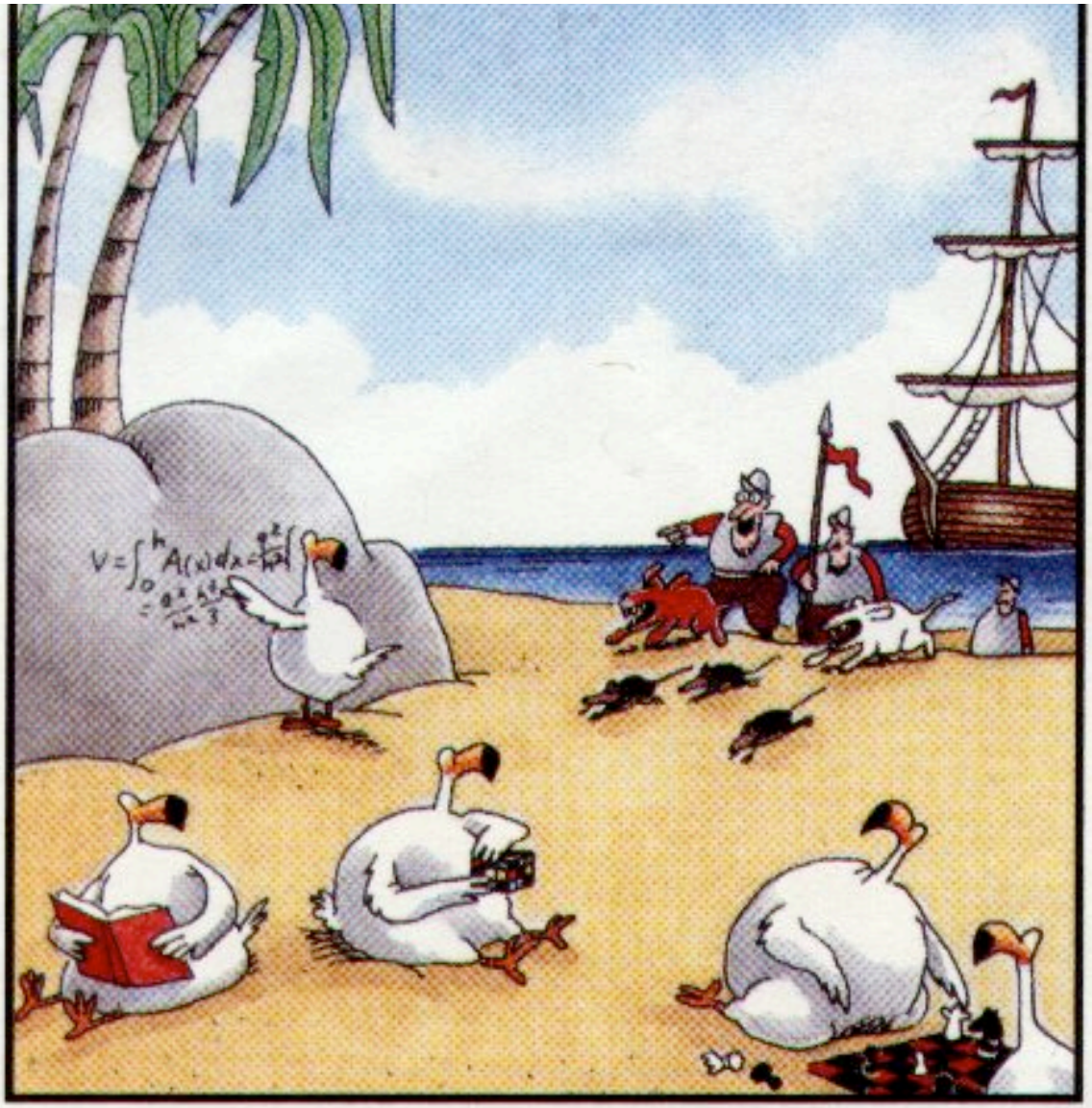
Evolution of Populations



Unbeknownst to most ornithologists, the dodo was actually a very advanced species, living alone quite peacefully until, in the 17th century, it was annihilated by men, rats, and dogs. As usual.

- **Gene Pools**

1. All of the genes in a population

   - Contains 2 or more alleles (forms of a gene) for each trait

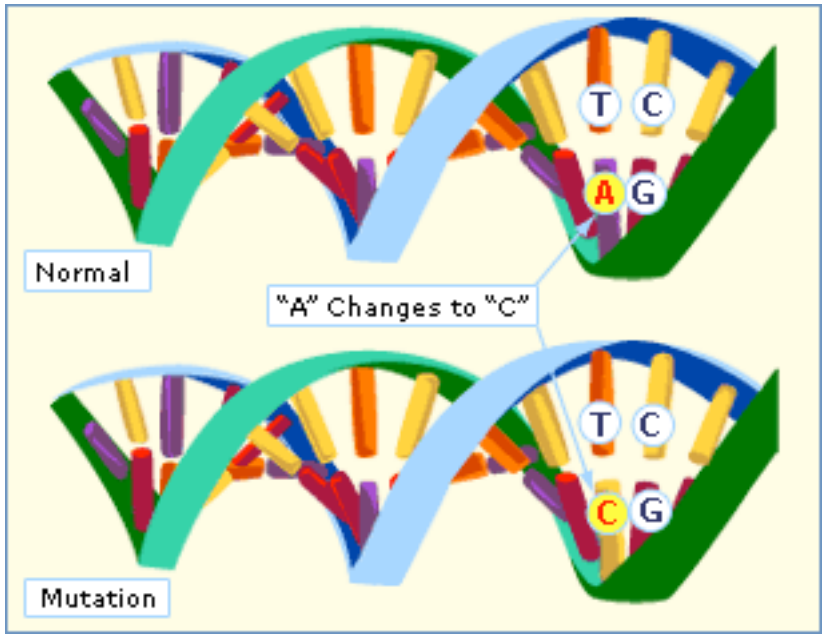
2. Relative frequencies - # of times an allele occurs in a gene pool compared to other alleles

- Sources of Genetic Variation

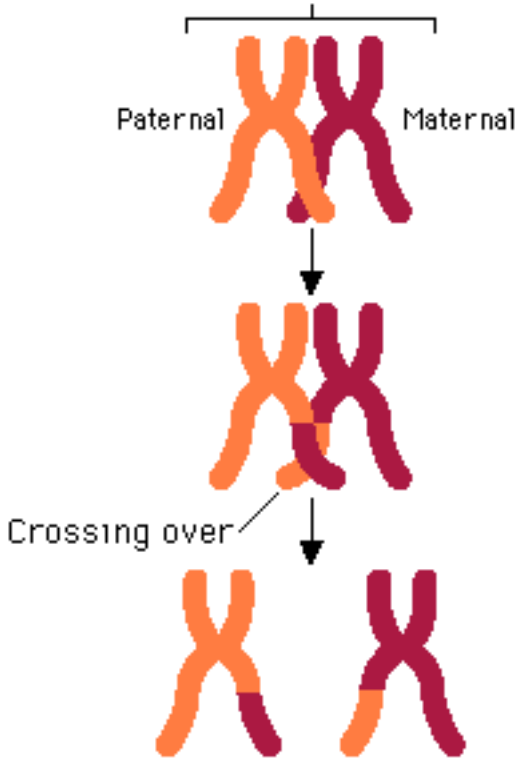
1. Mutations

   - Causes = mistakes in replication, radiation or chemicals

   - May or may not effect phenotype



2. Gene Shuffling – Occurs during production of gametes
   - 8.4 million (2^23)different combinations of genes
   - Crossing over also increases genotypes



