Title: The Causes of Microevolution

Title Slide

Narrator: Welcome to this presentation on the causes of microevolution. The causes of microevolution are deceptively simple. Each has spawned entire careers worth of study. Each has a role to play in changing the form and ultimately the identity of species.

Slide 2

Title: What Causes Microevolution?

Slide Content:
Text:
1. Mutation
2. Gene flow
3. Genetic drift
4. Nonrandom mating
5. Natural selection

Image: large question mark

Narrator: So the conditions that lead to microevolution are mutations, gene flow, genetic drift, nonrandom mating, and natural selection. It is important that you understand each of these and eventually see how they fit into the larger picture of macroevolution.

Slide 3

Title: Mutations

Slide Content:
Text:
- Are changes in an organism’s DNA
- Alone do not have much effect on a large population
  - Rare
  - Usually negative or neutral (NOT goal oriented)
- Ultimate source of genetic variability

Image: None

Narrator: Let’s begin with mutation. Mutation, as we’ve discussed previously, is a random change in the nucleotide sequence of a gene. Of course, the introduction of a new allele immediately changes allele frequencies. However, because mutations are rare occurrences and because most mutations are harmful to the recipient (or at least neutral), this is a relatively minor cause of microevolution. Nonetheless, it is typically the ONLY way that genetic variability is introduced into a species. Let me state that in another fashion, all variation in organismal form that we see today was ultimately caused by mutations.

Slide 4

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Image: None

Narrator: Next, gene flow. The name of this phenomenon really emphasizes the fact that population geneticists are focused on the movement of genes, not the species that carry them.

Slide 5
Title: Gene Flow
Slide Content:
Text: Alteration of the frequency of alleles by the immigration of individuals from a different population (also emigration)

Image: Simple diagram showing what happens when two different kinds of birds crossbreed

Narrator: Gene flow is a simple concept: Individuals of a species capable of breeding immigrate into or emigrate out of a population carrying their genes with them. If an immigrant or an emigrant group has a different allelic composition that the population they are joining or leaving, then the allele frequencies of the study population will change.

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Image: None

Narrator: Genetic drift is change in allele frequency due to chance. Small populations tend to experience greater random change from generation to generation than large populations.

Slide 7
Title: Genetic Drift
Slide Content:
Text:
- Small populations more influenced by genetic drift
- Fixation or loss of allele
To explain, consider a scenario in which a forest glen contains a population of 18 snails. It is not hard to imagine that some event unrelated to the snails' genotype could prevent at least one of the snails from reproducing (e.g., a branch falls and squishes one of the poor snails). If just one of the snails fails to reproduce, that means 6 percent of the gene pool (2 gene copies/36 total gene copies) will be unavailable to contribute to the next generation; in that case, the next generation's gene pool will most certainly have different allele frequencies than the starting population. This figure shows simulations of the change in the frequency of one allele from generation to generation in this small population. Even with no advantage or disadvantage conferred by this allele, it quickly proceeds to fixation where it becomes the only allele in the population or complete loss from the population. This is why small populations tend to have reduced genetic diversity.

Slide 8
Title: Genetic Drift
Slide Content:
Text:
Drift is not as fast in large populations

Narrator: In a population of 100 individuals, random events are less likely to have as profound effect; fixation or loss due to drift is therefore, much less likely in the same number of generations.

Slide 9
Title: Genetic Drift
Slide Content:
Text:
• If populations are reduced to a small number of individuals—a population bottleneck, genetic drift can reduce the genetic variation.
  – e.g., Cheetah
• Founder effect
  – e.g., Amish

Narrator: Numerous examples of rapid genetic drift due to small populations have been documented. One cause is population bottlenecks, where a population is greatly reduced in size and the individuals are lost without regard to their genotype. Like a few colored marbles shaken at random out of a bottle, the alleles that make it through the population contraction are a random sample of the initial gene pool. Because of rapid drift in the small populations remaining after the bottleneck, alleles and therefore genetic diversity are likely to be lost. This happened when the world’s cheetah population was reduced to a mere few litters approximately 10,000 years ago. Even though the population rebounded to thousands of individuals, the genetic diversity remains incredibly low to this day.

