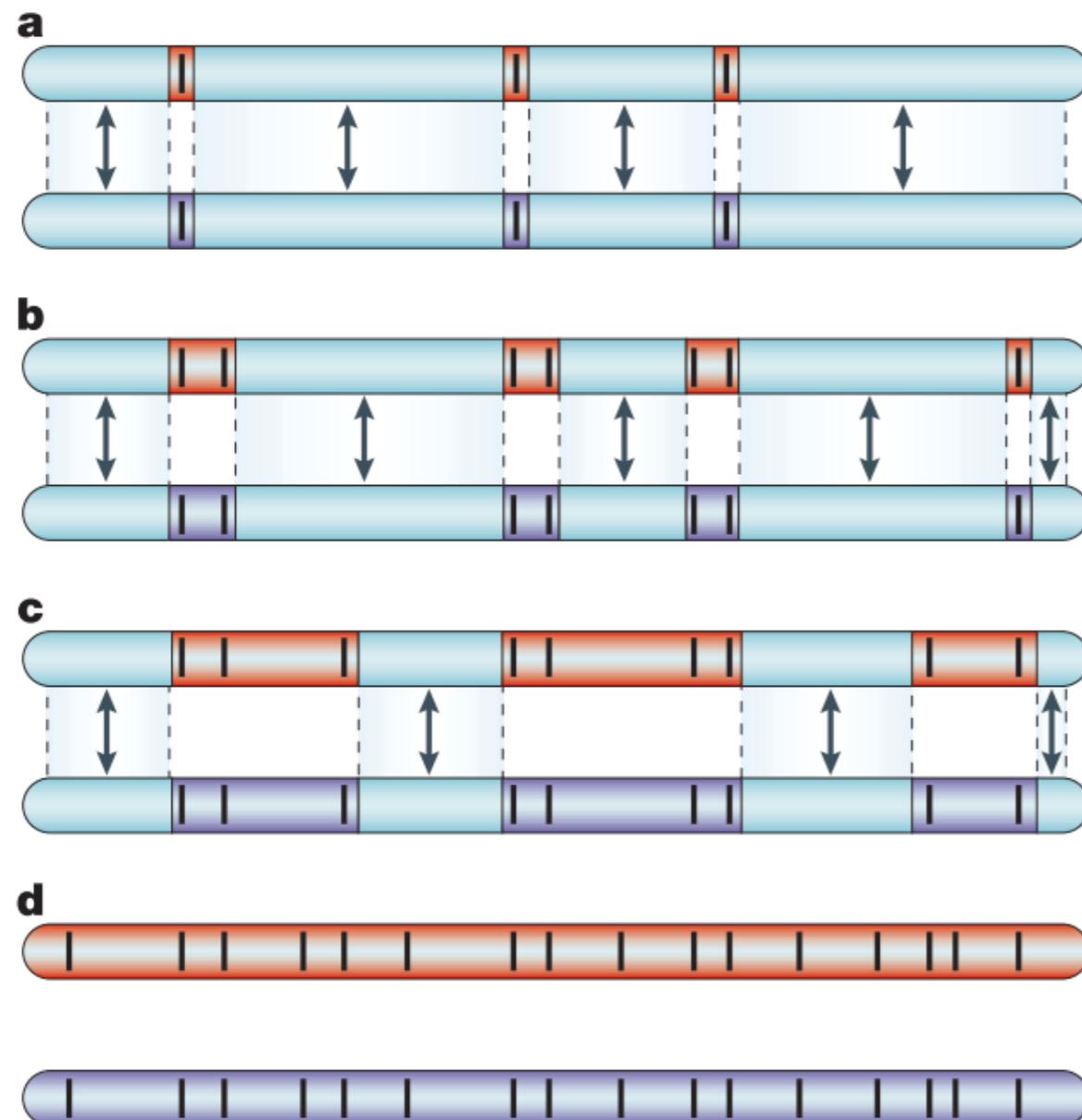




# The genic concept of speciation

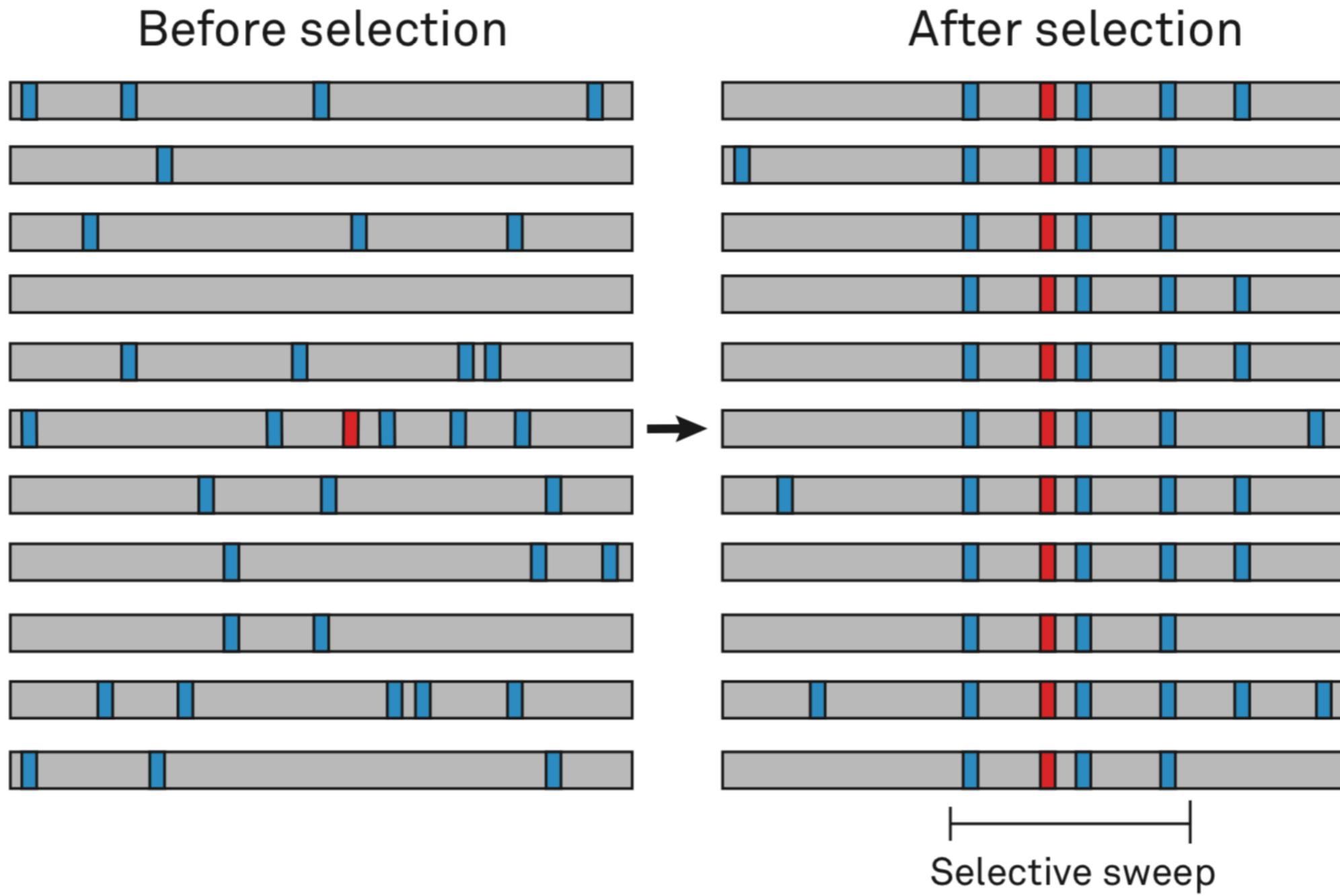


