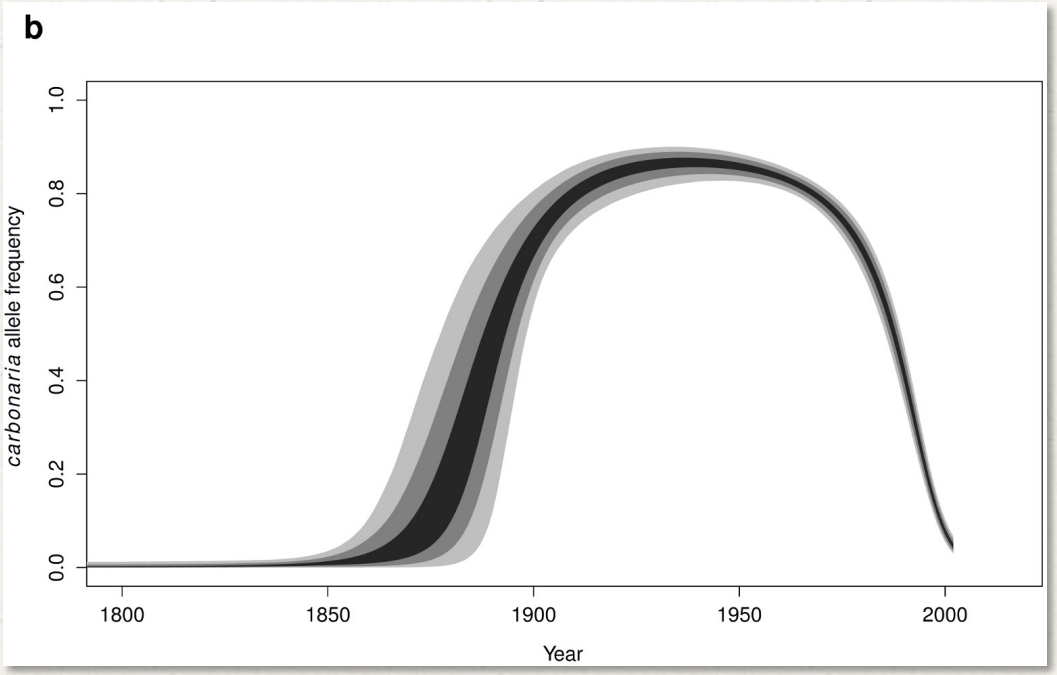
Don’t forget to submit questions for our horizon scanning exercise at the end of the week

SELECTION

Identifying the basis of adaptation using genomic techniques

Peppered moth (*Biston betularia*)



van't Hof et al. 2016, Nature

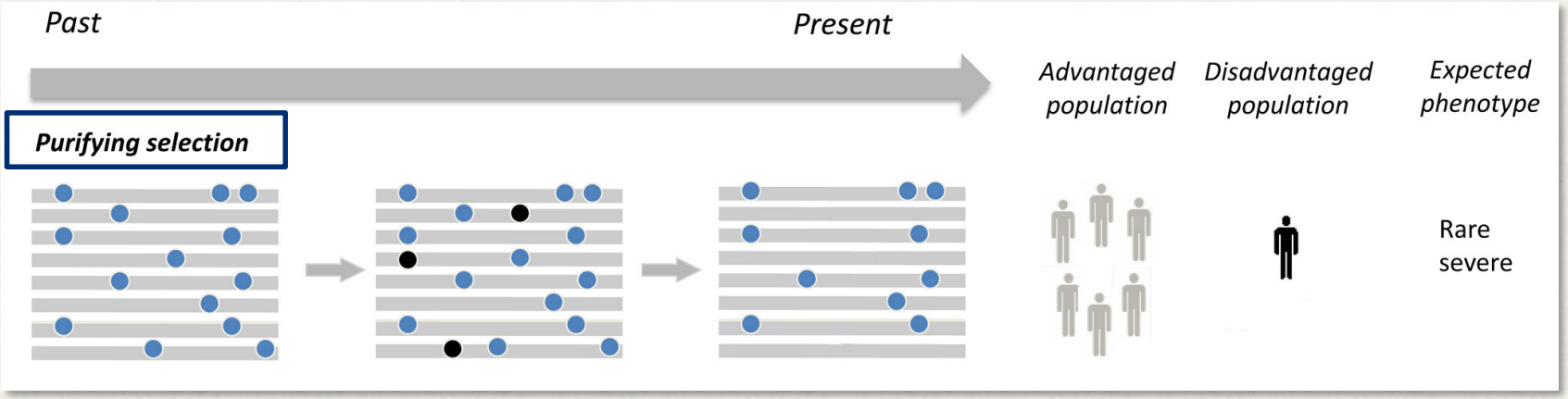
Goals

Types of selection

Signatures of selection

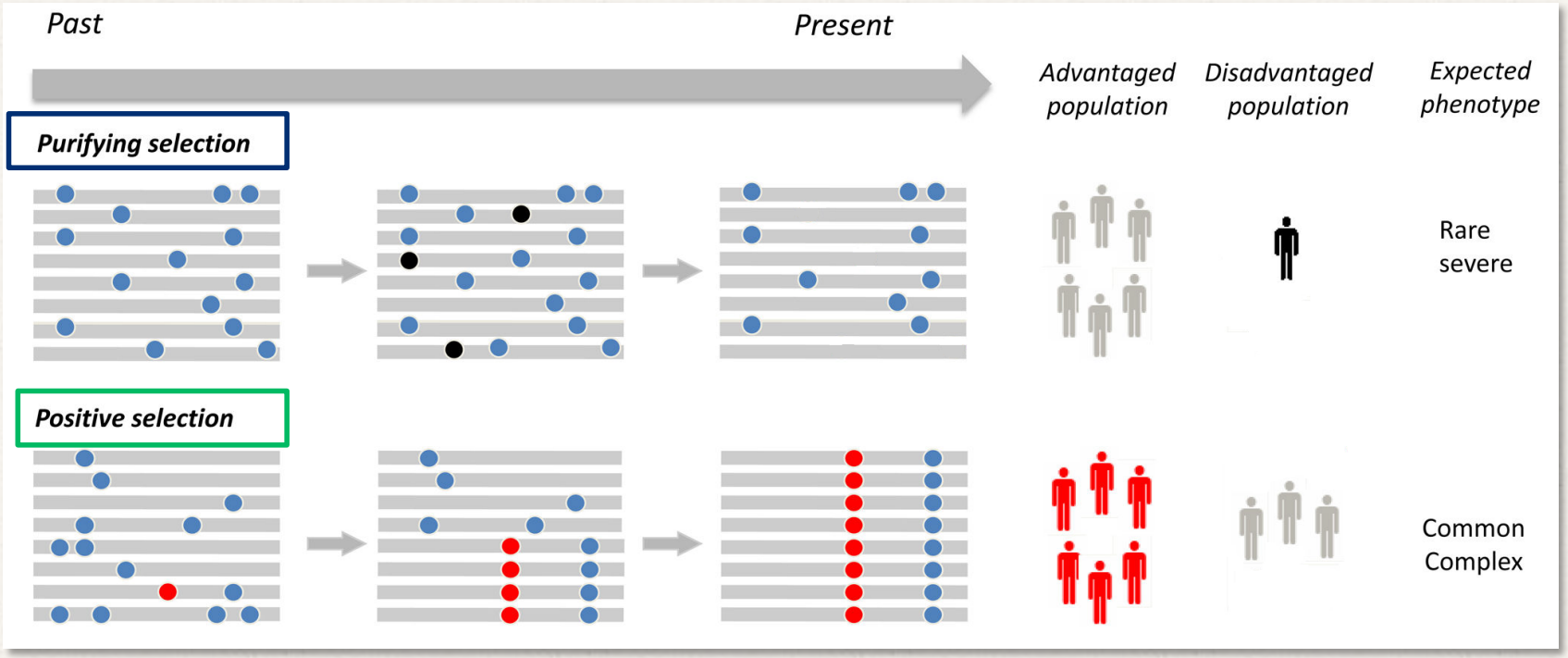
- Examples using genomics

Types of selection



Modified from Quintana-Murci & Clark (2013)

Types of selection



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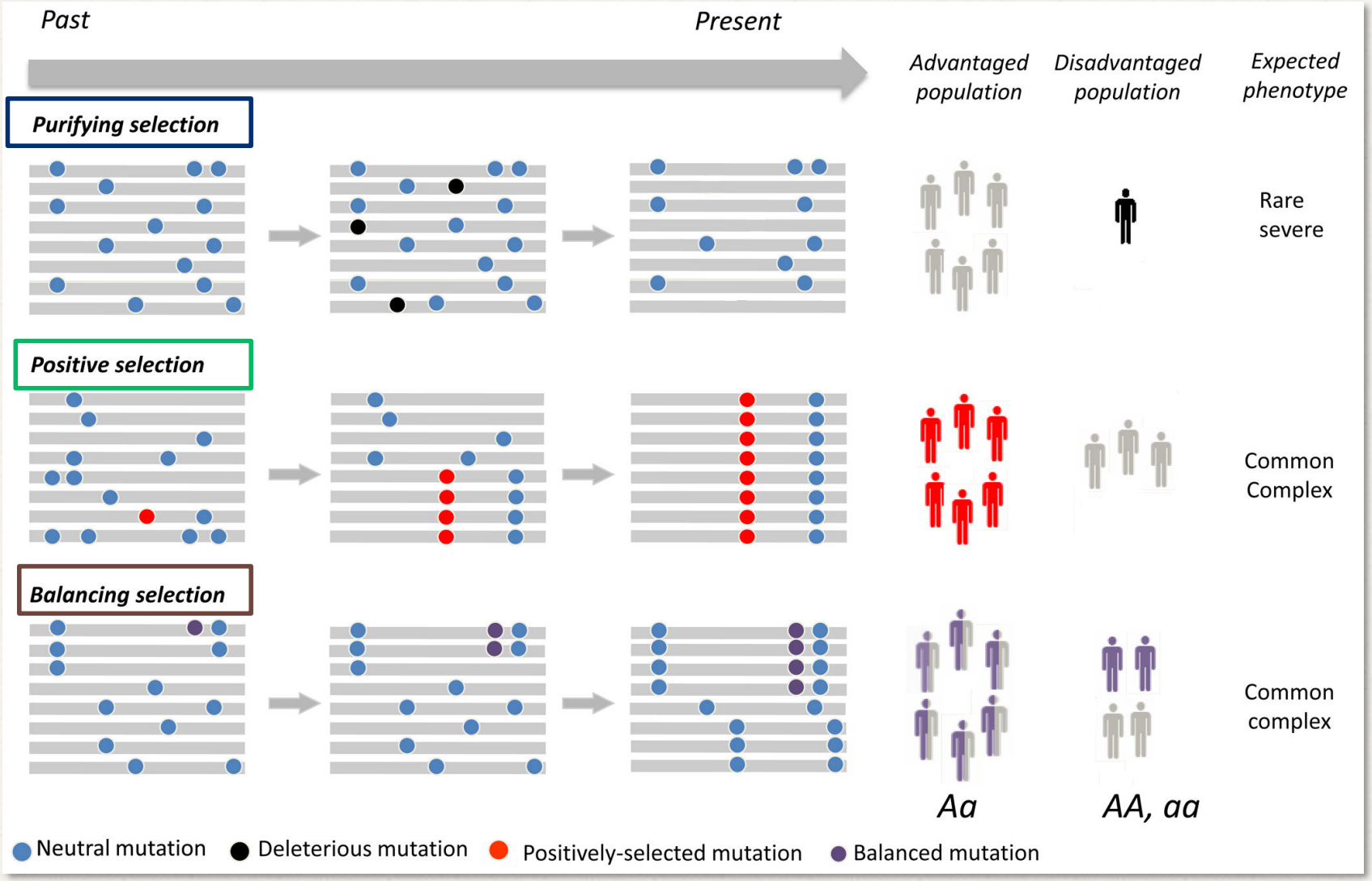
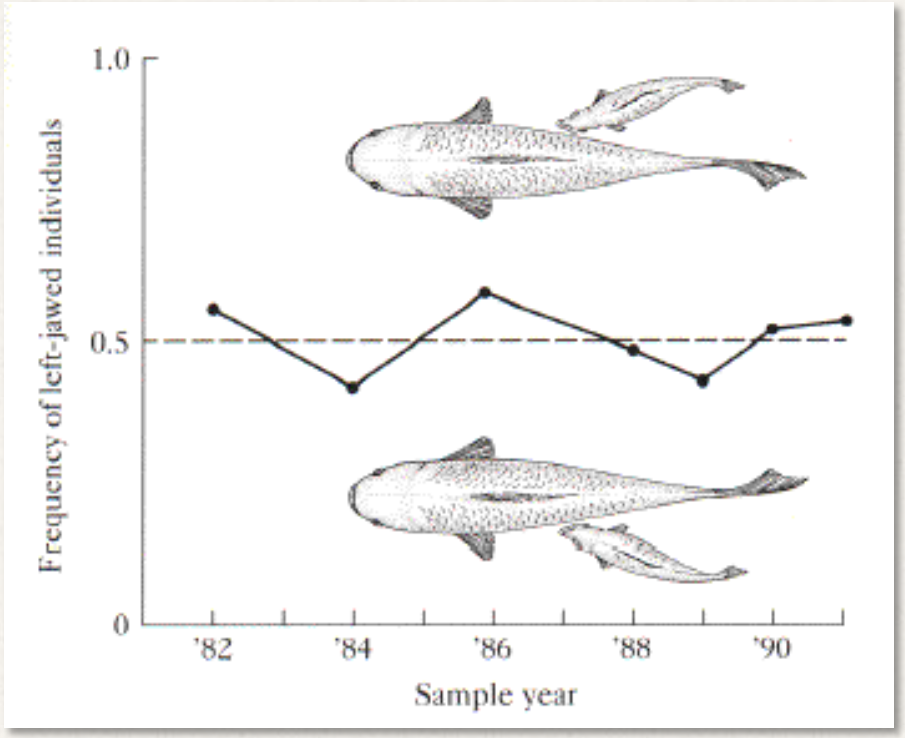
Types of selection



