



Chapter 4: Biodiversity and Evolution

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Biodiversity

- * Also called biological diversity
- * Variety of the earth's species, the genes they contain, the ecosystems in which they live, and the ecosystem processes such as energy flow and nutrient cycling that sustain all life
- * Components: species diversity, genetic diversity, ecosystem diversity, functional diversity

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Biodiversity as Natural Capital

- * Supplies us with food, wood, fibers, energy, and medicines
- * Preserves air quality, water quality, and soil fertility
- * Helps dispose of wastes and control pests

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How did biodiversity happen?

- * Biological evolution - changes in the genes of populations causes changes in biodiversity
- * Darwin and Wallace observed that organisms are in constant competition for resources and that the more suited an organism is to obtaining the resource, the more likely it will survive to reproduce and pass on its traits (genes).
- * Natural Selection - individuals of a population have genetically based traits that enhance their ability to survive and produce offspring with the same trait

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Evolution and Mutations

- * VERY IMPORTANT TO REMEMBER: Populations evolve; individuals do not.
- * Genetic variety occurs through mutations (random changes in the structure or number of DNA molecules in the cell that can be inherited by offspring).

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Natural Selection

- * Adaptations (adaptive trait) - a heritable trait that enables an individual organism to survive through natural selection and reproduce more than other individuals under prevailing environmental conditions

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Natural Selection

- * Summary
 - * Genes mutate
 - * Individuals are affected
 - * Populations evolve that are better adapted to survive and reproduce under existing environmental conditions

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Limits to Natural Selection

- * Change in environmental conditions can lead to such an adaptation only for genetic traits already present in a population's gene pool for traits resulting from mutations.
- * Even if a beneficial heritable trait is present in a population, the population's ability to adapt may be limited by reproductive capacity.

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Misconceptions about Evolution

- * "Survival of the fittest" means "survival of the strongest"
 - * "Fittest" refers to reproductive success
- * Traits not developed out of need
 - * Traits are developed by accidental mutations that provide advantages
- * Involves some grand plan of nature which causes species to become more perfectly adapted
 - * Mutations are random and do not lead to perfection. Instead it leads to genetic diversity.

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Geological Impacts on Evolution

- * Tectonic plate movement impacts the location of the continents and ocean basins which greatly impacts currents (air and water) which impacts climate.
 - * This has an impact on the types of organisms that can exist in a specific place.
- * The movement of the continents allows species to move and adapt to new environments and form new species through natural selection.
- * Earthquakes - cause fissures that can separate populations and cause them to evolve independently forming new species
- * Volcanos - destroy habitats and reduce or wipe out populations

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Climate Impacts Evolution

- * Fluctuations in climate
 - * Cooling and covering the huge parts of the earth with ice
 - * Warming which causes ice melt and higher sea levels
- * This impacts the locations of various ecosystems
- * Catastrophic events can impact climate (asteroids)

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Species Evolution

- * Speciation - two species arise from one
 - * For sexual reproducers, this is when members of a population evolve to the point where they can no longer produce fertile offspring
- * Usually takes place in a two phases
 - * Step 1 - Geographic Isolation - when two groups of a population become isolated for long periods (physical barrier or migration)
 - * Step 2 - Reproductive Isolation - mutation operate independently in the geographically isolated groups
- * Humans now impact speciation in greater ways through artificial selection and genetic engineering.

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Extinction



- * Extinction - entire species no longer exist
- * Endemic Species - species found only in one location
 - * These species are very susceptible to extinction
 - * Ex. Golden Toad
- * Background extinction - normal rate of species extinction
- * Mass extinction - rise in extinction rates above the background level caused by a catastrophic, widespread event

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Mass Extinction

- * The fossil record suggests that there have been five mass extinctions during the past 500 million years
 - * Ex. 250 million years ago as many as 95% of species became extinct
- * Mass extinctions also provide opportunity for the evolution of new species that can fill unoccupied ecological roles

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Species Diversity

- * Species diversity - the number of different species a community contains (species richness) and the abundance of individuals (species evenness)



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Species Richness

- * It is thought that increases species richness enhances the stability of a species
- * The more diverse an ecosystem, the more productive it is and more successful the ecosystem.

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Role of Species

- * Niche - the role that a species plays in an ecosystem
 - * This is not the same as habitat
- * Species are classified as either generalist or specialist
 - * Generalist - have broad niches
 - * can live in many different places, eat a variety of foods, and tolerate wide changes in environmental conditions
 - * Specialist - have narrow niches
 - * live in one type of habitat, use only one type of food, and tolerate narrow changes in environmental conditions

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Native vs. Nonnative Species

- * Native species - those that normally live and thrive in a particular ecosystem
- * Nonnative species - those deliberately or accidentally introduced into an ecosystem (sometimes called invasive, exotic, or alien)
 - * These are not always bad. Some are introduced to help an ecosystem. (ex. African Bees in Brazil)

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Indicator Species

- * Indicator species - provide early warnings of damage to an ecosystem or community
 - * Ex. Trout need high levels of oxygen in water. If the trout begin to die, one clue could be that the oxygen levels are too low and other, less sensitive, species could be impacted if the problem progresses.
 - * Ex. Birds are very sensitive to environmental changes. (That is why canaries were used in mines. This is also why occasionally many birds will be found dead, and it will not be clear why.)

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Amphibians

- * Often indicator species because of their amphibious nature (impacted by environmental changes in water and on land at different stages of life)
- * Since the 1980s, amphibian populations have been declining world-wide
- * Possible causes:
 - * Habitat loss and fragmentation
 - * Prolonged drought
 - * Pollution
 - * Increases in UV radiation
 - * Parasites
 - * Viral and fungal diseases
 - * Climate change
 - * Over hunting
 - * Nonnative competitors

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Why care about amphibians?

- * Sensitive biological indicators of environmental changes
- * Play an important ecological role (control insect populations, eggs provide food for other species)
- * Compounds in their skins have been found to have medicinal purposes for pain killers and heart disease and more cures could be out there
- * Threatens biodiversity

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Keystone Species

- * Keystone Species - have a large effect on the types and abundances of other species in an ecosystem
- * Usually have limited numbers so they are vulnerable to extinction. (Ex. American alligator)
- * Keystone species can play significant roles:
 - * Pollination
 - * Top predator

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Foundation Species

- * Foundation species - shapes community by creating or enhancing habitats in ways that benefit other species



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Sharks

- * Why are they killed?
 - * Food (shark fin soup)
 - * Fear
 - * Accidentally (nets)
- * Why save them?
 - * Possible keystone species (top predator)
 - * Could help us treat cancer (sharks almost never get cancer)
 - * Sharks heal faster than normal and could provide us with information on how to promote healing of wounds

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