Coalescents

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Fig. 3  a, Genealogical tree for 134 types of human mtDNA (133 restriction sites used. The tree accounts for the site differences observed. The tree is not intended to represent more than this one. The
Genealogy of gene copies in a random-mating population
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Untangling this genealogy by left-right swappings ...
Genealogy of a sample of gene copies
Ancestry of a sample in the population pedigree
Why lineages coalesce

under the Wright–Fisher model

each gene comes from a random copy in the previous generation

a chance of \( 1 \) out of \( 2N \) that another one comes from the same copy

hence it takes about \( 2N \) generations for two lineages to coalesce
Kingman’s coalescent

Random collision of lineages as go back in time (sans recombination)
Collision is faster the smaller the effective population size

In a diploid population of effective population size $N_e$

Average time for $k$ copies to coalesce to $k-1 = \frac{4N_e}{k(k-1)}$

Average time for two copies to coalesce = $2N_e$ generations

Average time for $n$ copies to coalesce = $4N_e \left(1 - \frac{1}{n}\right)$ generations
Two sources of variability

(1) Randomness of mutation
affected by the mutation rate $u$
can reduce variance of
number of mutations per site per branch by examining more sites

(2) Randomness of coalescence of lineages
affected by effective population size $N_e$
coalescence times allow estimation of $N_e$
can reduce variability by looking at
(i) more gene copies, or
(ii) more loci
Coalescent with population growth

During a population bottleneck, there is expected to be a burst of coalescence.

Down near the root of the tree, effects of population size become difficult to see.
Coalescent with migration
Coalescent with migration, untangled
Coalescent with recombination

Different markers have slightly different coalescent trees
Coalescent with recombination
Random coalescents from the same population
A phylogeographic study

The rotifer *Brachionus plicatilis*

A phylogeographic study
Why mitochondrial eve? The Out-Of-Africa Hypothesis

(vertical scale is not time or evolutionary change)
Mitochondria from Neanderthals!

Svante Pääbo


The tree with Neanderthals

![Tree diagram showing relationships between Neanderthals and modern humans.](image)
Coalescents in related species

Tree of gene copies, compared with the phylogeny of the species for the case in which effective population size is small compared to the number of generations between speciations.

The tree of gene copies has topology consistent with the phylogeny.
Coalescents in related species

Tree of gene copies, compared with the phylogeny of the species for the case in which effective population size is large compared to the number of generations between speciations.

The tree of gene copies has topology inconsistent with the phylogeny.
Hey and Kliman

Jody Hey


Ranges of East African Drosophila species

- East Africa
  - D. melanogaster
  - D. simulans

- Madagascar
  - D. seychellea
  - D. mauritianus

- Seychelles

- Mauritius
Coalescent among Drosophila species
Coalescent among Drosophila species

YP2

% Divergence

SE-C1
SE-C2
SE-P1
SE-P2
SE-P4
SE-P3
SI-L11
SI-L12
SI-CA1
SI-CA2
SI-K1
SI-K2
MA-1
MA-3
MA-4
MA-6
MA-2
MA-5
ME-L11
ME-L12
ME-NJ1
ME-NJ2
ME-K1
ME-K2
How it was done

This projection produced

- using the \texttt{prosper} style in \LaTeX,
- using \LaTeX{} to make a \texttt{.dvi} file,
- using \texttt{dvips} to turn this into a Postscript file,
- using \texttt{ps2pdf} to make a PDF file, and
- displaying the slides in Adobe Acrobat Reader.

Result: nice slides using freeware.