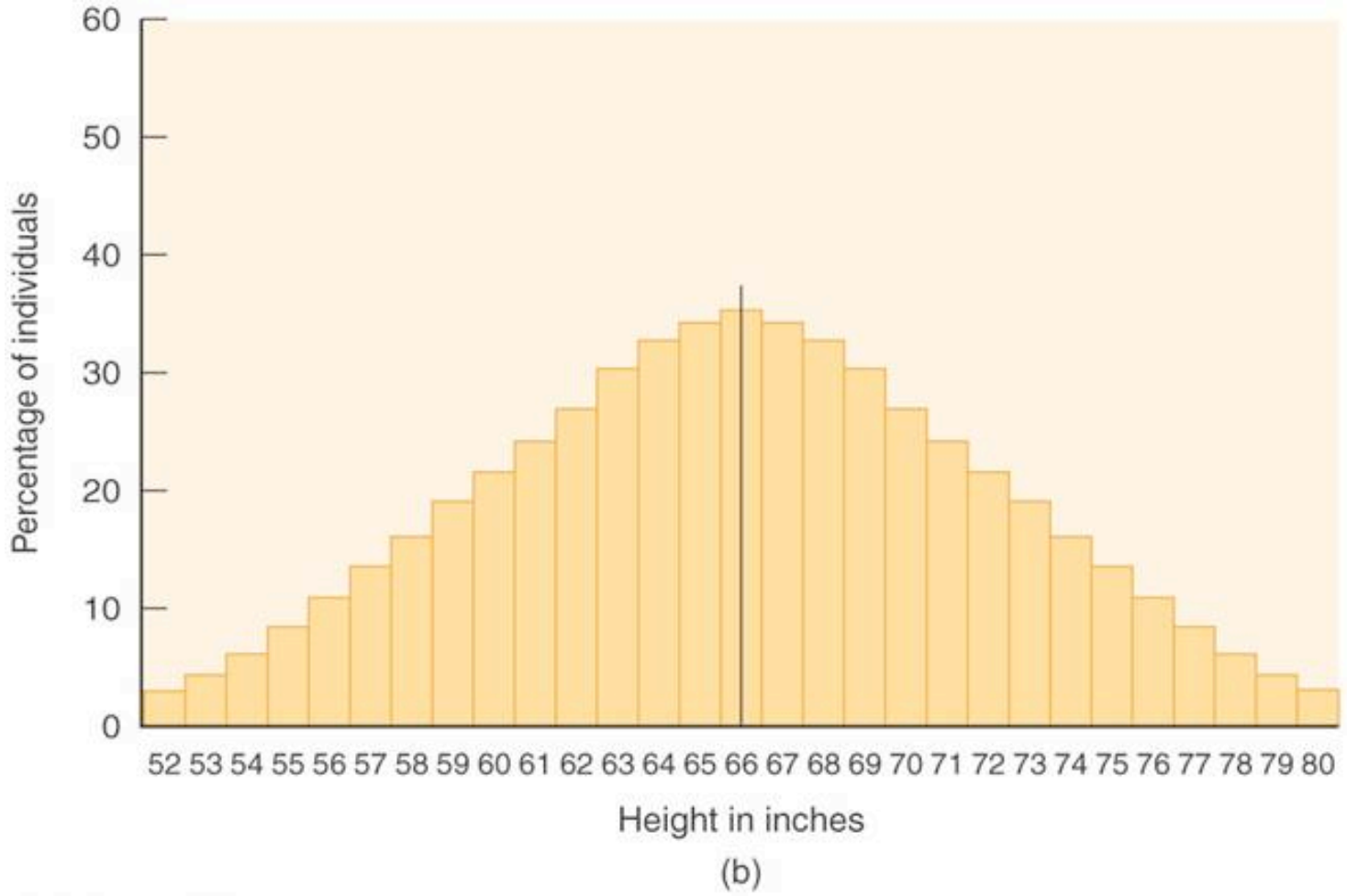
- Single Gene and Polygenic Traits

1. # of phenotypes produced for a given trait depends on the number of genes that control the trait

- Single-gene trait – controlled by a single gene that has 2 alleles
- Has fewer phenotypes than a polygenic trait
- Show’s simple dominant-recessive pattern – Widow’s Peak

2. Polygenic Traits – Controlled by 2 or more genes [height]

- Show a wide range of phenotypes



16-2 Evolution as Genetic Change

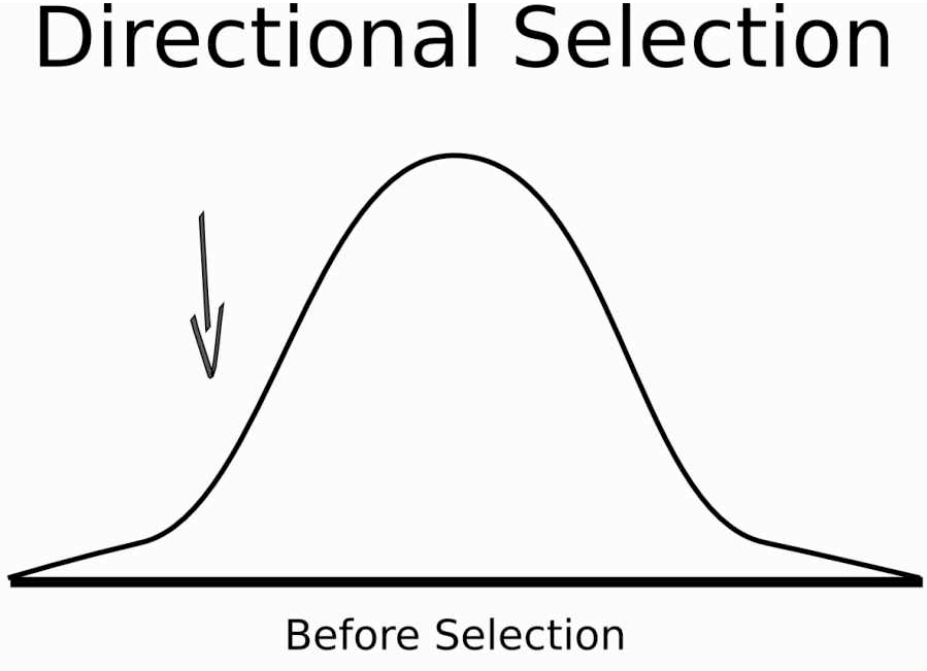
- Natural Selection on Single-gene traits

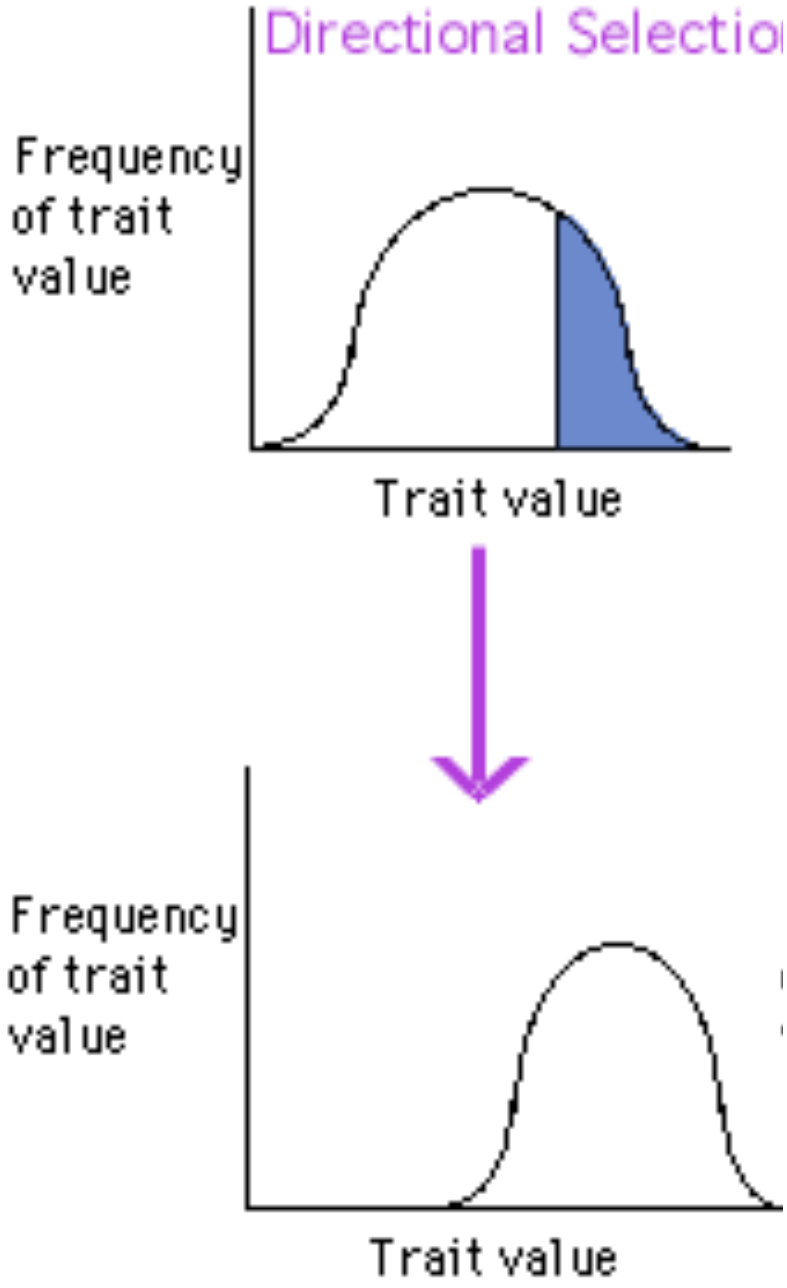
1. Can lead to changes in allele frequencies & thus to evolution
2. White moth vrs. Dark moth

- Frequency of new allele will increase if this mutation makes some individuals more fit for their environment

- Natural Selection on Polygenic Traits

1. **Directional Selection** – When individuals at only one end of a bell curve of phenotype frequencies have higher fitness than individuals in the middle or at the other end.