Divergent loci resist gene flow

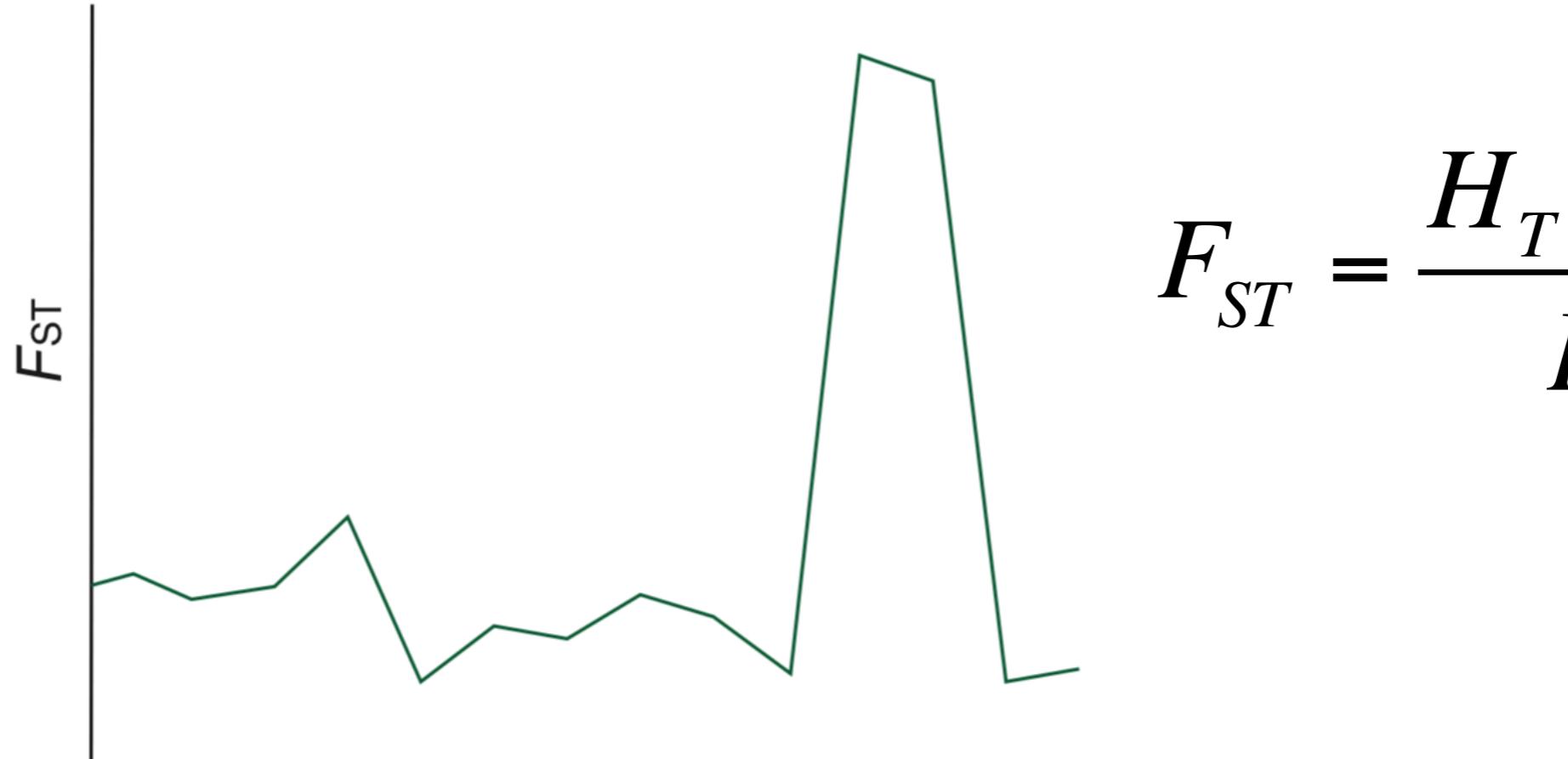
Gene flow continues but  
linkage builds and divergent  
regions grow

