BIOL 112

Lecture 4: Evolution and Population Genetics cont.

Is a population at HWE (not evolving)

1. calculate allele frequencies of a trait in a population of a species
2. predict genotype frequencies if population were at HWE
3. compare predicted and actual

   see examples from class

iclicker question 1.

Fitness

- Fitness in evolutionary terms refers to reproductive success (i.e. the number of offspring- how well you pass on your genes)
- relative fitness: the contribution an individual makes to the gene pool of the next generation relative to others

Assumptions of Hardy-Weinberg Equilibrium

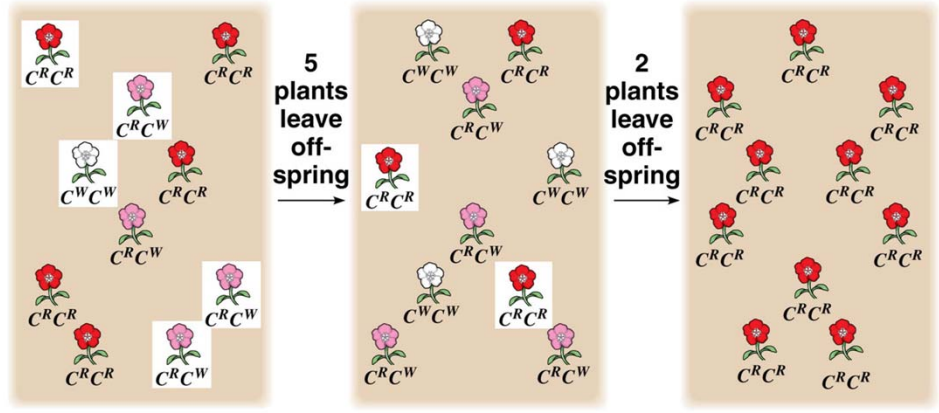
- 1. Large Population Size
- 2. No mutation
- 3. No migration in or out of the population
- 4. Random mating
- 5. No Natural Selection
  - WHAT HAPPENS WHEN THESE ASSUMPTIONS ARE VIOLATED?

1. A very large population size

violation: small population size

- *genetic drift: by **chance** the allele frequencies fluctuate more likely to happen in small population
- *If a large catastrophe happens reducing the population size drastically this is called bottleneck effect (eg. a hurricane wipes out a bunch of trees)
- *If a small group of individuals becomes isolated by chance their allele frequencies may be different from the original population this is called Founder Effect

Genetic Drift



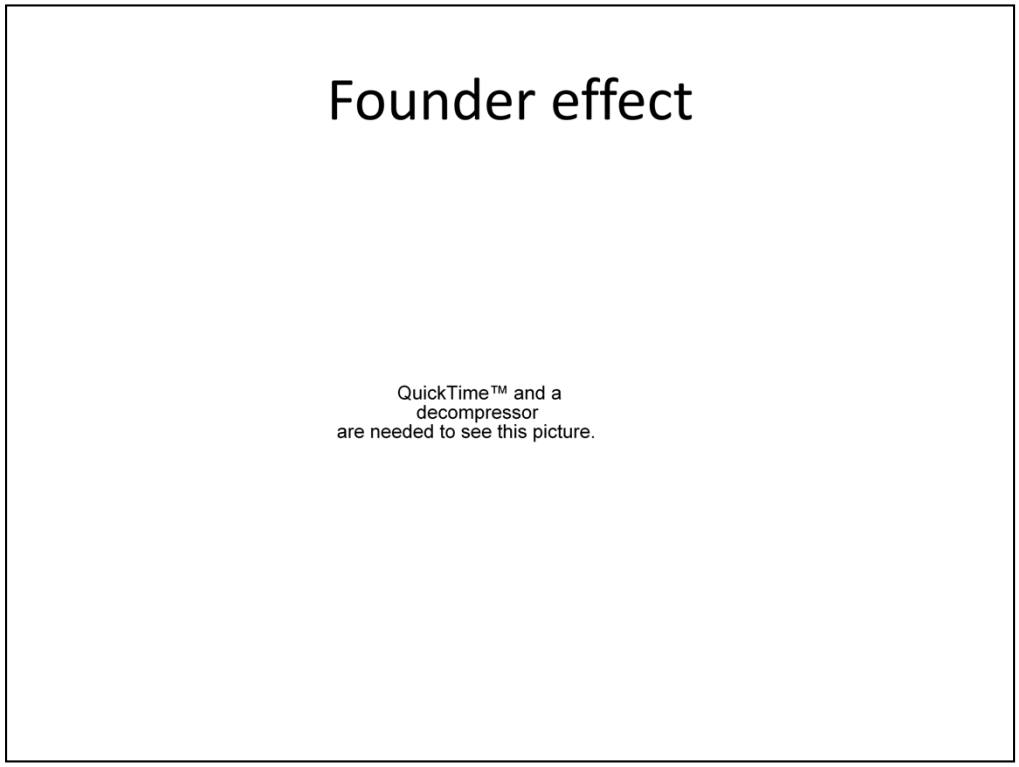
Generation 1
p (frequency of C^R) = 0.7
q (frequency of C^W) = 0.3