Modified from Quintana-Murci & Clark (2013)

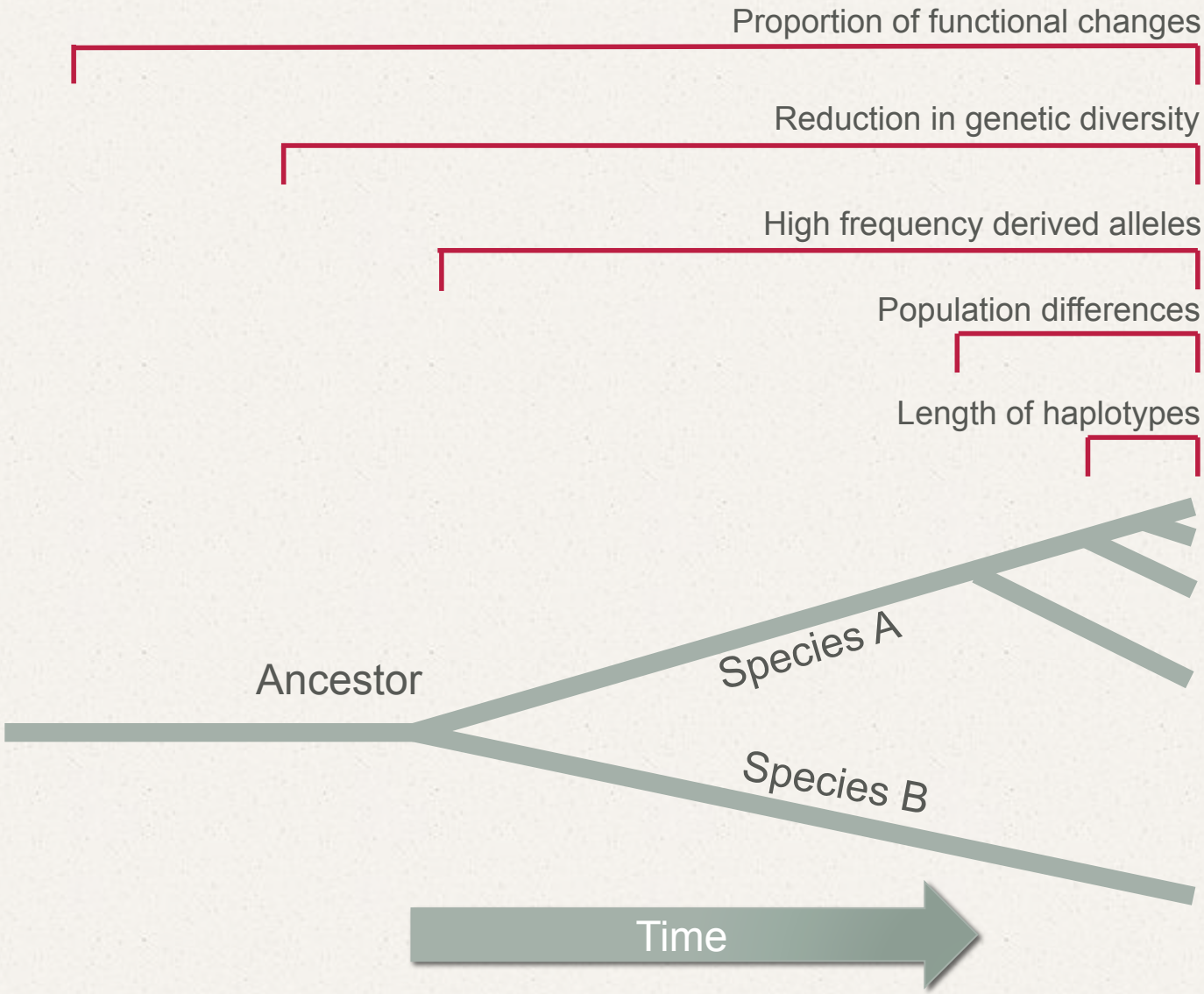
Frequency-dependent (balancing) selection

Lee et al. 2010, J Fish Biol



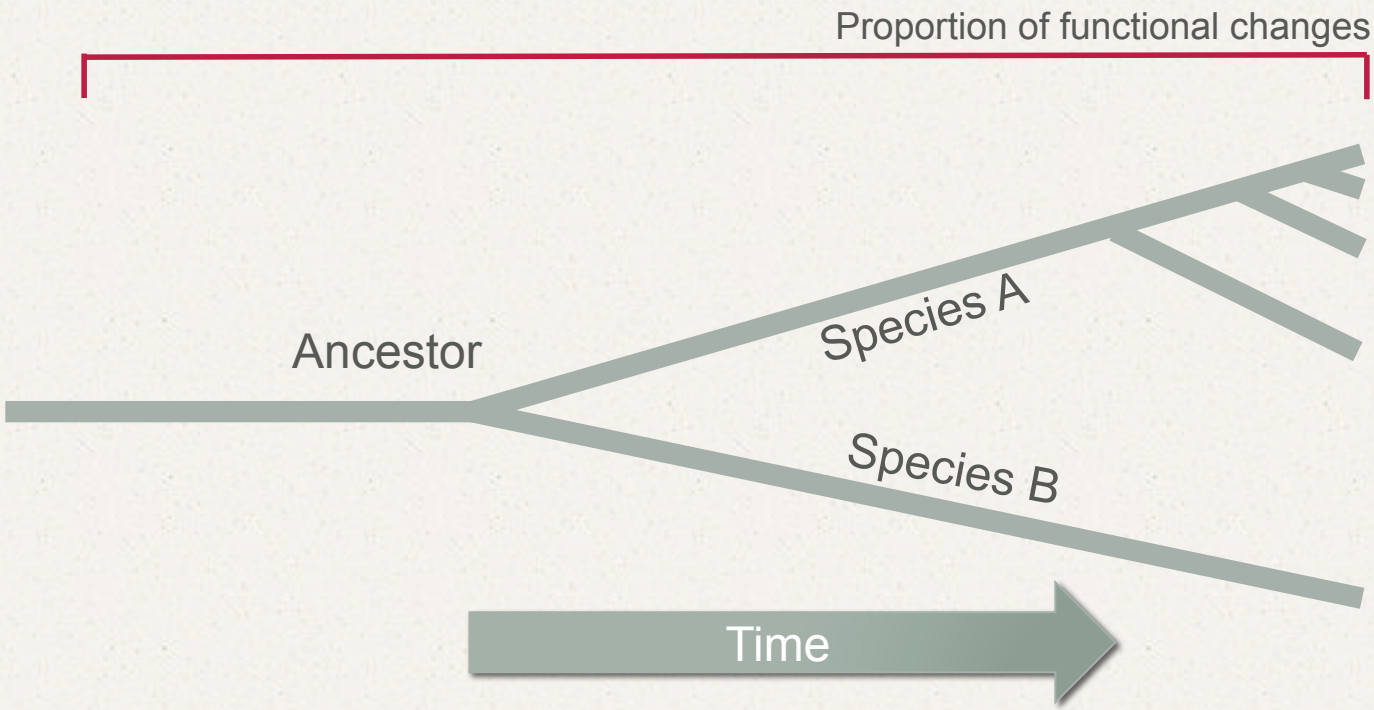
Hori 1993,Science
&
http://bio.research.ucsc.edu/~barrylab/classes/evolution/Image61.gif