Complete reproductive  
isolation evolves

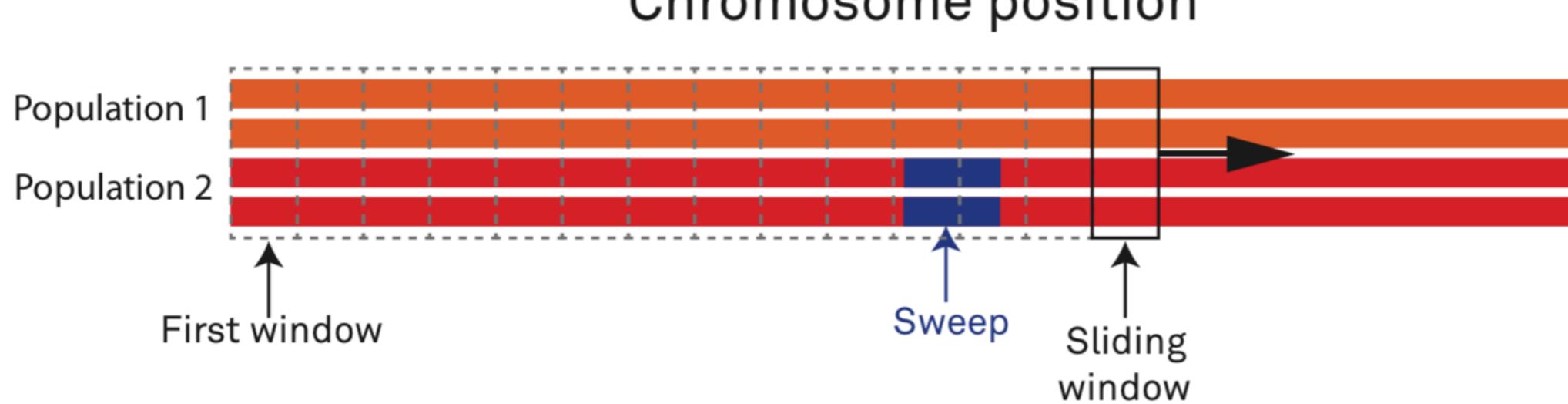
# A simplified selective sweep



# Sliding window estimates to detect selection

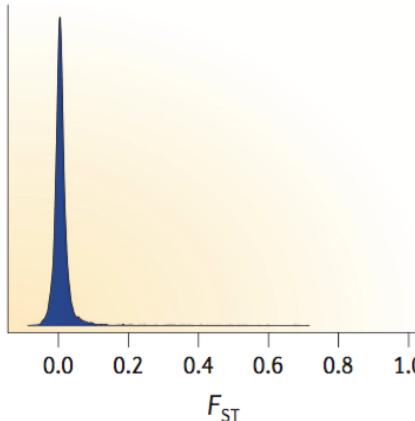


$$F_{ST} = \frac{H_T - H_S}{H_T}$$

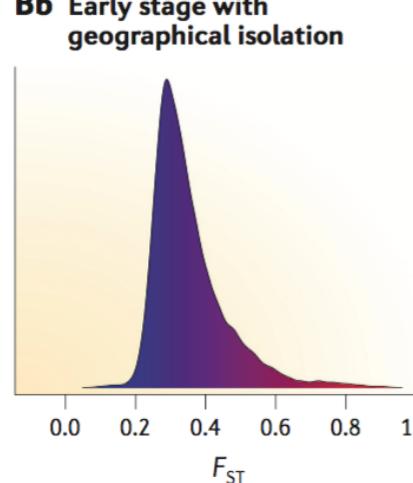


# Continuums and islands

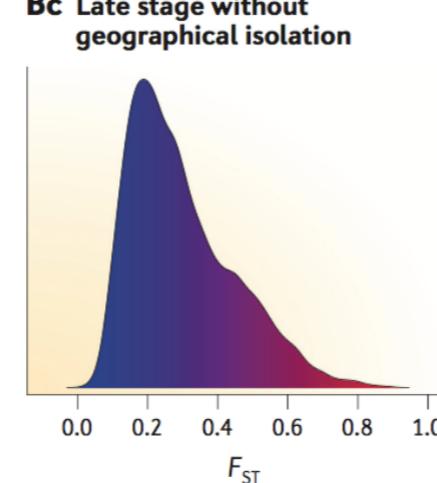
**Ba** Early stage without geographical isolation



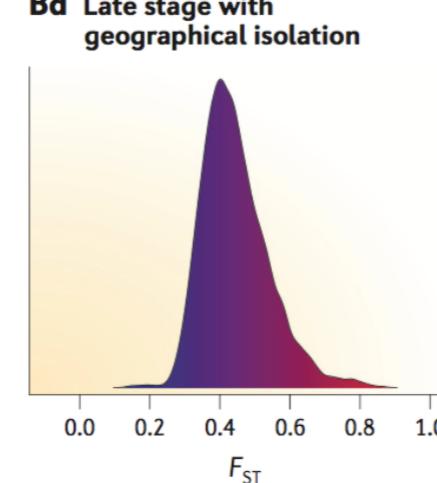
**Bb** Early stage with geographical isolation



