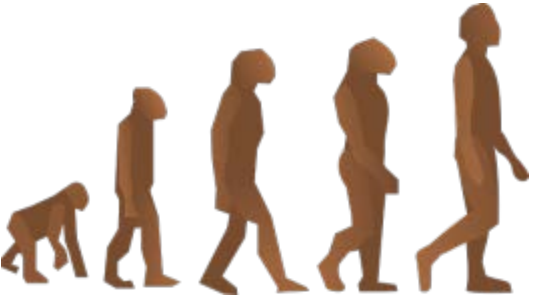
Signatures of past natural selection in the genome



Recombination can also help us detect natural selection

- Recombination rates not constant across genome
  - We already discussed “crossover hotspots”
  - Some regions have more hotspots than others
- Often low near centromeres

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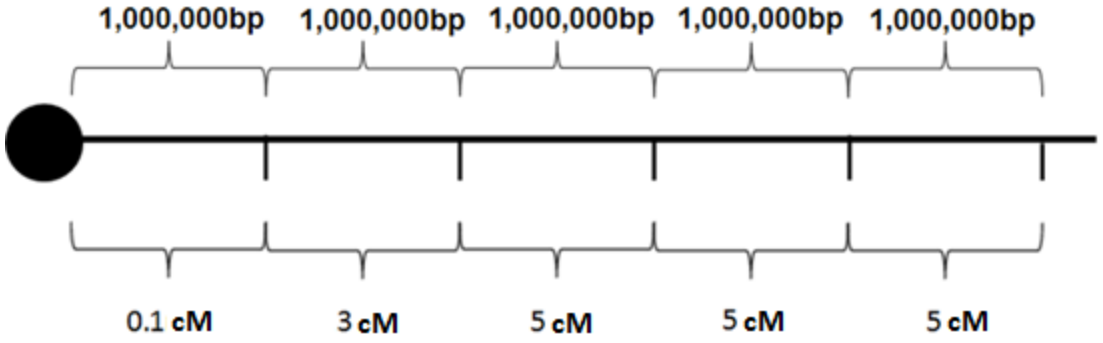

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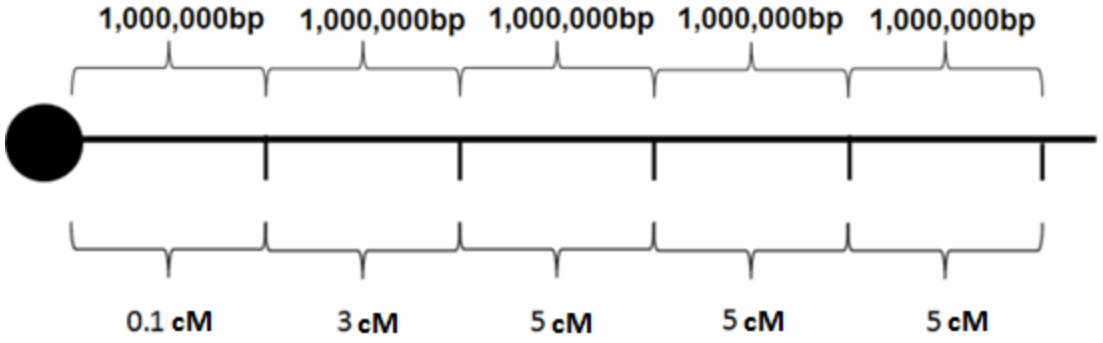
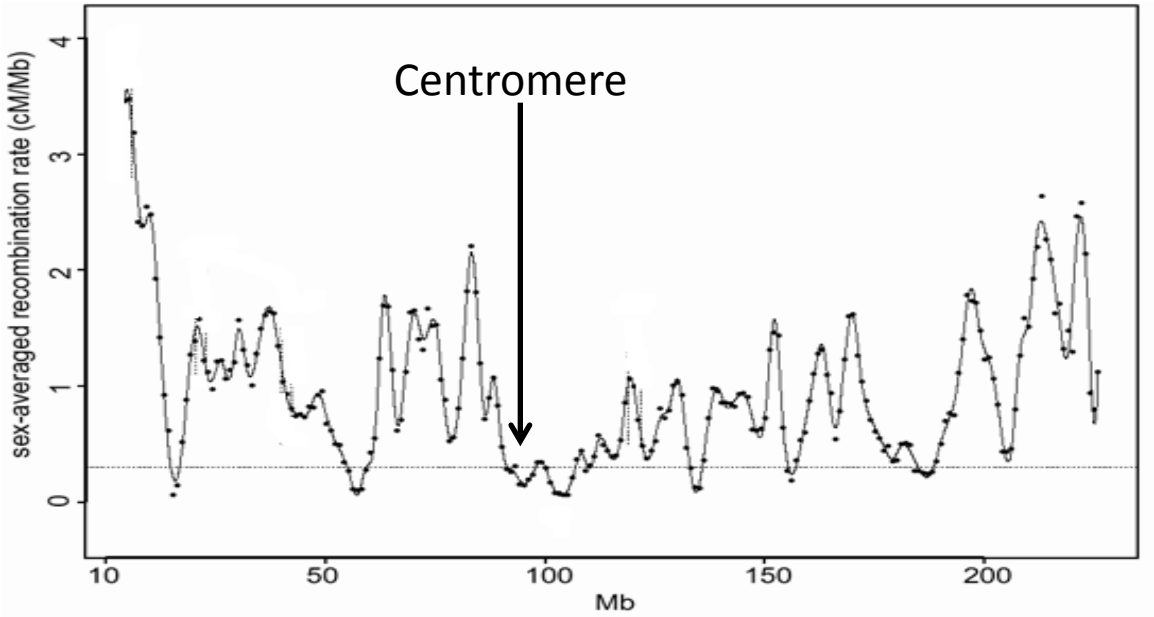