Signatures of positive selection



Modified from
Sabeti et al. 2006
Nature

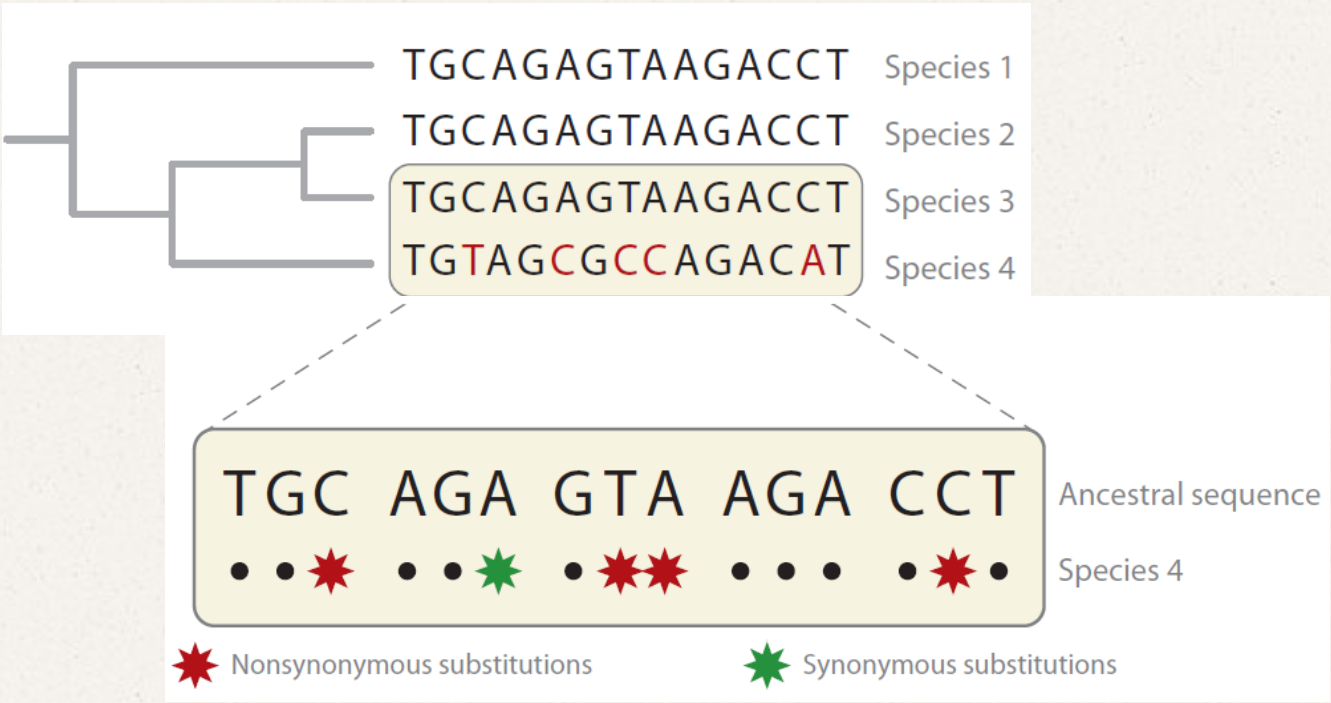
Signatures of positive selection



Modified from
Sabeti et al. 2006
Nature

Proportional of functional changes: Ka/Ks (dn/ds) ratio

Synonymous changes are assumed to be neutral



$$Ka = \frac{\text{non-synonymous changes}}{\text{non-synonymous sites}}$$

$$Ks = \frac{\text{synonymous changes}}{\text{synonymous sites}}$$

Vitti *et al.* (2013)

Proportional of functional changes: Ka/Ks (dn/ds) ratio

Synonymous changes are assumed to be neutral

$$Ka = \frac{\text{non-synonymous changes}}{\text{non-synonymous sites}}$$

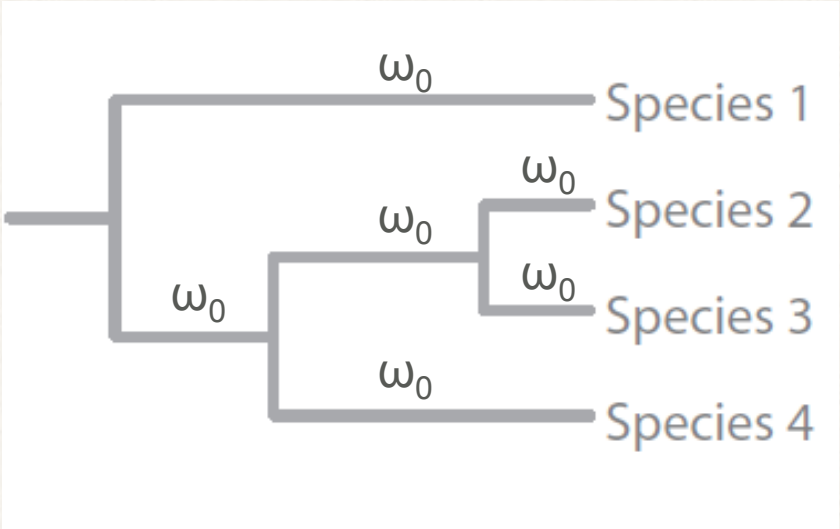
$$Ks = \frac{\text{synonymous changes}}{\text{synonymous sites}}$$

Ka / Ks > 1	Ka / Ks = 1	Ka / Ks < 1
Positive selection	**Genetic drift**	**Purifying selection**
$\lambda > \mu$	$\lambda = \mu$	$\lambda < \mu$

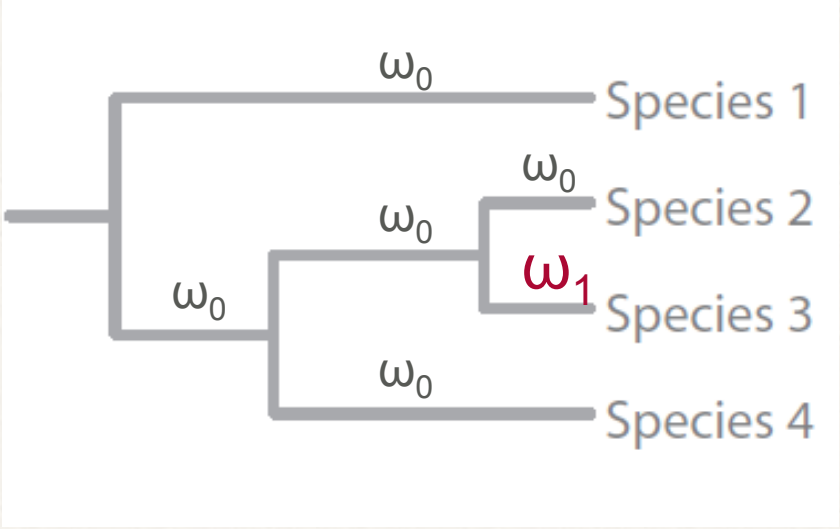
Vitti *et al.* (2013)

