

## Chapter 7: Biological Diversity

### ✓ **What is Biological Diversity**

- Biodiversity refers to the variety of life forms in an area.
  - Expressed as the number of species in an area
  - Or the number of genetic types in an area
- We must understand:
  - How interactions among species increase or decrease diversity, and
  - How the environment affects diversity.

### ✓ **Why Do People Value Nature?**

- Eight Reasons
  - Utilitarian
  - Public service
  - Moral
  - Theological
  - Aesthetics
  - Recreational
  - Spiritual
  - Creative

### ✓ **What is Biological Evolution**

- How did biological diversity come about?
  - Before modern science, many felt it was too amazing to have come about by chance.
  - Beliefs were that it must have been created by God
  - However, with the rise of modern science, other explanations became possible.

### ✓ **Biological Evolution**

- Charles Darwin
  - Nineteenth century scientist
  - Devised the explanation of diversity known as biological evolution

### ✓ **Biological Evolution**

- Refers to the change in inherited characteristics of a population from generation to generation.
- It can result in new species

### ✓ **Biological Evolution**

- New species arise as a result of...
  - Competition for resources
  - The difference among individuals in their adaptations to environmental conditions
  - Since the environment changes, which individuals are best adapted changes too.

✓ **Biological Evolution**

- Four processes lead to evolution
  - Mutation,
  - Natural selection,
  - Migration and
  - Genetic drift

✓ **Genes**

- Genes, contained in chromosomes within cells, are inherited from one generation to the next
- A Genotype is the genetic makeup of an individual or group.

✓ **DNA**

- Genes are made up of DNA (deoxyribonucleic acid), a complex chemical compound
- DNA is made up of chemical building blocks that form a code, an “alphabet”.
  - The alphabet is made up of the four letters: A,C,G,T
    - How these letters are combined or coded determines the message passed to a cell

✓ **Mutation**

- When cells divide
  - DNA is reproduced
  - Each cell gets a copy
  - If an error occurs in the reproduction of DNA it gets passed to new cells
  - Sometimes an external agent (chemicals, radiation, viruses) comes in contact with DNA and alters it.

✓ **DNA Change = Mutation**

- When these changes occur, the cell is said to have undergone mutation.
- Sometimes a cell or offspring with a mutation cannot survive
- And other times, individuals with the mutations are so different, that they cannot reproduce with the original population
- When this happens, a new species is created

✓ **Natural Selection**

- Some individuals may be better suited to the environment than others.
- Those better able to survive and reproduce leave more offspring.
- Their descendants form a larger proportion of the next generation.

✓ **Natural Selection**

- Four primary characteristics
- ✓ Genetic variability
- ✓ Environmental variability
- ✓ Differential reproduction that varies with the environment
- ✓ Influence of the environment on survival and reproduction

✓ **Natural Selection**

- When natural selection takes place over a long period of time, a number of characteristics can change.
- The accumulation of changes may be so great that the present generation can no longer reproduce with individuals that have the original DNA structure,
- This results in a new species
- The accumulation of changes may lead to reproductive isolation
- Species = a group of individuals that can reproduce with each other.

✓ **Geographic Isolation and Migration**

- Sometimes two populations become geographically isolated for a long time
- Enough change happens through time that the populations can no longer reproduce with each other
- Two new species have formed

✓ **Geographic Isolation and Migration**

- Migration is an important evolution process over geologic time
- Example: At the end of the last ice age, Alaska and Siberia were connected by a land bridge that permitted migration
- When the land bridge was closed off, populations were closed off
- and new species emerged.

✓ **Founder Effect and Genetic Drift**

- Founder effect
  - Small # of individuals are isolated from larger population
  - Less genetic variation than original population
  - Which characteristics are present are affected by chance
- Genetic drift
  - Change in frequency of a gene *not* by mutation, selection or migration, but simply by chance
  - Chance plays a large role in what inherited characteristics remain in the population.
    - Example: a small population of animals might become isolated from the main population due to the intrusion of civilization
  - Genetic drift is considered a serious problem , especially with small populations of rare or endangered species

✓ **Founder Effect and Genetic Drift**

- Genetic Drift of small populations can be a problem for two reasons:
- ✓ Characteristics that are less adapted to existing environmental conditions may dominate, making survival of the species less likely
- ✓ The small size of the population reduces genetic variability and hence the ability to of the population to adapt to future changes in the environment

✓ **Basic Concepts of Biological Diversity**

- Genetic diversity:
  - Total # of genetic characteristics of a specific species, sub species or group of species.
- Habitat diversity:
  - The different kinds of habitat in a given unit area.
- Species diversity:
  - Species richness – total number of species in an area. Given as a number.
  - Species evenness - the relative abundance of species in an area. Given as a percentage.
  - Species dominance - the most abundant species
    - Dominance may be measured in:
      - Numerical dominance
      - Biomass
      - Coverage
      - Ability to amass resources
      - Or a combination of parameters such as relative abundance, relative frequency, and coverage.

