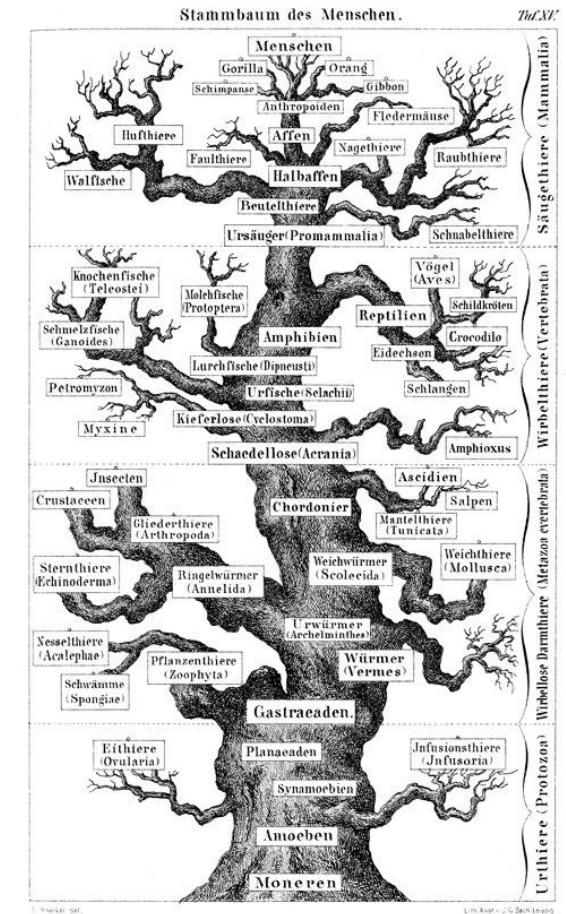
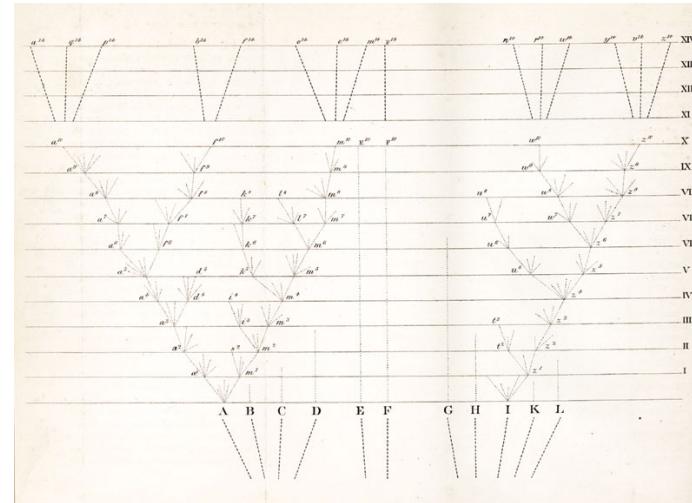
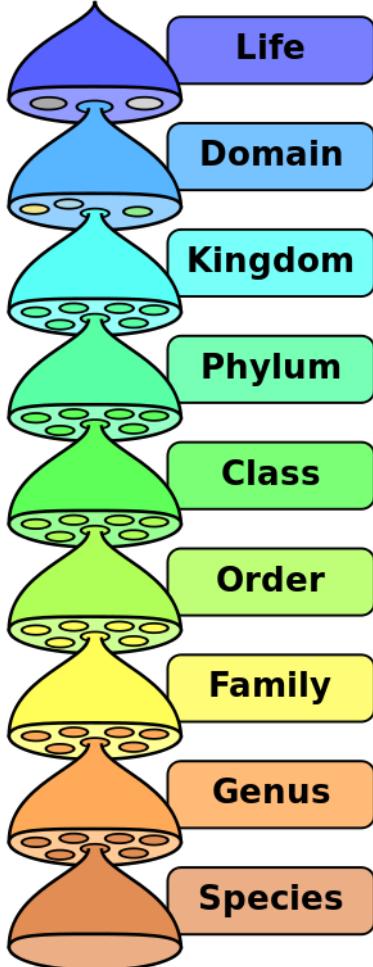


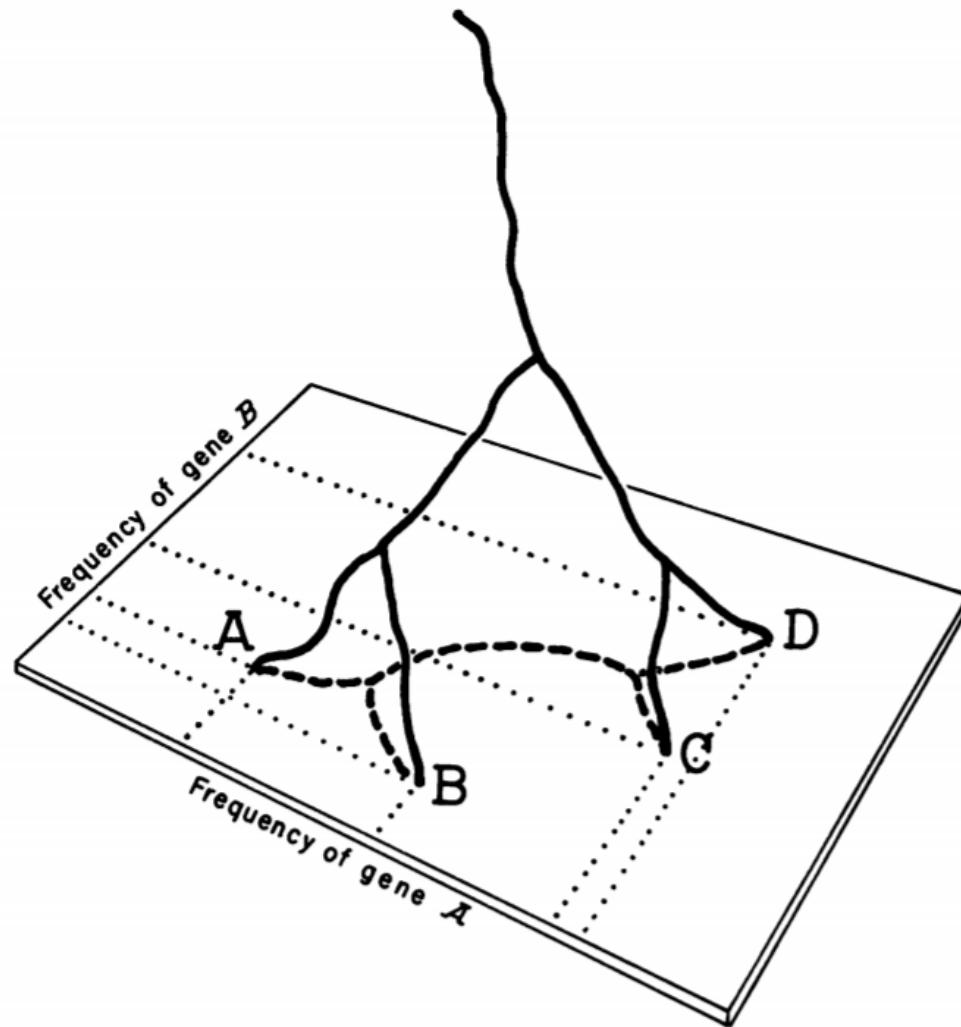
Trees, Admixture graphs and population structure

Using trees to describe (human) population structure

Trees are foundational to Systematics and Evolution



Where do trees come from?