Generation 2
p = 0.5
q = 0.5

Generation 3
p = 1.0
q = 0.0

Bottleneck effect

Founder effect



Summary of effects of genetics drift

- Genetic drift happens most often in small populations
- The change in allele frequencies is **random**
- May result in loss of genetic variation (some alleles gone)
- This cause of change in allele frequency is not adaptive. Sometimes deleterious alleles increase in frequency.

DEME 1.0 demonstration

this is a excel based program that can simulate how different violations of HWE can change allele frequency

2. No mutation

- Mutations happen very slowly but new alleles are created by mutation
- mutation is the source of genetic variation

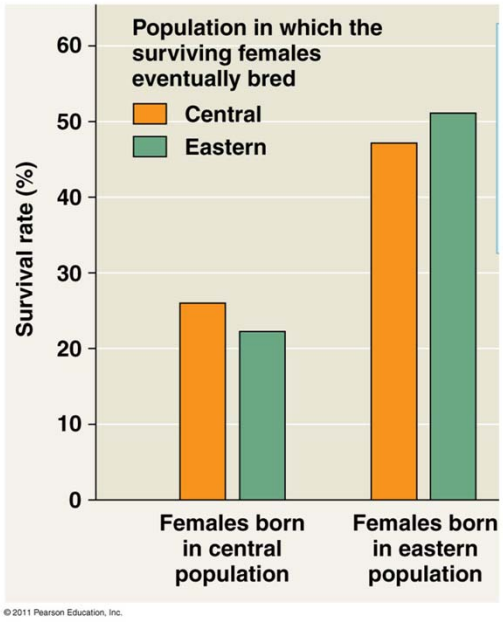
3. No migration out or in

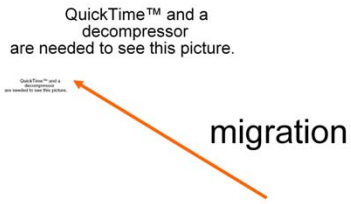
- Migration or gene flow is an important source of changing allele frequencies in populations (can undo effects of genetic drift and even local adaptation or natural selection)
- Gene flow can result in either non-adaptive or adaptive change. Can increase genetic variation potentially adaptive or decrease frequency of alleles better suited for environment

Gene flow can decrease the fitness of a population

- For example, the great tit (*Parus major*) on the Dutch island of Vlieland
  - Observation of difference in fitness between east and central island populations (East populations produced more recruits)

QuickTime™ and a
decompressor
are needed to see this picture.





Immigration from the mainland to the central population introduces alleles that decrease fitness- were not adaptive to local environment

4. random mating

Violation: non random mating-

- inbreeding: mating with close relatives can change allele frequencies (e.g. can increase the frequency of a rare deleterious recessive allele)
- Sexual selection

Sexual selection

1. Mate choice: e.g. females select a male with certain phenotype

2. Direct competition between the same sex for mates of the opposite sex

QuickTime™ and a
decompressor
are needed to see this picture.

Are females selecting mates with good genes?

