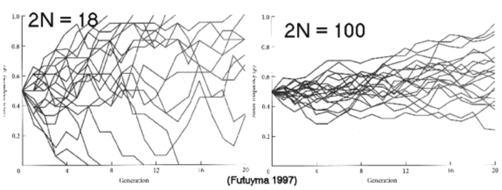
Lecture 15

Complete Genetic Drift
Begin Selection
Readings: Article 14, Chapter 5 S&S

Genetic drift

- Genetic drift is an intrinsic, stochastic process that results in change in allele frequencies due to chance. The smaller the population, the more rapid the change, and the greater the likelihood of fixation.



Principles of Genetic Drift

- 1. If N=infinity, there is no genetic drift.
- 2. The smaller the population, the greater Δp
- 3. The direction of change is random.
- 4. Eventually, populations will become fixed for allele A_1 or A_2, with more rapid fixation in small populations.
- 5. Drift may be important even in large populations if $N_e << N_{tot}$. This is true if:
  - a population is not 'panmictic' or
  - if the sex ratio is skewed

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

Effective Population Size

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

Real World

- ➟Rare plants and animals (defined as those with small N) will tend to have lower genetic diversity than common species
- ➟This can be reflected in: (a) greater fixation, (b) fewer alleles at a locus, (c) lower heterozygosity.

Wolverine (*Gulo gulo*): 250-300 individuals in the lower 48 states. Has been proposed for listing on the Endangered Species List. Small, fragmented populations in southern part of range

Drift-Related Phenomena: (1) Population Bottlenecks

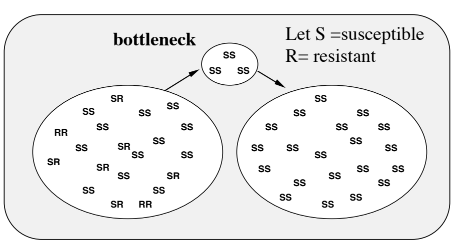
- Populations naturally fluctuate in size. When N is low, the stochastic process of drift can reduce genetic variation.

Victims of Population Bottlenecks

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

Subsequent Consequences of Reduced Genetic Variability

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



Victims of Population Bottlenecks

- Elephant seals found to have no allelic variation at 24 enzyme-coding loci. Reduced to 20 animals in the late 1890's (overhunting). Now N>30,000.

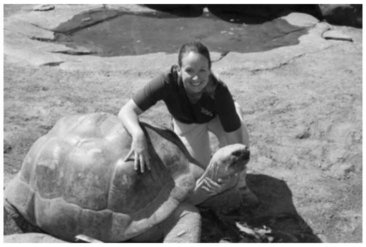
Genetics of Turtles

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

Drift-Related Phenomena: (2) Founder Effect

Difference in allele frequency in an isolated population due to chance 'founding' of the population by a random subset of a 'mainland' population; associated lower genetic variation in the isolated population is due to small N of the founding population

Founder Effect Demonstration



And the difference between chance and selection

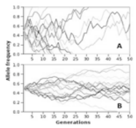
Summary of Drift

- Drift is a powerful force for changing allele frequencies in small populations
- Drift generally results in loss of genetic variation over time

Thought Question: In the DEMO, if natural selection was acting, how would this be reflected in Δp (and therefore DIFFER from genetic drift?

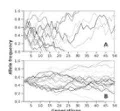
- A. $\Delta p = 0$
- B. $|\Delta p| > 0$
- C. Δp would always be +
- D. Δp would always be –
- E. Δp would be non-random

Sample Exam Question



The above diagrams show simulations of genetic drift for a 1 gene two allele system. The populations may be both N=100, both N=10, or one may be N=10 and the other may be N=100. Based on what you know about genetic drift, what can you say about the populations depicted in diagrams A and B, above?
(A) N=10 in diagram A, and N=100 in diagram B
(B) N=100 in diagram A, and N=10 in diagram B
(C) N=100 in both
(D) N=10 in both
(E) It is impossible to infer which diagram depicts a population with N=10 or N=100 because genetic drift is stochastic.

Sample Exam Question



Regardless of your answer to the question above, in which population would you expect the allele to reach fixation more quickly?
(A) The population in A
(B) The population in B
(C) Neither. They would reach fixation equally quickly
(D) Neither allele would reach fixation
(E) It is impossible to infer which population would reach fixation more quickly

Yet another

- After a VERY long time of genetic drift (thousands of generations), what can be said with virtual certainty about one particular population of 10 individuals?
- (A) p will reach 1
- (B) q will reach 1
- (C) either one allele or the other will reach fixation
- (D) neither allele will reach fixation
- (E) It is impossible to infer what will happen after a VERY long time

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 ____________

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.