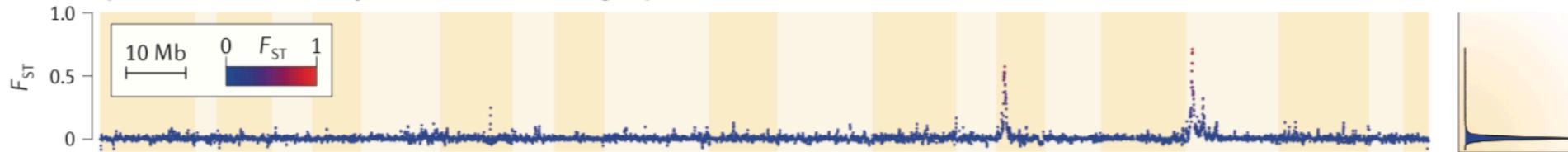
**Bc** Late stage without geographical isolation



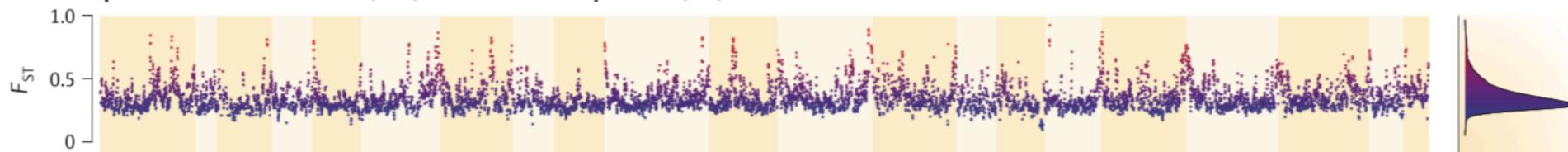
**Bd** Late stage with geographical isolation



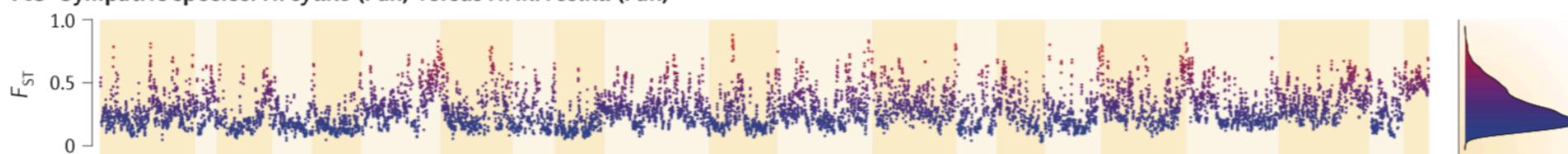
**Aa** Parapatric races: *H. m. amaryllis* (Per) versus *H. m. aglaope* (Per)



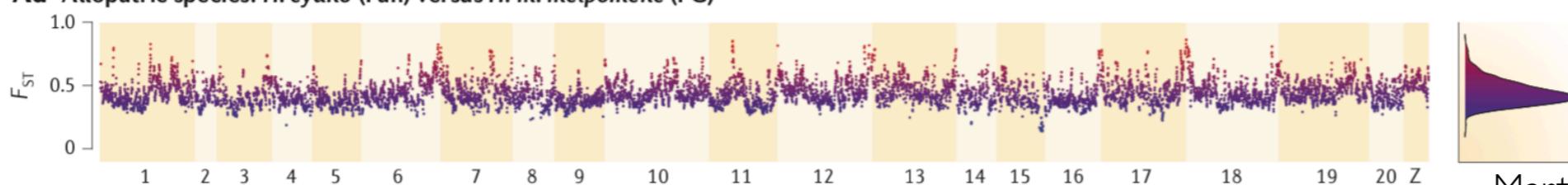
**Ab** Allopatric races: *H. m. rosina* (Pan) versus *H. m. melpomene* (FG)



