

Molecular coevolution

Steve Paterson

Host-parasite interactions

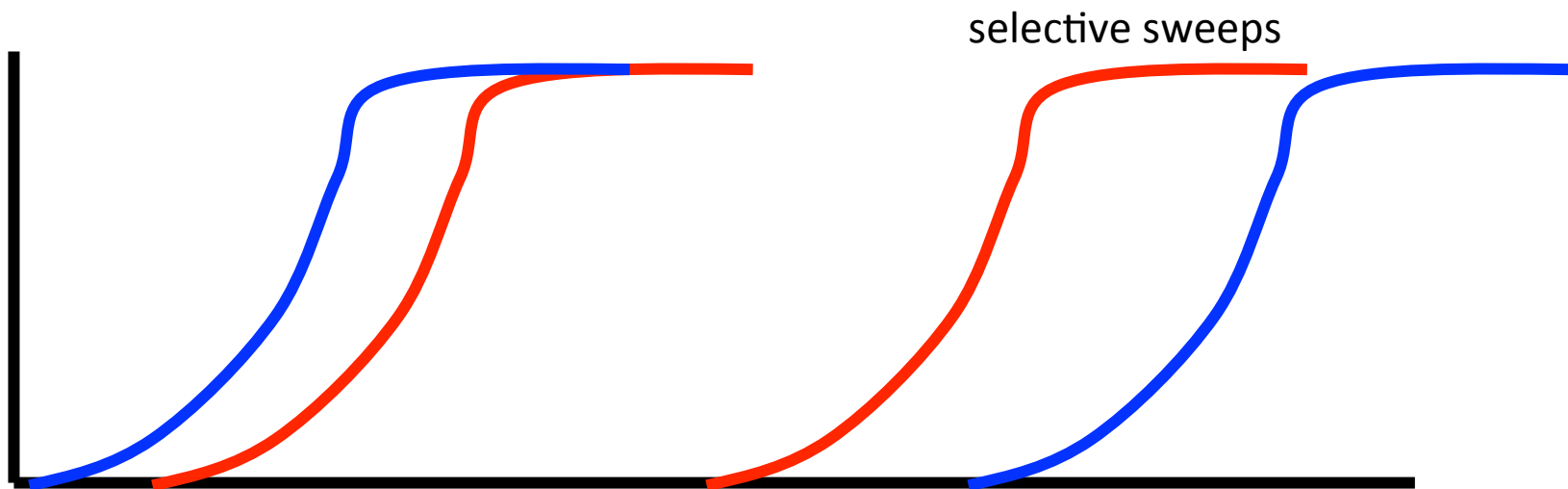
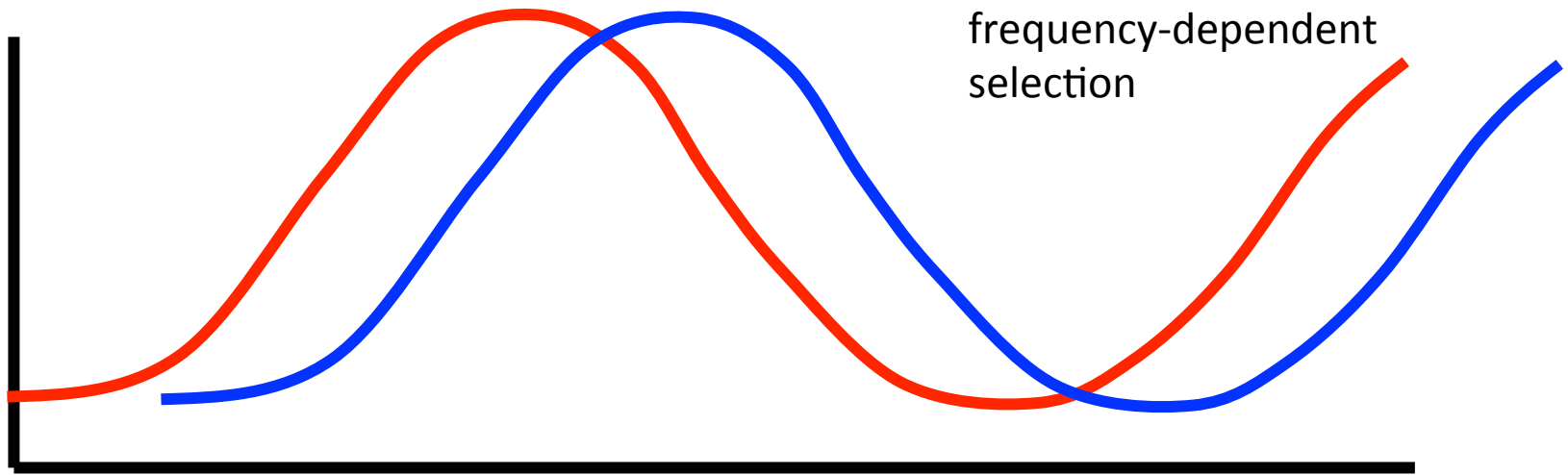
- Drive diversity within species
- Drive divergence between species