Proportional of functional changes: Branch Site Test

$\omega = dn/ds$



Background Model

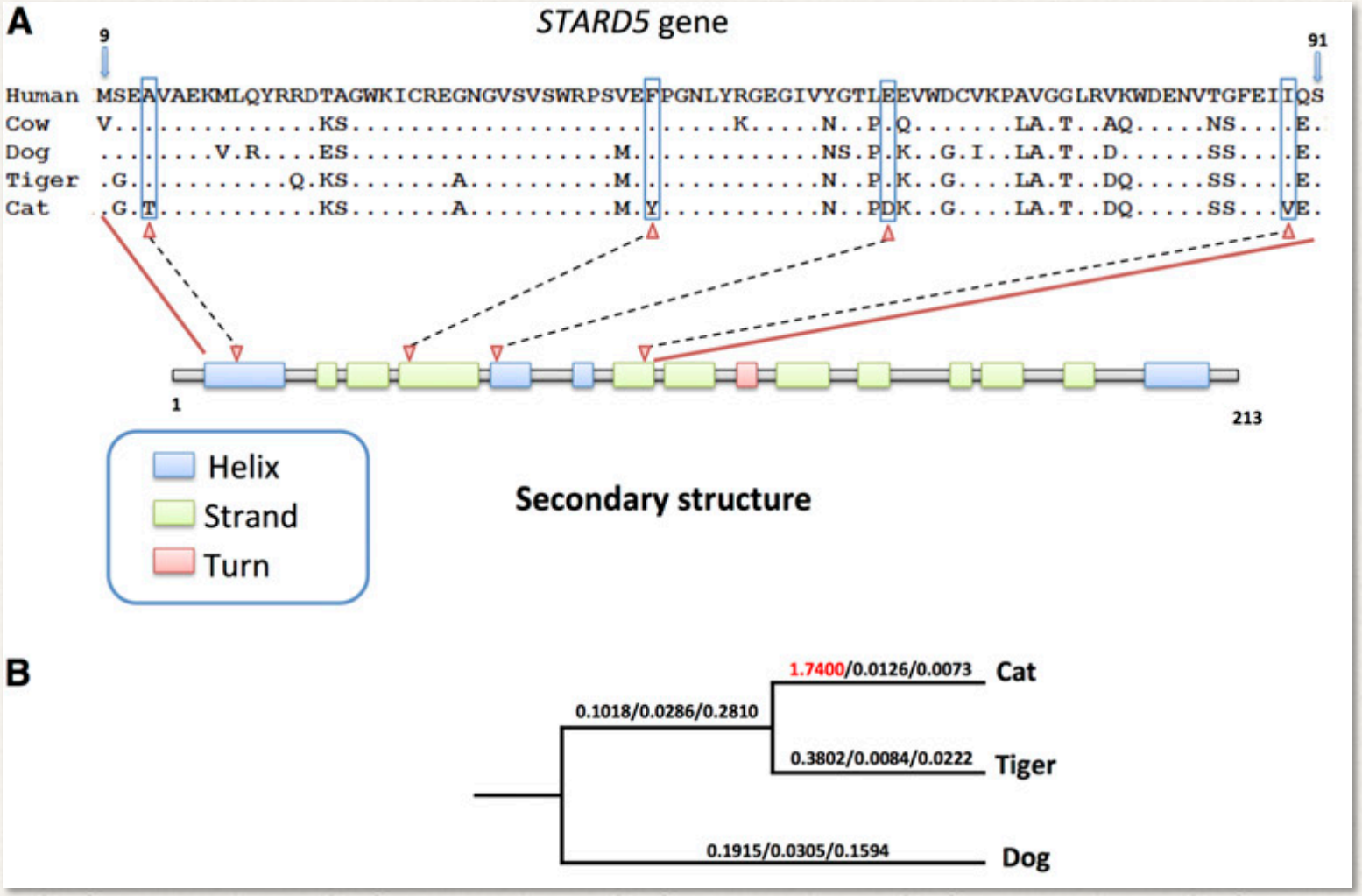


Increased Rate Model

Compare both models using a likelihood ratio test

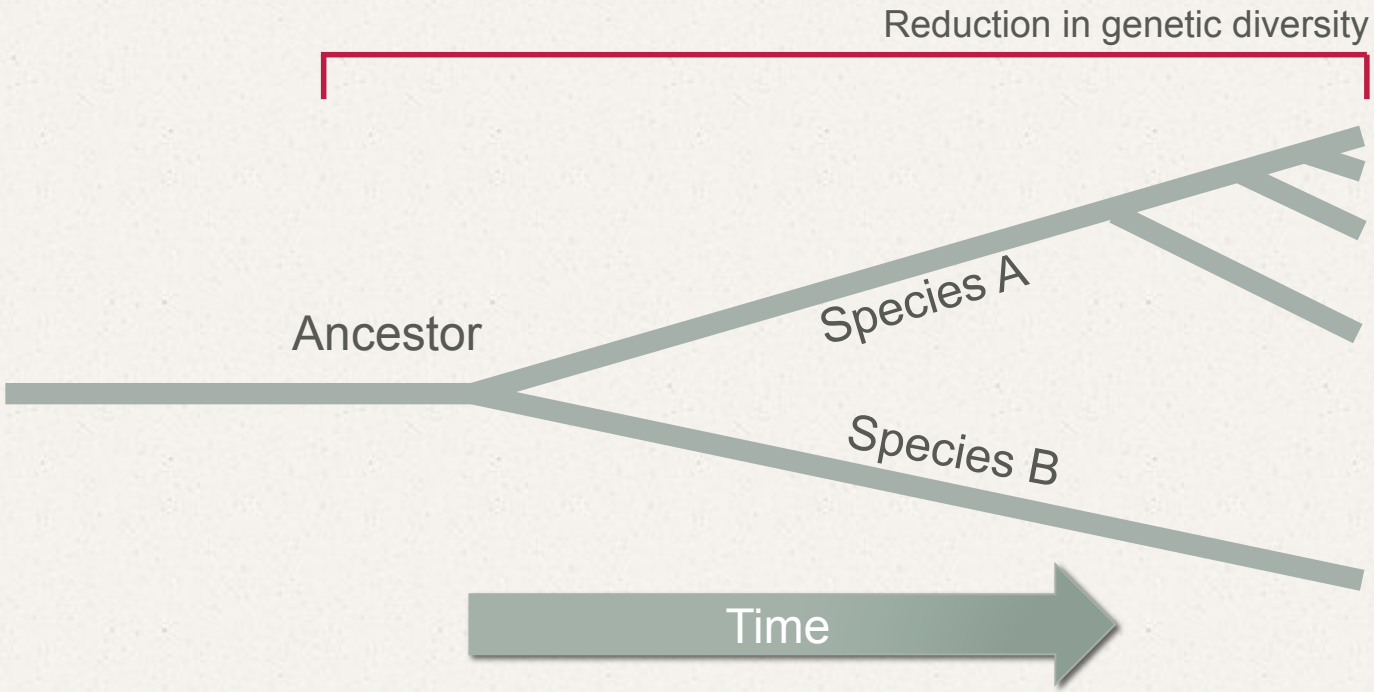
See Yang & dos Reis (2011) Mol Biol Evol
or PAML software manual

Proportional of functional changes: Branch Site Test



Montague et al. (2014) PNAS

Signatures of positive selection



Modified from
Sabeti et al. 2006
Nature

Reduction in genetic diversity

- McDonald-Kreitman (MK) Test

	Polymorphism	Divergence
Non-synonymous	4	8
Synonymous	5	2

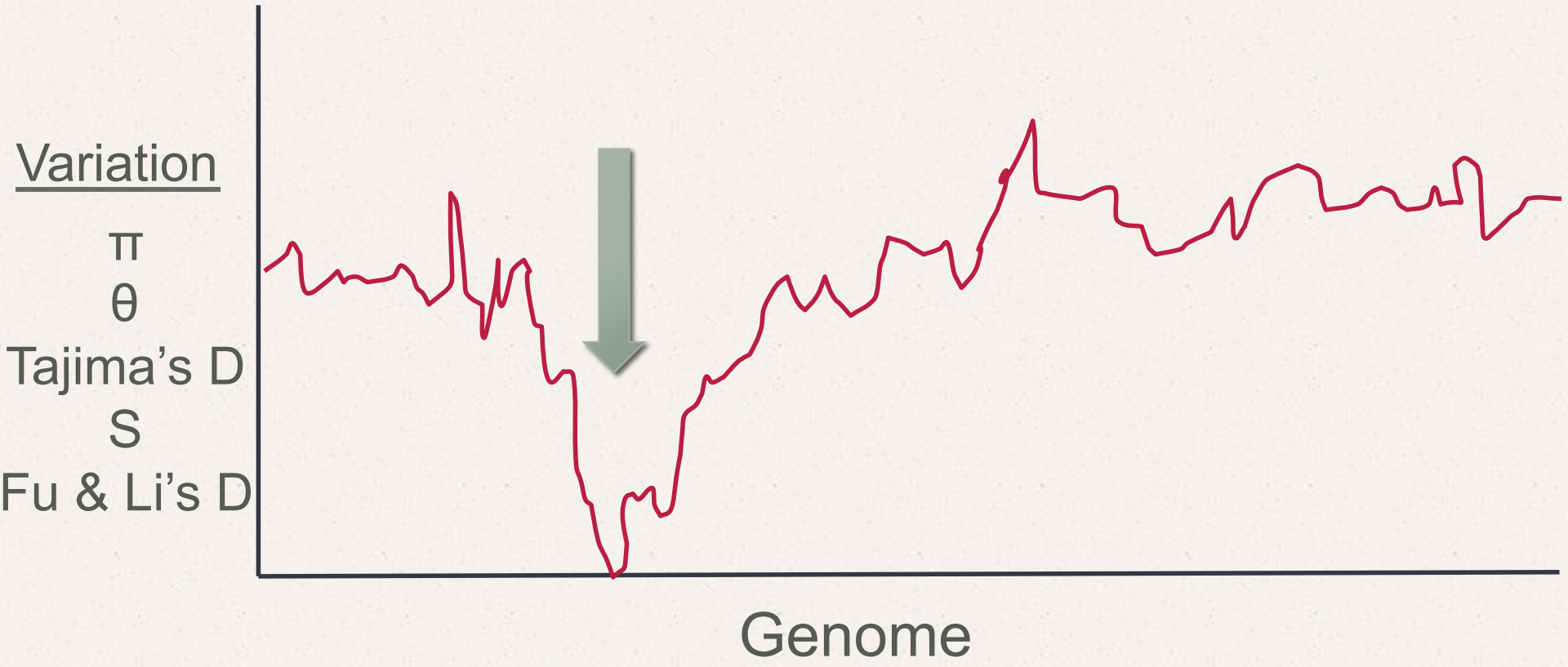
4/5 << 8/2
Fisher Exact Test ($p < 0.05$)

- Hudson–Kreitman–Aguade (HKA) Test

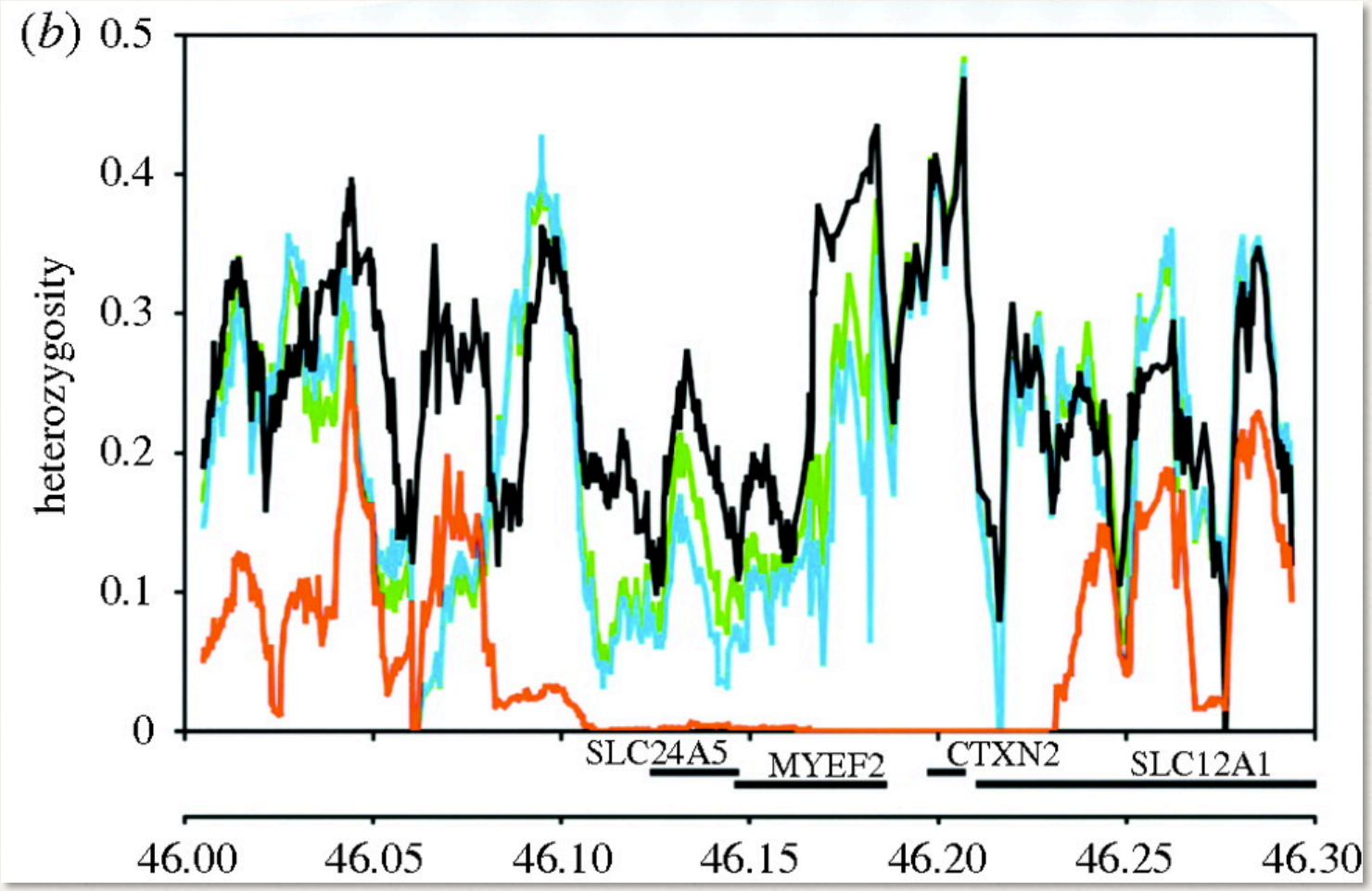
	Polymorphism	Divergence
Gene	0.00093	0.056
Neutral locus	0.022	0.052

0.00093/0.056 << 0.022/0.052
Fisher Exact Test ($p < 0.05$)