But when does this model break?

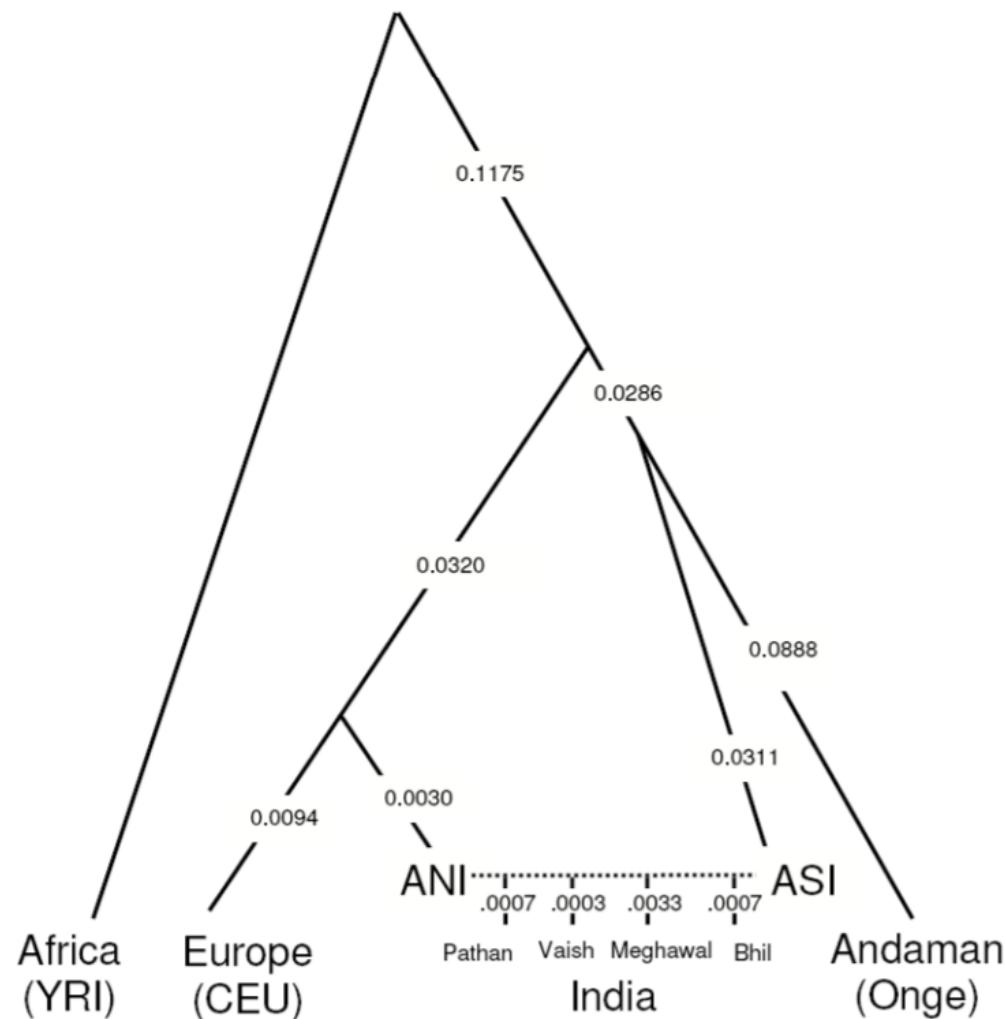
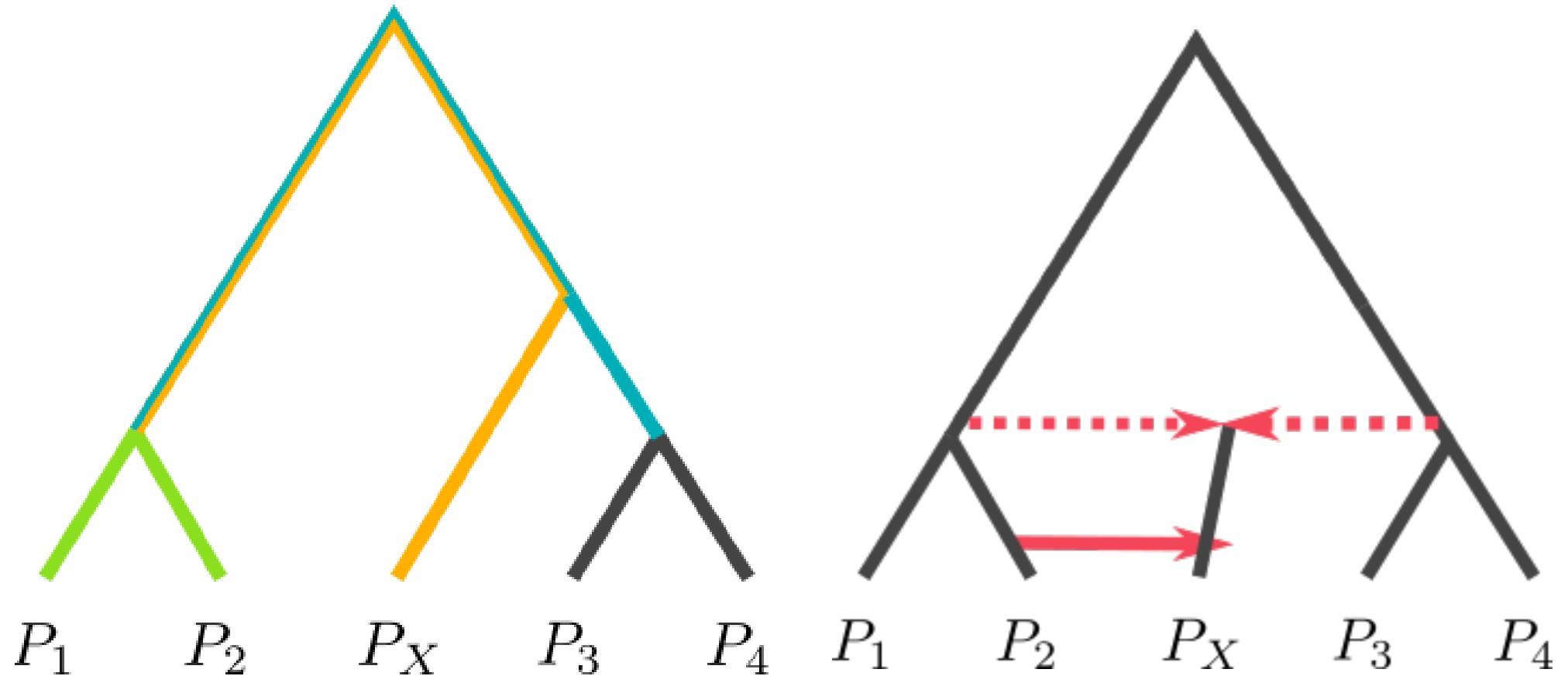


Figure 4.