✓ **The Evolution of Life on Earth**

- Earliest fossils 3.5 billion years old was a photosynthetic ancestor of bacteria (Archaea)
- Released large amounts of oxygen into the atmosphere
- For the next 2 billion years, only such microbial forms lived on Earth.
  - Because of this, these microbial forms were the driving force in changing the atmospheric chemistry of the Earth.
  - They paved the way for oxygen breathing animals

✓ **The Evolution of Life on Earth**

- Cambrian Period
  - 600 mya - 500 mya
  - Earliest multicellular organisms
  - These organisms had shells, gills, filters, efficient guts and a circulatory system. Examples: Ancient trilobites, clams, urchins, & snails
  - Life remained in oceans
- Silurian Period
  - Plants evolved to live on land

✓ **The Evolution of Life on Earth**

- For larger, multicellular organisms, life on land required some major innovations:  
Innovations for life on land
  - Structural support
  - Internal aquatic environment
  - Means for exchanging gases with air instead of with water
  - A moist environment for reproduction system

✓ **The Evolution of Life on Earth**

- Devonian Period
  - 420 mya – 360 mya
  - First animals on land = crossopterygians (the first fish to venture onto land)
    - These animals had lobelife fins which they used like limbs
    - Also had internal nostrils instead of gills
  - These animals gave rise to the amphibians
  - The amphibians were still tied to water for survival and reproduction

✓ **Early Life on Land**

- Reptiles
  - Freed from water by evolving a watertight egg and can be incubated outside of the water
  - Originated in the Carboniferous (375 mya)
  - Widespread by the Jurassic (185 mya)
  - The ancient reptiles gave rise to the two orders of dinosaurs, and which, in turn, gave rise to mammals and birds.

✓ **The Evolution of Life on Earth**

- Mammals
  - More capable brain and faster metabolism
  - Placental uterus one key to mammalian success

✓ **The Number of Species on Earth**

- Roughly, 1.5 million have been named
- Different experts have said that the total # could be millions more
- New species are discovered all the time

✓ **The Number of Species on Earth**

- Scientists group living things on the basis of evolutionary relationships.
  - Three domains of organisms
    - **Eukaryotes** (*all animals, plants, protists or single-celled organisms, and fungi*)
      - Eukaryotes have a nucleus and organelles, Bacteria and Archaea do not.
    - **Bacteria**
    - **Archaea** (*microorganisms that resemble bacteria but are different from them in certain aspects of their chemical structure, such as the composition of their cell walls*)

✓ **The Number of Species on Earth**

- The least described and most difficult to classify are microbes
- Most of the species on Earth are insects or plants.
- Many species of fungi and protists.
- Relatively few mammals.

✓ **Why are there so many species?**

- Answer lies in...
  - The different ways in which organisms interact
  - The idea of the ecological niche

✓ **Interaction between Species**

- Competition
  - The outcome is negative for both groups
- Symbiosis
  - Benefits both participants
- Predation and parasitism
  - The outcome benefits one and is detrimental to the other.

✓ **Competitive Exclusion Principle**

- Two species that have exactly the same requirements cannot coexist in exactly the same habitat.

✓ **Niches: How Species Coexist**

- Species coexist by exploiting the available resources in a sufficiently different manner
- This way competition is avoided or reduced
- Thus, each species has a different ecological niche

✓ **Measuring Niches**

- A niche is the set of all environmental conditions under which a species can...
  - Persist, and
  - Carry out its life functions
- The measuring niche is known as the Hutchinsonian niche

✓ **Measuring Niches**

- For simplicity, only one environmental parameter can be measured at a time
  - Example: the temperature range in which a species survives
- If no competing species are present, the species has a relatively broad niche width – called the ***Fundamental Niche***

✓ **Measuring Niches**

- If there are other competing species, then the niche has a reduced niche width and is called the ***Realized Niche***
- Broad niches = generalists
- Narrow niches = specialists

✓ **Symbiosis**

- Describes a relationship between two organisms that
  - Is beneficial to both
  - Enhances each organism's chance of persisting
- Each partner called a symbiont
- Symbiosis exists because the symbionts coevolved.

- ✓ **Predation and Parasitism**
  - Relationship is beneficial for predator or parasite and negative for prey or host.
- ✓ **Predation**
  - One organism (predator) feeds on other live organisms (prey).
- ✓ **Parasitism**
  - One organism (the parasite) lives on, in, or within another (the host).
- ✓ **Environmental Factors that Influence Diversity**
  - Genetic Engineering
    - Information contained in DNA is enormous
    - We now have the ability to manipulate inherited characteristics
    - New possibilities pose novel problems
      - Adaptive characteristics vs. superpests