Reduction in genetic diversity

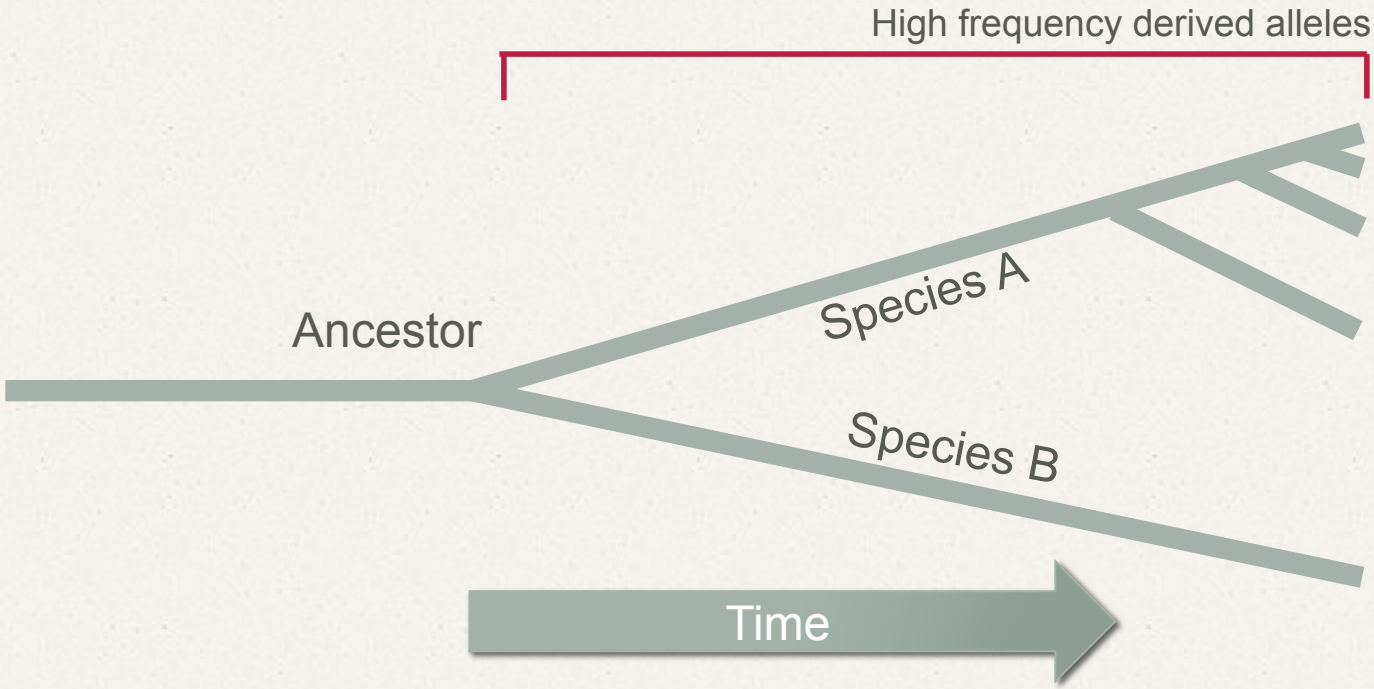


Reduction in genetic diversity



Lamason et al. (2005) Science

Signatures of positive selection

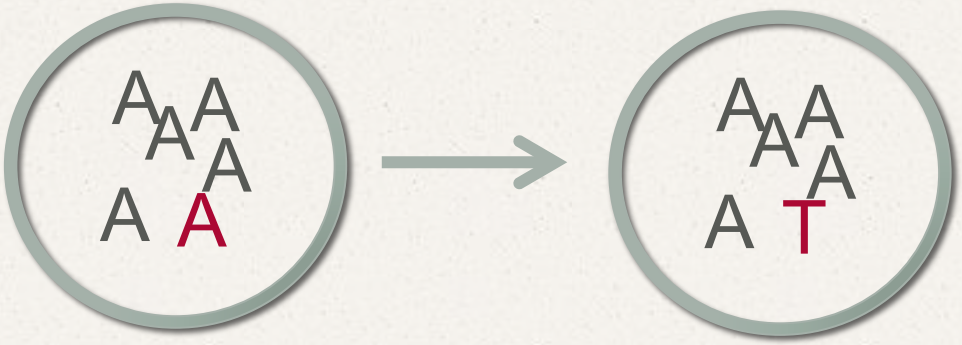


Modified from
Sabeti et al. 2006
Nature

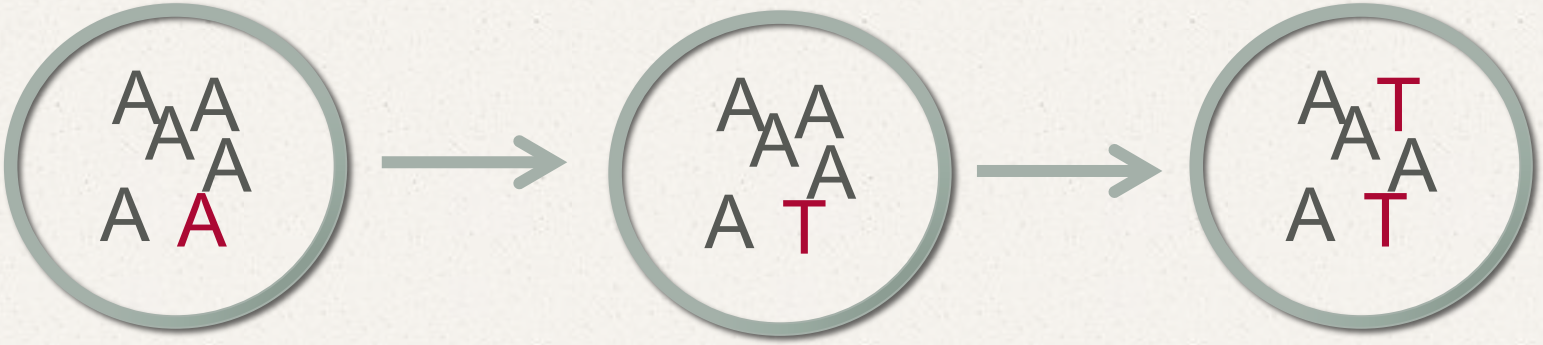
High frequency derived alleles

High frequency derived alleles

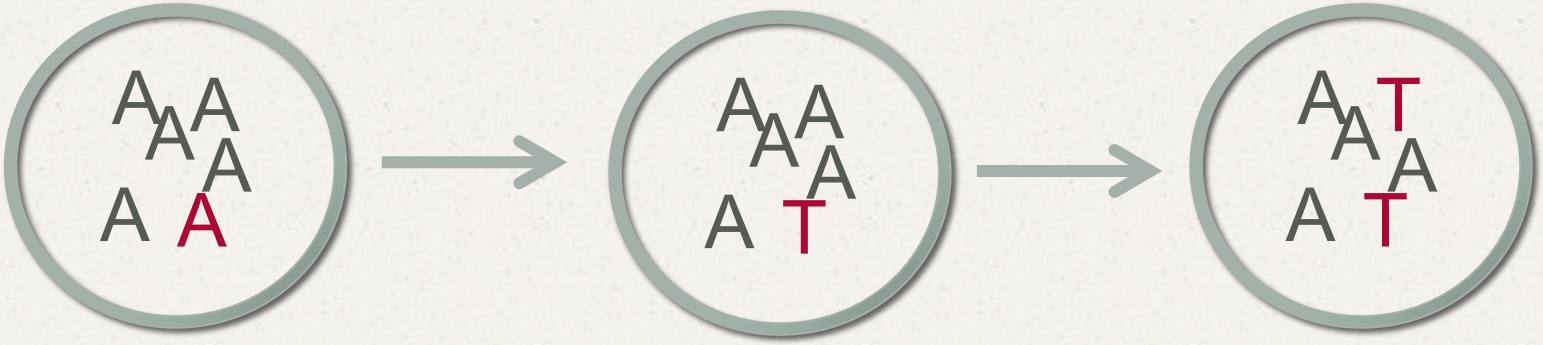
High frequency derived alleles



High frequency derived alleles



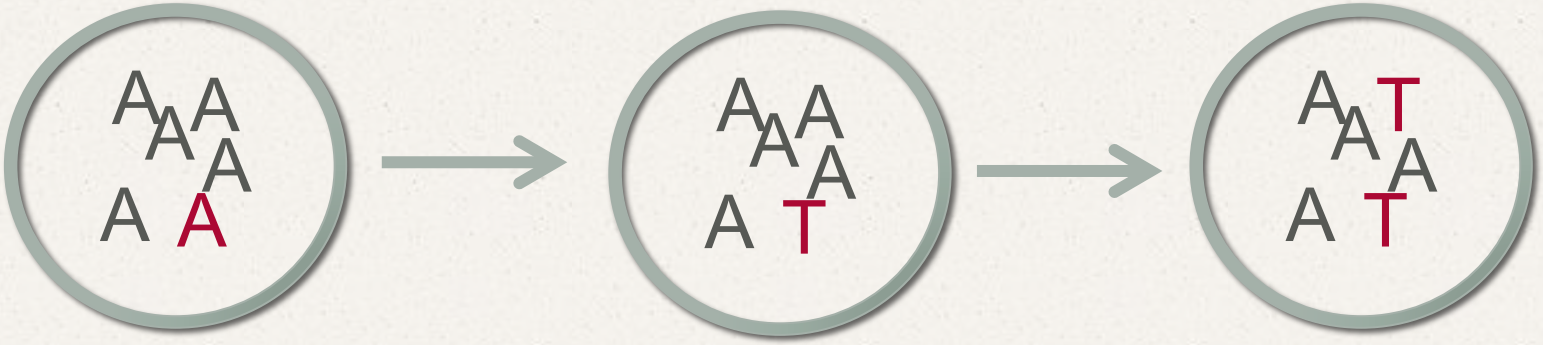
High frequency derived alleles



A = ancestral allele

T = derived allele

High frequency derived alleles



A = ancestral allele

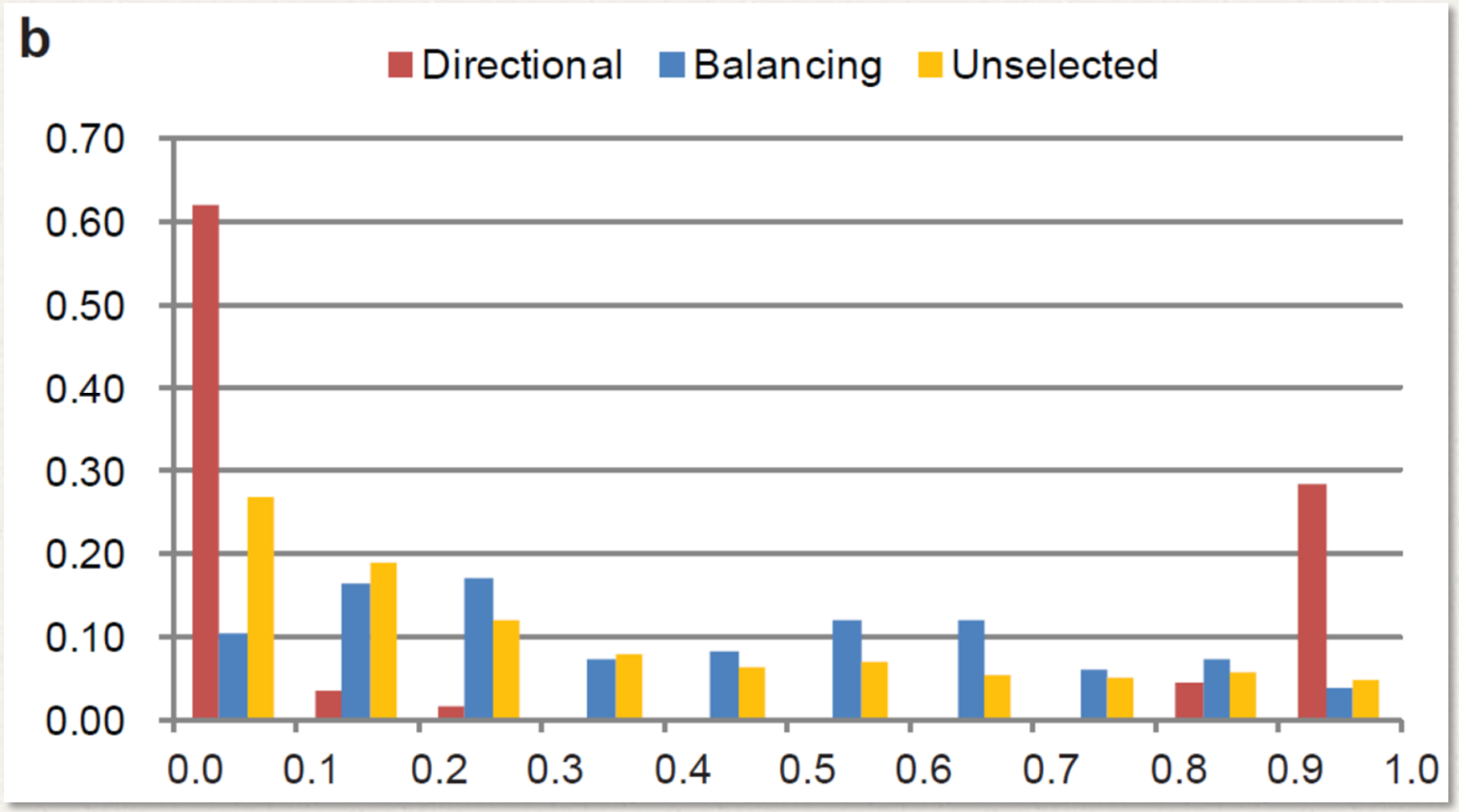
T = derived allele

Allele Frequency Spectrum (AFS)