A model relating the history of Indian and non-Indian groups. Modeling the Pathan, Vaish,

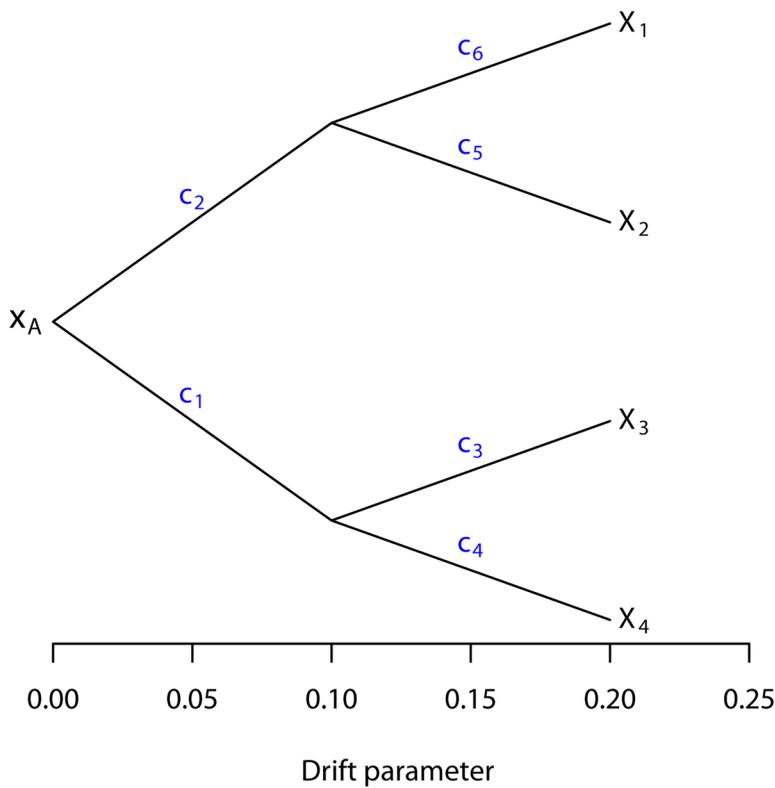
Trees and Admixture Graphs



Inference of Population Splits and Mixtures from Genome-Wide Allele Frequency Data

Joseph K. Pickrell^{1,*}, Jonathan K. Pritchard^{1,2,*}

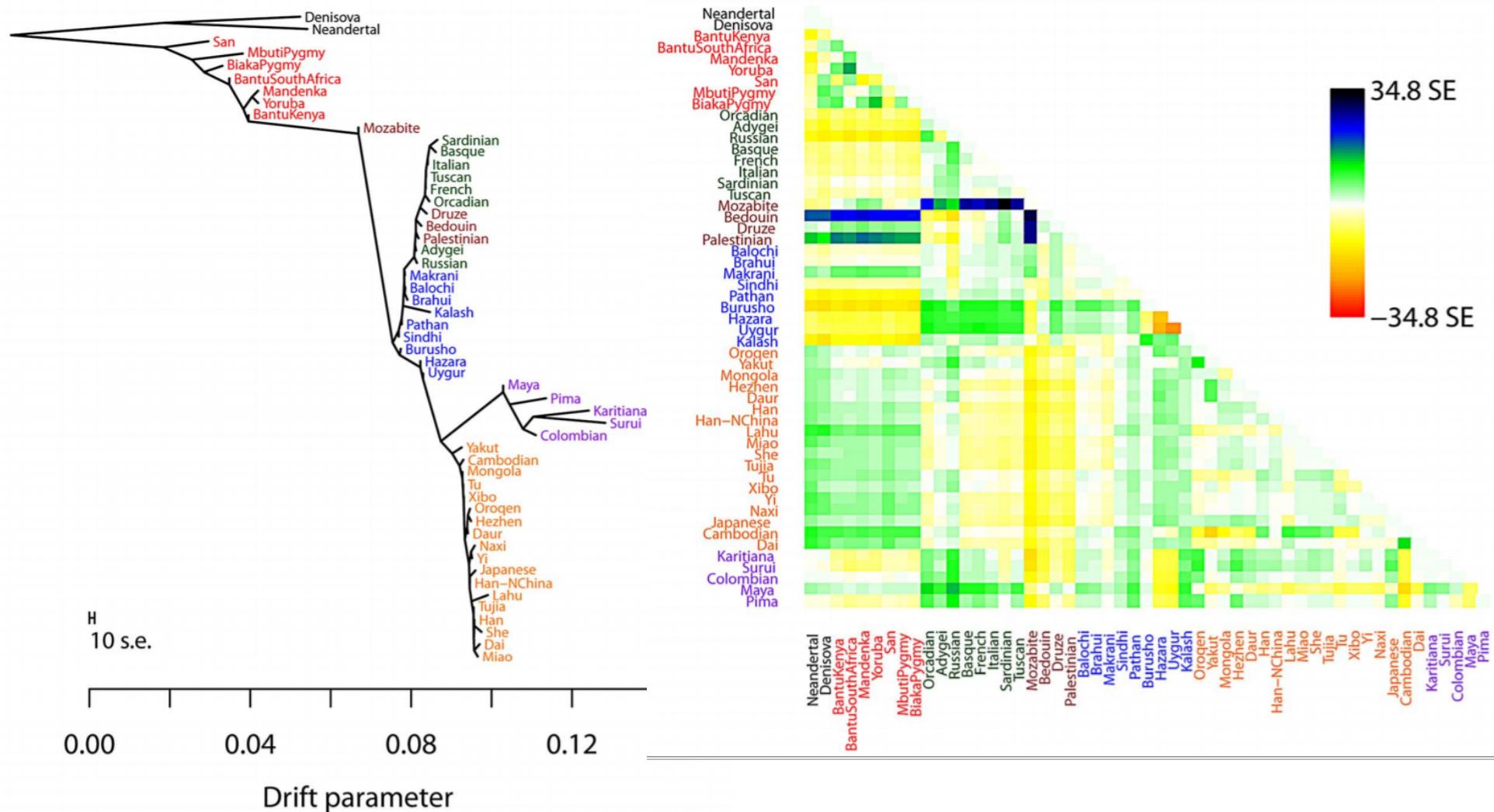
A. Example tree



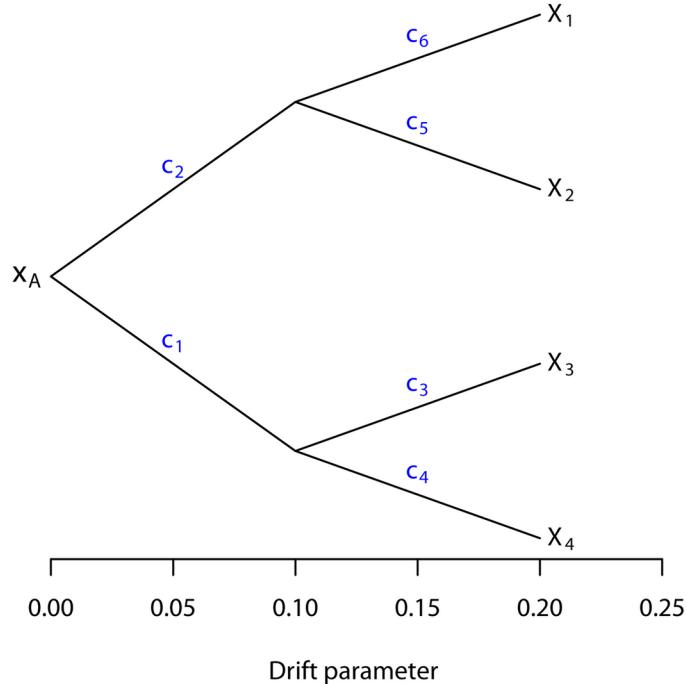
B. Covariance matrix for tree in A.