JBS Haldane

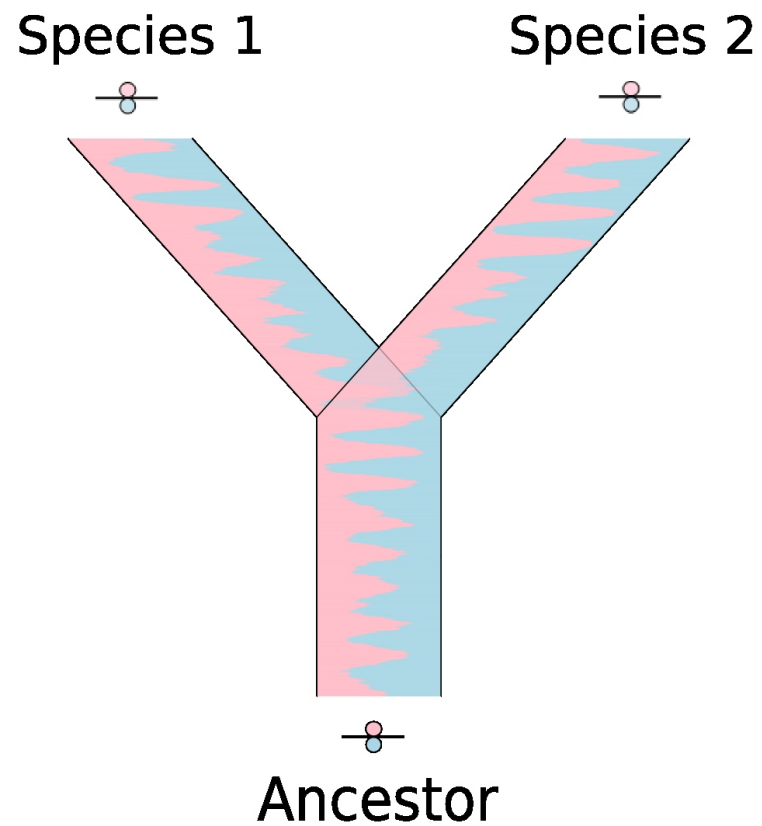


Haldane 1949 – Disease and Evolution

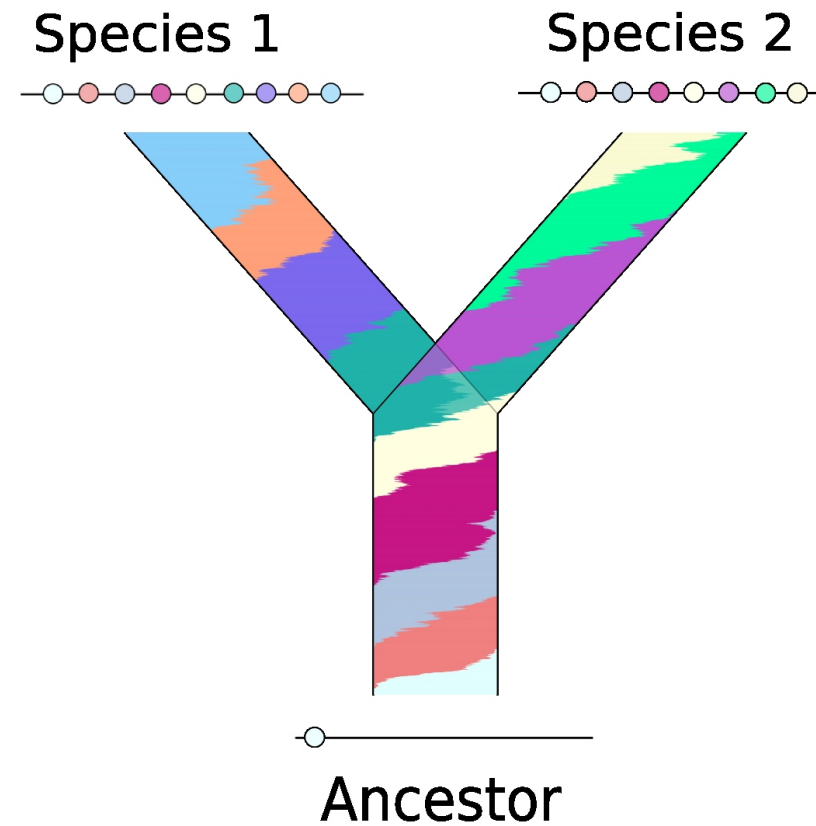
- ‘genetical diversity as regards resistance to disease is vastly greater than that regards resistance to predators’
- ‘it is much easier for a mouse to get a set of genes which enable it to resist *Bacillus typhi murium* than a set which enable it to resist cats’
 - Reprinted in ‘Evolution’ Mark Ridley