Site Frequency Spectrum (SFS)

High frequency derived alleles

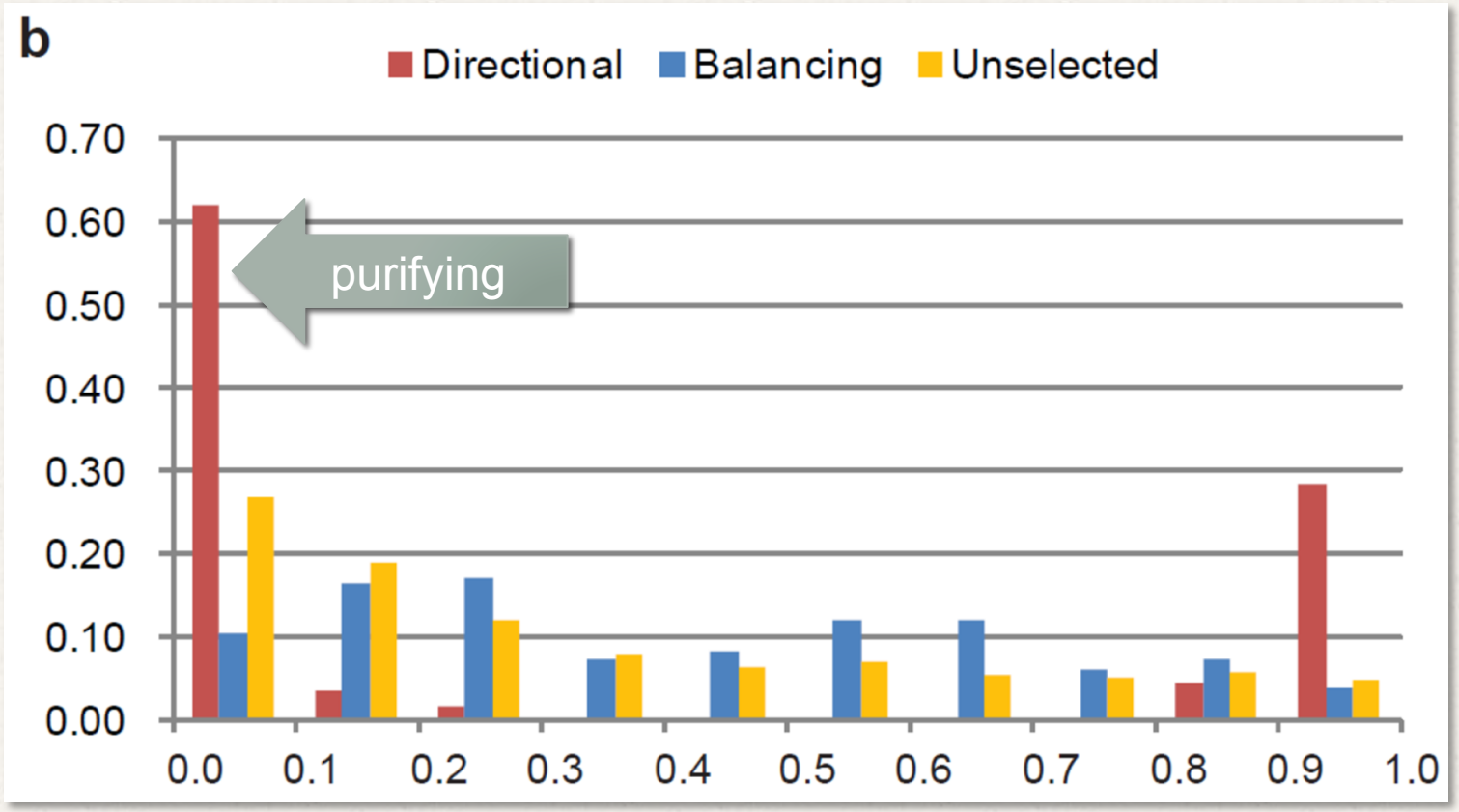
Pandas!!!!



Zhao et al. (2013) Nature

High frequency derived alleles

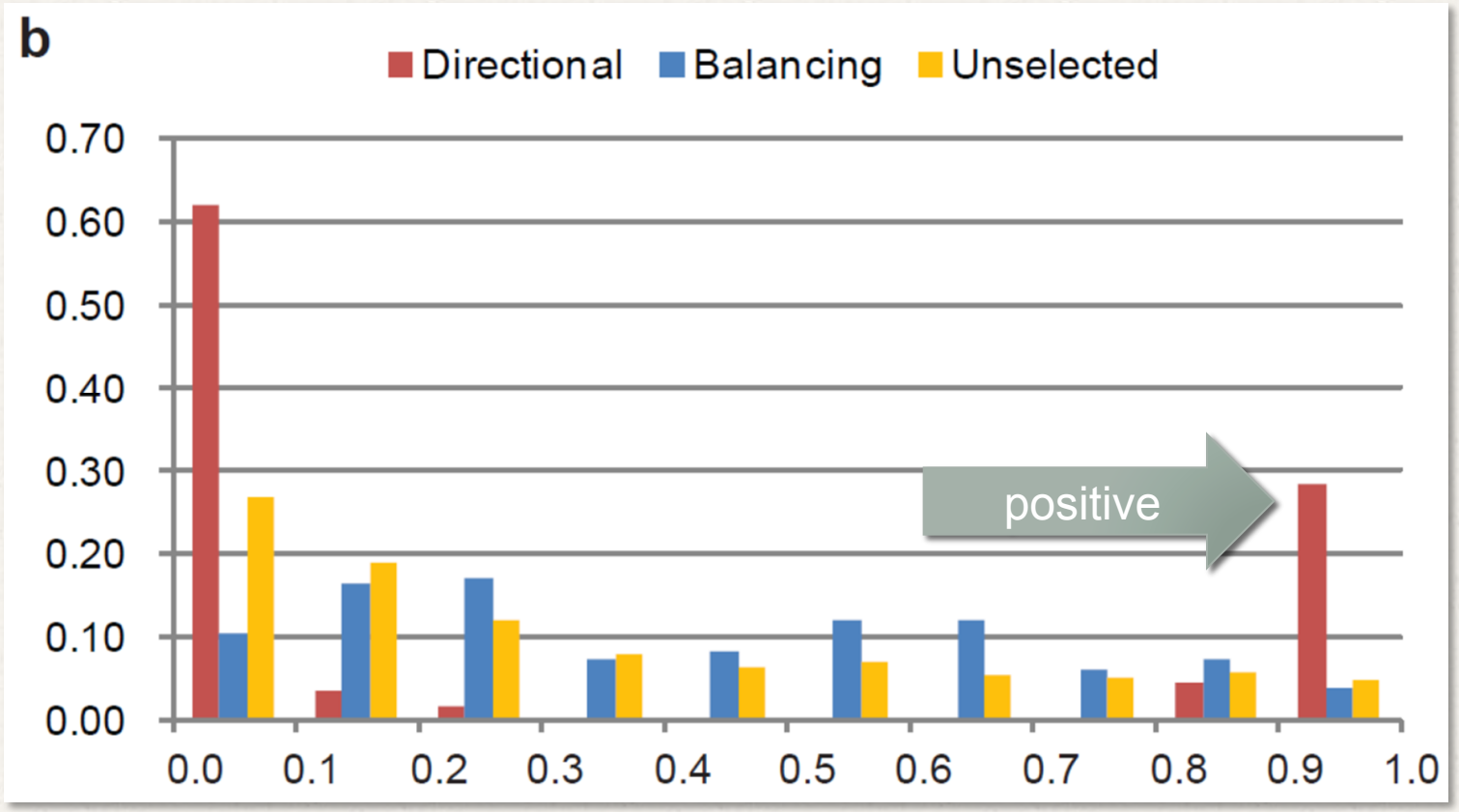
Pandas!!!!



Zhao et al. (2013) Nature

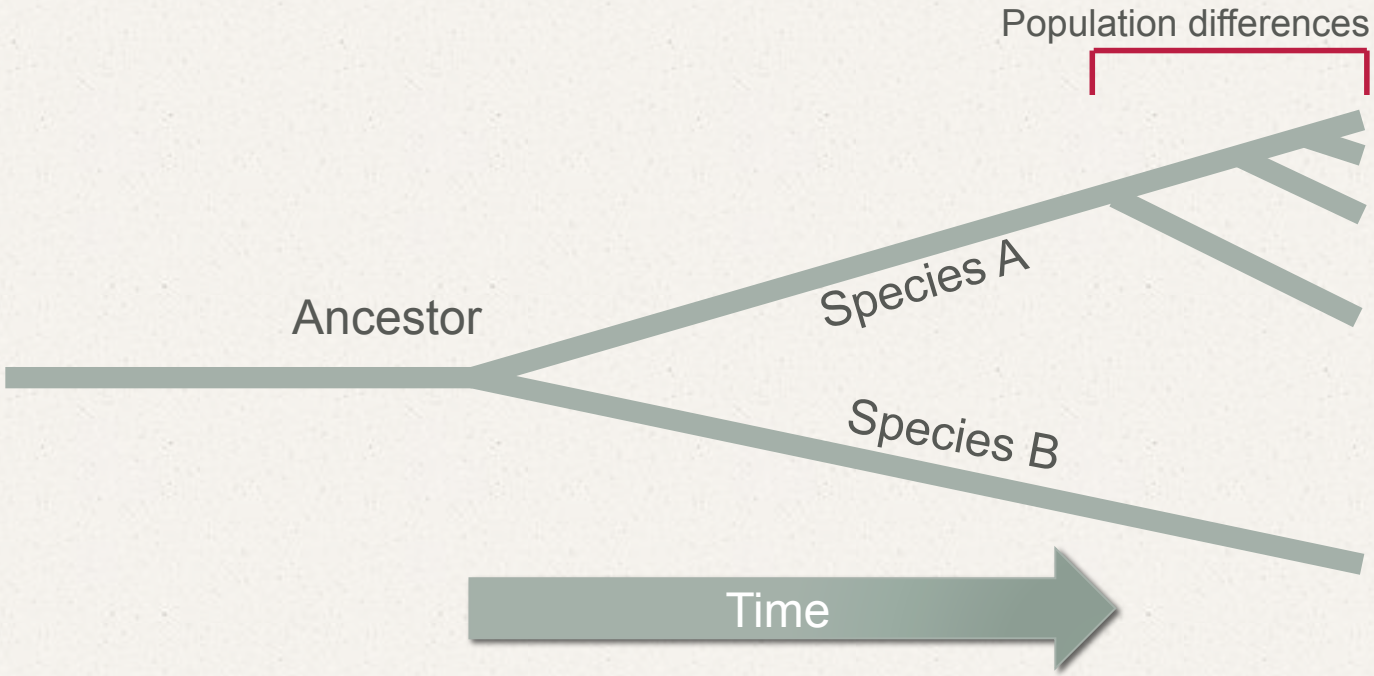
High frequency derived alleles

Pandas!!!!



