Speciation

Speciation is the process by which daughter species evolve from a parent species.

Outline

- Key concepts
- Biological species
- Reproductive Isolating Mechanisms
- Other concepts of species
- Allopatric speciation
- Sympatric speciation
- Adaptive radiation
- Key Terms
- Conclusions

Key Concepts:

- A species consist of one or more populations of individuals that can interbreed and produce offspring
- Populations of a species have a shared genetic history
- Speciation is the process by which daughter species evolve from a parent species
Key Concepts:
- There are many different mechanisms to isolate species
- Geographic barriers can start the process of speciation
  - Allopatric speciation
- With sympatric speciation, a species can form within the range of a parent species

Biological Species Concept
Defines a species as a population or group of populations whose members have the potential to interbreed in nature and produce viable, fertile offspring but are unable to produce viable fertile offspring with members of other populations.

Same species or not?
- [Similarity between different species. The eastern meadowlark (Sturnella magna, left) and the western meadowlark (Sturnella neglecta, right) have similar body shapes and colorations. Nevertheless, they are distinct biological species because their songs and other behaviors are different enough to prevent interbreeding should they meet in the wild.]
- [Diversity within a species. As diverse as we may be in appearance, all humans belong to a single biological species (Homo sapiens) defined by our capacity to interbreed.]

Figure 24.3 A, B
Prezygotic and postzygotic barriers

Prezygotic barriers impede mating or hinder fertilization if mating does occur.

Individuals of different species:
- Mating attempt
- Habitat isolation
- Temporal isolation
- Behavioral isolation
- Mechanical isolation

Habitat isolation
- Individuals of different species
- Temporal isolation
- Behavioral isolation
- Mechanical isolation

Prezygotic and postzygotic barriers

Gametic isolation
- Reduce hybrid viability
- Reduce hybrid fertility
- Hybrid breakdown

Gametic isolation
- Reduced hybrid viability
- Reduced hybrid fertility
- Hybrid breakdown

Limitations of the Biological Species Concept

- The biological species concept cannot be applied to:
  - Asexual organisms
  - Fossils
  - Organisms about which little is known regarding their reproduction
Other Definitions of Species

- **The morphological species concept**
  - Characterizes a species in terms of its body shape, size, and other structural features

- **The paleontological species concept**
  - Focuses on morphologically discrete species known only from the fossil record

- **The ecological species concept**
  - Views a species in terms of its ecological niche

- **The phylogenetic species concept**
  - Defines a species as a set of organisms with a unique genetic history

Speciation

- Speciation can occur in two ways
  - Allopatric speciation
  - Sympatric speciation

Allopatric Speciation

- Speciation in geographically isolated populations
  - Probably most common mechanism
  - Some sort of barrier arises and prevents gene flow
  - Effectiveness of barrier varies with species
Extensive Divergence Prevents Inbreeding

- Species separated by geographic barriers will diverge genetically
- If divergence is great enough it will prevent inbreeding even if the barrier later disappears

Speciation without a Barrier

- Sympatric speciation
  - Species forms within the home range of the parent species
- In sympatric speciation
  - Speciation takes place in geographically overlapping populations

Polyploidy

- Polyploidy
  - Is the presence of extra sets of chromosomes in cells due to accidents during cell division
  - Has caused the evolution of some plant species
An autopolyploid

– Is an individual that has more than two chromosome sets, all derived from a single species

Failure of cell division in a cell of a growing diploid plant after chromosome duplication gives rise to a tetraploid branch or other tissue.

Gametes produced by flowers on this branch will be diploid.

Offspring with tetraploid karyotypes may be viable and fertile—a new biological species.

An allopolyploid

– Is a species with multiple sets of chromosomes derived from different species

Meiotic error; chromosome number not reduced from $2n$ to $n$

Unreduced gamete with 4 chromosomes

Hybrid with 7 chromosomes

Viable fertile hybrid (allopolyploid)

Normal gamete $n = 3$

Species A: $2n = 4$

Species B: $2n = 6$

An example of natural selection: Darwin’s finches

Showed relatively rapid evolution:
• Ancestral finches from mainland reached islands, underwent adaptive radiation and populated many diverse habitats
• Ancestral species became groups of closely related yet diverse populations
An example of natural selection: Darwin’s finches

Hawaiian Islands
- Volcanic origins, variety of habitats
- Adaptive radiations:
  - Honeycreepers - In absence of other bird species, they radiated to fill numerous niches
  - Fruit flies (*Drosophila*) - 40% of fruit fly species are found in Hawaii

Hawaiian Honeycreepers
A species consists of individuals in a population or populations. Populations of a species share genetic history. Speciation is the process by which species form from a population of a parent species. Genetic divergence is a buildup of differences in allele frequencies between populations.

Microevolutionary processes can give rise to reproductive isolating mechanisms. Speciation occurs gradually by genetic divergence. Pre-zygotic and post-zygotic isolating mechanisms contribute to speciation. There are two models of speciation: Allopatric speciation, and Sympatric speciation.