

## BI515 - Population Genetics

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### My research:

- **Avian** behavior, systematics, population genetics, and molecular evolution
- Behavior, molecular ecology, and systematics of **brood parasitic birds** and **estrildid finches**



## What is population genetics?

- the theoretical and empirical analysis of genetic variation in **populations** and the evolutionary processes\* responsible for generating and shaping that variation over time
  - ✧ \*mutation, selection, genetic drift, gene flow
- the foundation for evolutionary biology!

## Famous (and Less Famous) Quotes

- *"Nothing in biology makes sense except in the light of evolution."*
  - ✧ Theodosius Dobzhansky, 1973 (1964)
- *"Nothing in evolution makes sense except in light of population genetics."*
  - ✧ Michael Lynch, 2007

## The Modern Synthesis...

- combined Darwin's observations with Mendelian genetics to produce a coherent theory of evolutionary change
  - ✧ even though methods for directly assaying genetic variation were not yet available!
  - ✧ seminal papers from 1918 to 1932
- **R.A. Fisher** (1890-1962)
  - ✧ *The Genetical Theory of Natural Selection* 1930
- **Sewall Wright** (1889-1988)
  - ✧ *Evolution and the Genetics of Populations* (4 vol.) 1968-78
- **J.B.S. Haldane** (1892-1964)
  - ✧ *The Causes of Evolution* 1932

## After the Modern Synthesis...

- theory developed during the modern synthesis has been extensively tested (and revised) based on molecular genetic data since the 1960's
- 1968, 1983: *The neutral theory of molecular evolution* - Motoo Kimura (1924-1994)
- 1973: the **nearly** neutral theory - Tomoko Ohta (1933- )

## Three recent “revolutions”

### ○ **Coalescent theory**

- ✧ Kingman 1982; Wakeley 2008 *Coalescent Theory*
- ✧ “turns population genetics on its head”

### ○ **Genomics**

- ✧ complete genome sequences
  - ✧ 1977: phage  $\Phi$ -X174 (5386 nucleotides)
  - ✧ 2001: human draft genome (~3 billion nucleotides)
  - ✧ 2007 - ? : “1000 genomes” project, “BGI”
- ✧ SNPs (single nucleotide polymorphisms)
  - ✧ 1998: dbSNP; now with > 20,000,000 human SNPs
- ✧ high throughput genotyping (rapidly developing...)

### ○ **Computation**

- ✧ Markov-chain Monte Carlo simulation & Bayesian stats

## How many parents do you have?

- Not a trick question!
- Answer: 2

## How many grandparents?

Answer: 4

## How many ancestors?

- Great-grandparents: 8 ( $2^3$ )
- Great-great-grandparents: 16 ( $2^4$ )
- Great-great-great-grandparents: 32 ( $2^5$ )
- .
- .
- Great<sup>10</sup>-grandparents: ?
- Great<sup>20</sup>-grandparents: ?
- Great<sup>30</sup>-grandparents: ?

# How many years ago?

- Great-grandparents: 100
- Great-great-grandparents: 130
- Great-great-great-grandparents: 160
- .
- .
- Great<sup>10</sup>-grandparents: ?
- Great<sup>20</sup>-grandparents: ?
- Great<sup>30</sup>-grandparents: ?