Zhao et al. (2013) Nature

Signatures of positive selection



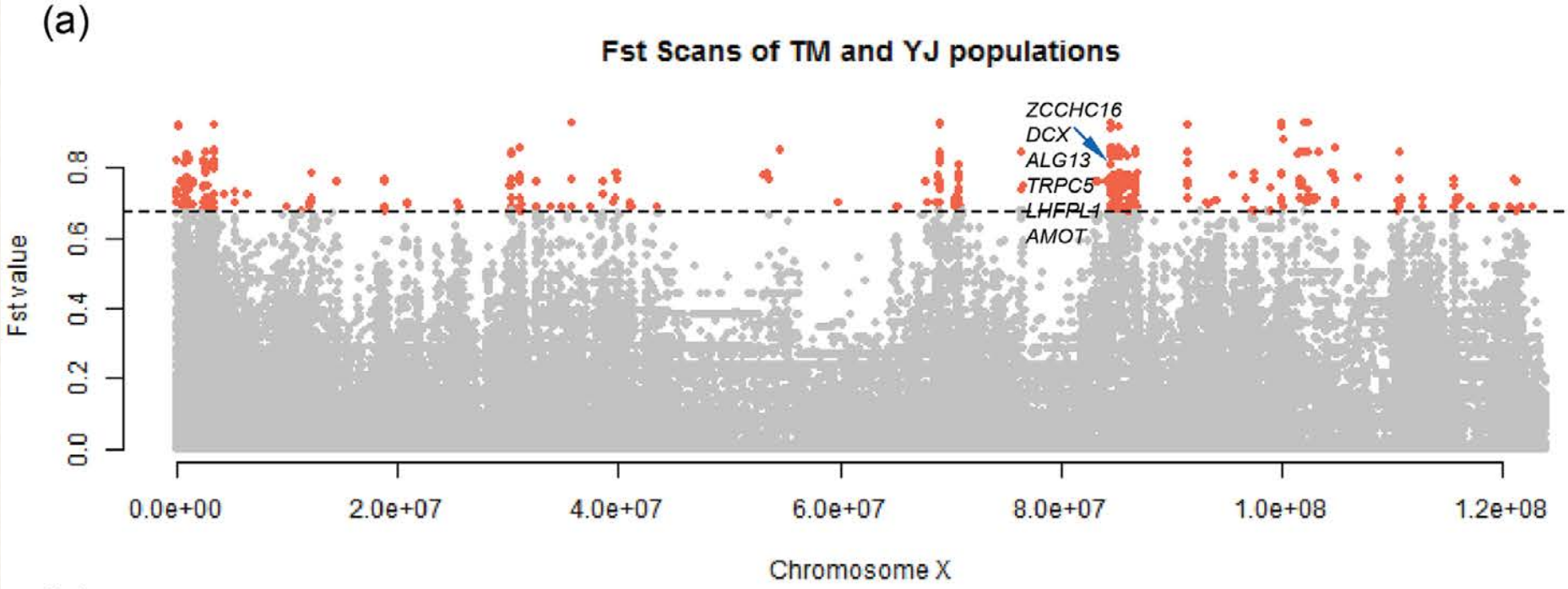
Modified from
Sabeti et al. 2006
Nature

Population differences

- F_{ST} Outlier Tests

Population differences

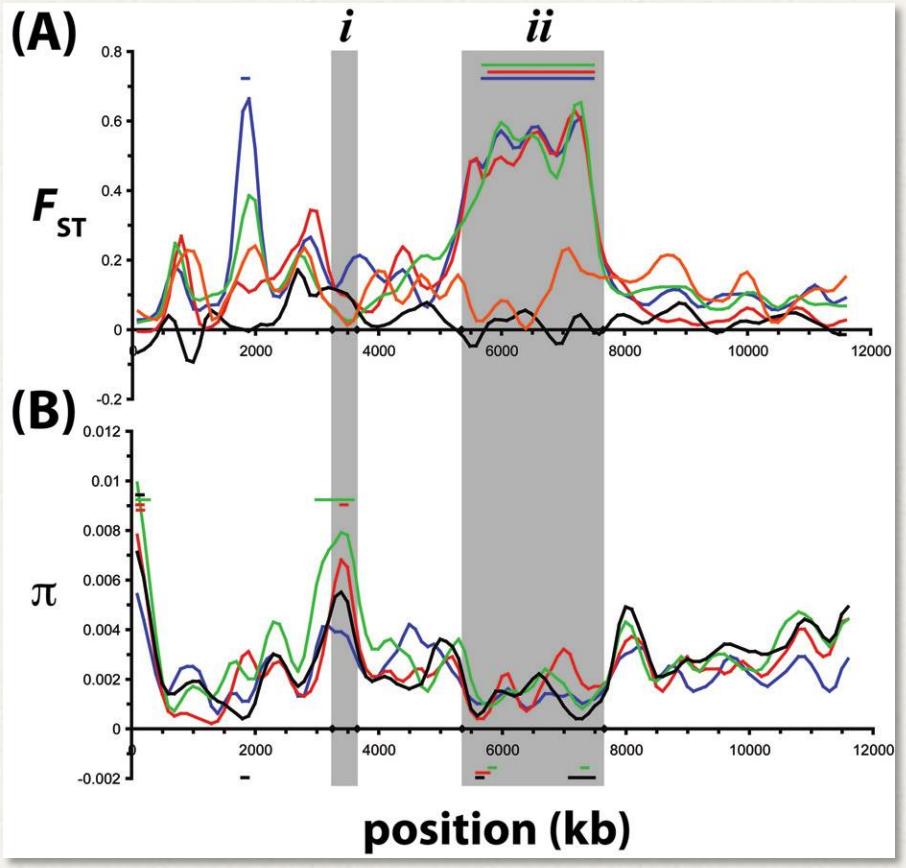
- FST Outlier Tests



Wu et al. (2016) Sci Rep

Population differences

- Joint FST and Heterozygosity distribution
  - First Proposed: Lewontin & Krakauer (1973) Genetics



Hohenlohe et al. (2010) Plos Genet

Population differences

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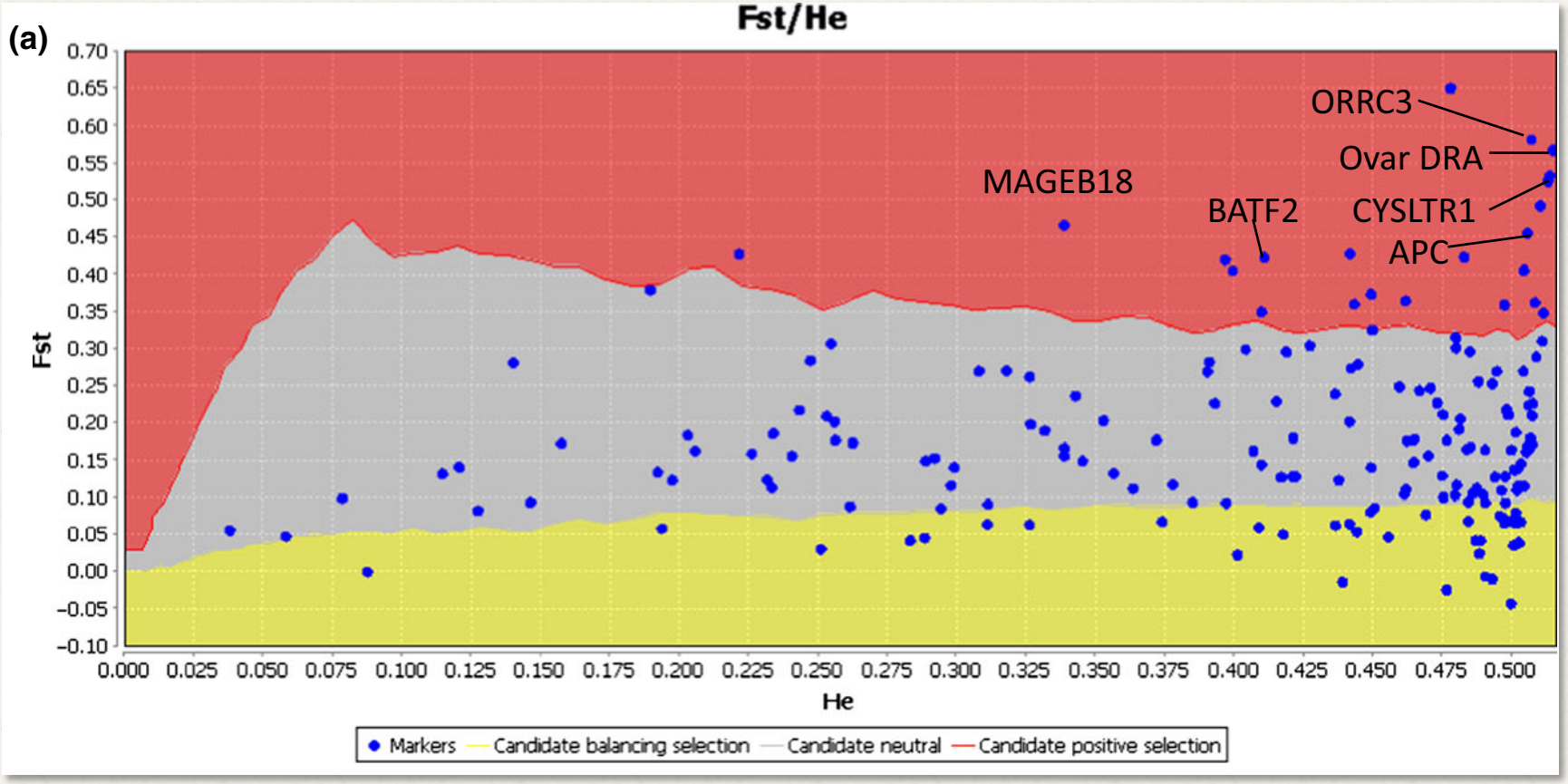
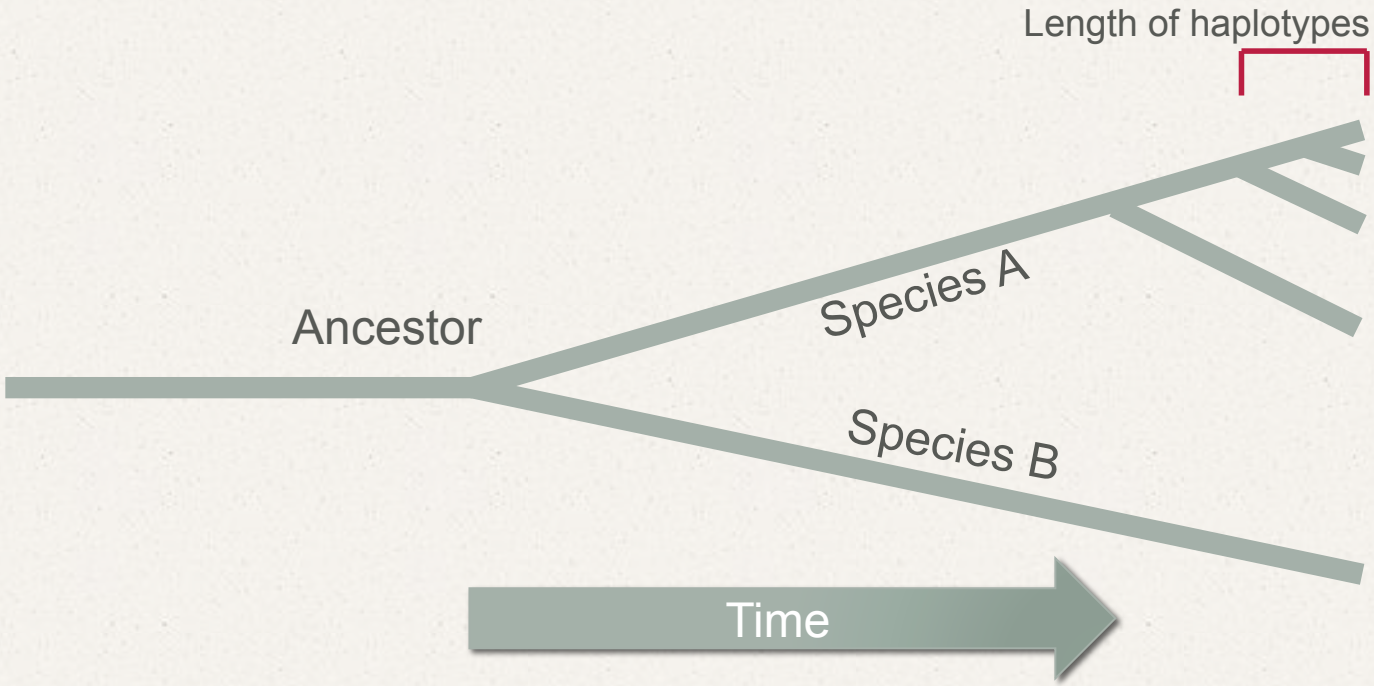


