Lecture Outline: Species Interactions

I. **Introduction to Ecology and Interspecific Interactions**
   A. Definition of Ecology: Interactions between organisms and their environment.
   B. Interspecific Interactions: Focus on interactions between species (species-species interactions).
   C. Symbology for Assessing Effects on Species:
      1. Plus sign (+): Species is helped (benefit).
      2. Minus sign (-): Species is harmed (detriment, waste of energy, reduced fitness, or injury).
      3. Zero (0): Neutrality (neither helped nor harmed).

II. **Types of Interspecific Interactions**
   A. Competition (-/-)
      1. The only interspecific interaction that is harmful to **both** species involved.
      2. Occurs when two different species seek the same limited resource (e.g., food, sunlight, or any resource they want or need).
   B. Predation (+/-)
      1. One species (predator) kills and eats another species (prey).
      2. Typically used for animals eating other animals.
      3. Example: Predator benefits (gains energy), prey is harmed (dies, cannot pass on genes).
   C. Herbivory (+/-)
      1. One species eats vegetation (a plant or an alga).
      2. The consumed organism is usually not killed, but the action is still detrimental to it.
   D. Symbiosis (Close Living Arrangement)
      1. Definition: Interaction where two species have a very close living arrangement; literally meaning "the condition of living together."
      2. Mutualism (+/+)
         a. Benefits both species involved.
         b. Example: Acacia tree and ants
            (1) The tree provides food rewards (hollow bag-like structures) for the ants.
            (2) The ants protect the tree by destroying anything that comes near, including competing small plants and stinging animals.
      3. Parasitism (+/-)
         a. The parasite benefits by living in or on the host.
         b. The host is harmed (receives the detriment).

4. Commensalism (+/0)
    a. One species benefits, and the other species is neutral (no observable effect).
    b. Actual examples of zero effect are rare or hard to measure definitively.
    c. Example: Buffalo and egrets
        (1) Egrets benefit by eating insects flushed out by the buffalo, reducing foraging energy.
        (2) The buffalo is close to neutral, as the effect is minimal.

E. Facilitation (+/+ or 0/+)
1. Defined as one species helping another species to exist, typically through its mode of life rather than intentionally.
2. The second species is **always** helped (+).
3. The facilitator (often a plant) may be neutral (0/+) or may also benefit later (+/+).
4. Example: Salt-tolerant species in a salt marsh
    a. The species shades the soil, reducing heating and evaporation.
    b. Preventing evaporation stops the soil from becoming excessively salty (hypertonic environment).
    c. This allows other plant species to start growing there, increasing species richness.

III. **Ecological Concepts of Space and Resources**

A. Community vs. Ecosystem
1. A **community** is all the living things (populations) in an area.
2. An **ecosystem** includes the entire community plus all the non-living components (air, water, rocks).

B. Niche (or Niche)
1. Definition: The set of all resources that an individual species uses within an ecosystem.
2. Natural selection disfavors occupying the same niche to minimize competition.

C. Subdivisions of Niche
1. **Fundamental Niche**: The niche a species would occupy if nothing prevented it.
2. **Realized Niche**: The actual niche a species is occupying.
3. The fundamental niche is usually at least as large as, or larger than, the realized niche.
4. Experimental evidence (Barnacles): Competition prevents the realized niche from filling the entire fundamental niche.

D. Avoidance of Competition
1. Character displacement: Species living together evolve traits that specialize their resource use.
2. Example: Galapagos Finches

a. When two highly related species live together, one develops a much smaller bill than the other.
b. This divergence facilitates specialization in different diets (e.g., cracking harder vs. easier seeds) to avoid competition.

IV. **Coloration Patterns and Mimicry**

A. Cryptic Coloration
1. Excellent camouflage that makes the organism hard to discover.
2. Evolution is favored because it protects the organism from predators.

B. Aposematic Coloration
1. Obvious, non-camouflaged coloration (e.g., black, orange, and blue).
2. Functions as an advertisement or warning signal to predators that the organism is harmful (e.g., poisonous).

C. Mimicry (Imitation)
1. Batesian Mimicry
a. A **harmless** species mimics a harmful or dangerous species.
b. Example: A harmless caterpillar mimicking a venomous parrot snake by appearance, movement, and sound.
2. MÃ¼llerian Mimicry
a. Two or more species that are **all harmful** (e.g., stinging or unpalatable) evolve to look very similar.
b. The similar appearance serves as a universal advertisement of danger.