Directional Selectio
Frequency of trait value
Trait value
Frequency of trait value
Trait value

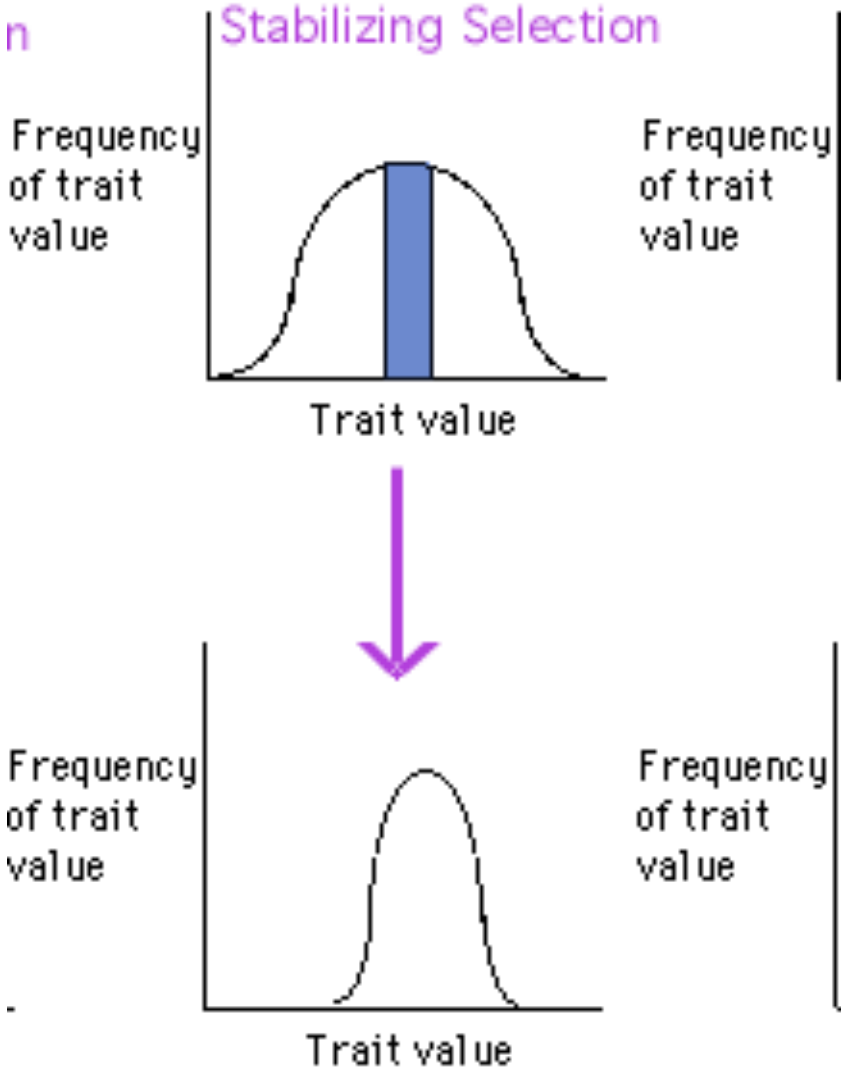
Directional Selection Graphs

- Evolution causes an increase in the # of individuals with the trait at one end of the curve
- Example: Increase of beak size of finches on the Galapagos

2. **Stabilizing Selection** – Individuals with an average form of a trait (near center of curve) have highest fitness

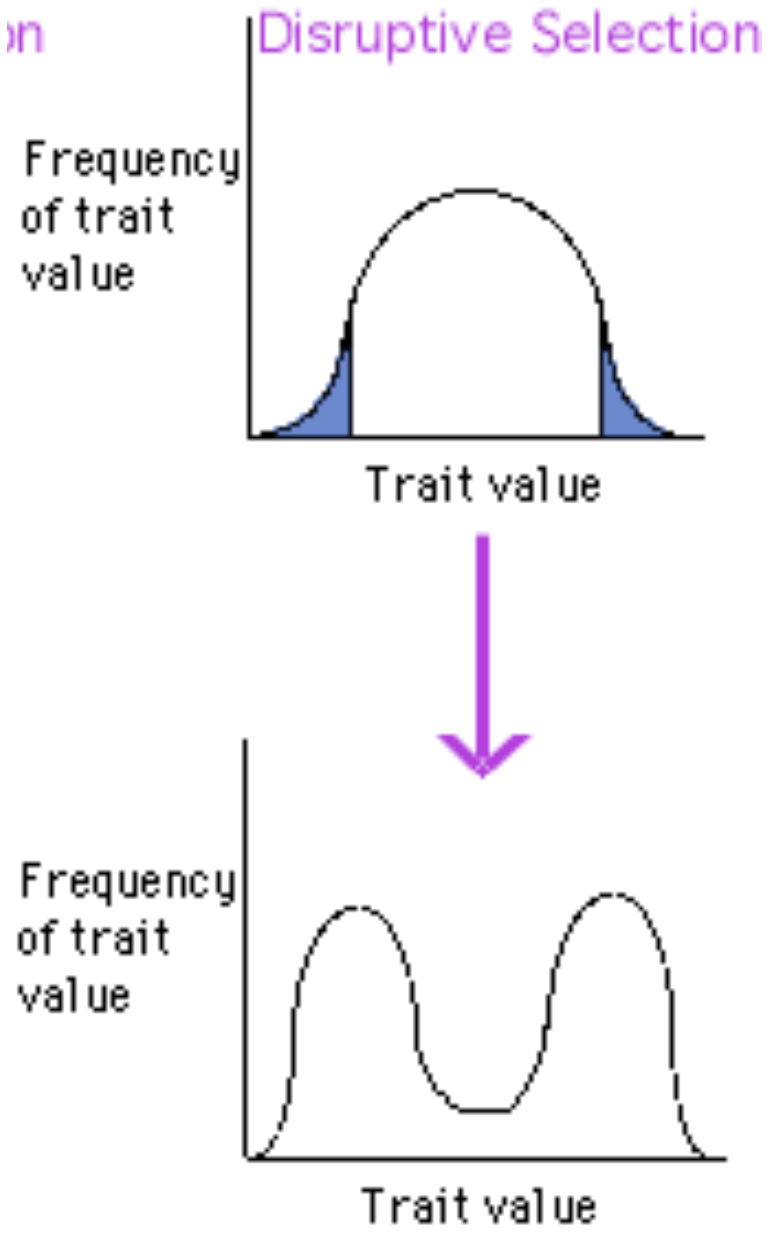
- Keeps curve at its current position
- Example: birth weight

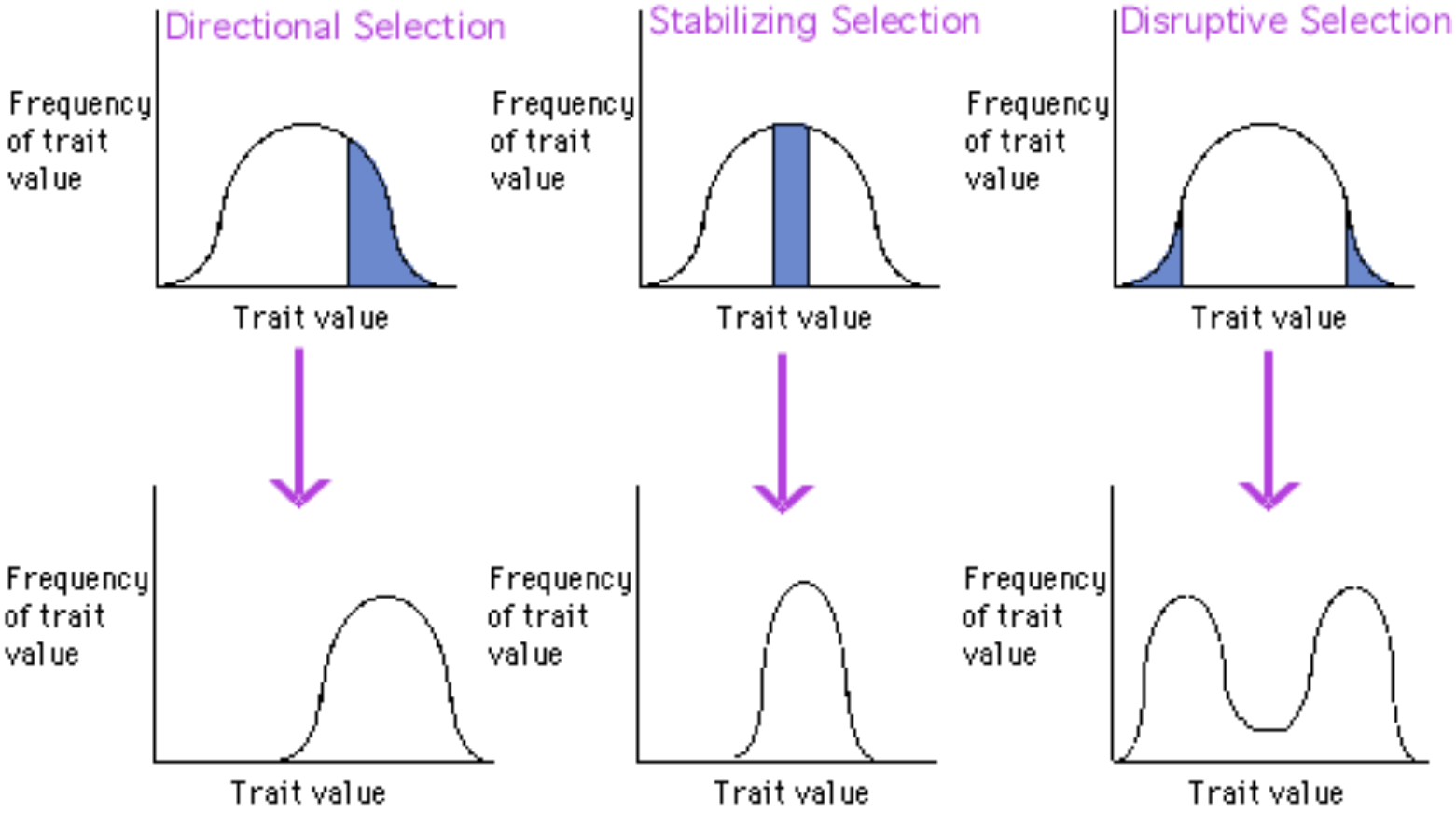
n


Stabilizing Selection
Frequency of trait value
Trait value
Frequency of trait value
Frequency of trait value
Trait value
Frequency of trait value

