

Lecture 17

Complete Genetic Drift  
Begin Selection

Readings: Article 14, Chapter 5 S&S

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Genetic Drift and Small Populations

- Genetic drift results in most rapid allele frequency change in small populations
- Rare plants and animals will tend to lose genetic variability (heterozygosity drops)
- Is drift unimportant in large populations?
- \*\*\*\*\*Not necessarily!\*\*\*\*\*

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Effective Population Size

- Individuals often mate within a small neighborhood, making  $N$  effectively small (and therefore drift becomes a potent force)

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### Effective Population Size

- Even if a population is panmictic (randomly mating with no distance limitation),  $N_e < N$  because not all individuals in a population are reproductive
- Skewed sex ratio may lower  $N_e$

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### Population Bottlenecks

- Due to effects of stochastic factors on **population size**, the stochastic process of drift can reduce genetic variation in low N periods

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### Consequences of Reduced Genetic Variability

- Cheetah - concern about reduced resilience in the face of environmental challenges, including disease.

**bottleneck**

Let S =susceptible  
R= resistant

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**Genetics of Turtles**

- ⇒ Demonstration of population bottleneck
- ⇒ GG=Dark Green Turtles
- ⇒ Gg=Dark Green Turtles
- ⇒ gg=Light Green Turtles

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**Victims of Population Bottlenecks**

- ⇒ Cheetahs contain almost no allelic variation!
- ⇒ Population bottlenecks: 10,000 ybp due to ice age, 100 ybp due to overhunting



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**Genetic Drift and Effective Population Size**

- ⇒  $N_e < N_{total}$  due to limited migration
- ⇒  $N_e < N_{total}$  due to skewed sex ratios
- ⇒  $N_e$  may have been small in the past, reducing genetic diversity
  - ⇒ Population Bottleneck

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## More Drift-like Effects

→ Founder Effect -

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## Founder Effect Demonstration

→ Special visit from the stars of the Red Green show!



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## Summary-Genetic Drift

- Genetic drift is allele frequency change due to 'sampling error'
- Drift results in fixation of one allele or the other
- The rate of fixation is N-dependent, with fastest rates of change occurring in small populations
- Population bottlenecks and founder effects are historical phenomena that produce drift-like loss of genetic variation and differentiation

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**Natural Selection**

⇒ Charles Darwin

ON

**THE ORIGIN OF SPECIES**

BY MEANS OF NATURAL SELECTION,  
OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE  
FOR LIFE

1859

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**Natural Selection  
(modern translation)**

⇒ Verbal Model:

⇒ If a population:

- ⇒ \_\_\_\_\_
- ⇒ \_\_\_\_\_
- ⇒ \_\_\_\_\_

⇒ Then, a population will \_\_\_\_\_

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**Natural Selection**

⇒ Mathematical model:

⇒ Hardy-Weinberg Law holds, but we now allow different phenotypes to survive or reproduce differentially

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**Model of Natural Selection**

→ Allele number passed on is modified by survival and fertility. Assume 'big bang' life history, then

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**Model of selection**

→ Likewise,

→ We now have the numerator, and continuing in like fashion, we derive the denominator (=all alleles)

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**Model of Selection**

→ Yielding,

→ To simplify, factor 2 and  $N_t$  from the numerator and denominator, and let  $l \bullet m = W$  (absolute fitness). We will use relative fitness ( $w$ , rather than  $W$ ), where

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**Model of Selection**



⇒ The selection equation can now be 'iterated' to project future allele frequency change, given initial  $p$ , and fitnesses associated with each genotype.

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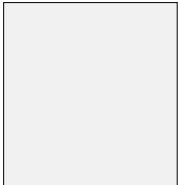
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**Iteration of the Selection Model**



⇒ Selection model is deterministic (unlike drift), predicting specific allele frequency changes

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**Summary**

⇒ Evolutionary change by natural selection occurs when (a) there is phenotypic variation in a population, (b) at least some of this variation is heritable, and (c) the phenotypic variation affects fitness.

⇒ In a one gene, two allele model, the result is allele frequency change.

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