

Lecture 17

Complete Genetic Drift
Begin Selection

Readings: Article 14, Chapter 5 S&S

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!*****

Effective Population Size

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

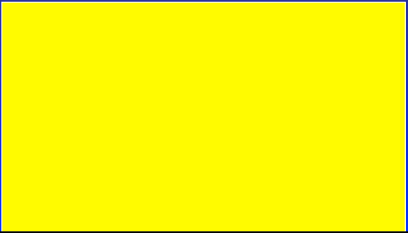
Effective Population Size

- 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



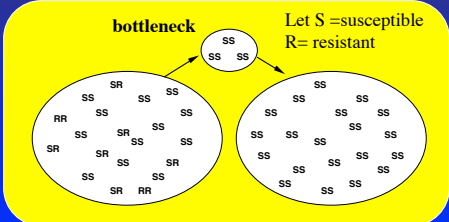
Population Bottlenecks

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



Consequences of Reduced Genetic Variability

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




Let S =susceptible
R= resistant

Genetics of Turtles

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

Victims of Population Bottlenecks

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



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

More Drift-like Effects

→ Founder Effect -

Founder Effect Demonstration

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



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

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

**Natural Selection
(modern translation)**

→ Verbal Model:

→ If a population:

- _____
- _____
- _____

→ Then, a population will _____

Natural Selection

→ Mathematical model:

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

Model of Natural Selection

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

Model of selection

→ Likewise,


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

Model of Selection

→ Yielding,

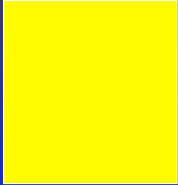
→ To simplify, factor 2 and N_1 from the numerator and denominator, and let $l \cdot m = W$ (absolute fitness). We will use relative fitness (w , rather than W), where

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.

Iteration of the Selection Model



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

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.