The founder effect, where a small group of individuals settle an unhabituated area and form a new isolated population, can also lead to rapid genetic drift and unusual allele frequencies. As an example, the Amish of Lancaster County, Pennsylvania, exhibit a much higher occurrence of a genetic disease...
Ellis-van Creveld syndrome than the general population. Approximately 1 out of every 200 children in that community is born with the disease versus 1 out of 60,000 in the general population. The Amish founded the Lancaster community with fewer than 400 individuals, including a carrier of a rare disease causing allele. This carrier, Samuel King, arrived in 1744. Drift resulted in the harmful allele becoming more common and because the population is reproductively isolated, the frequency of the allele remains higher than in the general public to this day.

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Image: Graph showing the Hardy–Weinberg principle for two alleles

Narrator: If you are still looking for that certain special someone that you wish to have children with, will you select someone at random? No? Most animals do not, so most will demonstrate some degree of nonrandom mating.

Slide 11

Title: Nonrandom Mating

Slide Content:
Text: Sexual Selection for Adaptive/Non-adaptive Features

Images: A peacock and a drawing of Vitruvian Man by Leonardo Da Vinci

Narrator: Just as we find aspects of looks or behavior enticing in a potential mate, so too do other animals. For example, if peahens favor large colorful tail feathers in peacocks, then the alleles that contribute to large colorful feathers will likely be more common in the next generation’s gene pool as large more colorful tail-feather bearing males are more likely to mate than drab small-feathered males.

Slide 12

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Image: Charles Darwin
**Narrator:** Natural Selection was the mechanism of evolution proposed by Darwin. Basically, alleles that make an organism more fit than the other members of its species will become increasingly common while other alleles will become rarer.

**Slide 13**

**Title:** Natural Selection

**Slide Content:**

**Text:**
- Success or fitness is defined as the relative number of offspring produced by an individual
- Acts on existing genetic variation
- Leads to greater fitness of the population under current conditions, NOT perfection

**Image:** Several sets of chromosome pairs

**Narrator:** Whoa! This is a very important and very misunderstood concept. First, by fitness, we are referring specifically to the relative number of reproductively capable offspring an organism produces: How many more offspring does an individual produce compared to others of the same species in the same population? This may have nothing to do with physical prowess; an asthmatic, near-sighted, gluten intolerant gazelle may be more fit than its fleet footed, normal vision, gluten-loving cousin if it can hide from predators better and survive to make more babies.

Students often mistakenly believe that natural selection creates a perfect genetic response to any challenge faced by a species. Instead, some agent of stress on the population (e.g., predator, sickness, environmental stress) will lead to unequal reproductive success in the population if a more advantageous allele already exists in the population. This allele would have been created by some past mutation. It would not have occurred because the species needed it. In fact, populations have been driven to extinction in the face of stress because adaptive alleles were not present in the gene pool.

Another point that needs to be made is that the popular expression "survival of the fittest" somewhat misstates what happens under natural selection. "More successful reproduction by the, at least slightly more fit than others," doesn’t have the same appeal. While better adapted forms leave behind more offspring, this doesn’t mean that these individuals are perfectly adapted to their environment; they are just better adapted than the other possibilities in their population. Also, whatever form is "fittest" now, might not be in the future if conditions change. For example camouflage that enables a mouse to hide against a background of dry grasses may be beneficial during a drought but catastrophically inadequate in green fields watered by regular rainfall.

**Slide 14**

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**Slide Content:**

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**Image:** None
Narrator: So five things can cause the allele frequencies in a population to change, bringing about microevolution:

1. Mutation, how new alleles are created
2. Gene flow, when immigration and emigration move genes
3. Genetic drift, random changes in allele frequency that are particularly rapid in small populations
4. Nonrandom mating, mate preferences can favor the spread of particular alleles
5. Natural selection, some alleles confer a reproductive advantage to some individuals in a population over others.

Slide 15

End of Presentation