Populations, Communities, and Species Interactions

Environmental Science

What is Ecology?

- Ecology is the scientific study of the interactions between organisms and their environment.
- Natural History and Beyond
- Two critical parts:
  - Organisms
  - Environment

Interdisciplinary science

Ecological Terms

- Organism - any form of life
- Species – naturally interbreeding individuals that produce fertile offspring
- Population - group of same species
- Community - all organisms in a certain area
- Ecosystem - organisms and abiotic factors
- Ecotone - ecosystem transition zone
- Biome - no strict definition. The major types of communities typical of broad climatic zones
- Biosphere - All Earth’s ecosystems

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<tr>
<th>TAXONOMIC LEVEL</th>
<th>HUMANS</th>
<th>CORN</th>
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<tr>
<td>Kingdom</td>
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<td>Class</td>
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<td>Family</td>
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<td>Genus</td>
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<td>Species</td>
<td>Homo sapiens</td>
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What makes up the environment?

- Biotic and Abiotic components
  - Biotic
    - All Living components
  - Abiotic
    - All the non-living chemical and physical factors that affect living things

What IS a species?
Adaptation

- Adaptation - Process where species acquire traits that allow them to survive in their environments.
  - Limited range of physiological modifications.
  - Inheritance of specific genetic traits allowing a species to live in a particular environment.
    - Population-level phenomenon, not the individual.
    - * Over evolutionary time, not the lifespan of an individual.

Galapagos Finches

Evolution

- The idea that living things evolved over time had been around a long time
- Lamarck published on evolution the year Darwin was born (1809)
- It was the *mechanisms* proposed to explain this process that changed over time
- Lamarck’s use and disuse, inheritance of acquired characteristics ideas
  - Giraffe's neck, Arnold's kids.

What is evolution?

- People have understood that things evolve for 1000’s of years…but how does it happen?

Artificial selection: cattle breeders of ancient Africa
Canines - *Canis familiaris*

"Yo quiero Artificial Selection!"

Artificial selection: diverse vegetables derived from wild mustard

The scientific name for broccoli, *Brassica oleracea*, is also shared by cabbage, Chinese cabbage, cauliflower, collards, Brussels sprouts, kale, kohlrabi, and tronchuda kale, and many others!

**Natural Selection puts forward two main ideas:**

1. The concept of evolution, meaning that the diversity of species on the earth today arose by decent and modification of existing species
2. That natural selection is the cause of adaptive evolution, i.e., that the modification of existing species results from the interaction between an individual’s genetic makeup and the environment leading to differential rates of survival and reproduction.

**Darwin’s main observations and conclusions...**

**Darwin’s Natural Selection**

- **Observation 1 - Overproduction**
  - Most populations have the potential to produce many more offspring than the environment can support with food, space, resources
  - Therefore: There is a struggle for existence among individuals, only a fraction survive.
- **Observation 2 - Individual Variation**
  - Individuals vary in their characteristics, much of this variation is heritable,
  - Therefore: there is differential reproduction success between individuals. Those best suited leave a larger share of offspring.

**Darwin’s main points as published 1859 in: The *Origin of Species by Means of Natural Selection***:

- Organisms arise by descent and modification of existing species
- Natural selection acts on individuals but results in changes in the population
- All organisms living today are the consequences of the environmental conditions faced by their ancestors
- Organisms appear well adapted to current conditions because these resemble the conditions in which they evolved.
- The theory does not predict perfect adaptation, it is not purposeful; rather, using random variation as the raw material, organisms evolve to match their environment by being the best available, not the best imaginable.
Interspecies interactions

• Species interaction, of many different types, can help structure communities
  – Competition
  – Predation
  – Symbiosis

Competition

• Interspecific competition
  – Competition can result in lower density of one or both species

• Competitive Exclusion Principle (CEP)
  – One species that has even a slight advantage will exclude others.

Competition cont.

• Ecological Niche
  – Sum total of a species’ use of the biotic and abiotic resources in its environment
  – How a species “fits” into an ecosystem
  – Competitive Exclusion Principle- Exclusion if two species share the same niche
  – May only need to have one difference in a niche to get a foothold

Competition in the Intertidal

J. Connell, 1961

Realized Niches  Fundamental Niches

Mechanisms of Interference Competition

Competition in the intertidal
Predation
- Many types of predation
  - Herbivore, parasite, carnivore,
  - A powerful factor in natural selection
- Predator adaptation-
  - Many familiar adaptations for feeding
  - Defensive adaptations- Plant and animal

Plant defensive adaptations
- Plants
  - Can’t run away, so have evolved a large number of anti-herbivore strategies
- Chemical toxins
  - May be fatal if absorbed through skin/ inhaled/ ingested.
  - Exposure can cause liver & kidney damage/ adverse effects/ cardiovascular system injury/ respiratory tract injury/ neurological effects/ reproductive effects/ delayed adverse health effects/ injury/ cumulative poison.
- Spines/thorns
- Thick epidermis

Animal defensive adaptations
- A number of ways to avoid being eaten
- Run away!!, hide, defend, alarm, gang up, school
  - Cryptic coloration
  - Transparency

Animal defensive adaptations
- Aposematic coloration
  - Warning coloration

Animal defensive adaptations
- Mimicry
  - Batesian- harmless look like poisonous-
    Model/Mimic
  - “Sheep in wolf’s clothing”

Parasites
- Symbiosis
  - Parasitic
    - Endoparasites
    - Ectoparasites
    - Parasitoids
Mutualism

• Symbiosis
  – Mutualism- interspecific interaction, both benefit
  – Often shows coevolution of both species (Acacia and Ants; Termites, Mycorrhizae)