.02	0.16
<i>Potamochoerus porcus</i>	0.01	0.69

Median p-values obtained by comparing each pair of individuals of the same taxon with each other through the comparison function.

Comparison function : results

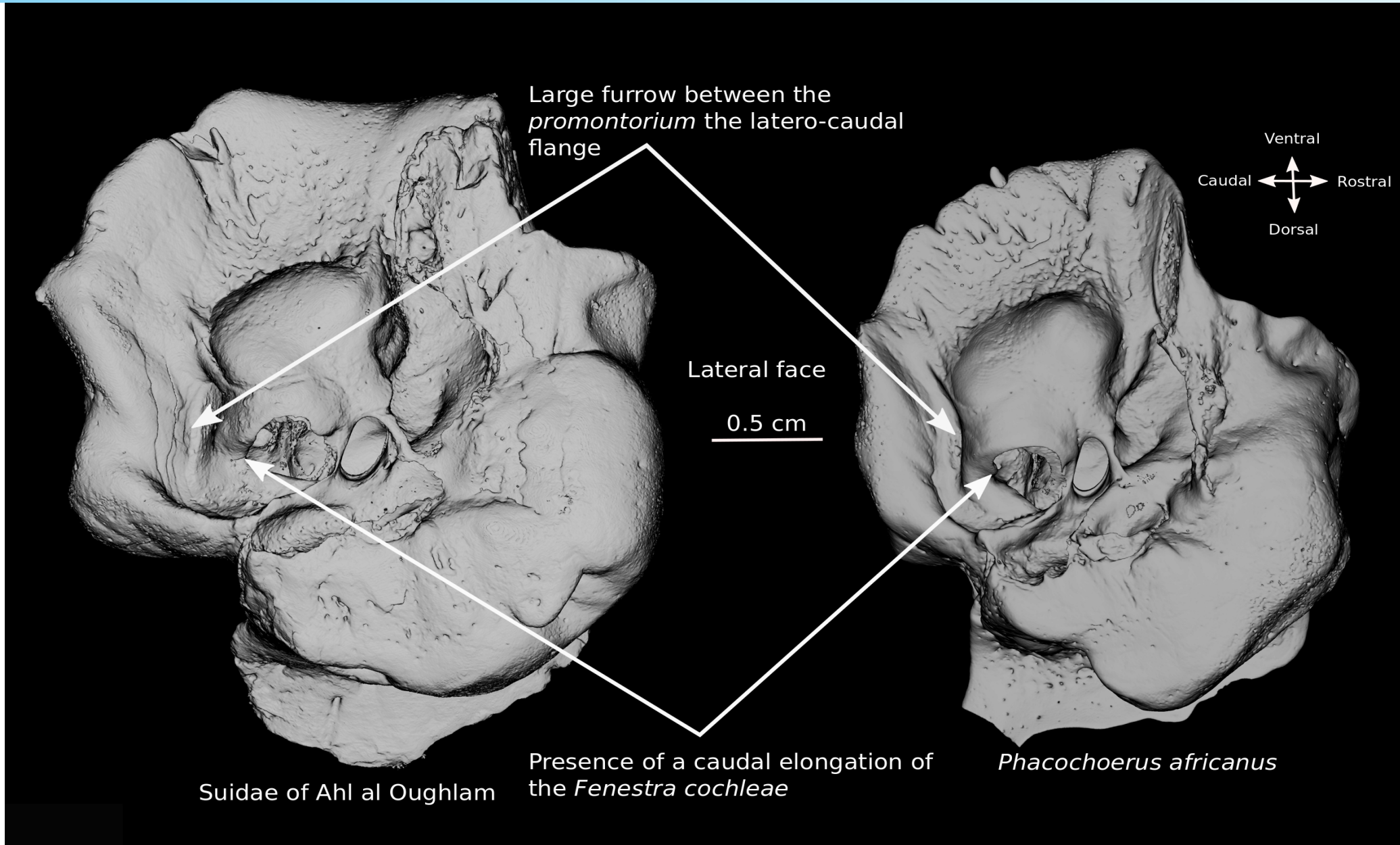
Baltazart et *al.*, in prep.