- This is of much interest to evolutionary biologist

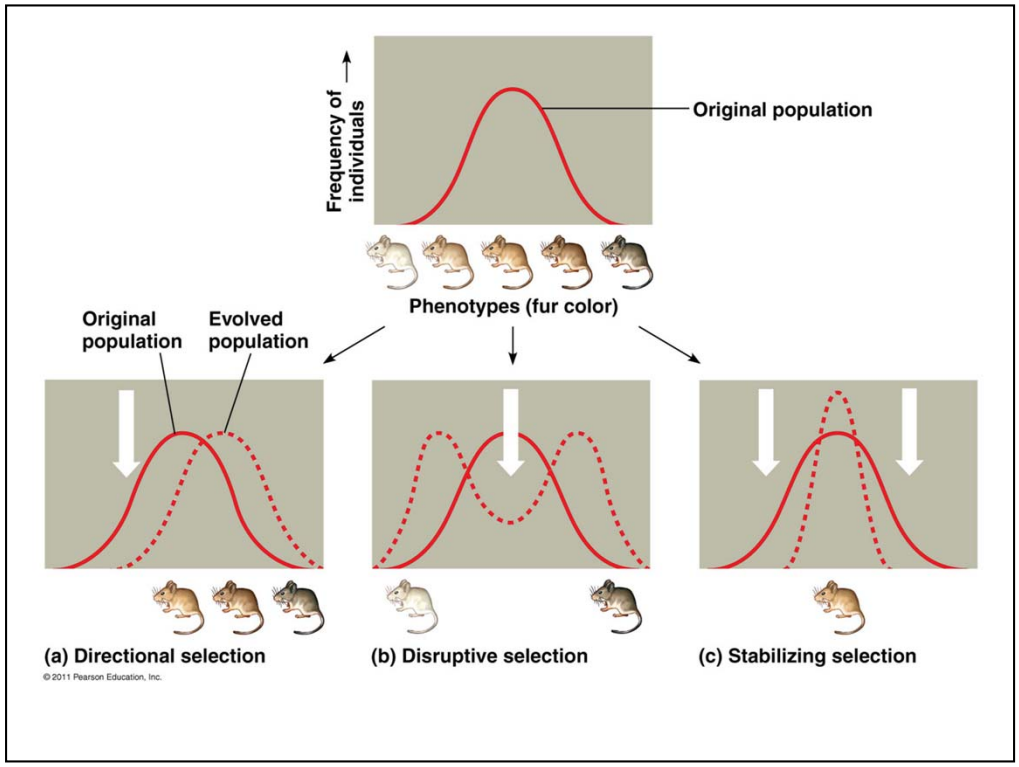
  e.g.

5. No natural selection

- Natural selection leads to changes in allele frequencies because those individuals with alleles better adapted to the habitat leave more offspring with those alleles.

Directional, Disruptive, and Stabilizing Selection

- Three modes of selection:
  - **Directional selection** favors individuals at one end of the phenotypic range
  - **Disruptive selection** favors individuals at both extremes of the phenotypic range
  - **Stabilizing selection** favors intermediate variants and acts against extreme phenotypes


Frequency of individuals
Original population
Phenotypes (fur color)
Original population
Evolved population
(a) Directional selection
(b) Disruptive selection
(c) Stabilizing selection
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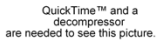
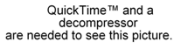
example of directional selection

Peppered moths- Industrial melanism

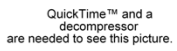
QuickTime™ and a
decompressor
are needed to see this picture.