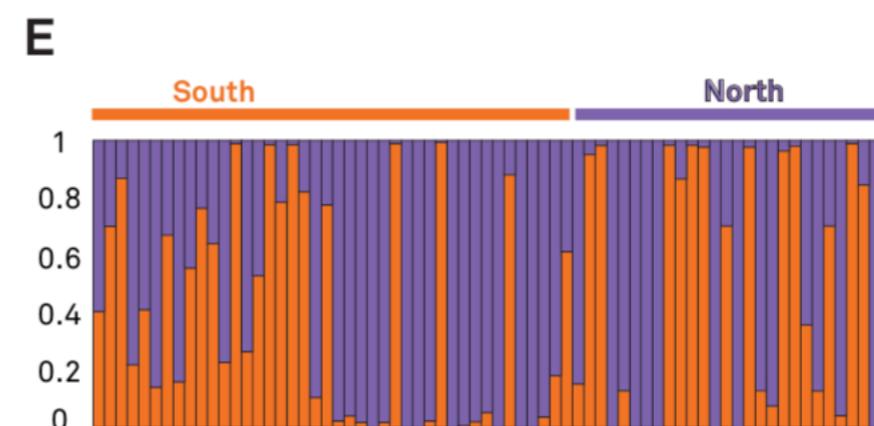
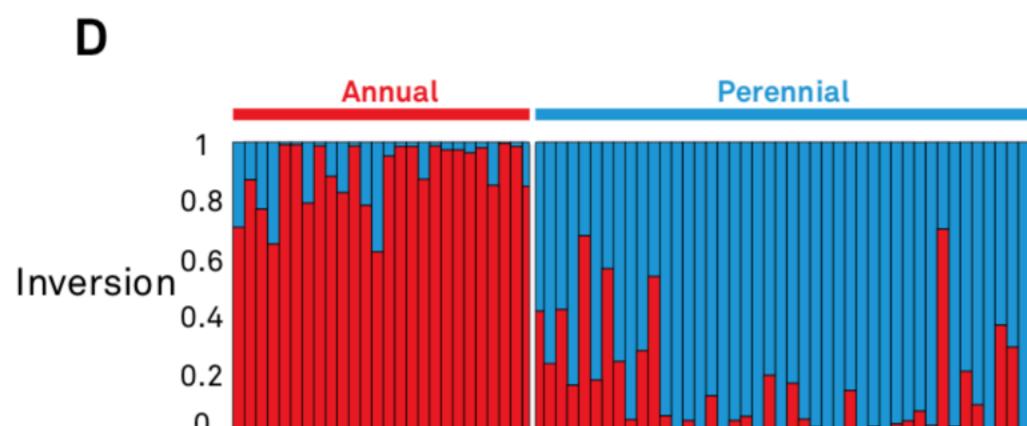
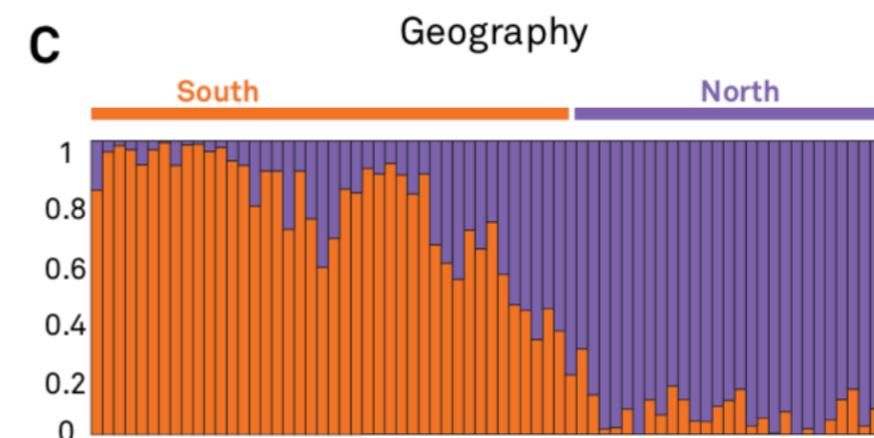
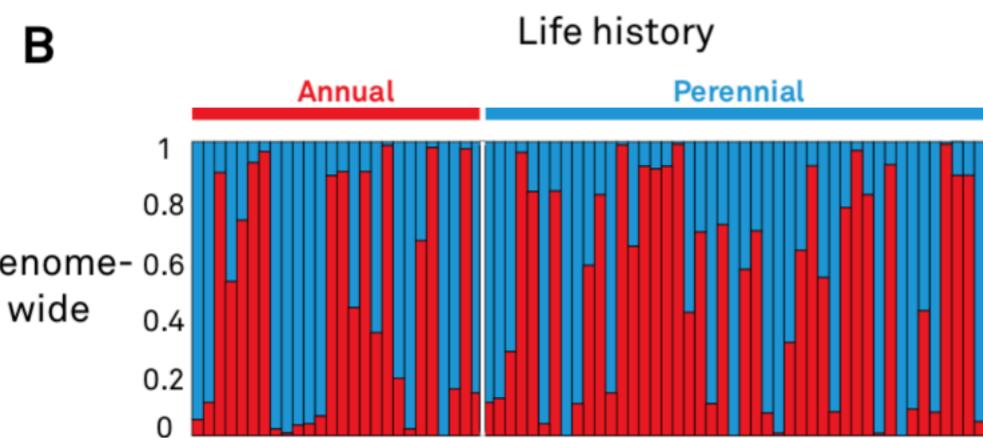
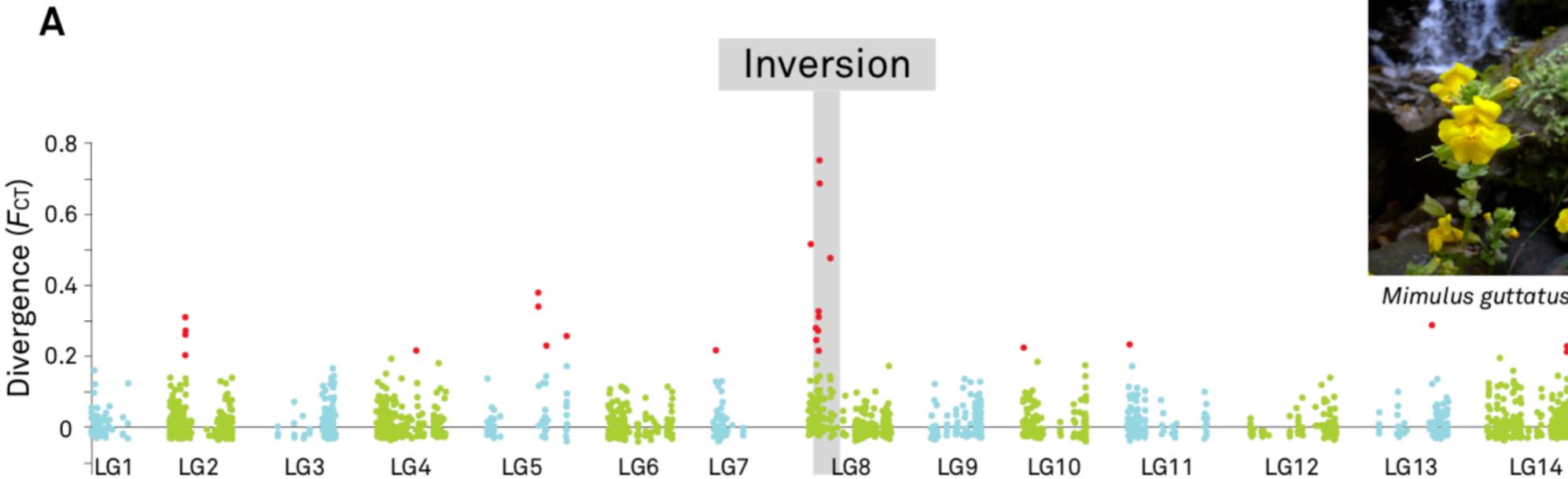
**Ac** Sympatric species: *H. cydno* (Pan) versus *H. m. rosina* (Pan)