2) Study of interspecific variability

Median p-valueAaO	Outline data	MFA factorial design data
<i>Hylochoerus meinertzhageni</i>	0.06	0.05
<i>Phacochoerus africanus</i>	0.55	0.58
<i>Kolpochoerus phillipi</i>	0.22	/
<i>Potamochoerus porcus</i>	0	0

Median p-values obtained after comparison with each individual from the Ahl al Oughlam material with all individual taxa of the African taxa.

Comparative anatomy

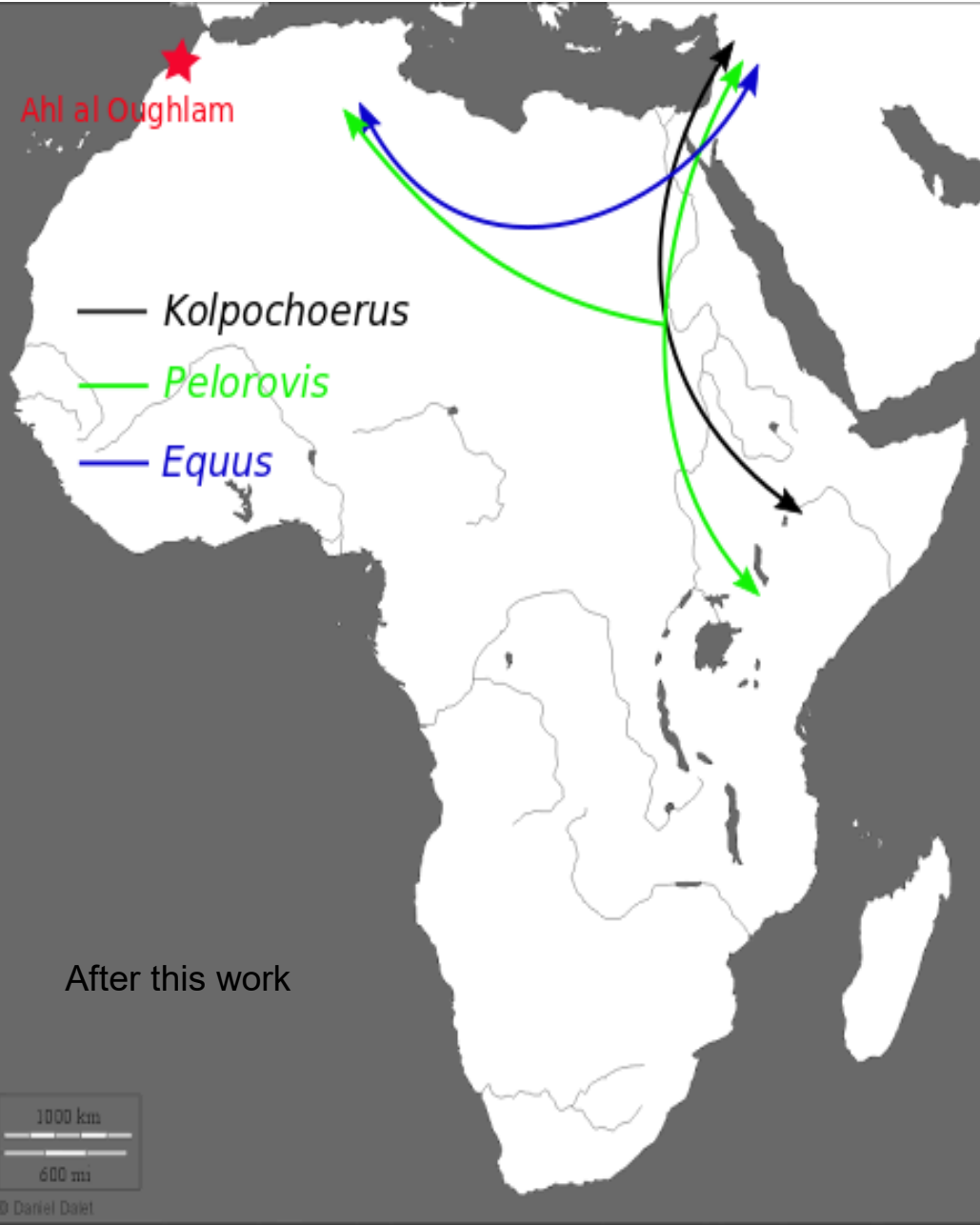
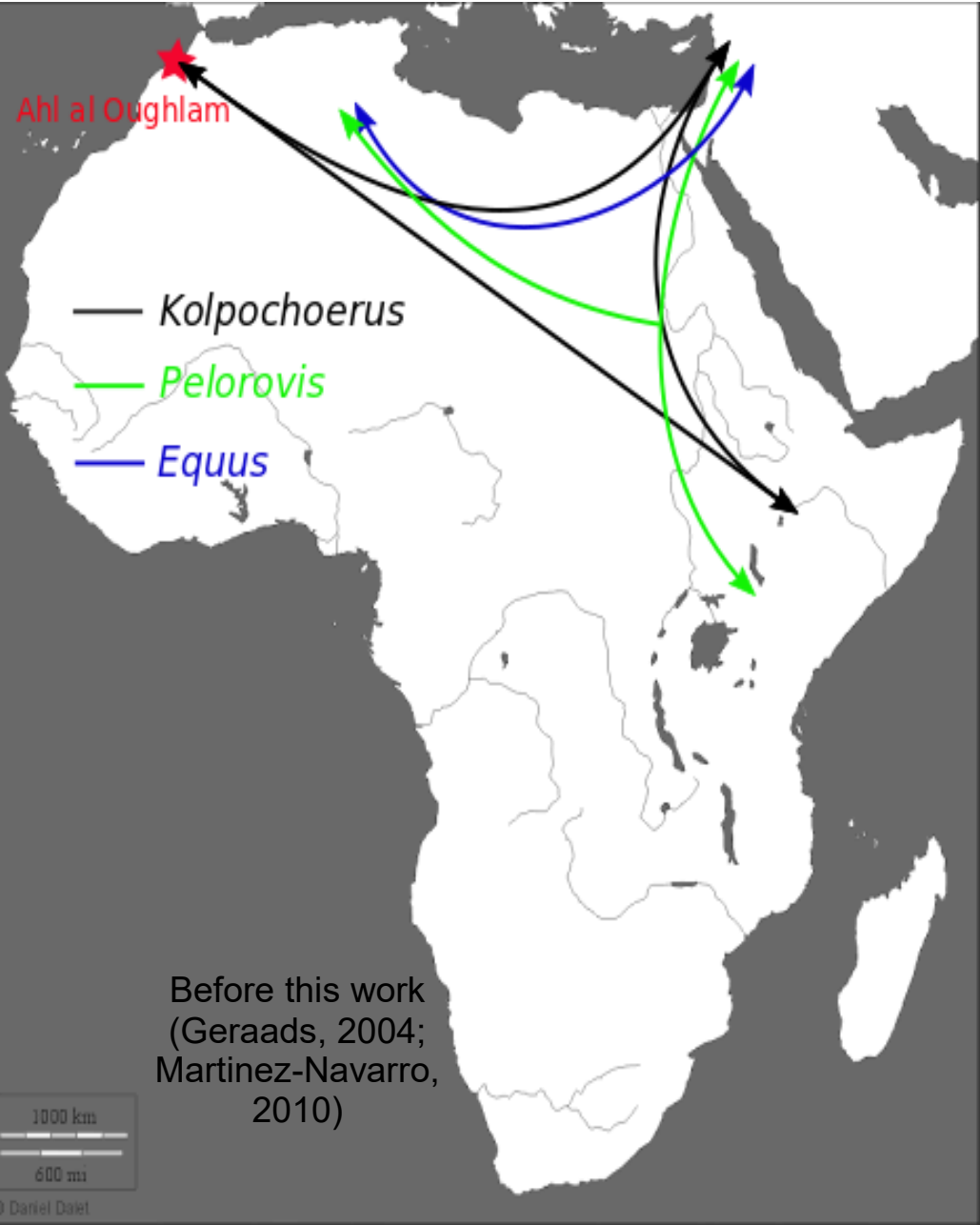


Morphological similarities between the extant *Phacochoerus* and the Suidae found at Ahl al Oughlam

Hypothesis 1: shared apomorphic characters?

Hypothesis 2: evolutive convergence?