Recombination *rate* (cM/Mb) lower near centromere

Recombination rates also vary more generally

- Figure of recombination rates along human chromosome 3



New adaptive alleles arising by mutation periodically

- Sometimes in regions where recombination is rare or absent (very low cM/Mb; no hotspots)

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GCATGCTAGTCGATTGCGGCATTTTCGGAGCTGATACCCCGGTAGCTGCTGGGTTTC
GCATGCTAGTCGATTGCGGCATTTTCGGAGCTGATGCCTCGGTAGCTGCTGGGTTTC
*                    *                   *   *               *
```

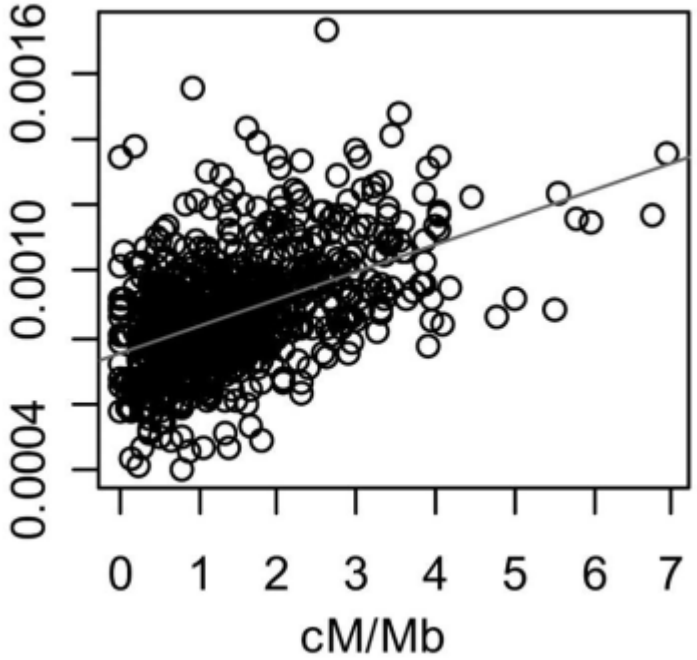
Prediction:

- If you survey regions around the genome, what association should there be between recombination rate and pi?
  - No relationship?
  - Positive (high cM/Mb -> high pi)?
  - Negative (high cM/Mb -> low pi)?

Association in humans

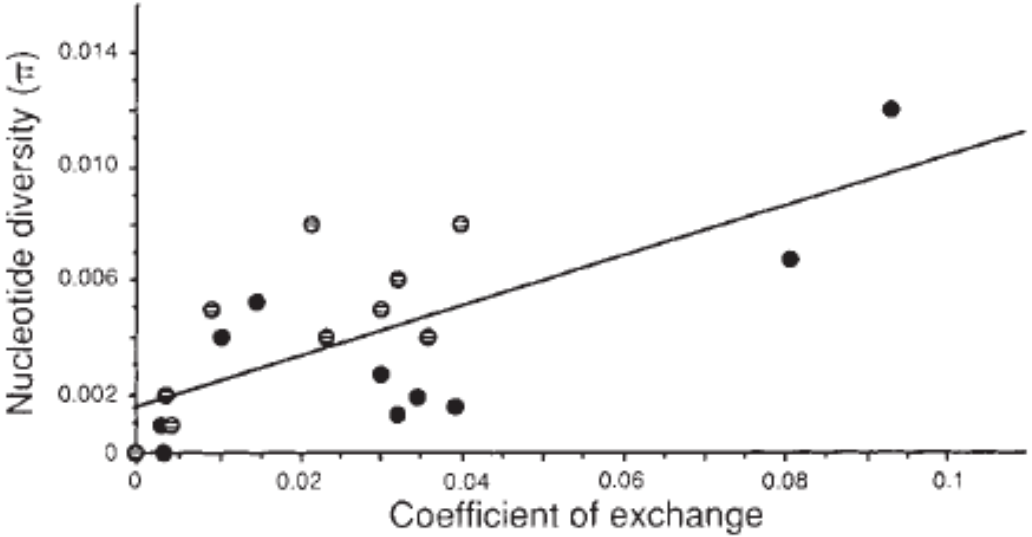
- Matches expectation: high pi in regions of high recombination

- Hellman et al, 2005, *Genome Research*



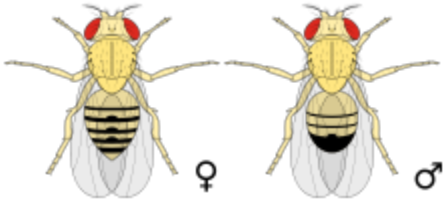
Association in Drosophila

- Matches expectation: high pi in regions of high recombination



Begun & Aquadro, 1992, *Nature*

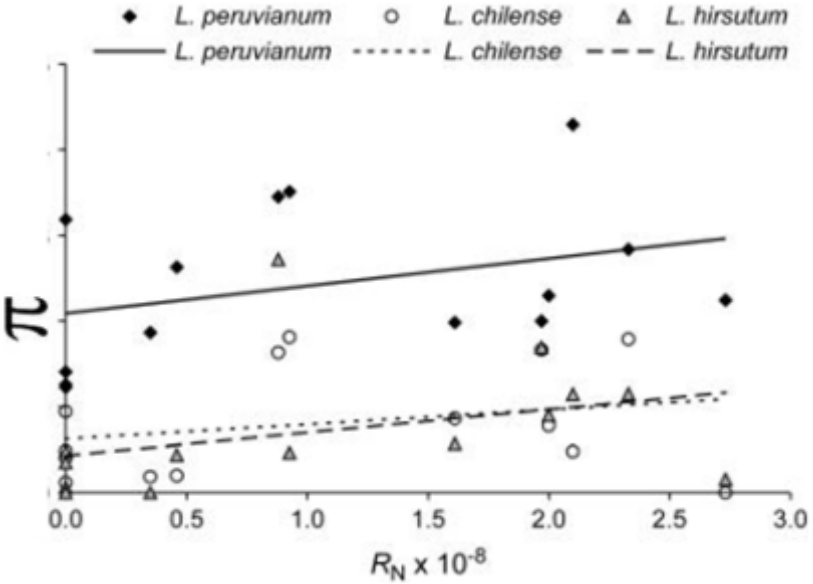
Paper cited >500 times!



Association in tomato species

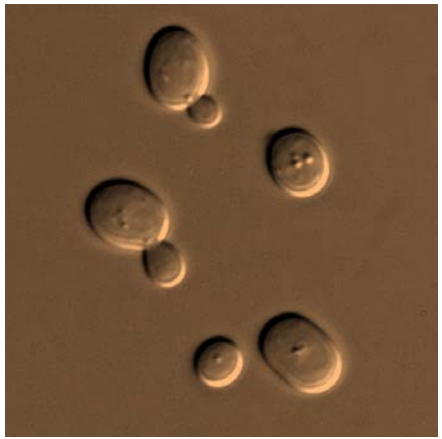