(a) Fluctuating selection

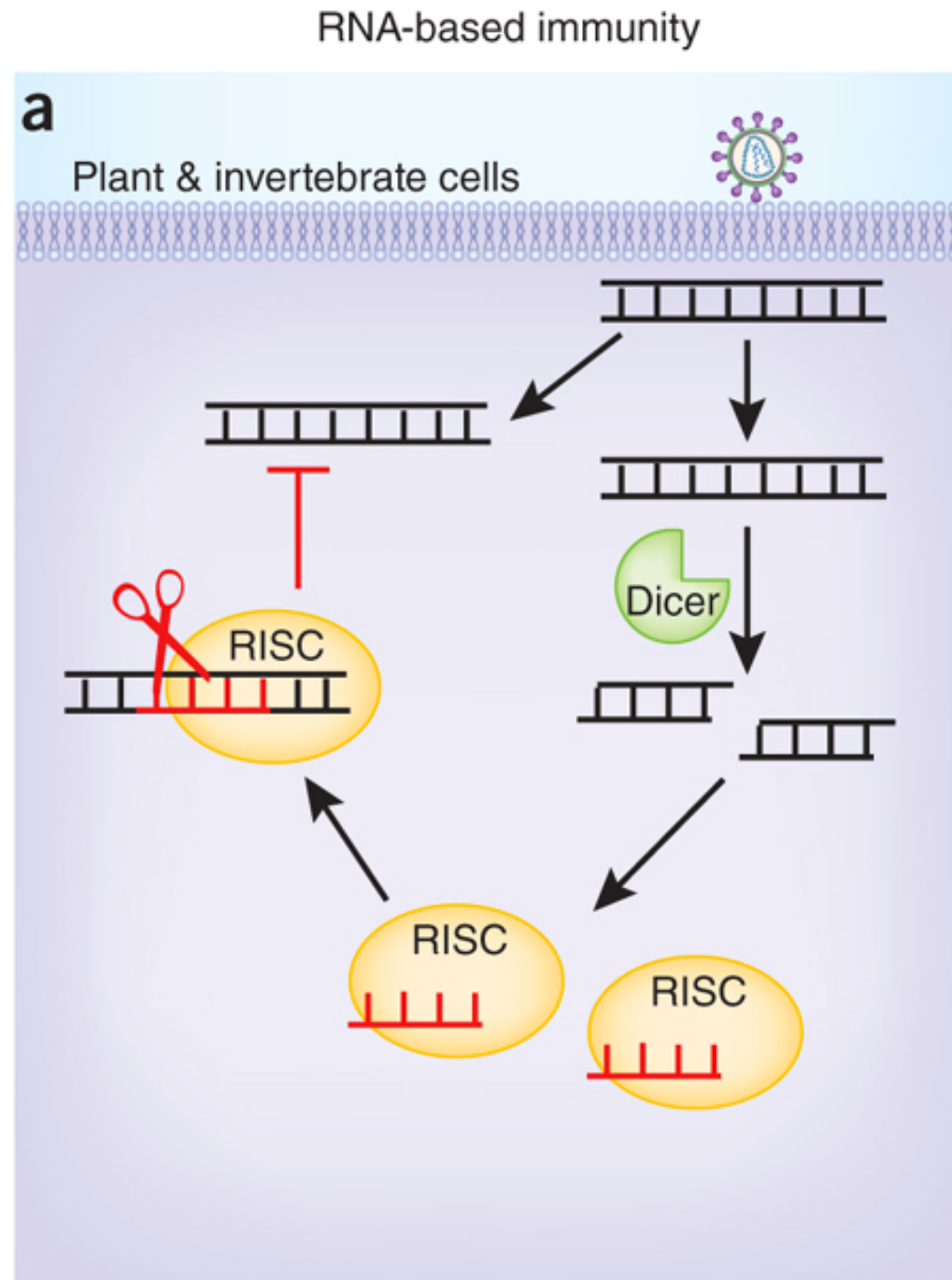


(b) Directional selection

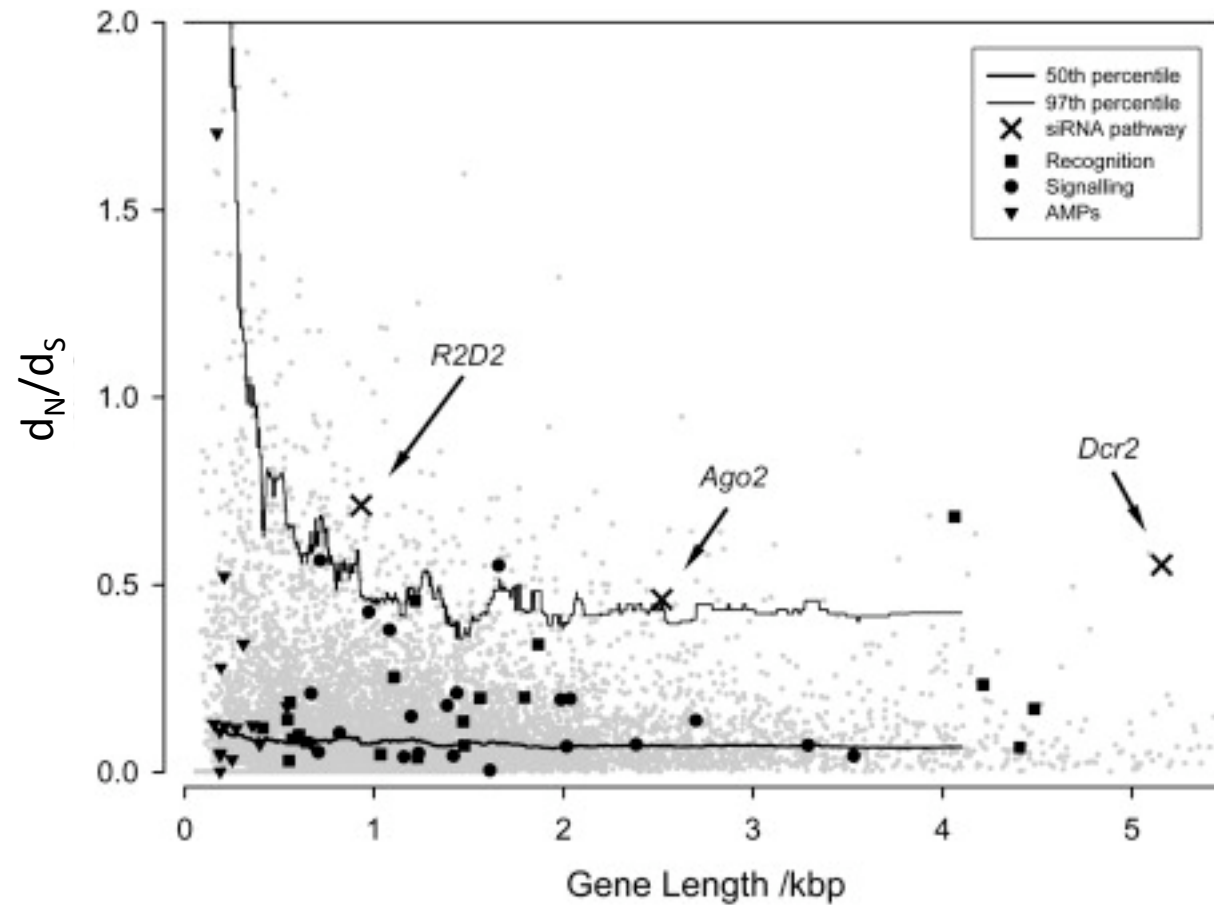


Anti-viral immunity in *Drosophila*

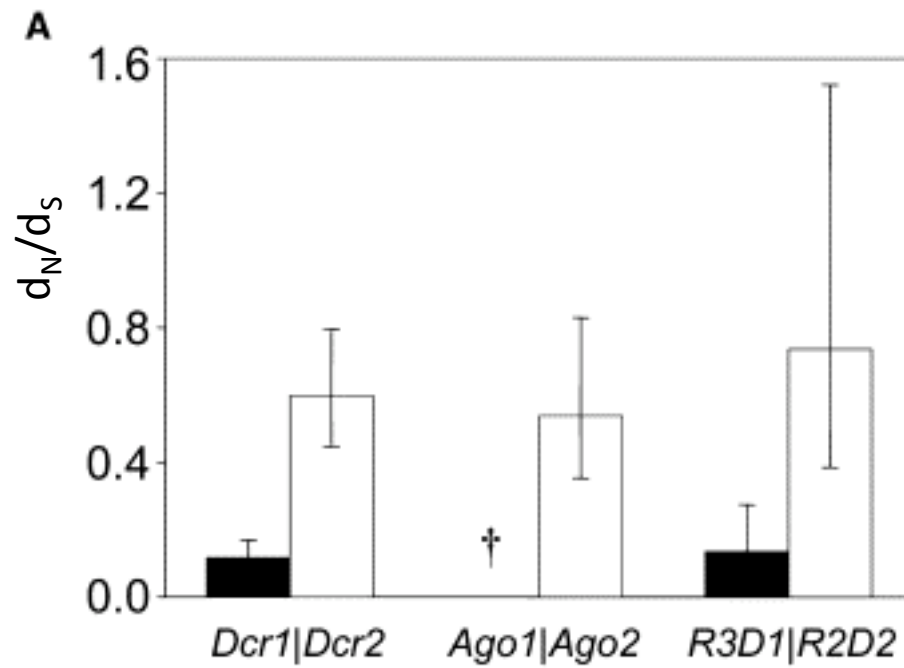
Yan and Chen (2012)
Nature Immunology 13, 214–222