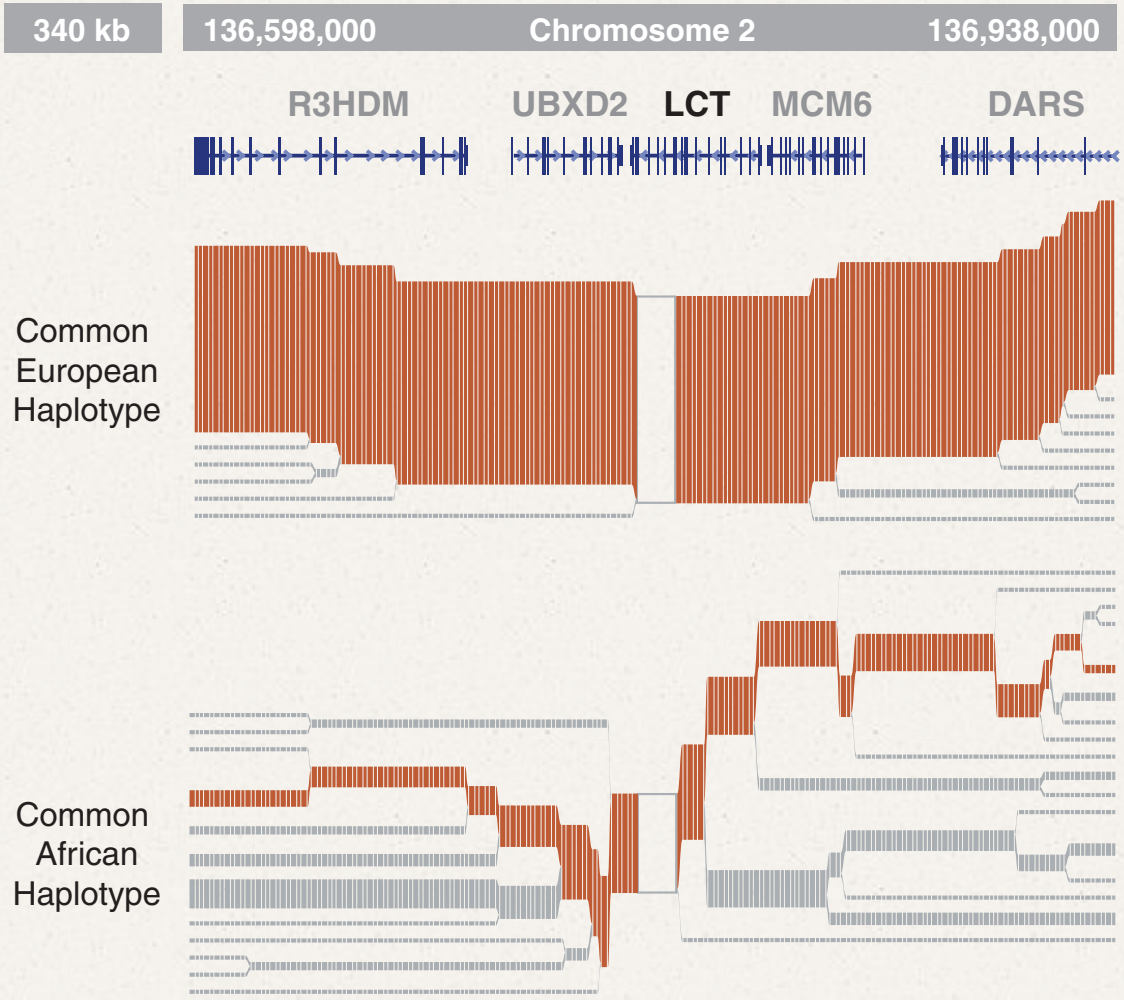
Roffler et al. (2010) Mol Ecol Res

Signatures of positive selection



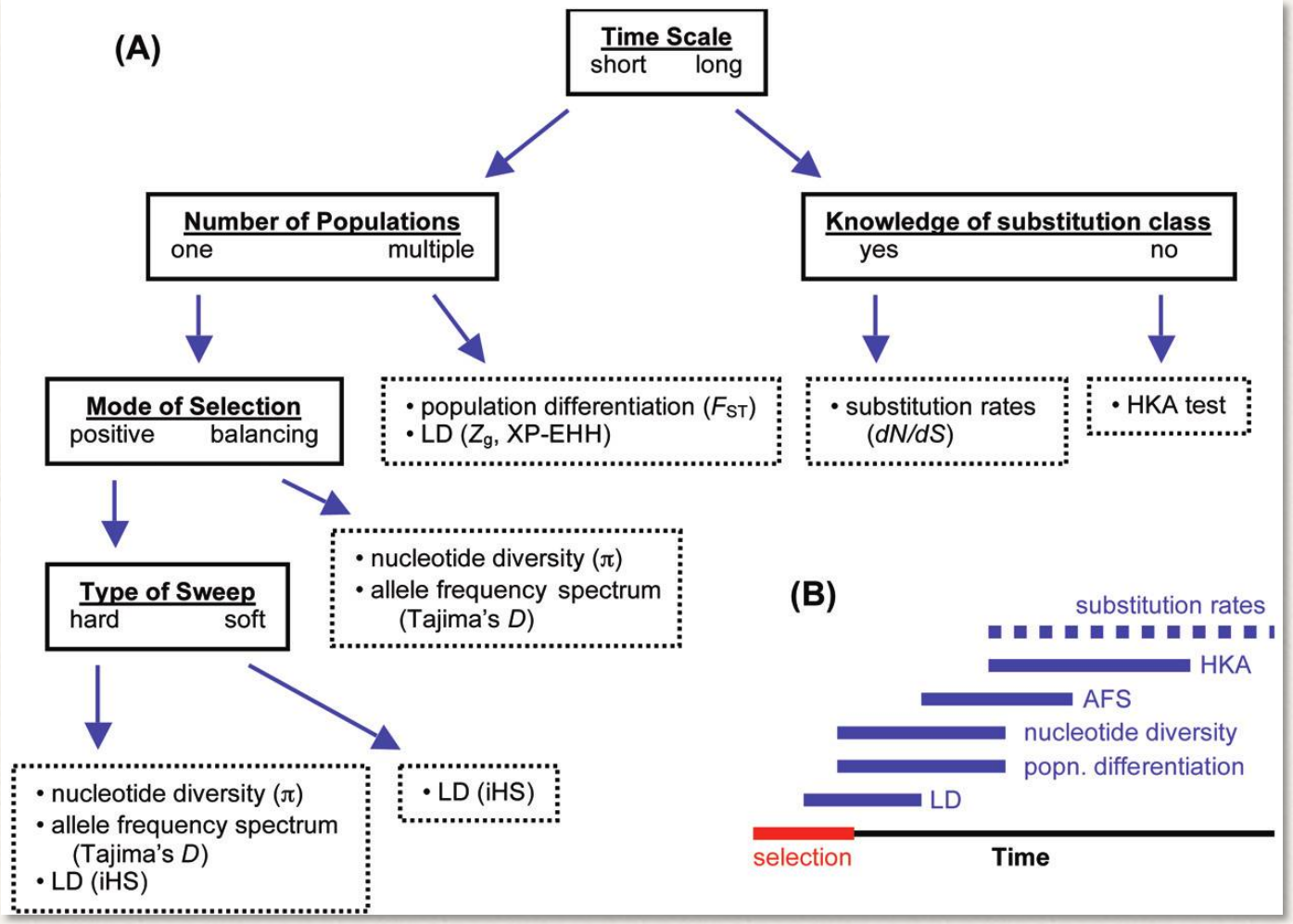
Modified from
Sabeti et al. 2006
Nature

Length of haplotypes



Bersaglieri et al. (2004) Am J Hum Genet

Decision tree for detecting selection



Hohenlohe et al. (2010) Int J Plant Sci

Disclaimers!

- Watch out for demography!!!!!!
- Species specific concerns

Cnemidophorous sp.

QUESTIONS?


WHAT, YOU GUYS NEVER HEARD OF "SURVIVAL OF THE FITTEST"?..
THE ANKLE WEIGHTS FAD WAS SHORT-LIVED
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