Microevolution: The mechanism of evolution

What is it that evolves?

- Not individual organisms
- Populations are the smallest units that evolve
- Population: members of a species (inter-breeding individuals and their offspring) that occupy the same geographic region

Genes are the raw material of evolution

- Genotype
- Phenotype
- Alleles
- Gene pool
- Allele frequency
Microevolution:

The small changes in allele frequencies in populations over time; i.e., changes in a population's gene pool

Five agents of microevolution

• Mutation
• Gene flow
• Genetic drift
• Nonrandom mating
• Natural selection

Mutations

• Alteration in organism’s DNA
• Heritable
• Results in new or altered gene products
• Random
• Rare
• Usually has a harmful or no effect
• But beneficial mutations are indispensible to evolution
Gene flow

– Changes in allele frequencies due to immigration into, or emigration out of a population
- Occurs when individuals move between populations, or when one population of a species joins another
  • Mechanisms include dispersal of juvenile animals and the transport of pollen or seeds by wind or animals

Immigration leads to gain of alleles, increase in genetic diversity.
Emigration leads to loss of alleles, decrease in genetic diversity.

Genetic drift

• The chance alteration of gene frequencies in a small population
• Degree of influence is related to population size; populations in which genetic drift is likely to play a major role generally have 100 or fewer individuals
• Genetic drift does not lead to adaptation, but it does lead to changes in allele frequencies
Variations on Drift:

Genetic drift is very pronounced when very few individuals rebuild a new population (Bottleneck effect), or found a new one (Founder effect).

The bottleneck effect:

- Occurs when populations are reduced to small numbers (by some drastic event usually)
- Can severely reduce genetic variation b/c of very low number of individuals contributing to gene pool
- Examples: elephant seals, cheetahs
The founder effect:

-Occurs when a few individuals migrate to a new isolated location and start a new population
-Example: Ellis-van Creveld syndrome in Pennsylvania Amish

Both types of drift cause a reduction in genetic variation in a population; both types can lead to Inbreeding: mating among closely related individuals

When is genetic drift likely?

- Rare species
- Colonizing populations
- Skewed mating systems...
- ...Endangered species
Nonrandom mating

- Occurs when one member of a population is NOT equally likely to mate with any other member.
- Nonrandom mating is the rule in most populations

Nonrandom mating due to:

- Assortative mating:
- Occurs when individuals tend to mate with other individuals with the same genotype or phenotype
- Example: humans of similar heights
Nonrandom mating due to:

- Inability of organisms to move around
- Individuals mate with neighbors
- Promotes inbreeding
- Example: some plants

Nonrandom mating due to:

- Sexual selection: mating choice based on a particular phenotype
- Favors traits preferred by members of opposite sex; these traits do NOT necessarily have any survival advantage (sometimes actually disadvantageous)
- Females most often agents of sexual selection
- Example: frigate bird
Natural selection

- Some individuals will be more successful than others in surviving and reproducing, due to traits that give them a better “fit” to the environment
- The alleles of those who reproduce more will increase in frequency in a population

Comparing the five agents of microevolution:

- Natural selection is the only agent that consistently works to adapt organisms to their environment
- Evolutionary adaptation: inherited characteristic that enhances an organism’s ability to survive and reproduce in a particular environment.

- Mutations may or may not be adaptive
- Gene flow can be as random as the wind
- Genetic drift also random
- Nonrandom mating sometimes adaptive, sometimes not
What is “evolutionary fitness”?

- Individuals that leave the most offspring
- Absolute fitness impossible to determine
- Relative fitness changes as environment changes
- Highly specialized organisms at danger of extinction if environment suddenly changes

Three modes of natural selection

- Stabilizing selection
- Disruptive selection
- Directional selection
Stabilizing selection

- Selection acts against extreme phenotypes, favors intermediate forms; these have highest fitness.
- Ex: Human birth weights, gall-making flies

Diversifying (Disruptive) selection

- Selection acts against intermediate phenotypes, favors extremes
- The inverse of stabilizing selection
- Ex: European snail

Directional selection

- Selection acts against phenotypes at one of the phenotypic extremes.
- Ex: peppered moths
Directional selection in action:

Antibiotic resistance