Evolution of anti-viral genes in *Drosophila*

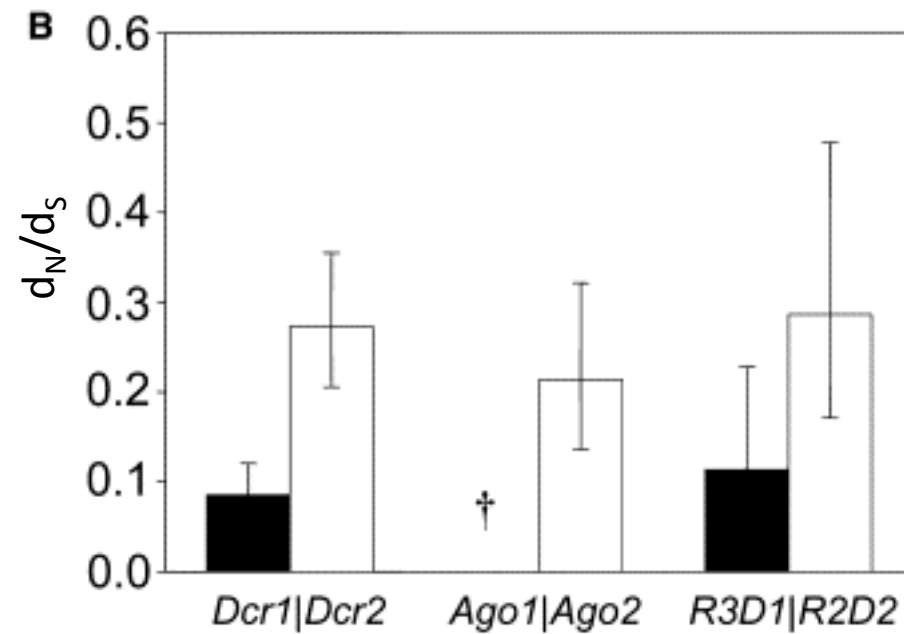


Obbard et al (2006) Current Biology 16: 580-585



Comparison of anti-viral genes (open bars) with their housekeeping paralogs (black bars)