3. **Disruptive Selection** – individuals at both ends of the curve have higher fitness than individuals near the center

- Selection acts against intermediate type
- Can cause 2 distinct phenotypes
- Finches with large or small beaks


on
Disruptive Selection
Frequency of trait value
Trait value
Frequency of trait value
Trait value


Directional Selection
Frequency of trait value
Trait value
Stabilizing Selection
Frequency of trait value
Trait value
Disruptive Selection
Frequency of trait value
Trait value
Frequency of trait value
Trait value
Frequency of trait value
Trait value
Frequency of trait value
Trait value

Test Prep Questions

- Natural Selection acts directly on

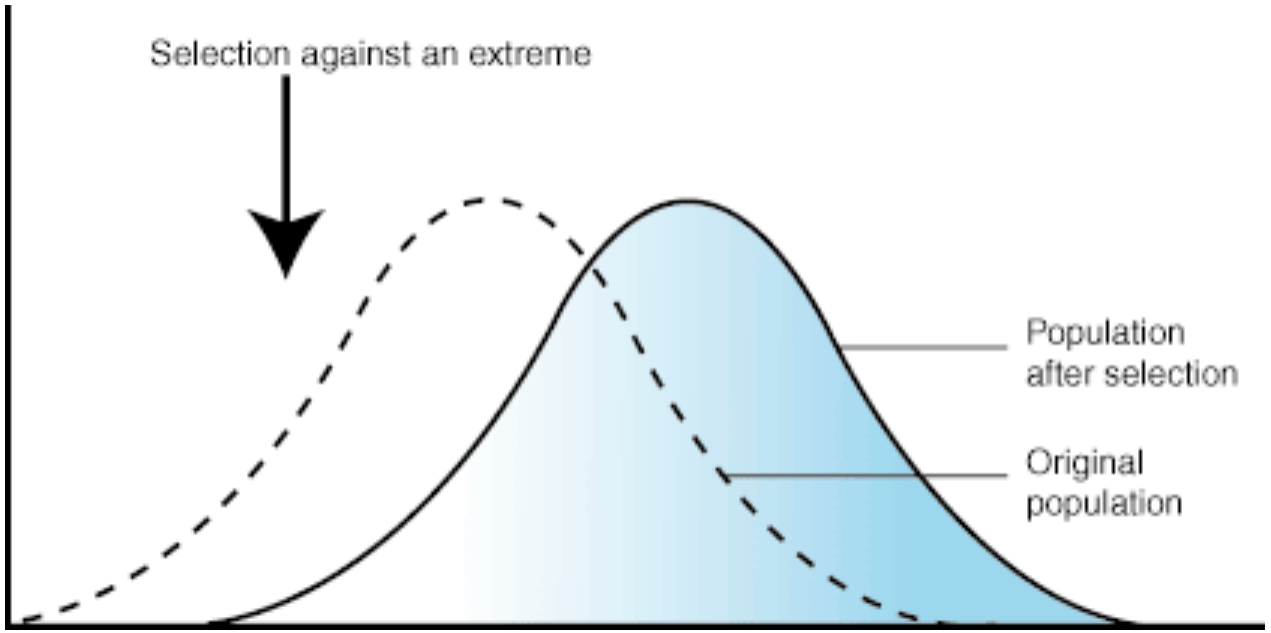
a. Genes
b. Mutations
c. Alleles
d. genotypes

Test Prep Questions

According to the Hardy-Weinberg principle, genetic equilibrium would be more likely in a population if

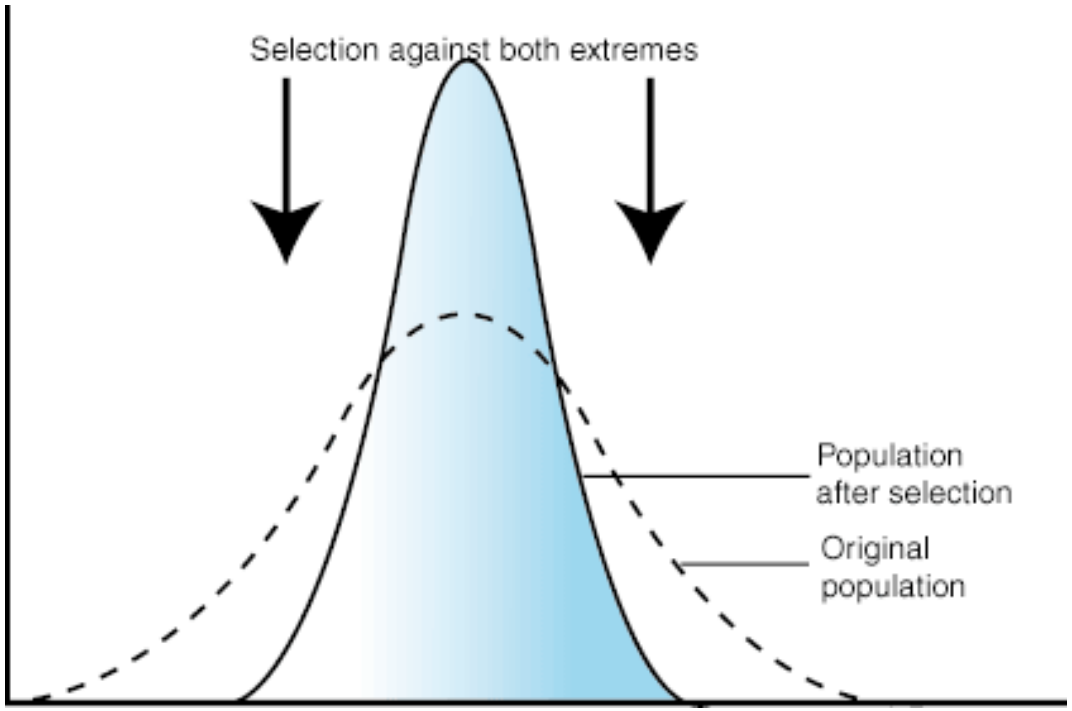
a. The population size rapidly decreases
b. Mutation rates are high
c. No natural selection takes place
d. There is frequent movement out of the population