**Ad** Allopatric species: *H. cydno* (Pan) versus *H. m. melpomene* (FG)

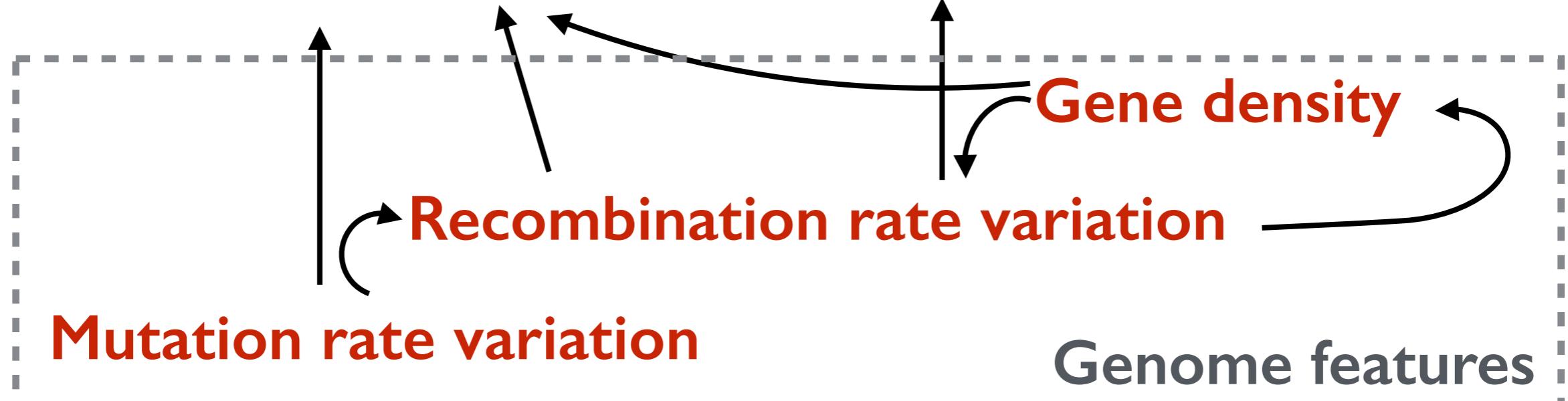
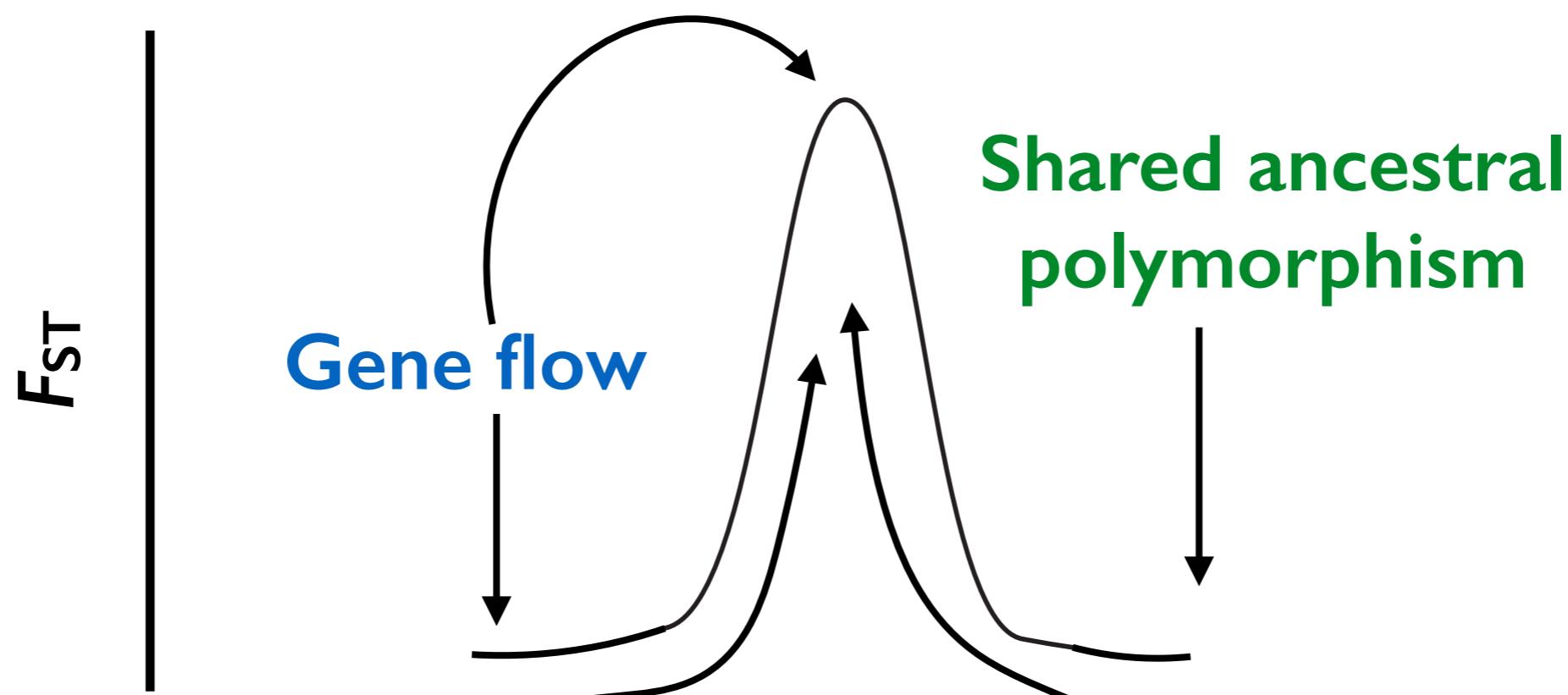