D. melanogaster and *D. simulans*

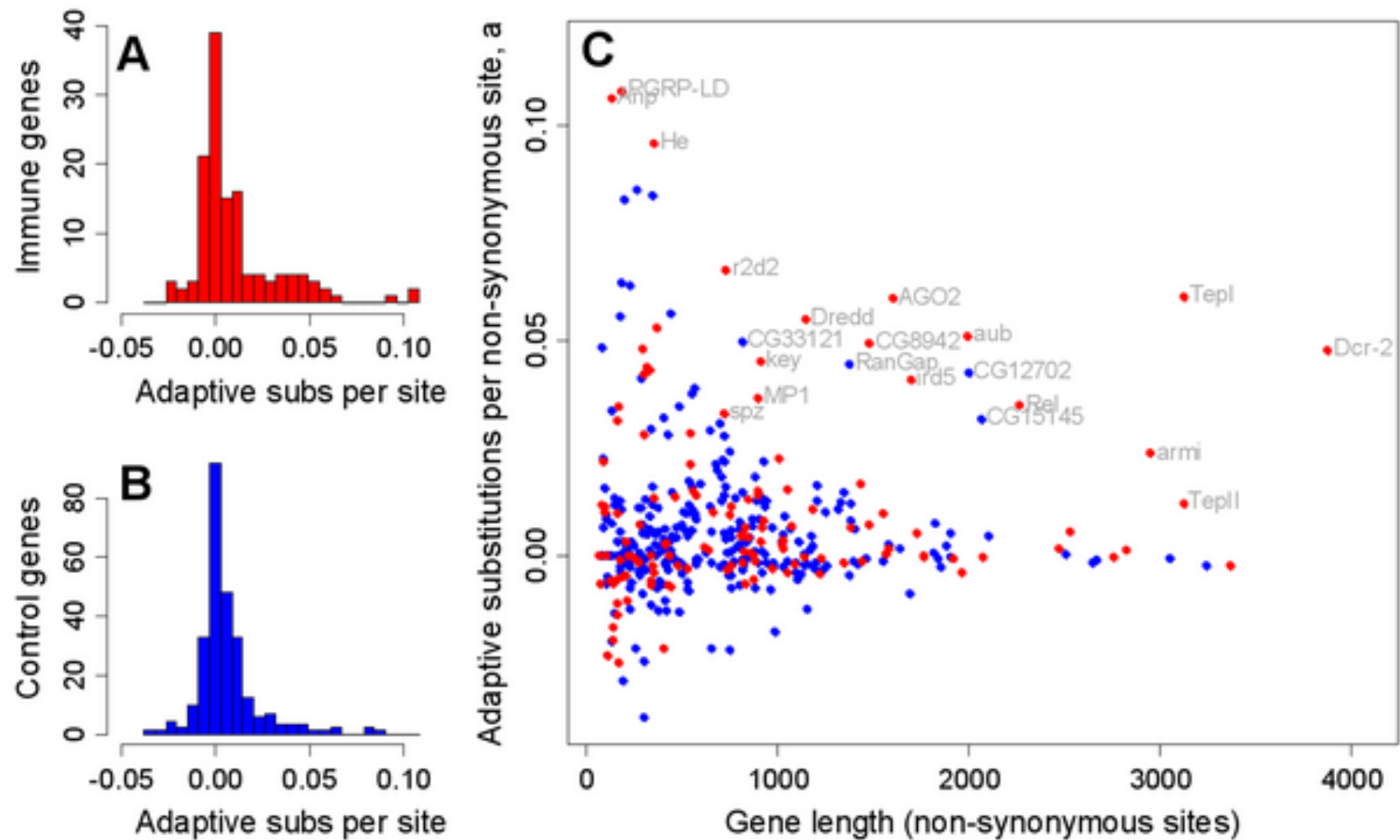


D. yakuba and *D. erecta*

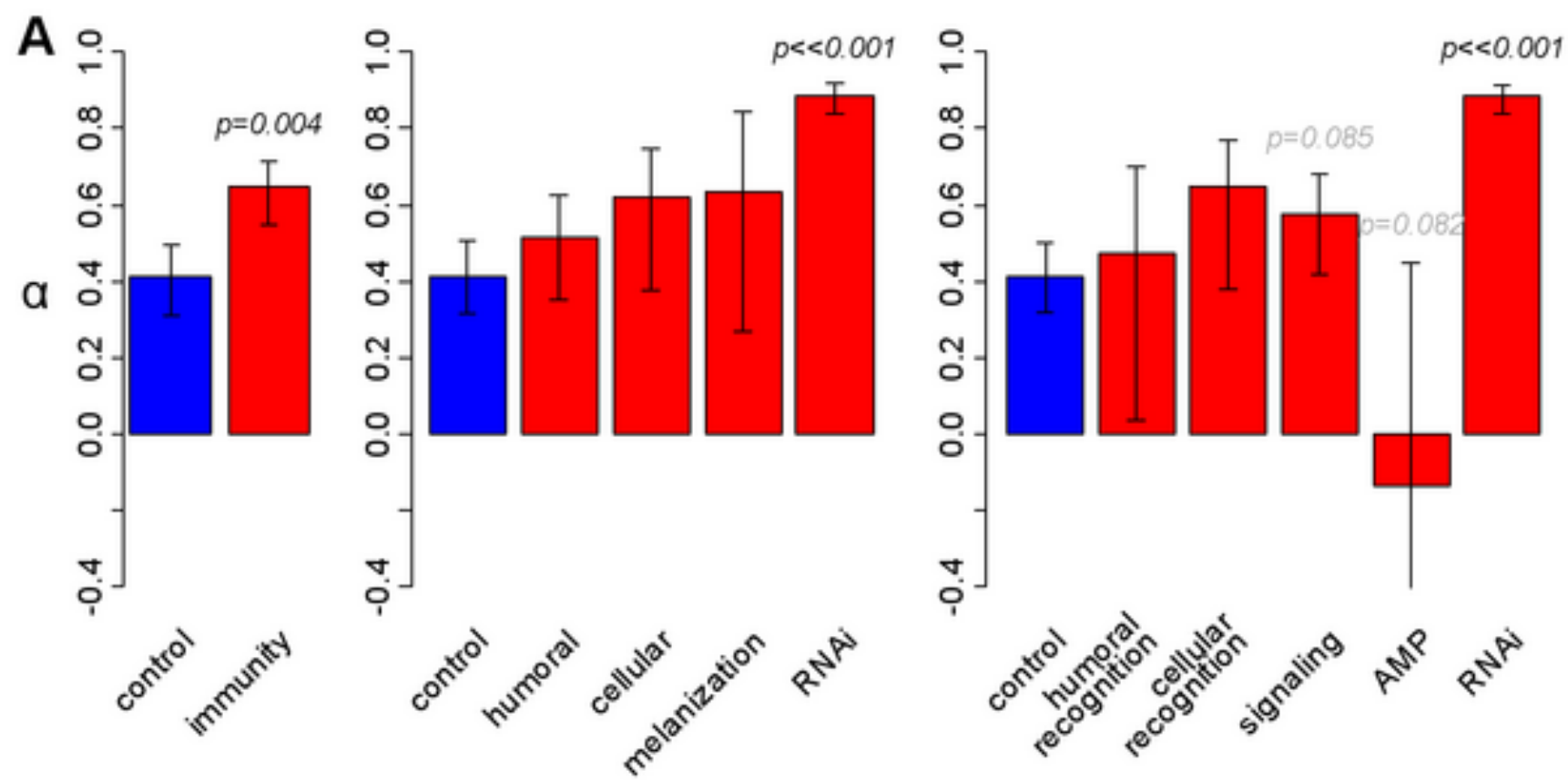
Polymorphism vs divergence