x_1	$c_2 + c_6$	c_2	0	0
x_2	c_2	$c_2 + c_5$	0	0
x_3	0	0	$c_1 + c_3$	c_1
x_4	0	0	c_1	$c_1 + c_4$

Inference of Population Splits and Mixtures from Genome-Wide Allele Frequency Data



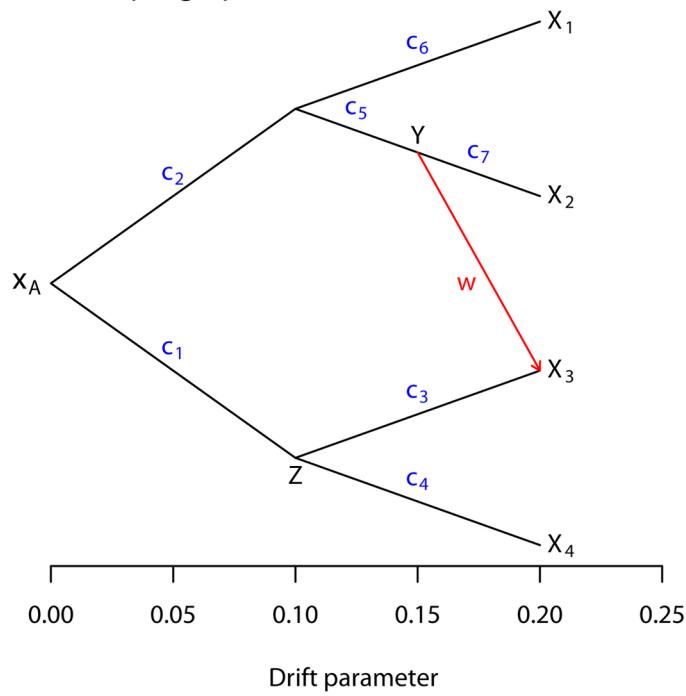
A. Example tree



B. Covariance matrix for tree in A.

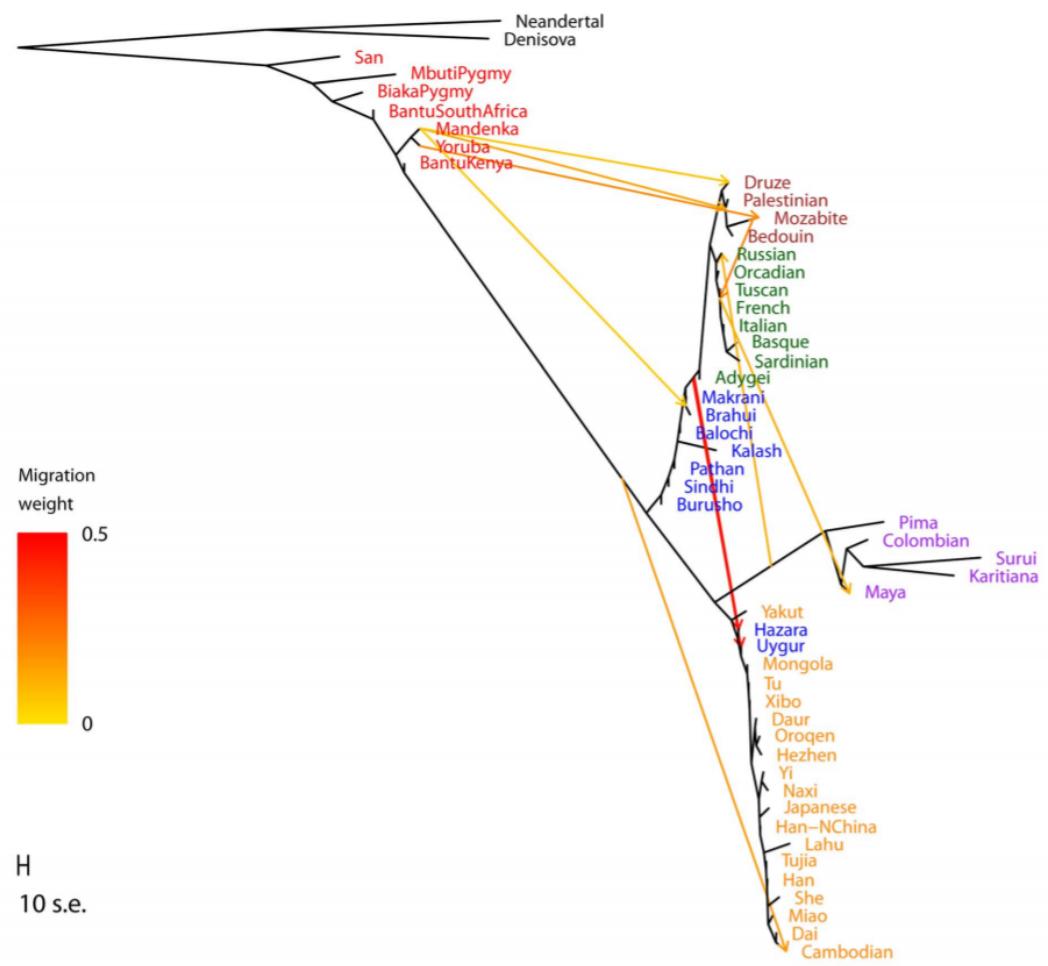
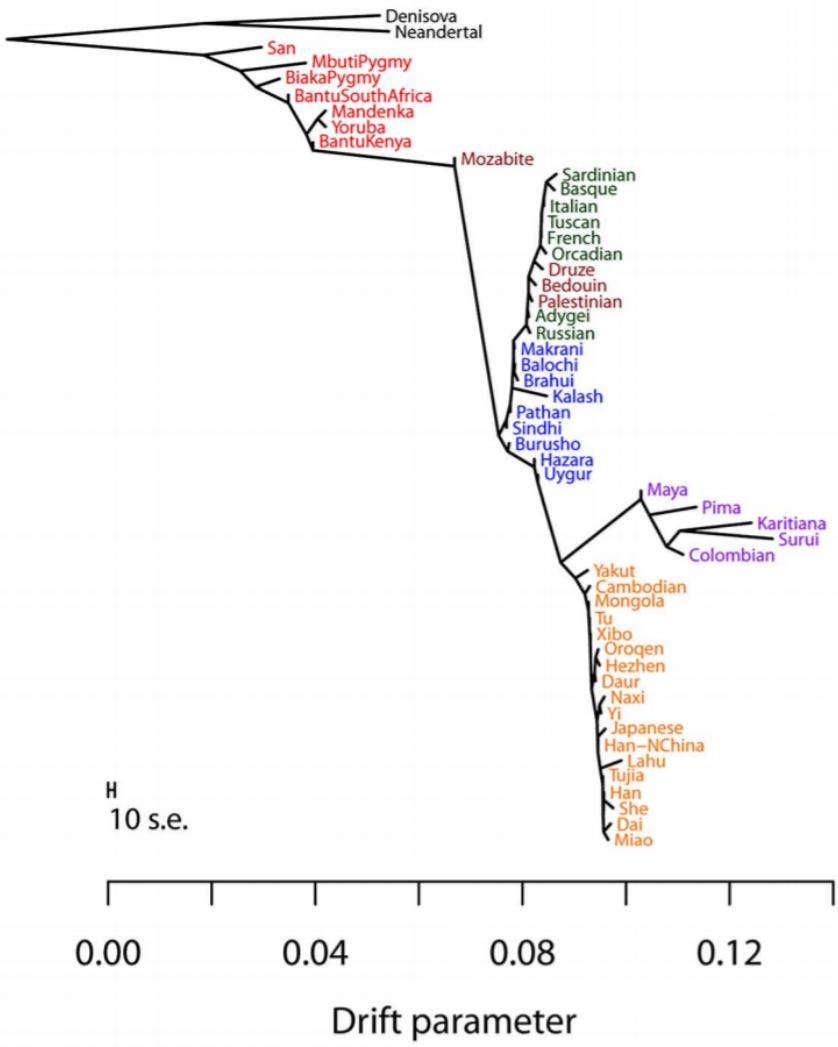
X_1	$c_2 + c_6$	c_2	0	0
X_2	c_2	$c_2 + c_5$	0	0
X_3	0	0	$c_1 + c_3$	c_1
X_4	0	0	c_1	$c_1 + c_4$