# Signatures of selection and speciation

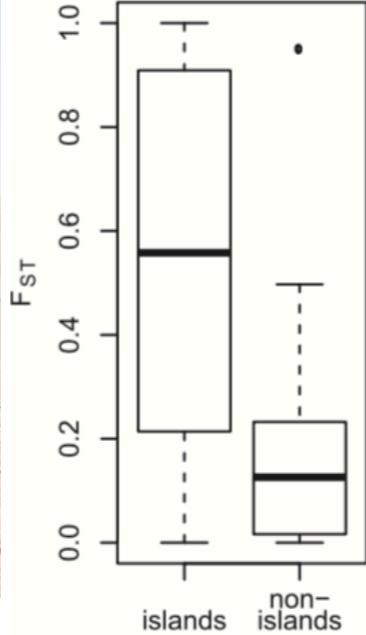


# Confounding factors

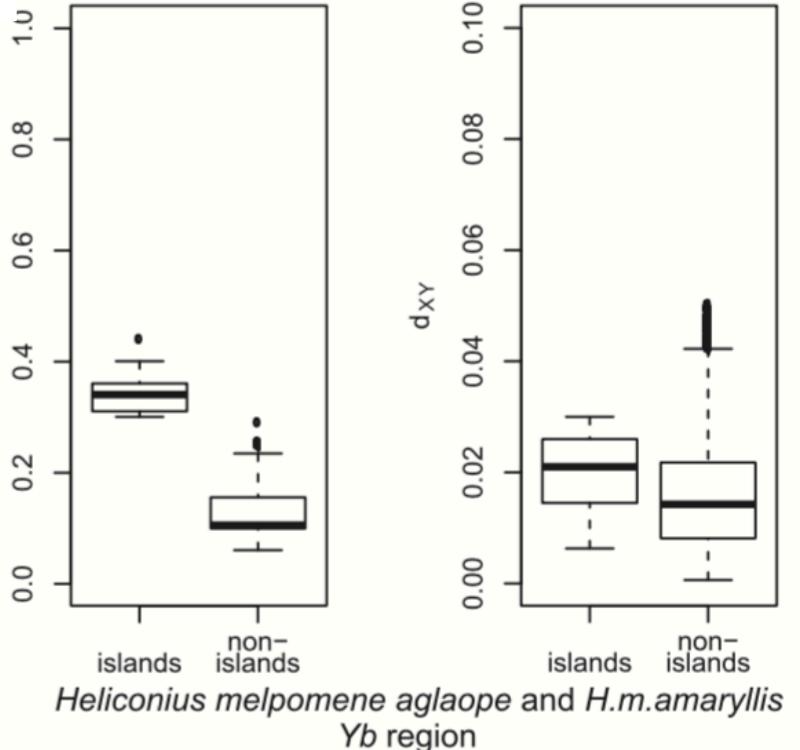
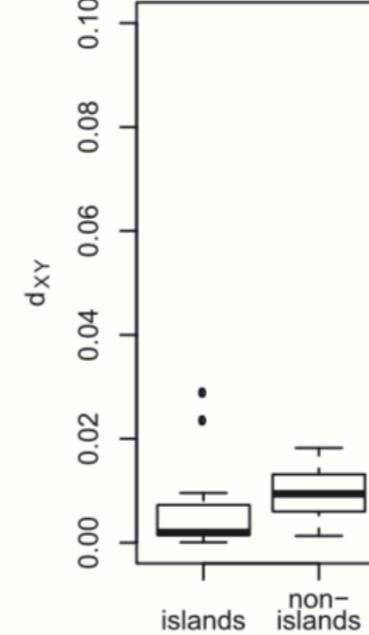
Demographic history



# Mirages and alternative explanations



*Anopheles coluzzii* and *A. gambiae*



*Heliconius melpomene aglaope* and *H.m. amaryllis*  
Yb region

- Background selection
- Local adaptation after isolation
- Shared ancestral polymorphism