V. **Trophic Structure: Food Chains and Food Webs**

A. Classification of Organisms
1. Producers (Autotrophs)
a. Are at the base of any food chain.
b. Perform **carbon fixation**: converting an inorganic carbon source (CO_2) into an organic compound (e.g., via photosynthesis or chemosynthesis).
2. Consumers (Heterotrophs)
a. Must obtain carbon already in organic form.
b. Absolutely rely on producers for organic compounds.

B. Food Chains and Trophic Levels
1. The chain consists of connected links with a specific order, starting with a producer.
2. Levels of Consumers:
a. Primary Consumer: Directly eats a producer.
b. Secondary Consumer: Eats a primary consumer.

c. Tertiary Consumer: Eats a secondary consumer.
d. Quaternary Consumer: Usually the highest level attained due to limitations.

C. Food Webs
1. A more realistic representation than a food chain, reflecting that most consumers eat a variety of things.
2. Composed of interconnected food chains (like strands of a spiderweb).
3. Plankton Example:
a. Phytoplankton: Producers (photosynthetic plankton, e.g., cyanobacteria).
b. Zooplankton: Consumers (carnivorous plankton).
4. The highest level consumer (e.g., humans) is in a **precarious position** because a disturbance to any lower level can easily cause them to topple.

VI. **Ecologically Special Species Categories**

A. Dominant Species
1. Defined as having more individuals of that species than anything else in the ecosystem.

B. Keystone Species
1. A species whose life functions are critically important to the overall health of the ecosystem.
2. It is typically **not** the dominant species.
3. Example: Sea star (controls the population of shellfish; without it, biodiversity of other species drops drastically).

C. Ecosystem Engineer
1. A species that fundamentally changes the physical geography or non-living makeup of the ecosystem.
2. Example: Beaver
a. Beavers build dams for living and mating.
b. The dam changes a single river ecosystem into two different places to live: still, deep water above and rapid flow below.

VII. **Disturbance and Succession**

A. Disturbance
1. Definition: Something out of the ordinary that causes life in the ecosystem to change suddenly.
2. Disturbances vary in intensity and frequency.
3. Types of Disturbances:
a. Natural (e.g., fire, earthquake, glacier movement).
b. Human-caused (e.g., ocean floor trawling, which denudes areas the size of states).

B. Intermediate Disturbance Hypothesis

1. Hypothesis stating that biodiversity is maximized at an **intermediate level of disturbance**.
2. Low disturbance: Ecosystem occupants become too successful, filling niches and leading to low biodiversity.
3. High disturbance: Too severe or frequent, killing organisms and reducing biodiversity.
4. Intermediate disturbance: Sufficient to disrupt stable conditions, open up niches, and maximize biodiversity.

C. Ecological Succession (Recovery Process)

1. Definition: The recovery process after a major disturbance, happening in stages, where each stage prepares the ecosystem for the next.
2. Primary Succession
   a. Follows the most severe disturbances where **even the soil is removed** (e.g., receding glaciers scraping down to bare bedrock).
   b. Requires starting from square one to create soil, which takes a long time.
   c. Pioneer stage features organisms like bacteria and lichens.
   d. Lichens speed up the breakdown of rock and produce organic material necessary for soil buildup.
3. Secondary Succession
   a. Follows less severe disturbances (e.g., major fire) where the **soil remains**.
   b. Recovery is faster as soil, bacteria, and seeds are already present.
   c. Some seeds require a fire cue to sprout when sunlight is open above them.

VIII. **Components and Drivers of Biodiversity**

A. Biodiversity Components

1. **Species Richness**: The number of different species in a given area.
2. **Relative Abundance**: The number of individuals of each species compared to the other species.
3. Overall biodiversity is higher when both factors are high and the community is not dominated by one species.
4. Biodiversity is crucial for ecosystem health; current human-caused extinction rates lead to a domino effect (toppling).

B. Influence of Water

1. Vertebrate species richness is positively correlated with overall dampness.
2. Dampness is measured by evapotranspiration (transpiration plus direct evaporation from the soil).
3. Tropical rainforests, the most biodiverse land biomes, receive rain daily, emphasizing water's importance as a resource.

C. The Island Effect

1. An ecological island is any place surrounded by something different from it (e.g., an oasis).
2. The smaller the island area, the lower the biodiversity.
3. Smaller areas crowd organisms together, forcing greater niche overlap and increased competition, leading to species die-out.

IX. **Applications of Ecology**

A. Ecologists study interactions, sometimes focusing on direct impacts on human health.

B. Examples of ecological research:

1. Studying the mammal species responsible for carrying fleas that transmit Lyme disease.
2. Studying birds that spread viruses, such as avian flu.