The graph below is an example of



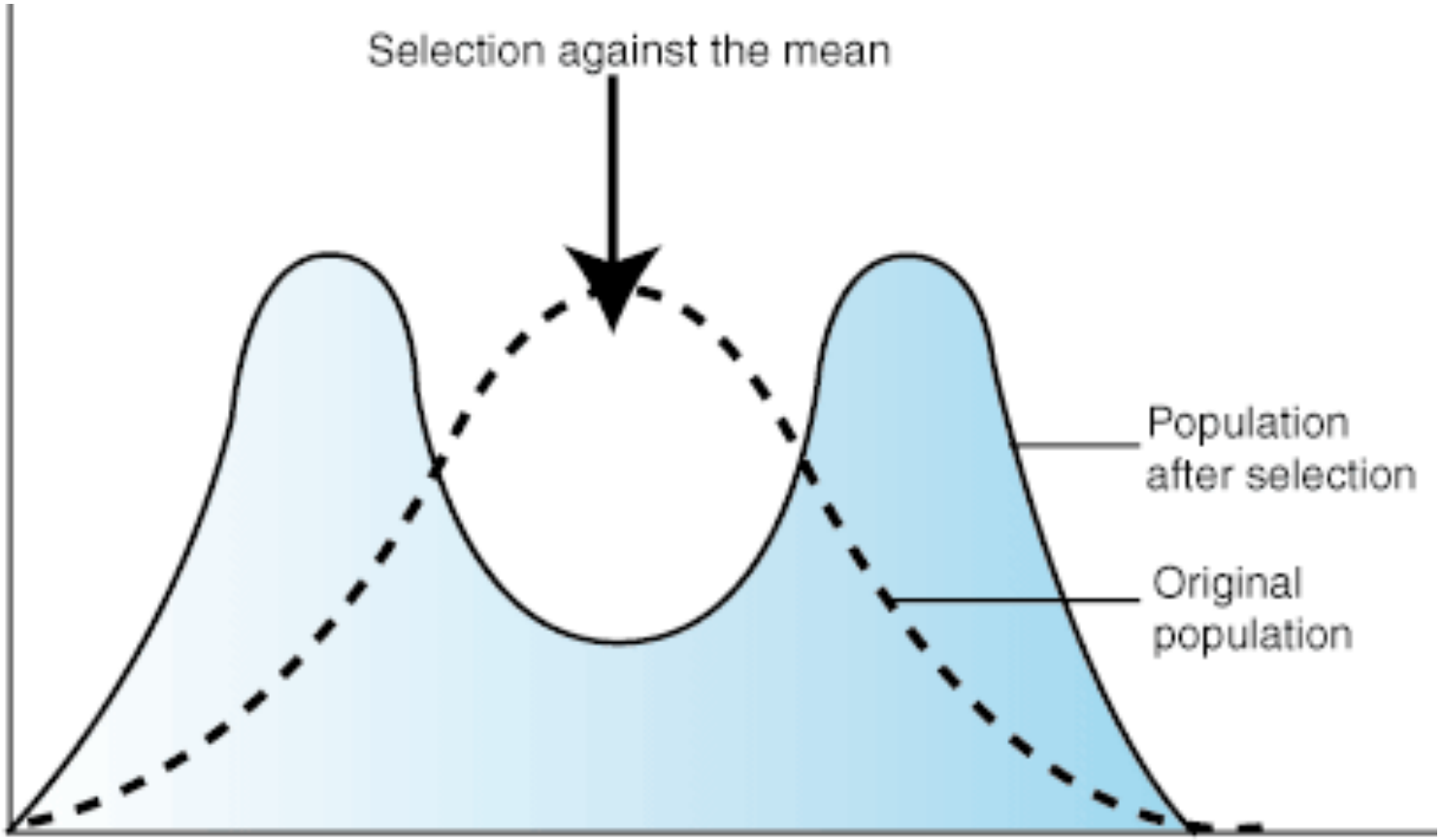
a. Disruptive selection
b. Genetic drift
c. Stabilizing Selection
d. Directional Selection

The graph below is an example of



a. Directional Selection
b. Stabilizing Selection
c. Genetic Drift
d. Gene Pool

What's This?


Selection against the mean
Population after selection
Original population

- Evolution Versus Genetic Equilibrium

- Hardy-Weinberg Principle: Allele frequencies in a population will remain constant unless one or more factors cause them to change.

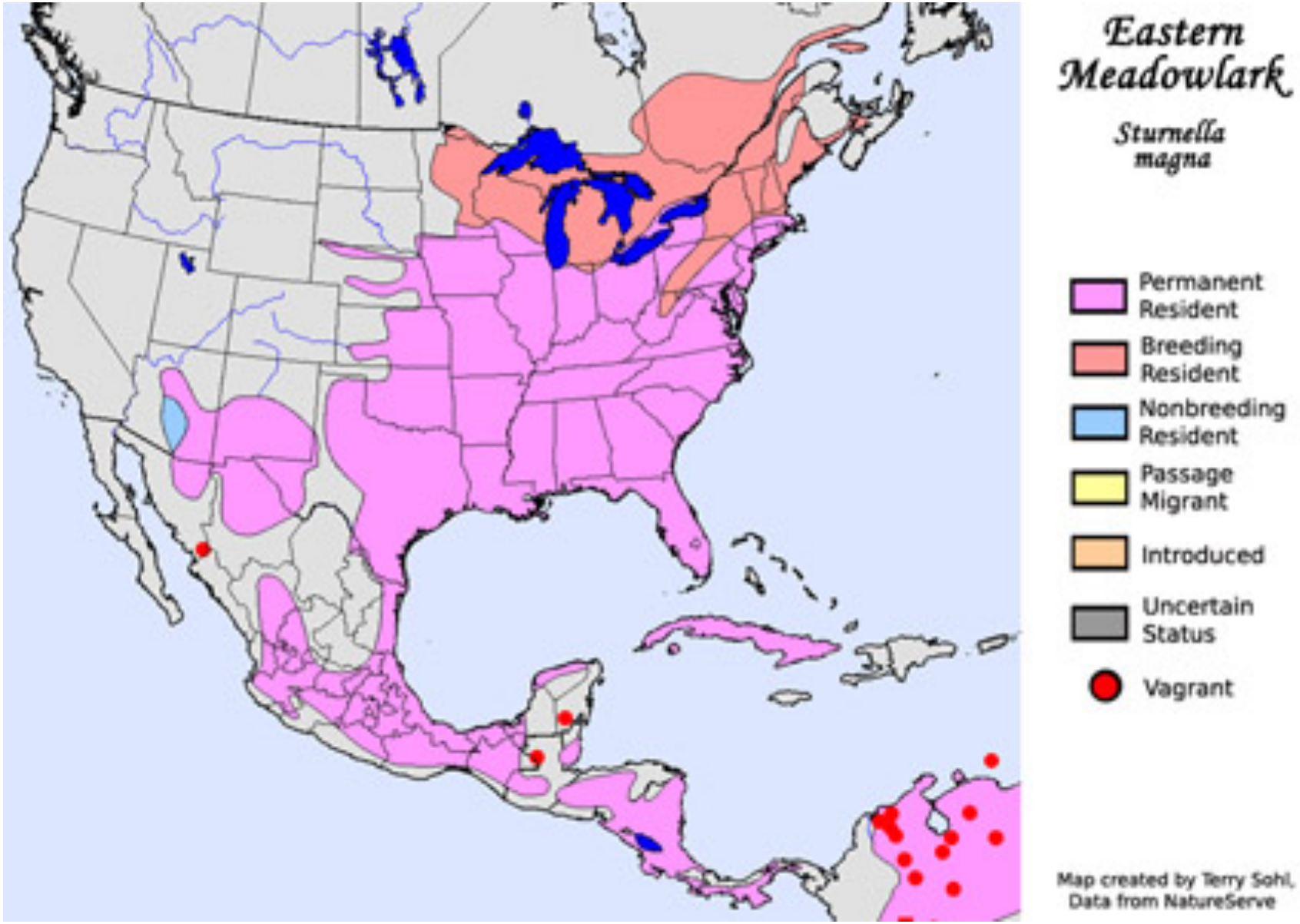
- Genetic Equilibrium: Situation in which allele freq. of a pop. do not change over time.