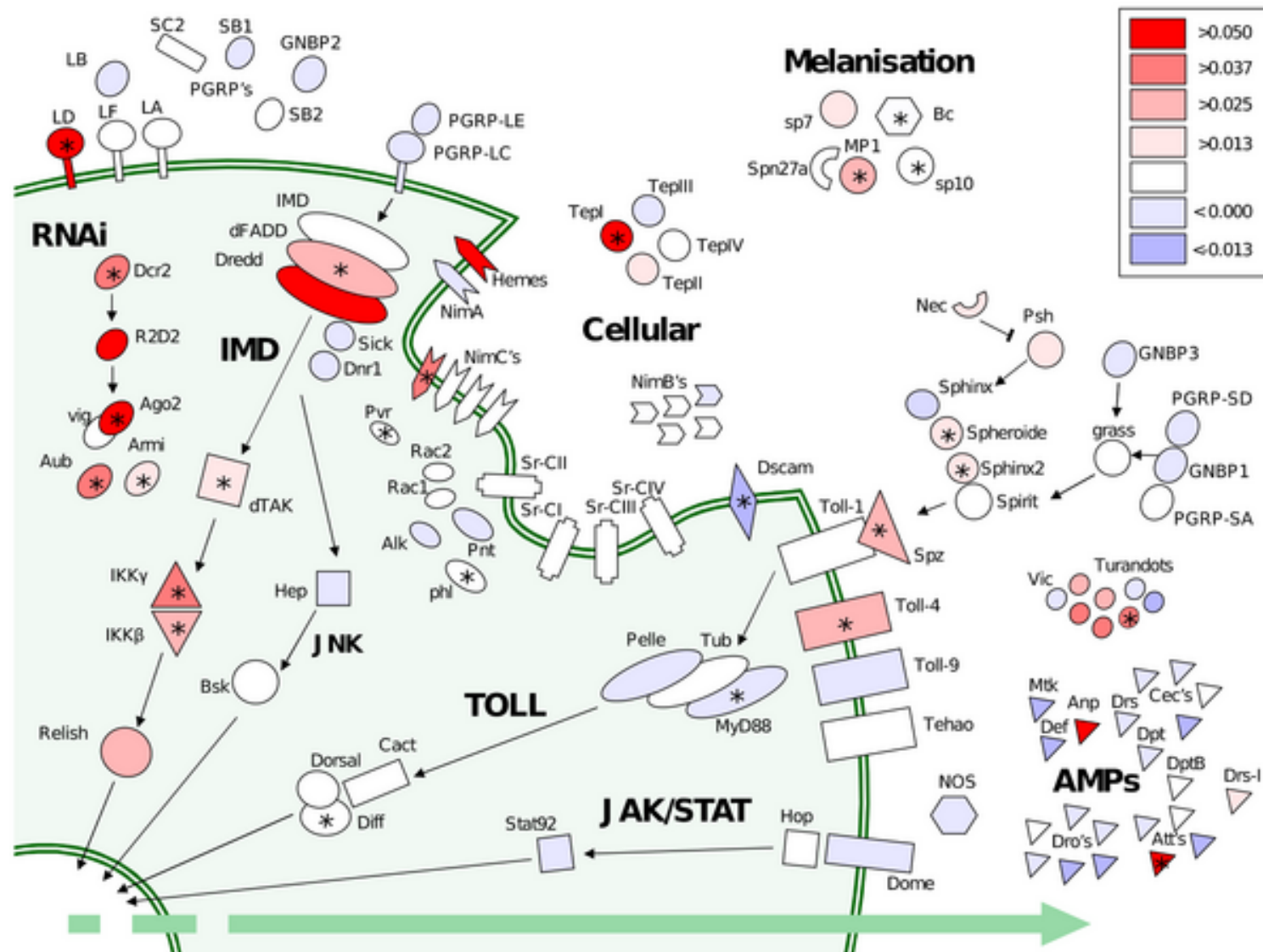
- Can use polymorphism within a species to generate null hypothesis for divergence between species
- Null hypothesis
(MacDonald-Kreitman)