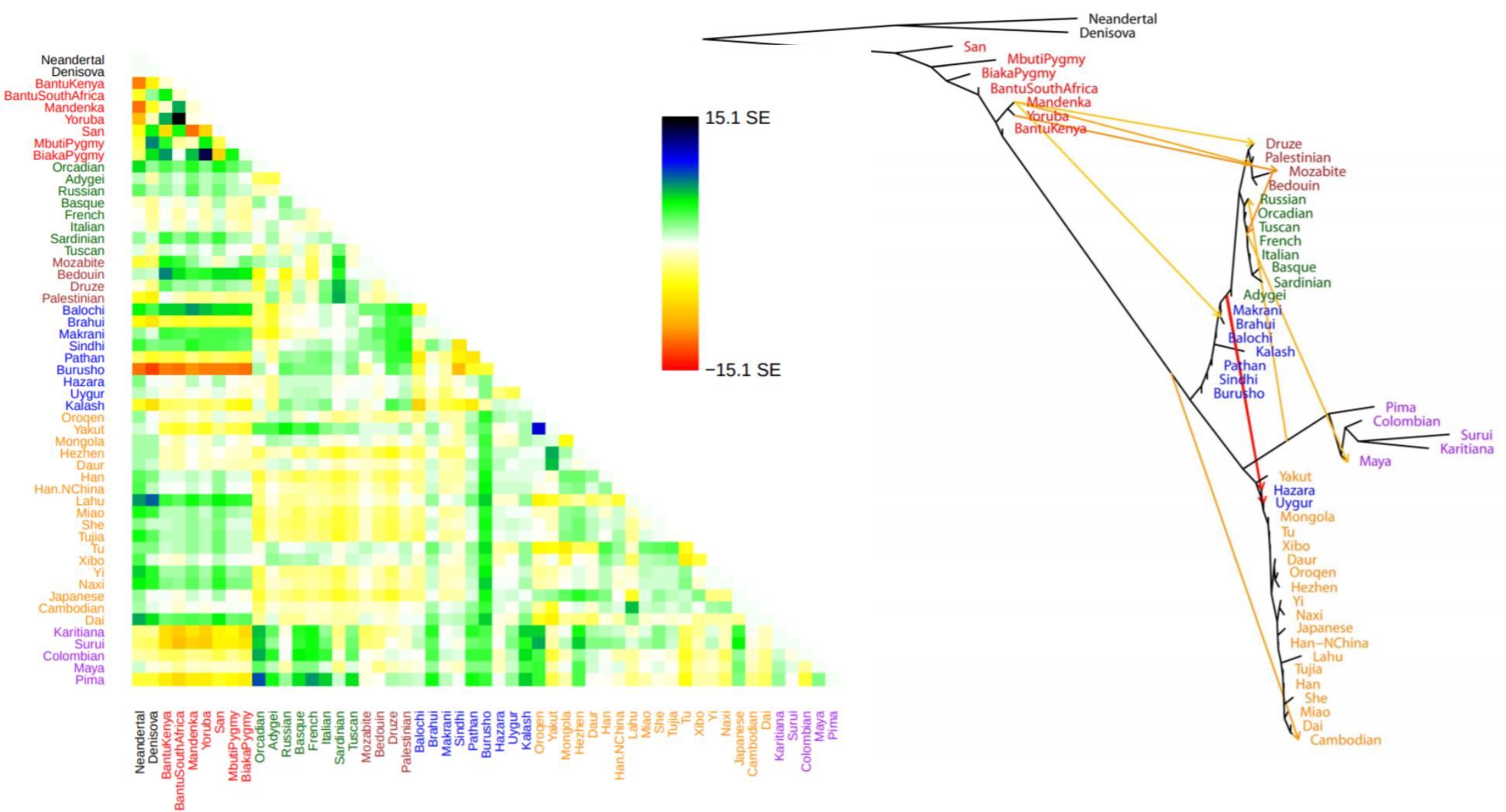
C. Example graph



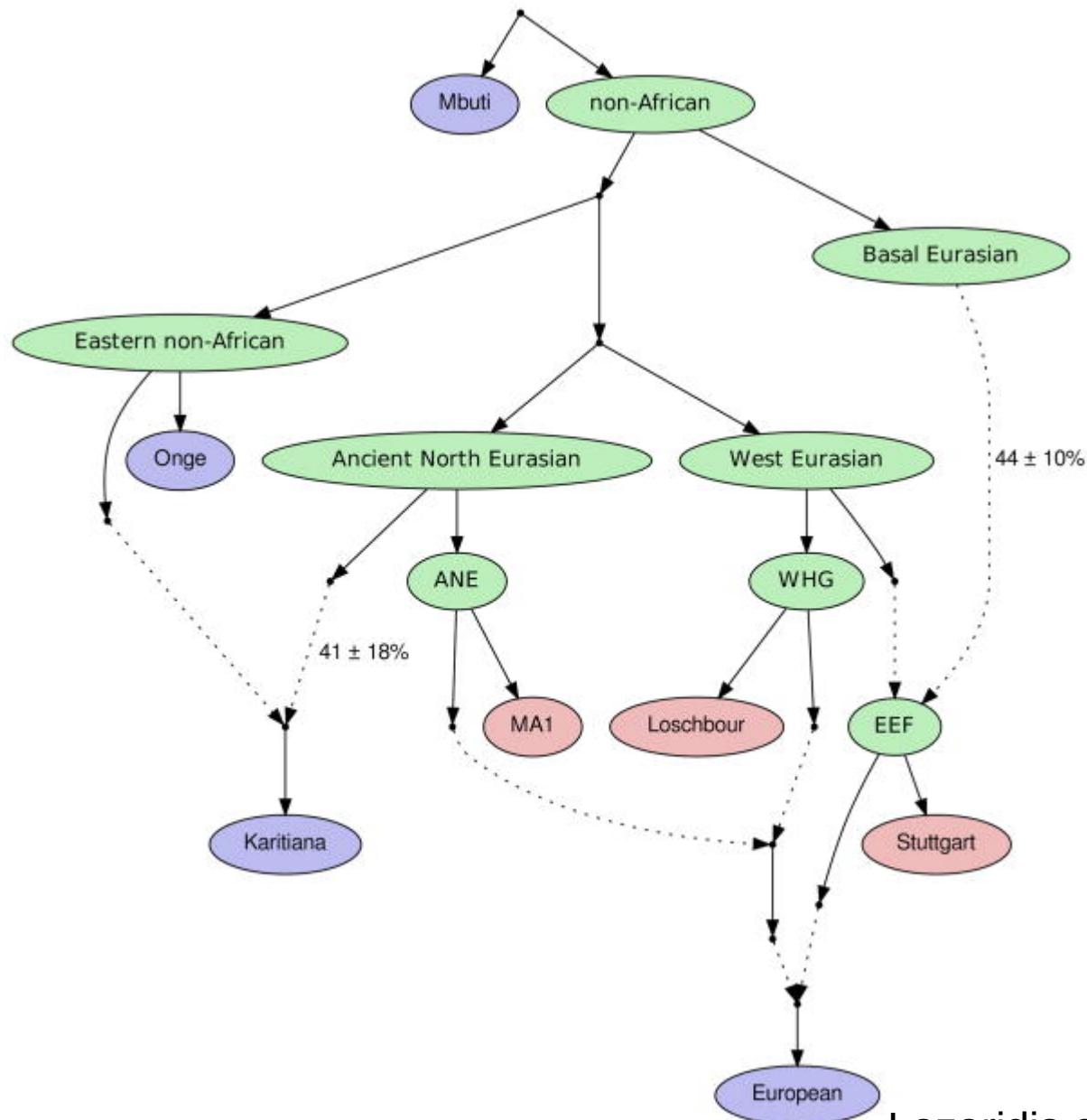
D. Covariance matrix for graph in C.