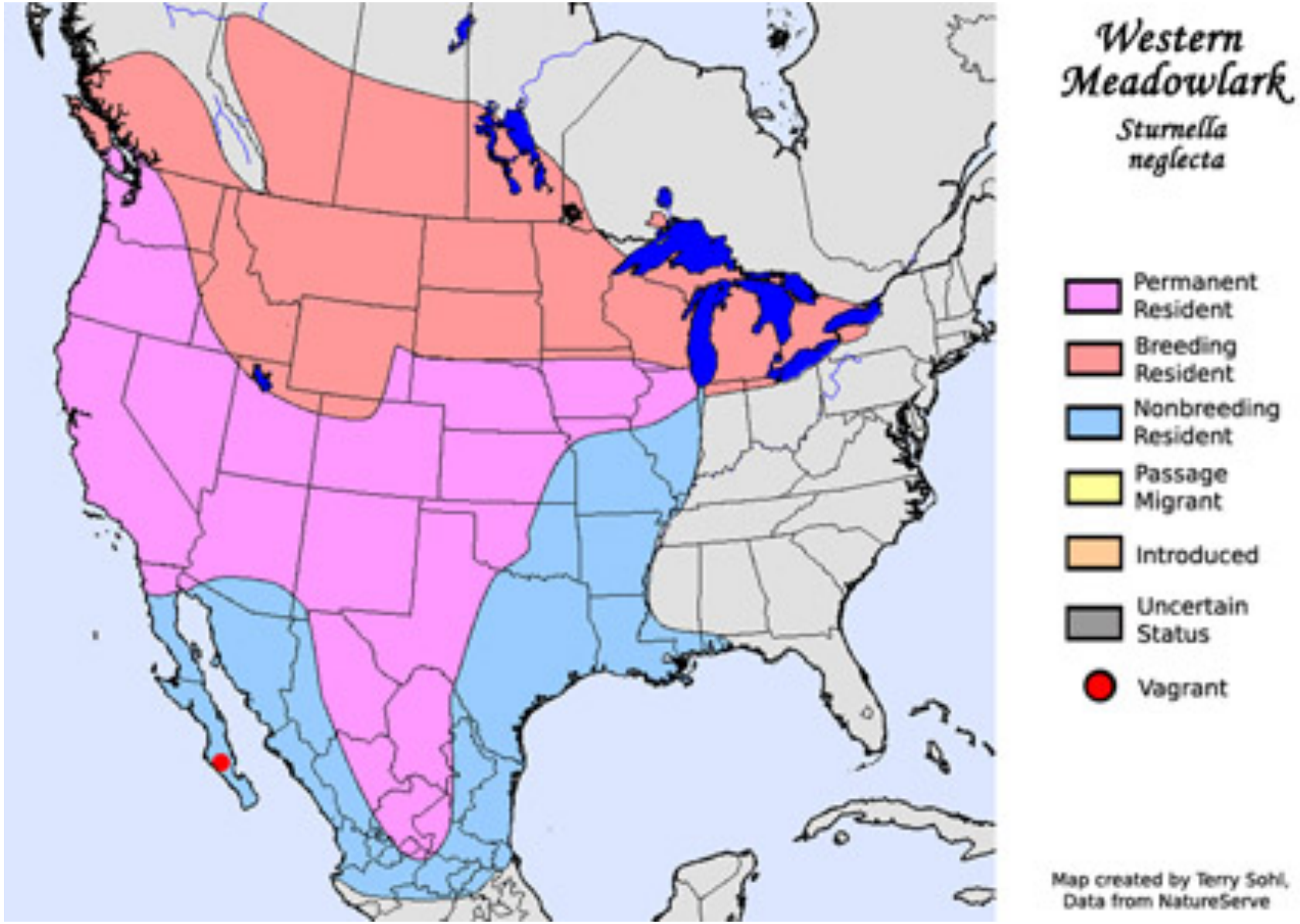
Process of Speciation

- Isolating Mechanisms – As new species evolve, populations become reproductively isolated from each other
- Reproductive Isolation – Members of two populations cannot interbreed & produce fertile offspring

a. Behavioral Isolation: Differences in behavior prevent breeding.

- Example: Eastern and western meadowlarks (pg. 404)


Eastern Meadowlark
Sturnella magna
Permanent Resident
Breeding Resident
Nonbreeding Resident
Passage Migrant
Introduced
Uncertain Status
Vagrant
Map created by Terry Sohl,
Data from NatureServe

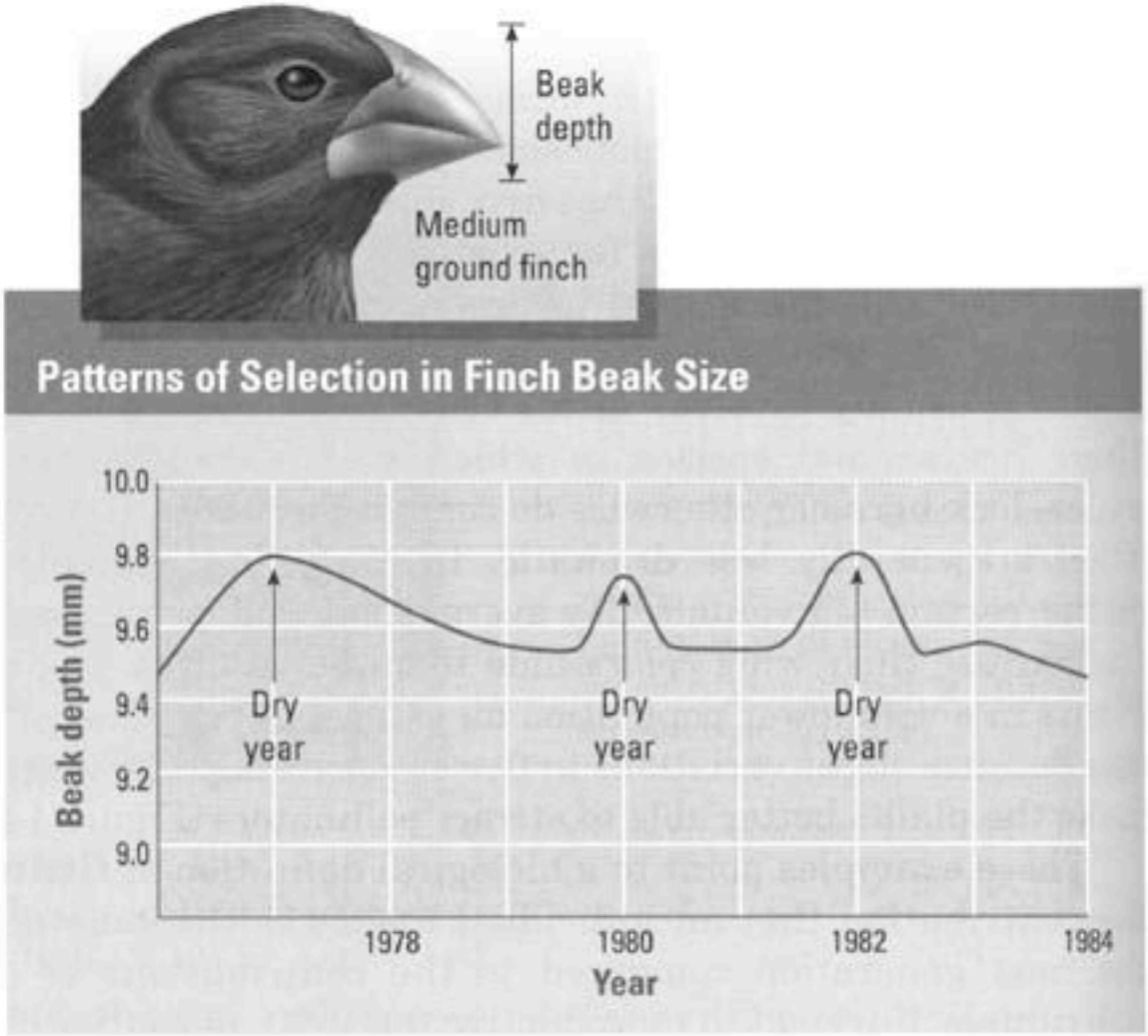

Western Meadowlark
Sturnella neglecta
Permanent Resident
Breeding Resident
Nonbreeding Resident
Passage Migrant
Introduced
Uncertain Status
Vagrant
Map created by Terry Sohl,
Data from NatureServe

b. Geographic Isolation: Separation of populations by barriers such as rivers, mountains, canyons, etc.

c. Temporal Isolation: 2 or more species reproduce at different times.

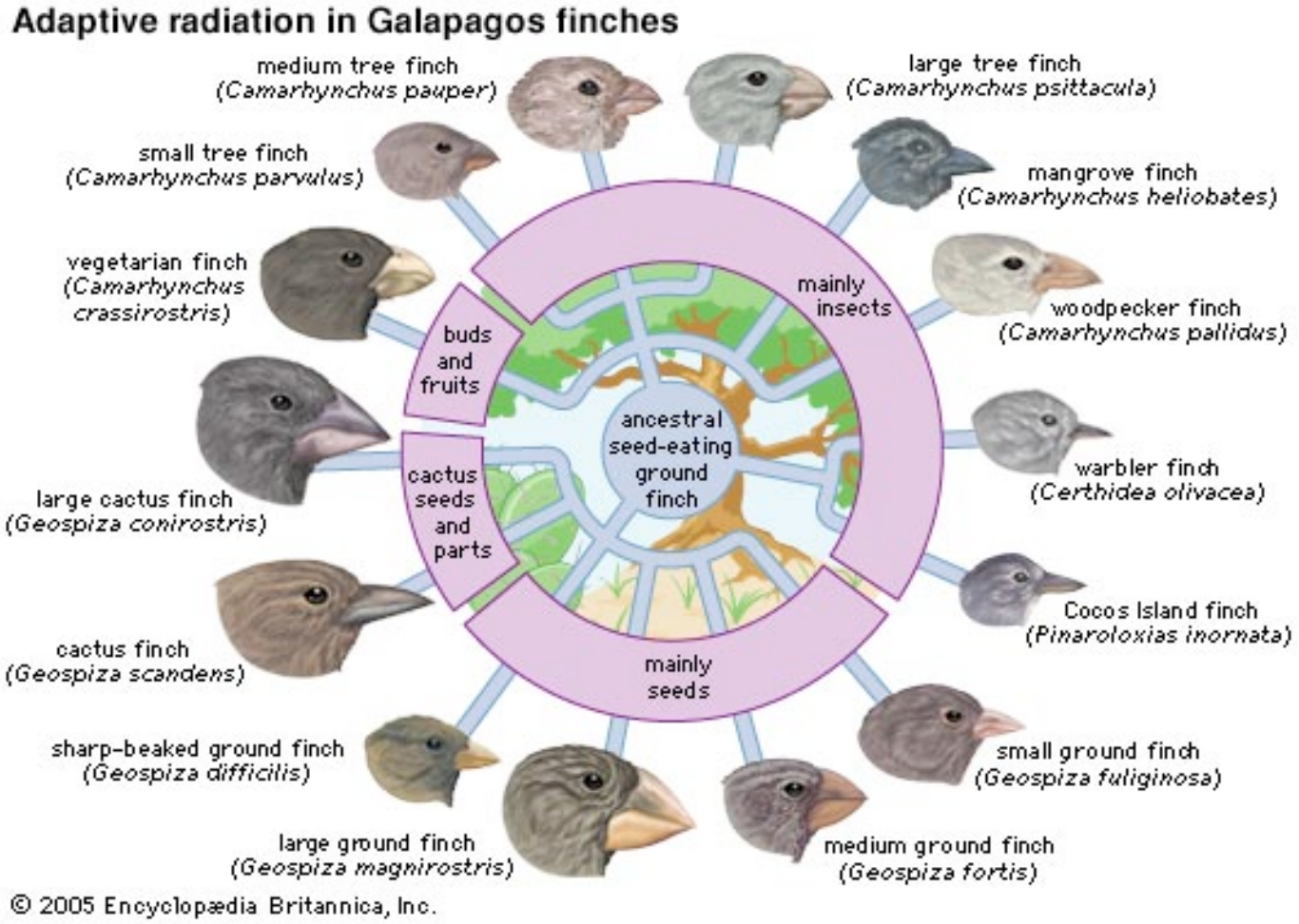
- Testing Natural Selection in Nature (Peter & Rosemary Grant, Darwin's Finches)

a. Variation – recorded lots of variation on traits of finches
b. Natural Selection – big-beaked birds survived during times of food scarcity



▲ **Figure 14-31** The Grants documented changes in beak size among medium ground finches over many years.

c. Rapid Evolution – Change in the phenotypes of the finches changed quickly over time, depending on the food supply.