Paleobiogeographic hypothesis



Before this work
(Geraads, 2004;
Martinez-Navarro,
2010)

After this work

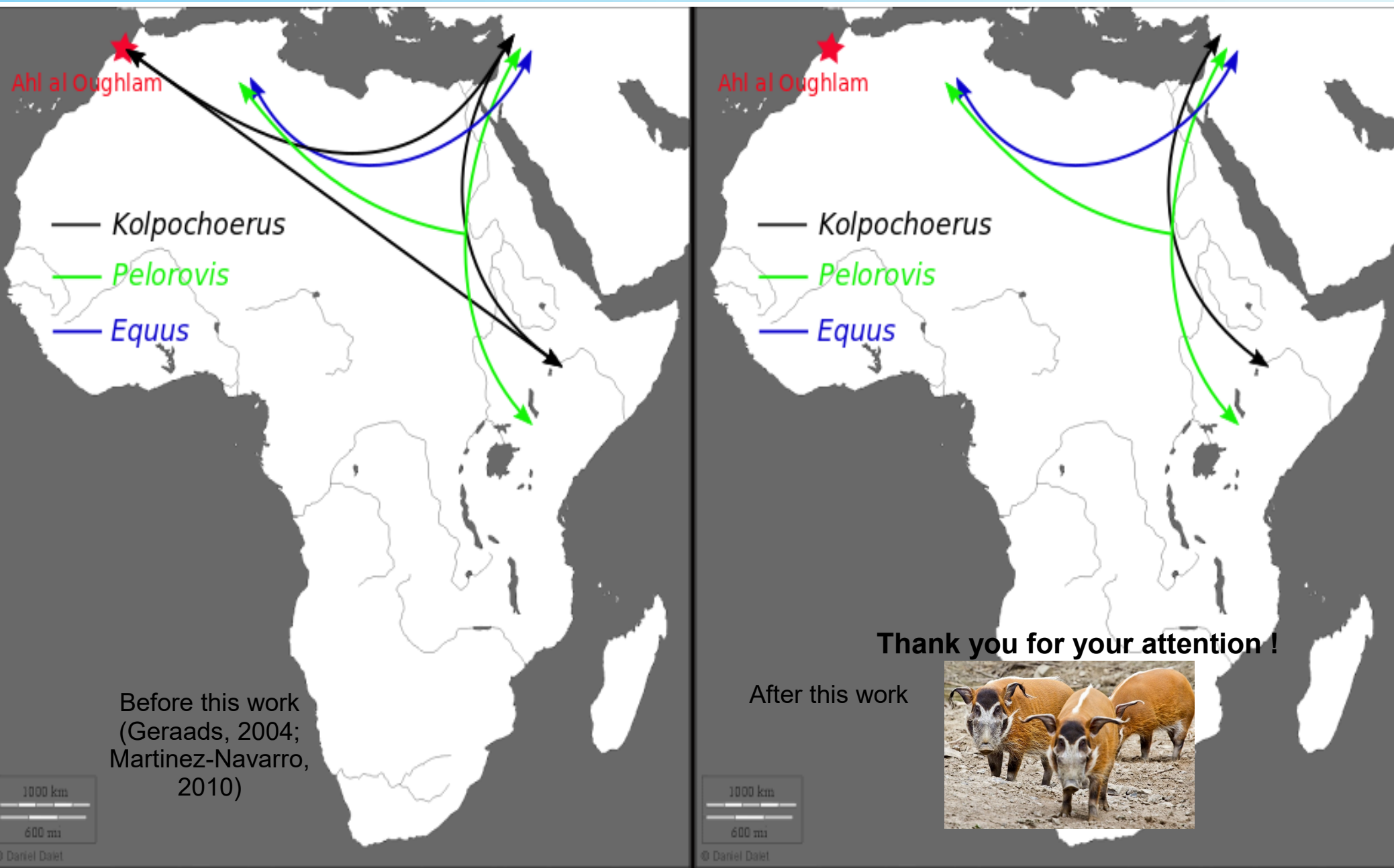
1000 km

600 mi

1000 km

600 mi

Paleobiogeographic hypothesis



Do you have any questions ? Are you looking for a PhD student ?

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