$$\frac{D_N}{D_S} = \frac{P_N}{P_S}$$



Obbard et al (2009) Quantifying adaptive evolution in the *Drosophila* immune system
PlosGenetics 5: e10000698



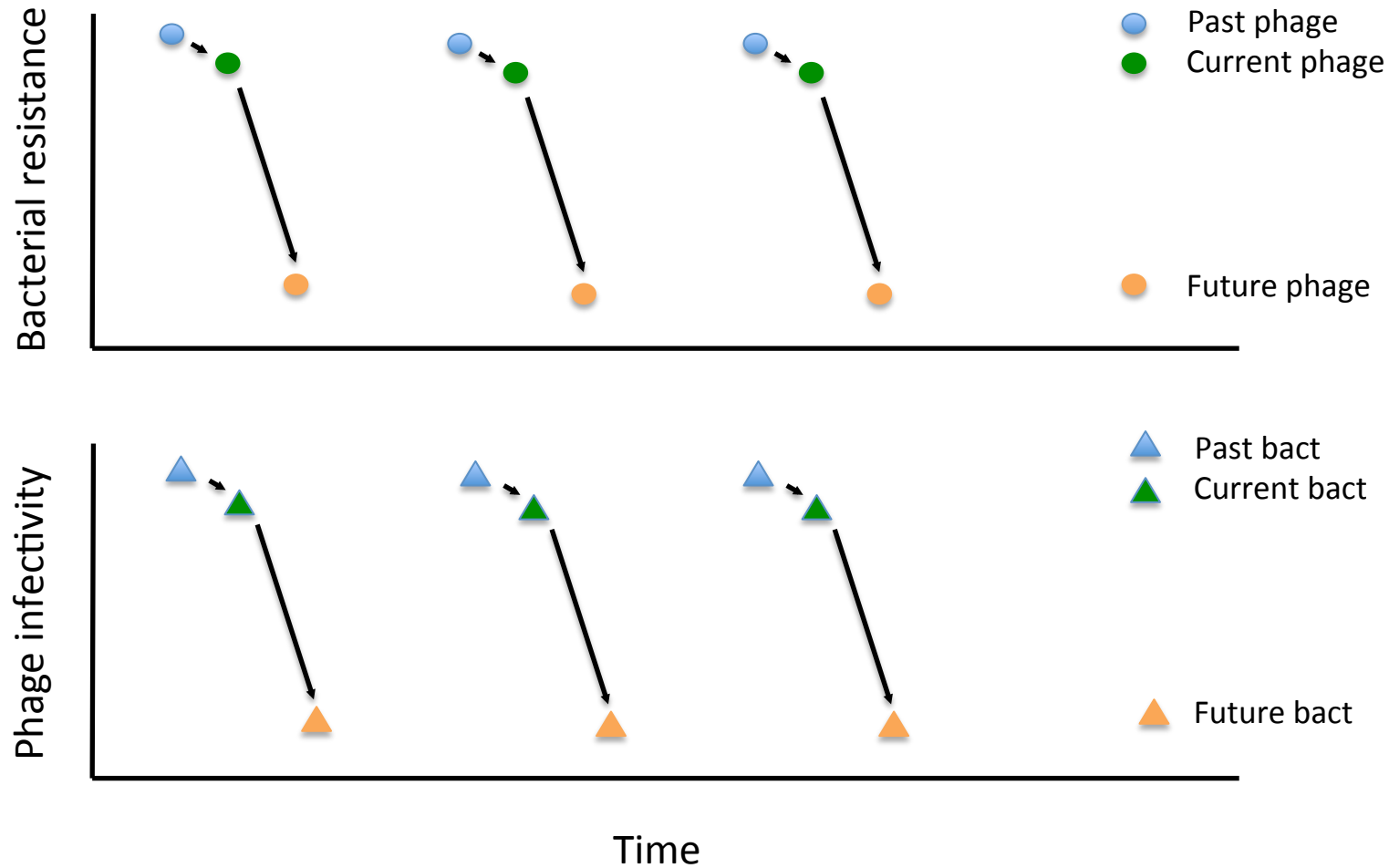


Red Queen Theory

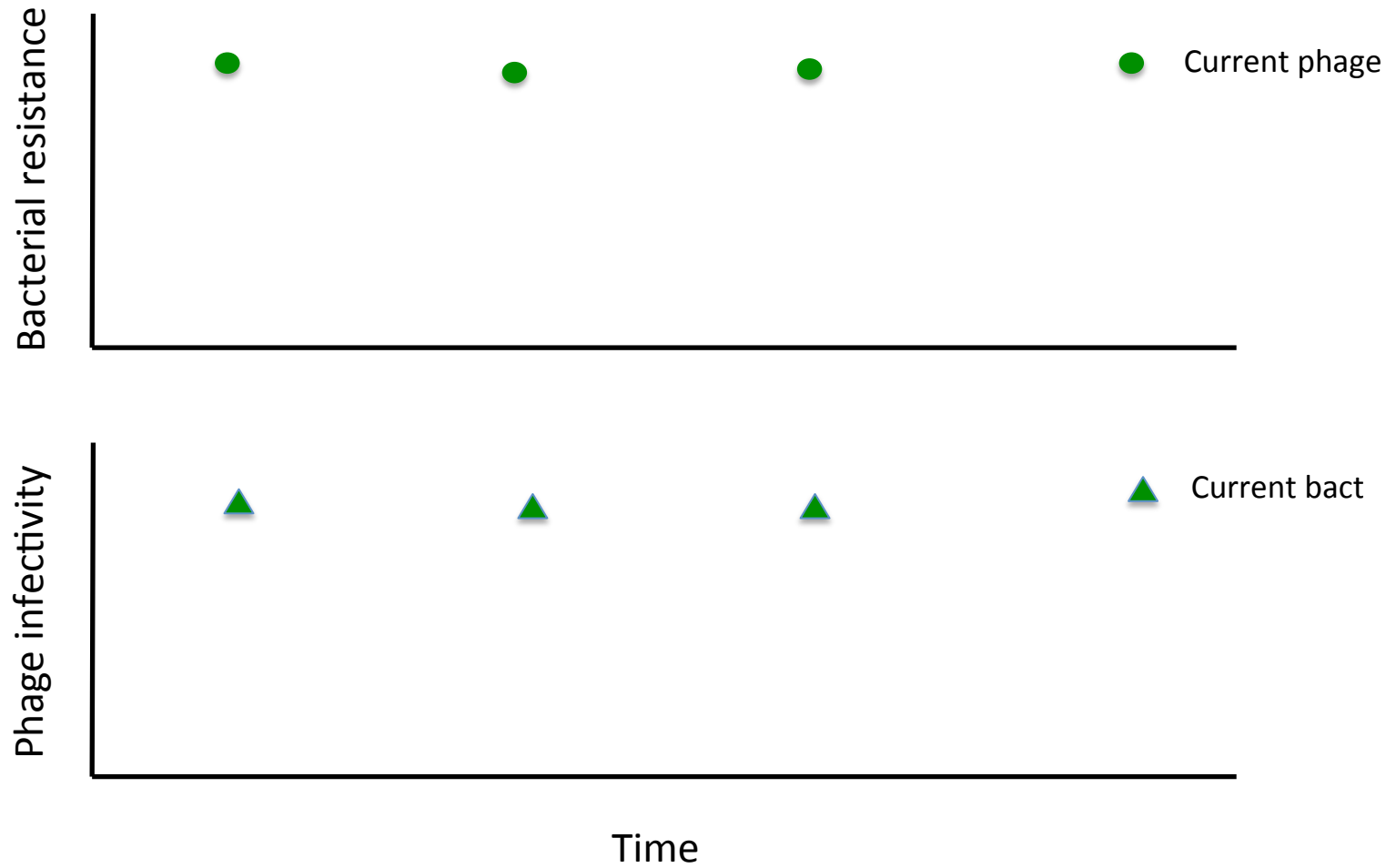


"Now, here, you see", said the Red Queen to Alice in Lewis Carroll's *Through the Looking Glass*, "it takes all the running you can do, to keep in the same place".

Pseudomonas & phage

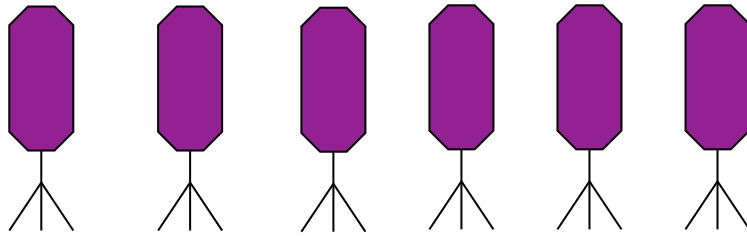


Pseudomonas & phage



Experimental evolution

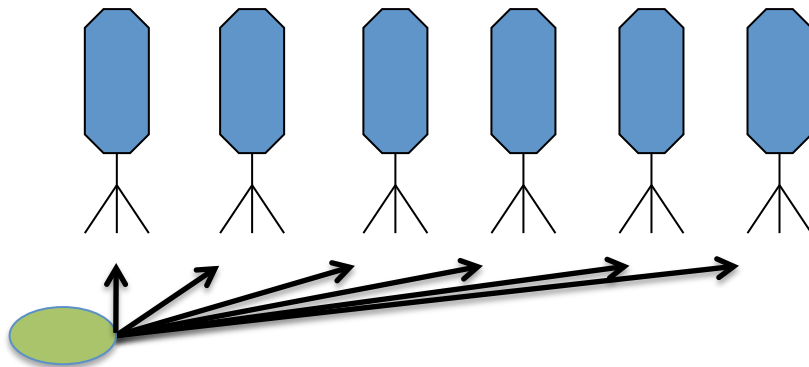
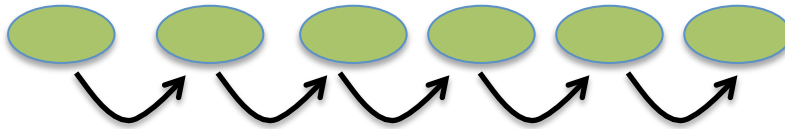
$\Phi 2$ phage



Phage adapt to hosts
and hosts adapt to phage
'co-evolution'