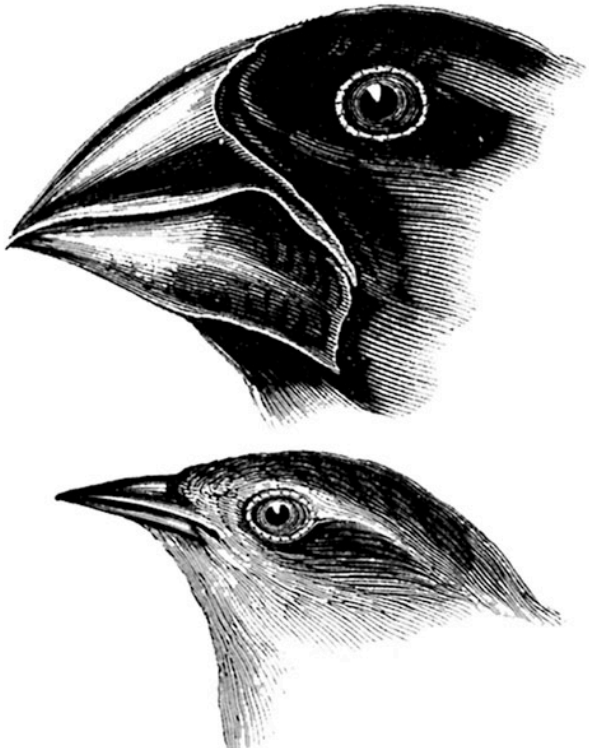


- Speciation of Darwin's Finches

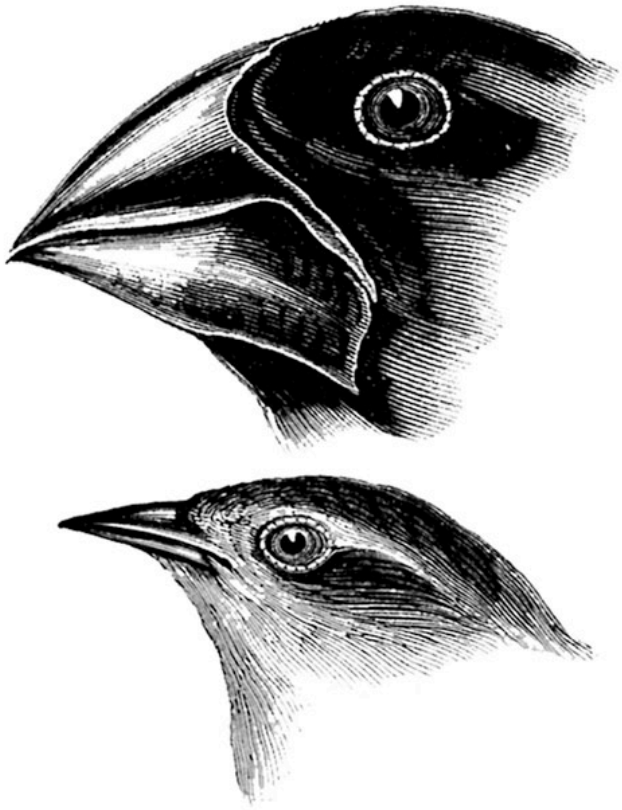
a. Arrival of the **founding** population from South America

b. Separation of populations – island to island

c. Changes in the Gene Pool – by natural selection

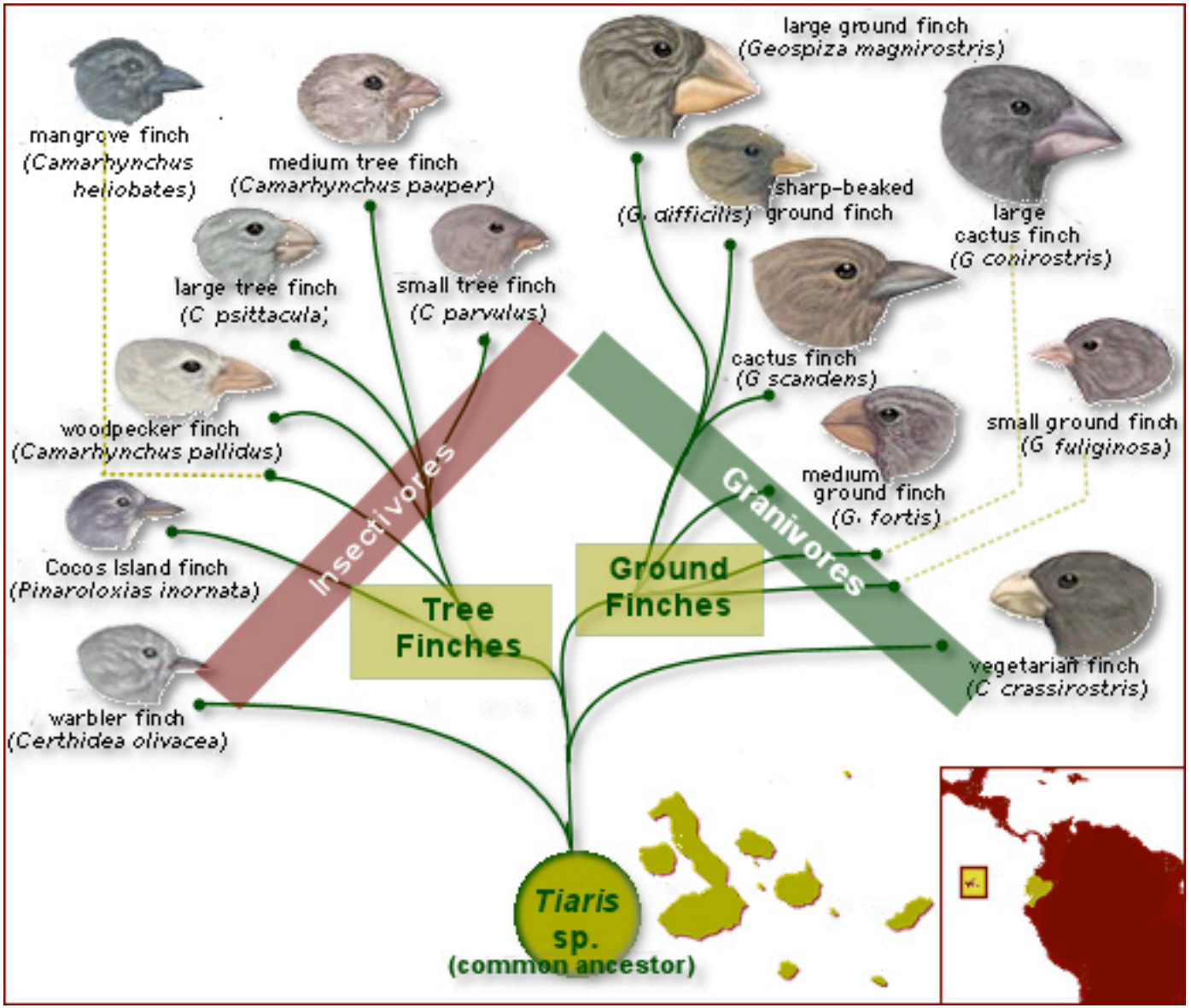


d. **Reproductive Isolation** – Birds picked mates with similar sized beaks
e. **Ecological competition** – for food during different seasons



f. **Continued Evolution** – 13 species of finches exist today

- Example of: **adaptive Radiation,** the process by which one species evolves into several different forms that live in different ways.


large ground finch
(Geospiza magnirostris)
mangrove finch
(Camarhynchus heliobates)
medium tree finch
(Camarhynchus pauper)
(G. difficilis)
sharp-beaked ground finch
large cactus finch
(G conirostris)
large tree finch
(C psittacula)
small tree finch
(C parvulus)
cactus finch
(G scandens)
small ground finch
(G fuliginosa)
woodpecker finch
(Camarhynchus pallidus)
medium ground finch
(G. fortis)
Insectivores
Granivores
Cocos Island finch
(Pinaroloxias inornata)
Ground Finches
Tree Finches
vegetarian finch
(C crassirostris)
warbler finch
(Certhidea olivacea)
Tiaris sp.
(common ancestor)

- Genetic Drift: Allele frequencies change because of chance.