X_1	$c_2 + c_6$	c_2	wc_2	0
X_2	c_2	$c_2 + c_5 + c_7$	$w(c_2 + c_5)$	0
X_3	wc_2	$w(c_2 + c_5)$	$w^2(c_2 + c_5) + (1-w)^2(c_1 + c_3)$	$(1-w)c_1$
X_4	0	0	$(1-w)c_1$	$c_1 + c_4$



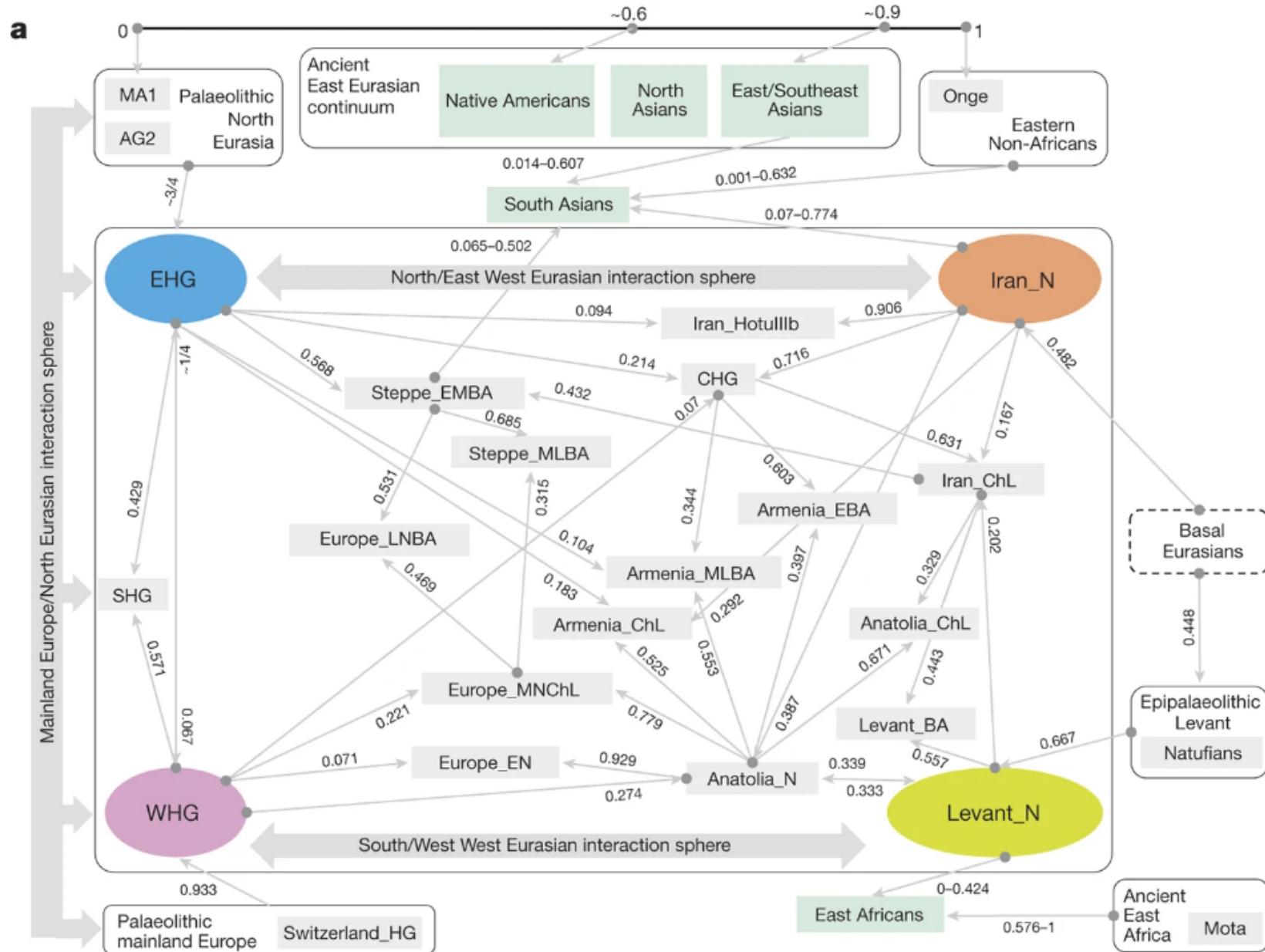


Admixture graphs



Lazaridis et al. 2014, Nature

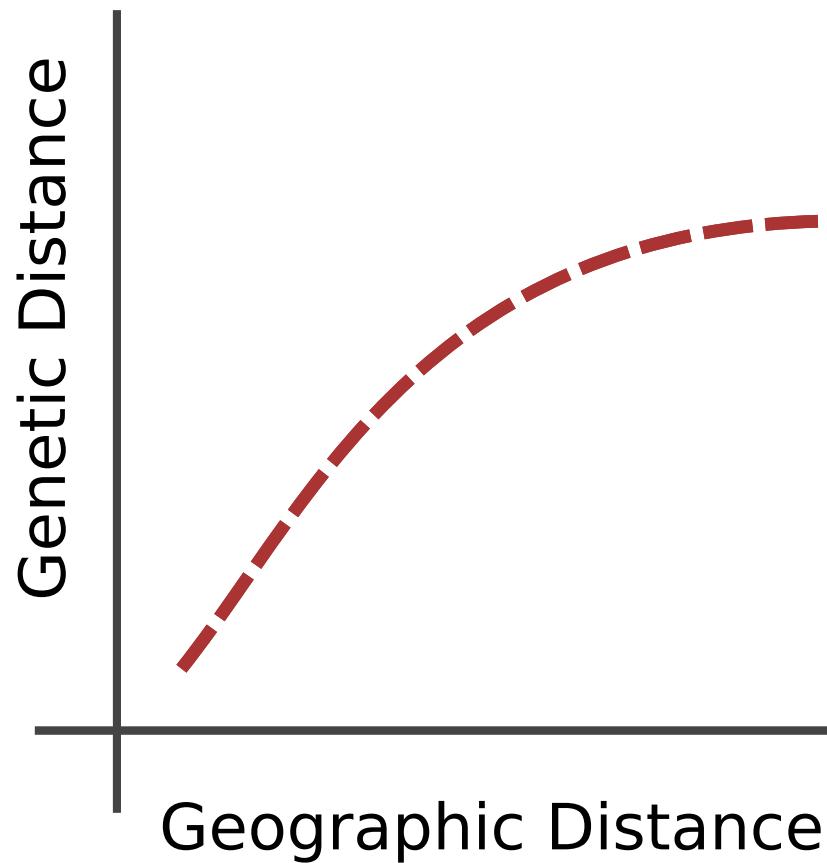
Over-the-top



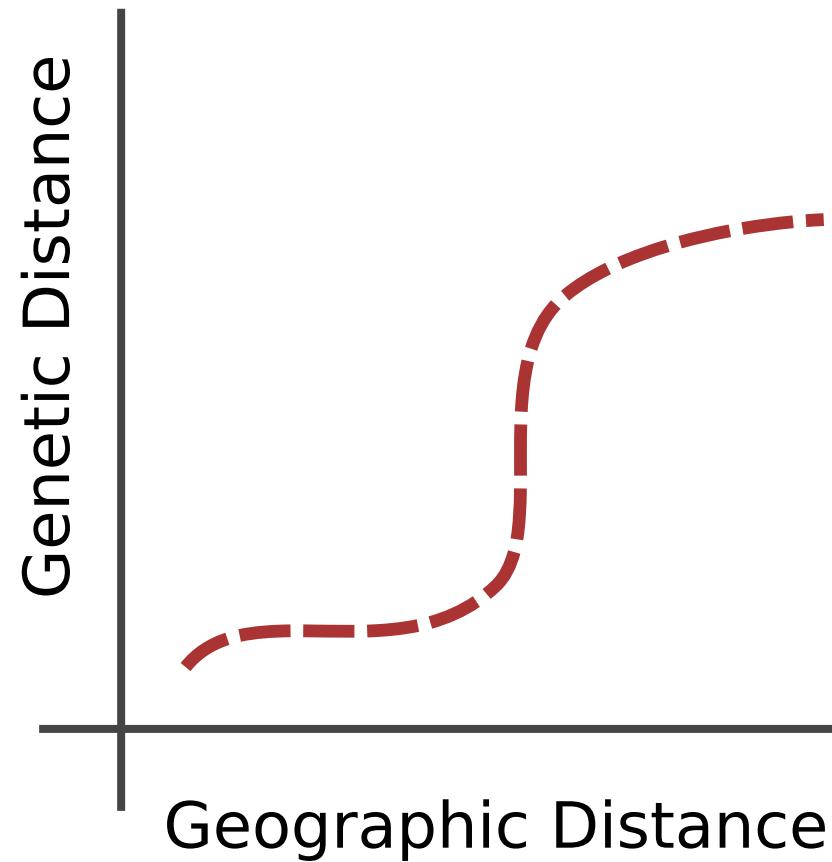
Population structure models

- When should we use trees?