host

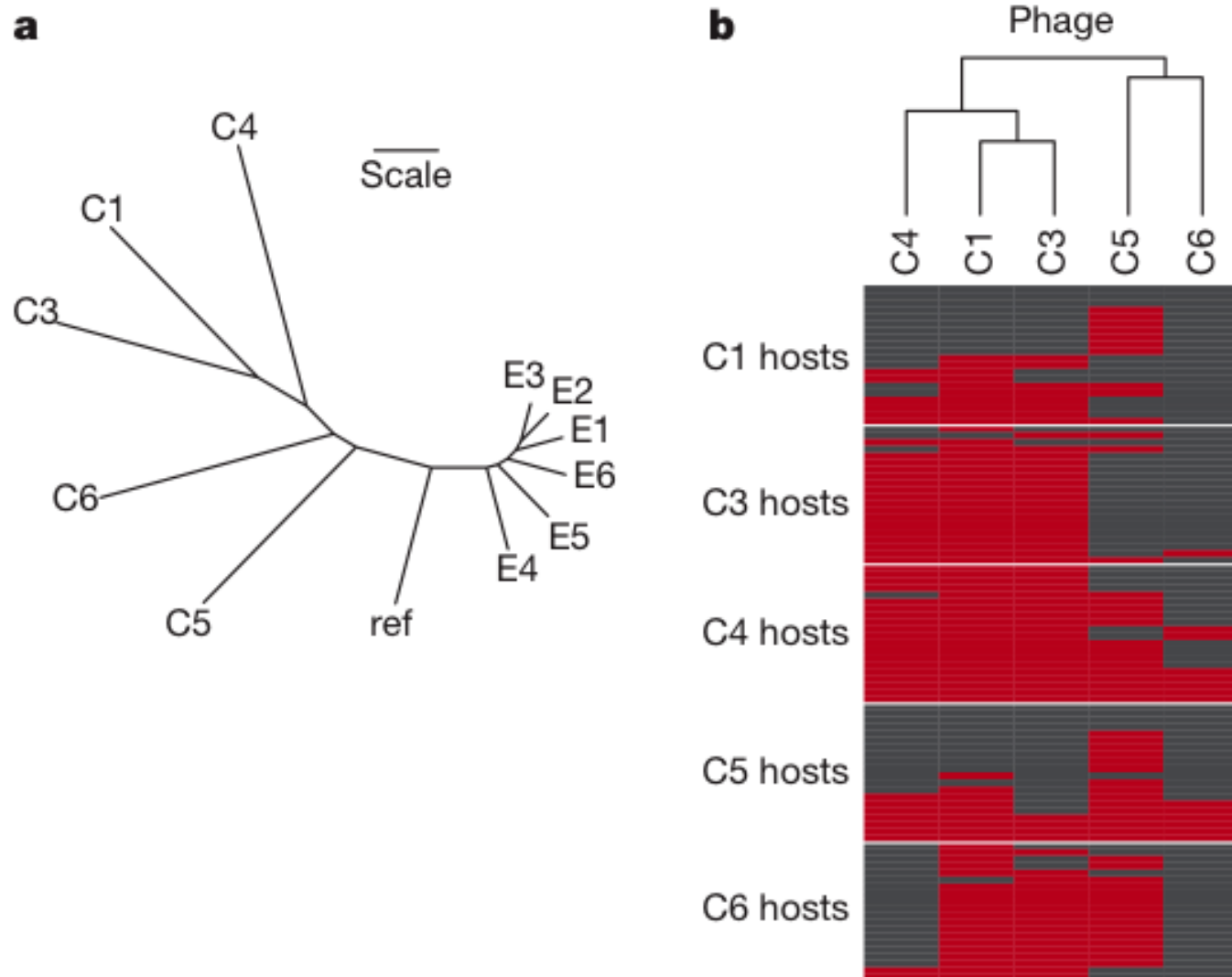


Phage adapt to fixed host
genotype **'evolution'**



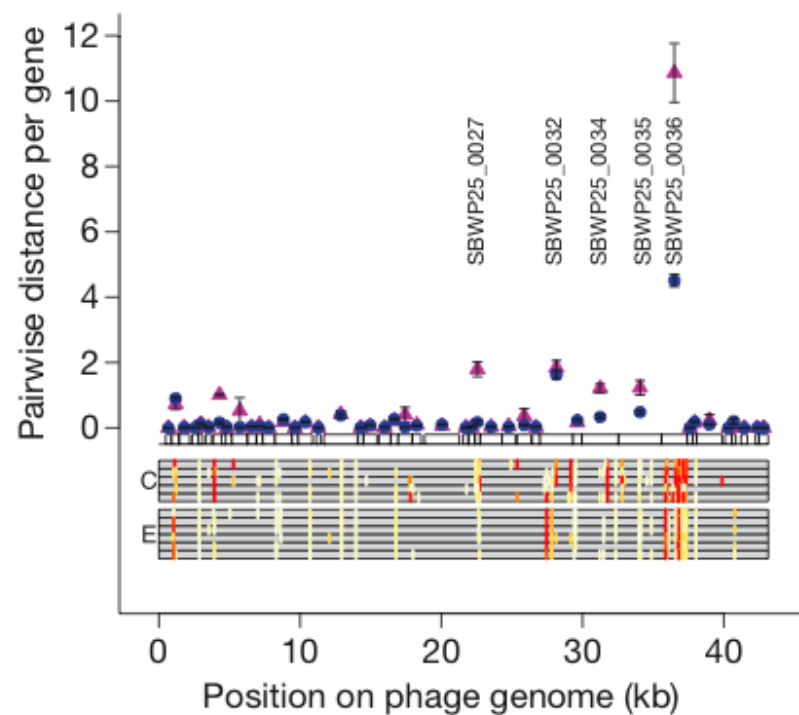
Next-gen sequencing

- 454 sequencing of replicate populations
 - c. 200x coverage
- Measure frequencies of variants arising by mutation and subsequently selected
 - Rate of molecular evolution with and without Red Queen?
 - Diversity within and divergence between populations?
 - What genes?

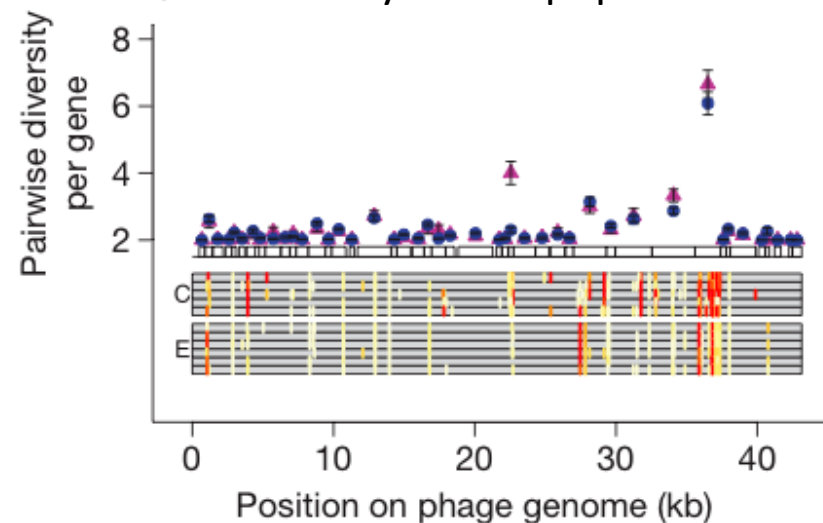


Paterson *et al* (2010) Antagonistic coevolution accelerates molecular evolution *Nature* 464: 275-278

a Divergence from ancestor



b Diversity within population



c