- The combined genetic information of all members of a population forms a

a. Niche
b. Phenotype
c. Gene pool
d. species

A single species that has evolved into many different forms (i.e. Darwin's Finches) has undergone

a. Punctuated Equilibrium
b. Mass Extinction
c. Adaptive Radiation
d. Directional Selection

One factor which is necessary for the formation of a new species is

a. Geographic barriers
b. Reproductive isolation
c. Different mating behaviors
d. Temporal isolation

Similar organisms that can breed with each other and produce fertile offspring make up a

a. Species
b. Gene pool
c. Population
d. Clone

The separation of populations that occurs due to timing of reproductive activity is called

a. Geographic isolation
b. Behavioral isolation
c. Temporal isolation
d. Genetic drift

Genetic drift involves changes in a population due to

a. Natural selection
b. Genetic equilibrium
c. Chance
d. mutations

Chapter 17 The History of Life

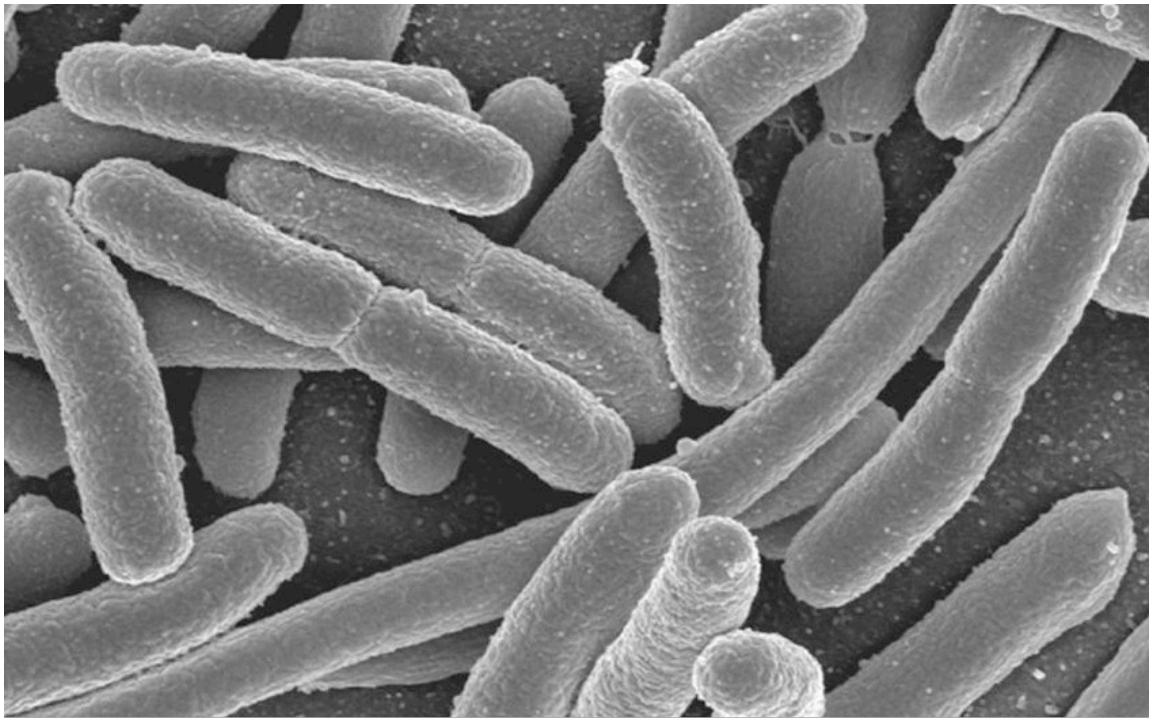
- 17-1 The Fossil Record

- The **Fossil Record** provides evidence of the history of life on earth and shows how organisms have changed over time

- More than 99% of all species on earth have become extinct.

- Most fossils form in sedimentary rock (pg.418)
- Sedimentary rock forms from particles of sand, silt, and clay.
- This process preserves the remains of organisms, forming fossils

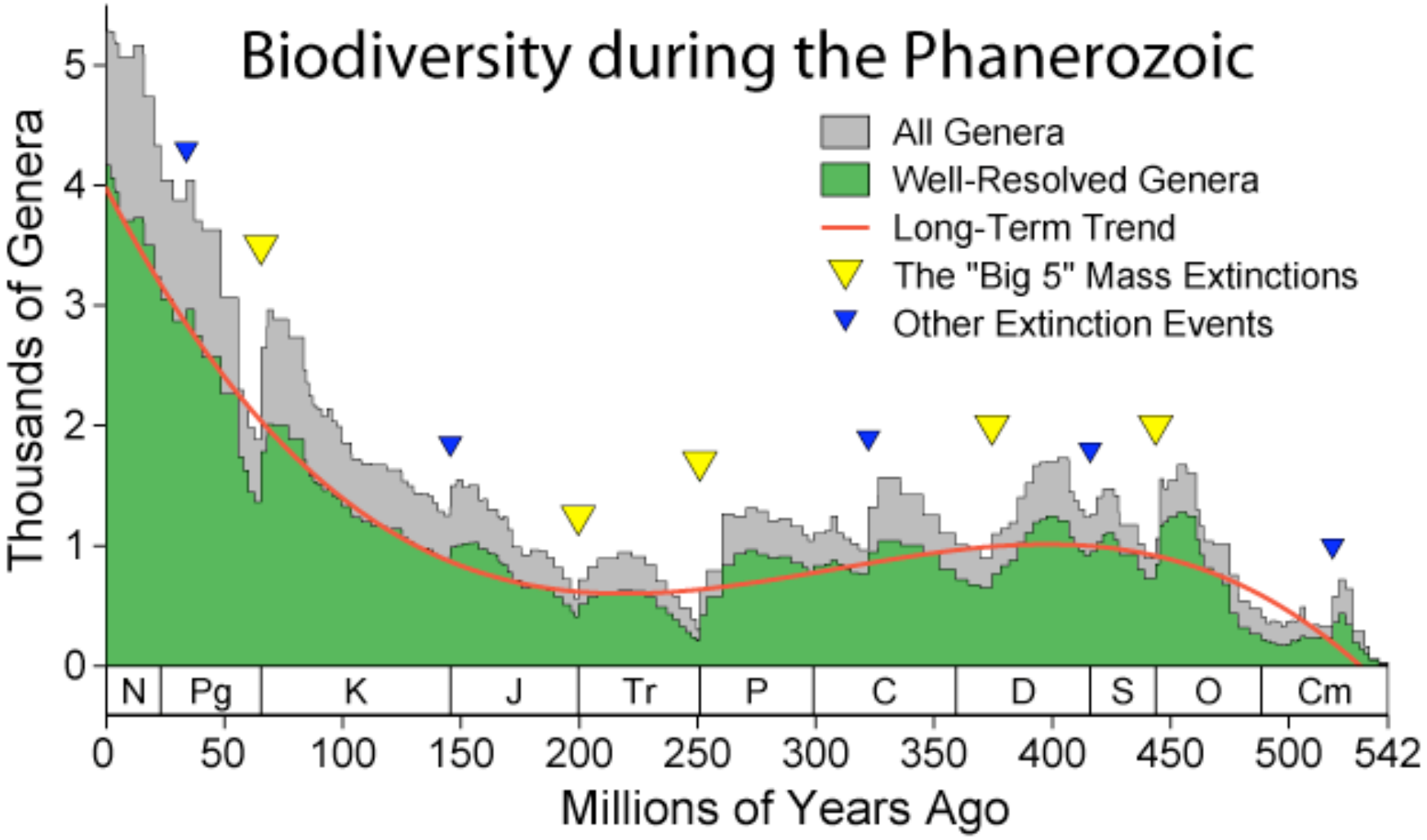
- The first organisms on earth were most likely today's **bacteria**.



- Coevolution: the process by which 2 species evolve in response to each other

- Example: a flower and a pollinating insect

- **Mass extinction** has encouraged the rapid evolution of surviving species by making new habitats available to them.


Biodiversity during the Phanerozoic
All Genera
Well-Resolved Genera
Long-Term Trend
The "Big 5" Mass Extinctions
Other Extinction Events
Thousands of Genera
0
1
2
3
4
5
N
Pg
K
J
Tr
P
C
D
S
O
Cm
0
50
100
150
200
250
300
350
400
450
500
542
Millions of Years Ago

- **Hox genes** – determine placement of arms, legs, wings…
- Could have affected evolution through small changes in timing during embryonic development

Test Prep Questions

- 5 conditions for Genetic Equilibrium:

1. Random Mating
2. Large population
3. No movement into or out of population
4. No mutations
5. No natural selection