Noor & Bennett (2008) **Heredity**  
Cruickshank & Hahn (2014) **Mol Ecol**

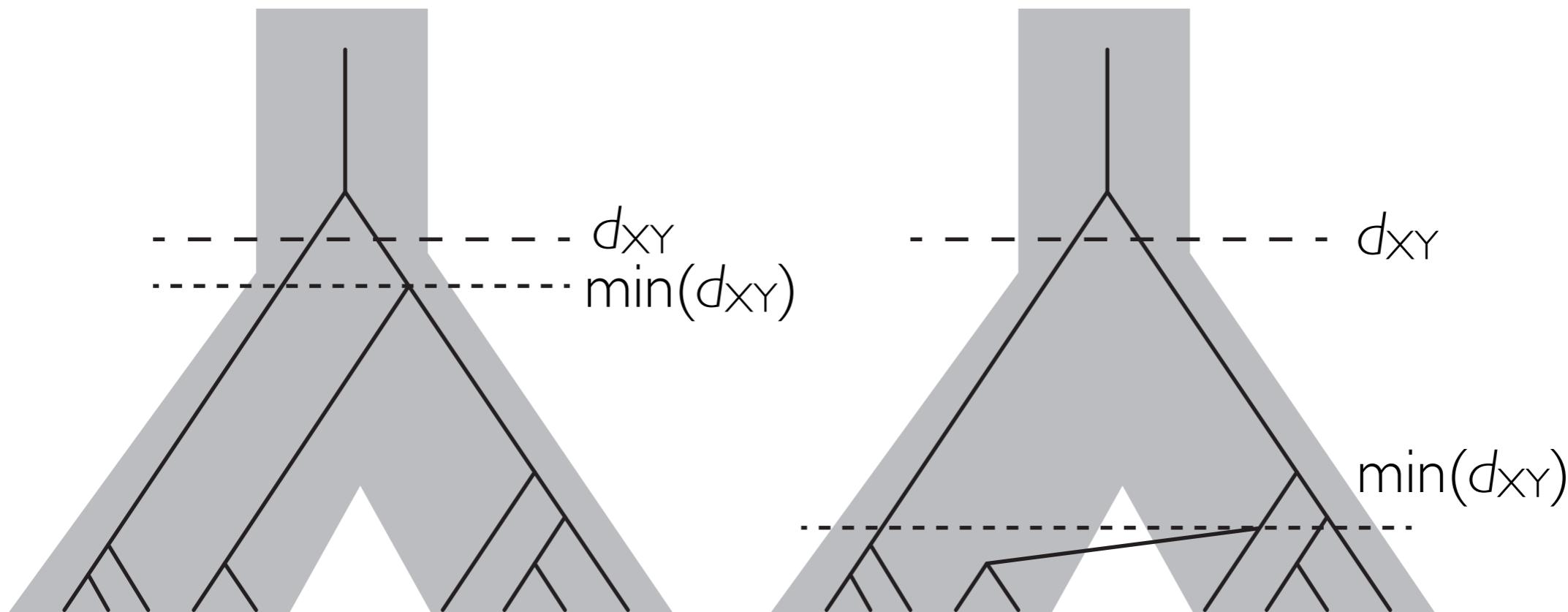
# Absolute measures of divergence

$$d_{XY} = \sum_{ij} x_i y_j d_{ij}$$

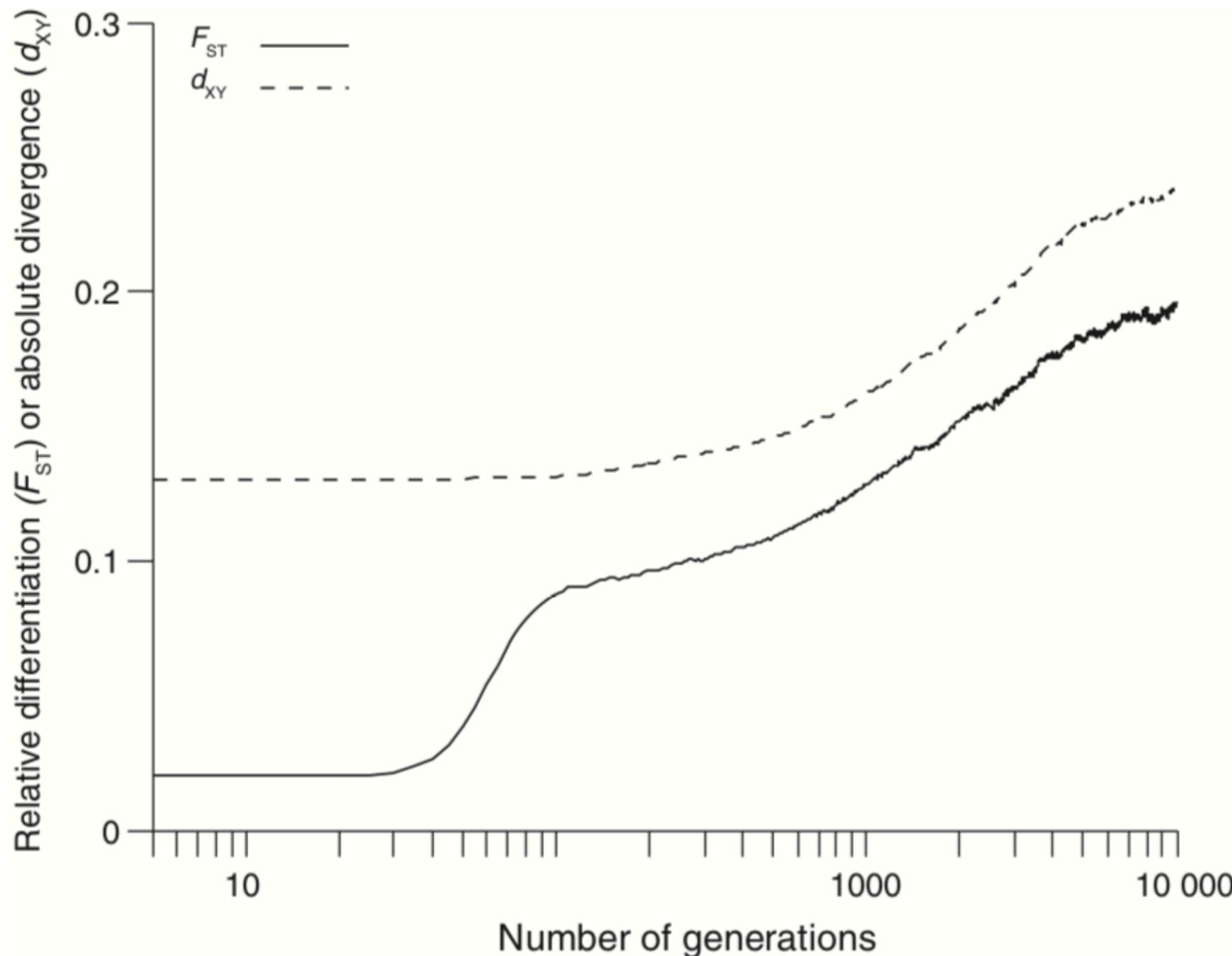
Average number of pairwise differences between two populations

Pop A	Pop B
ACTGTC	ATTAGC
ATTGTC	ACTGGC
ACTGTC	ACTAGC
ATTGTC	ATTAGC

Here  $d_{XY}$  is  
0.375



# Lag time between measures



# Linked selection and recombination