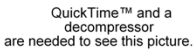
Examples of disruptive selection





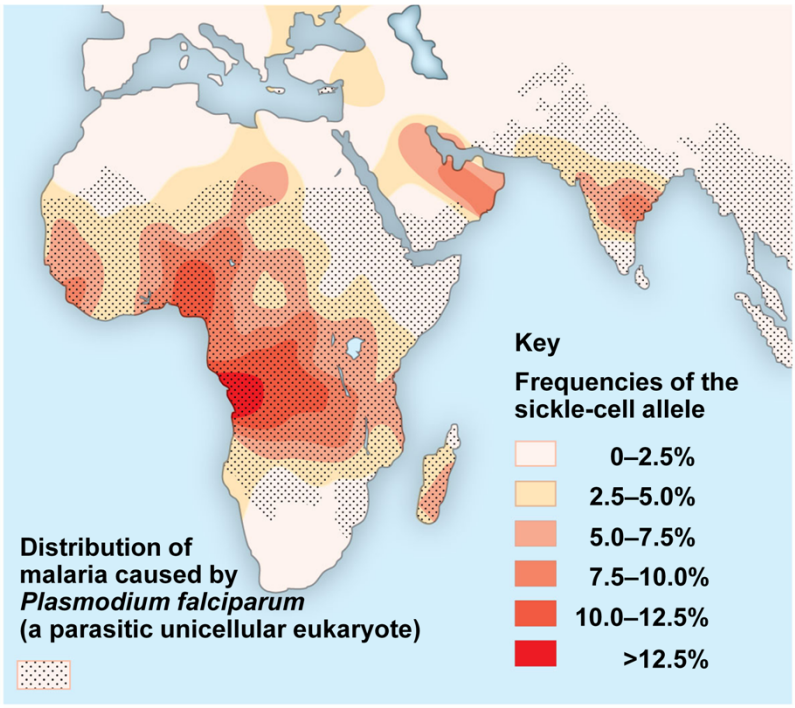
Examples of stabilizing selection

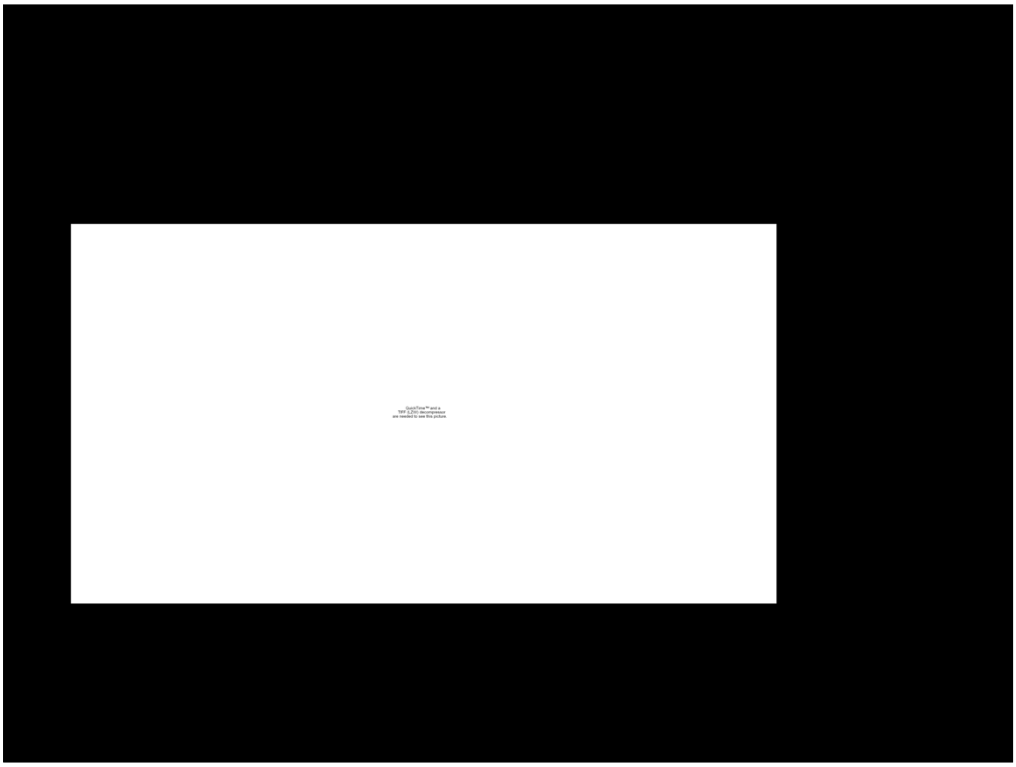




- **Heterozygote advantage** occurs when heterozygotes have a higher fitness than do both homozygotes
- Natural selection will tend to maintain two or more alleles at that locus
- The sickle-cell allele causes mutations in hemoglobin but also confers malaria resistance

Figure 23.17




QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Frequency dependant selection