- Matches expectation: high pi in regions of high recombination (but weakly statistically significant)

- Roselius et al, 2005, *Genetics*



Association in yeast

- FAILS to match expectation- no significant positive or negative relationship
  - Perhaps associated with more frequent asexual reproduction?



What does this mean???

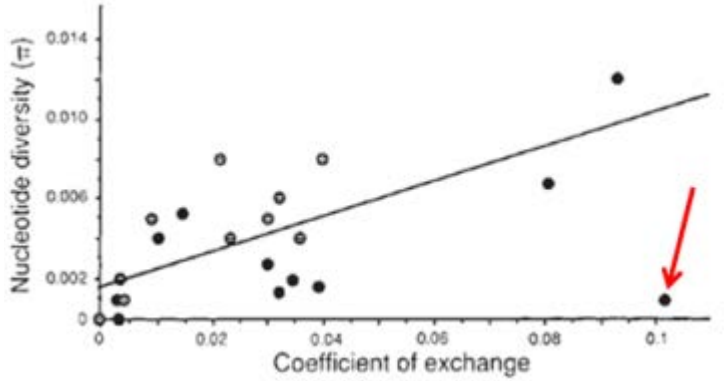
- We see this positive association between recombination rate and pi in many species
- This relationship is predicted from the action of natural selection

What does this mean???

- We see this positive association between recombination rate and pi in many species
- This relationship is predicted from the action of natural selection
- SELECTION'S IMPACT ON GENOMES OF MOST SPECIES IS **HUGE**! SELECTION IS **STRONG**!

Can we leverage this?

- We see that low recombination regions often have low variation (π)
- What if you see very low π in a small region of high recombination?
  - What might you infer happened?



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- **A recent selective sweep!**
  - Can use to find genes that experienced recent selection!

Background selection!

An alternative explanation for why pi and recombination rate are correlated…

…and a continuing, heated debate!

Image Credits, Unit 14-3

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