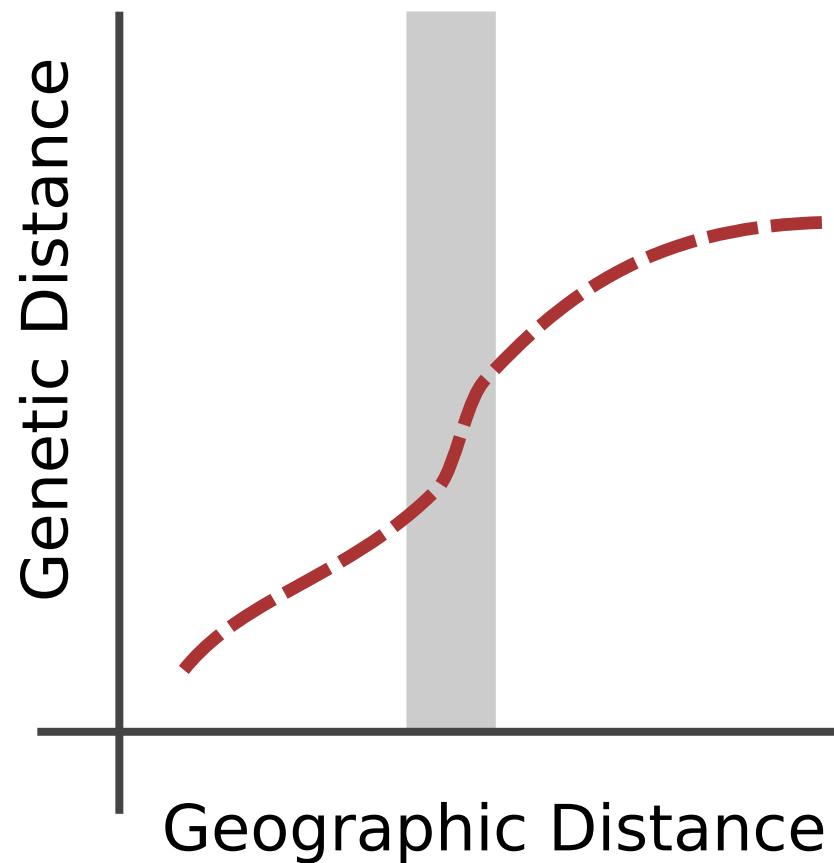
Continuous structure



Discrete structure



Inferring discontinuities



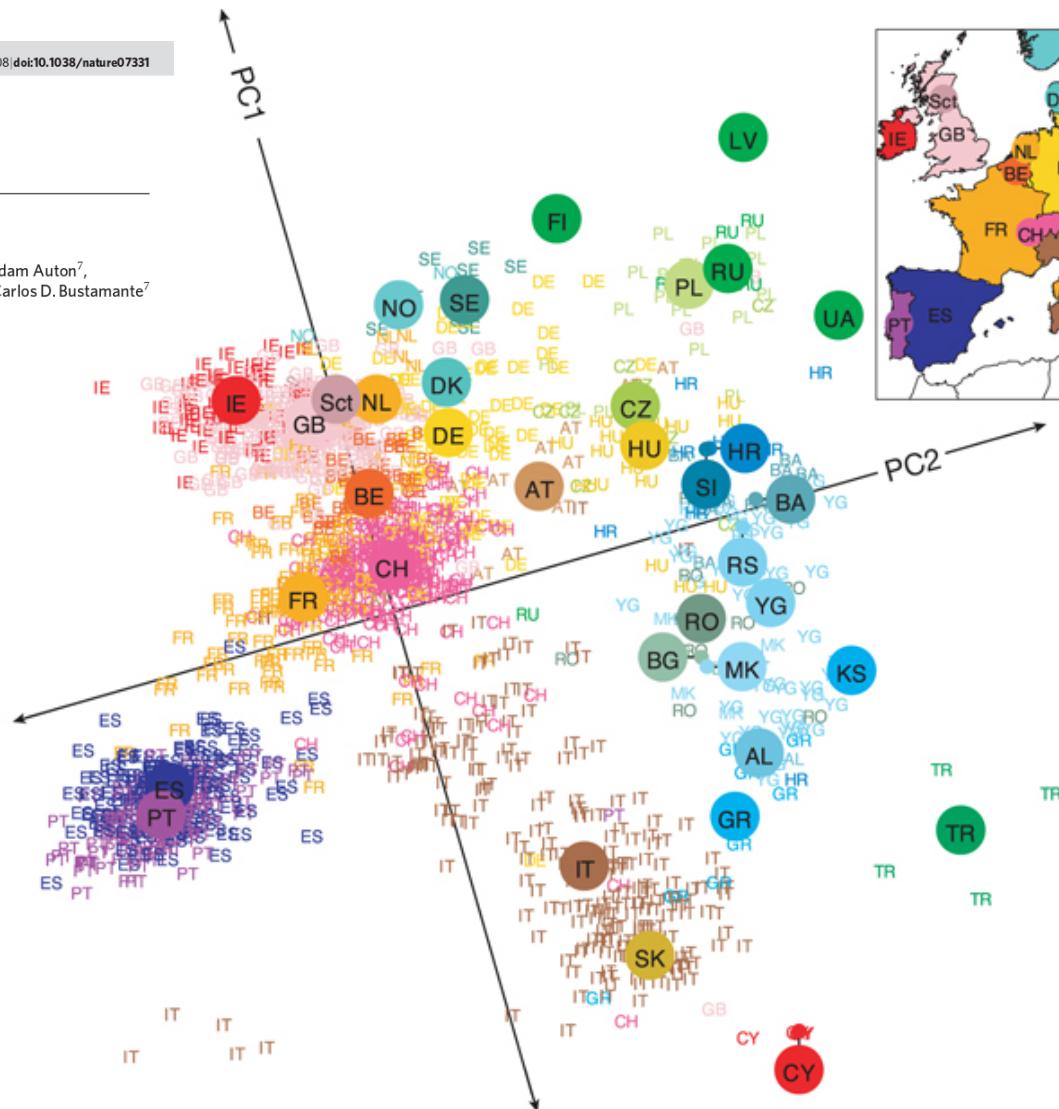
Or (nearly) continuous

nature
Vol 456 | 6 November 2008 | doi:10.1038/nature07331

LETTERS

Genes mirror geography within Europe

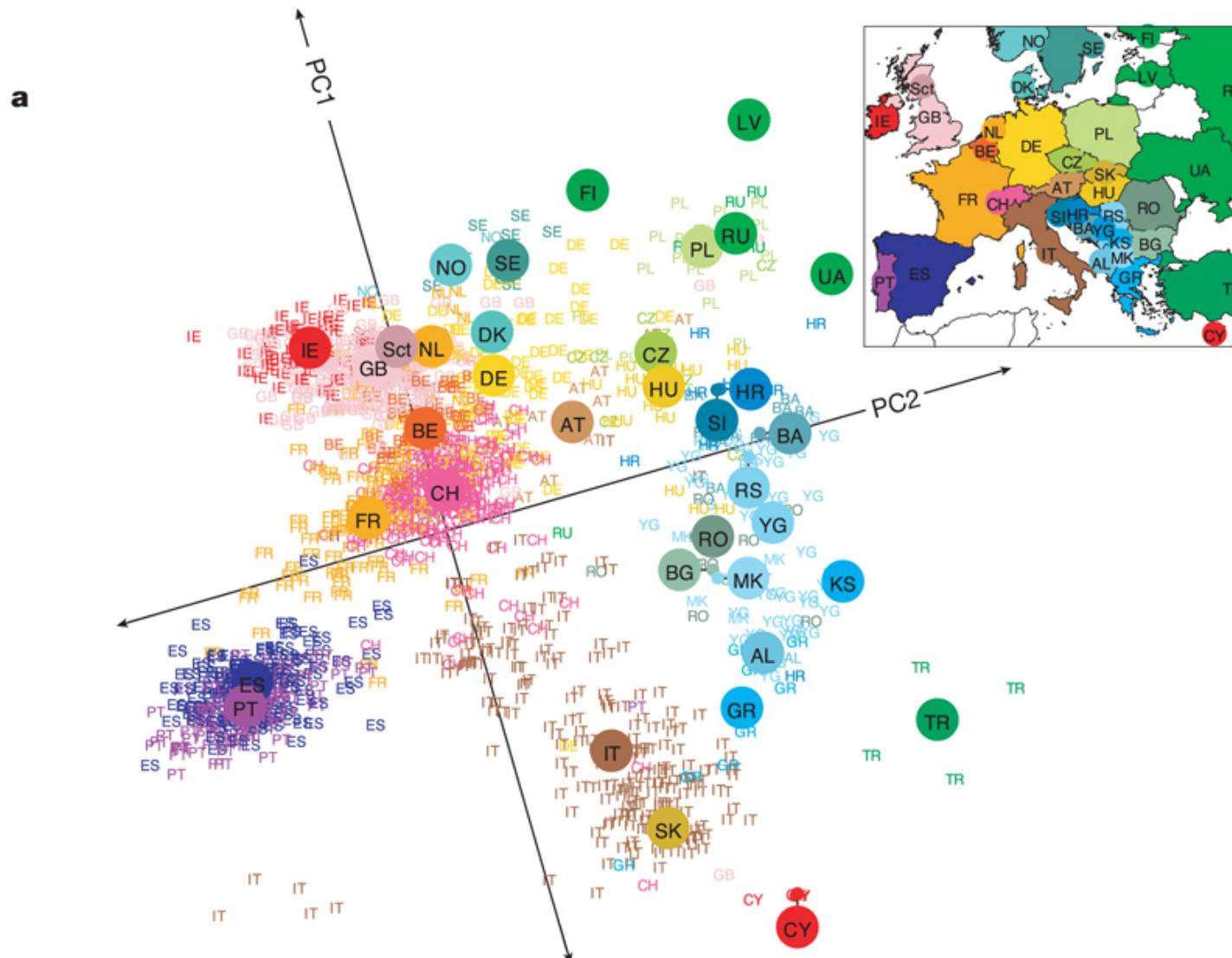
John Novembre^{1,2}, Toby Johnson^{4,5,6}, Katarzyna Bryc⁷, Zoltán Kutalik^{4,6}, Adam R. Boyko⁷, Adam Auton⁷, Amit Indap⁷, Karen S. King⁸, Sven Bergmann^{4,6}, Matthew R. Nelson⁸, Matthew Stephens^{2,3} & Carlos D. Bustamante⁷



LETTERS

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When should we use trees?

Trees / Admixture graph

- Sparse structure / sampling
- Large time scales
- Non-spatial structure

Spatial models / EEMS

- High-density sampling
- Small time scales
- Continuous structure