Biology EOC Review: Session 4

Classification

Taxonomy is the science of classifying organisms.
Carl Linnaeus used the similarities and differences among organisms to place them into groups. This system includes seven major groups into which each organism is placed from very general to very specific. Today's classification system has sub groups that Linnaeus did not include.

The groups are:

Domain
Kingdom
Phylum)
Class
Order
Family
Genus
Species

Binomial nomenclature: is the scientific name of an organism is the **genus and species** name. The scientific name of humans is **Homo *sapiens***. The genus is always capitalized and both words and emphasized (written in bold type, underlined, or italicized).
This two word naming is binomial nomenclature. See Video
Although not all scientists agree, there are generally 6 kingdoms: (Prokaryotic organisms have no nuclear membrane and no membrane bound organelles = bacteria. Eukaryotic organisms have those membranes = everything else).

Kingdoms (With some examples)
ARCHAEBACTERIA – single celled, found in extreme places, prokaryotic - bacteria
EUBACTERIA – more common, round, spiral, rod shaped, prokaryotic - bacteria
FUNGI – cannot make food, they absorb food – mushrooms, mold, yeast
PROTISTA – plant and animal-like organisms – algae, paramecium
PLANTAE – photosynthetic, multicellular organisms with cell walls
ANIMALIA – cannot make food, no cell walls, some simple, some complex, multicellular - vertebrates (fish, dogs) have backbones, invertebrates (snails, insects) do not

Modern classification systems use a number of methods to group organisms. These include: morphology (form and structure), embryologic development, molecular analysis (such as DNA, RNA), and phylogeny (evolutionary decent). Members of a species are very similar in structure. They are naturally able to reproduce, and their offspring are fertile. The Domain System is a more modern system of classification based on molecular structure. In this system there are only three divisions:

ARCHAEBACTERIA (Archea) – oldest, primitive bacteria
EUBACTERIA (Bacteria) – more advanced forms of bacteria
EUKARYA – all organisms with membrane bound organelles (everything but bacteria)

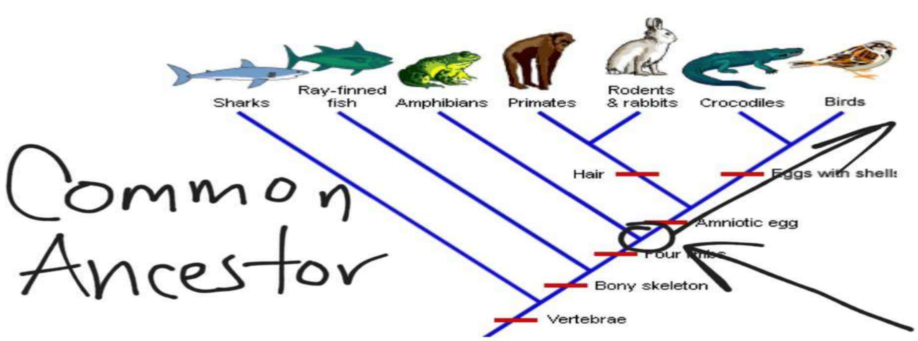
Binomial Nomenclature

BINOMIAL NOMENCLATURE OF SOME COMMON PLANTS AND ANIMALS	
COMMON NAME	**BINOMIAL NOMENCLATURE**
A. PLANTS	
1. Pea plant	*Pisum sativam*
2. Onion plant	*Allium cepa*
3. Mango plant	*Mangifera indica*
4. Wheat plant	*Triticum aestivum*
5. Banyan tree	*Ficus bengalensis*
6. Soya bean	*Glycine max*
B. ANIMALS	
1. Frog	*Rana hexadactyla*
2. Cat	*Felis domestica*
3. Dog	*Canis familiaris*
4. Housefly	*Musca domestica*
5. Cobra	*Naja naja*
6. Commom crap (Fish)	*Cyprinus carpio*

Some Phyla of Animals

1. Porifera – simplest animals: sponges
2. Cnidaria – have stinging cells: jellyfish, sea anemones, corals
3. Platyhelminthes – flatworms: planaria, flukes, tapeworms
4. Nematoda – roundworms: nematodes
5. Mollusca - soft bodies: snails, octopus
6. Annelida - segmented worms: earthworms, leeches
7. Echinodermata – spiny skinned, radially symmetrical: starfish, sea cucumbers, sand dollars
8. Arthropods – exoskeleton: arachnids, crustaceans, centipedes, insects
9. Chordata - have nerve chords: vertebrates like fish, birds, mammals

Try This. The scientific name for dog is Canis *familiaris.* The scientific name for wolf is Canis *lupus.* Which classification groups do dogs and wolves have in common?



Cladogram

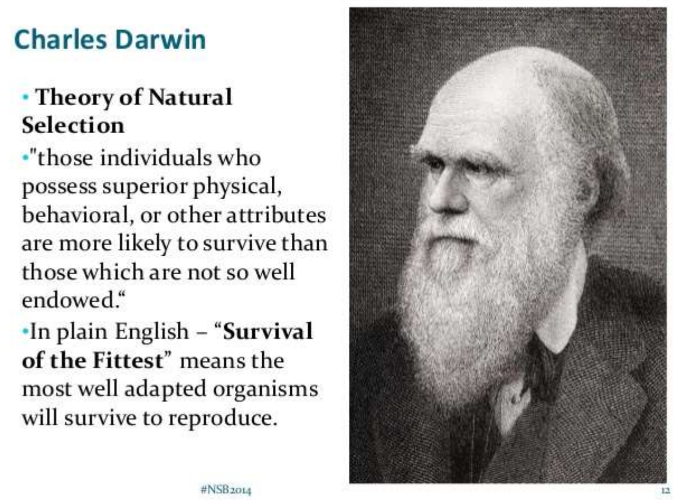
Is a diagram used in cladistics to show relations among organisms. A cladogram is not, however, an evolutionary tree because it does not show how ancestors are related to descendants, nor does it show how much they have changed; many evolutionary trees can be inferred from a single cladogram. A cladogram uses lines that branch off in different directions ending at a clade, a groups of organisms with a **last common**

ancestor. There are many shapes of cladograms but they all have lines that branch off from other lines. The lines can be traced back to where they branch off. These branching off points represent a hypothetical ancestor (not an actual entity) which can be inferred to exhibit the traits shared among the terminal taxa above it. This hypothetical ancestor might then provide clues about the order of evolution of various features, adaptation, and other evolutionary narratives about ancestors. Although traditionally such cladograms were generated largely on the basis of morphological characters, **DNA and RNA sequencing data & computational phylogenetics are now very commonly used in generation of cladograms**, either on their own or in combination morphology.

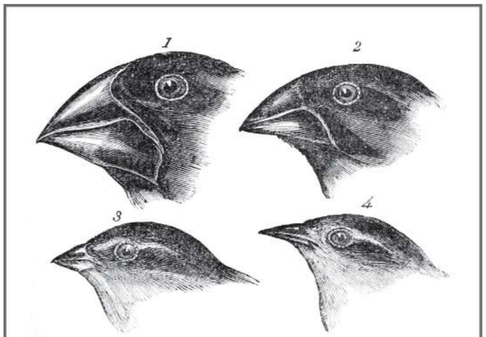
EVOLUTION

Modern Evolutionary Theory

In 1858 Charles Darwin and Alfred Wallace presented the basis for modern evolutionary theory. Based on the study of **fossils, geologic changes**, and most importantly the **anatomy and behavior** of a great many species, Darwin and Wallace concluded that modern species were descended from earlier, distinct species that had changed over time. They also had developed an explanation as to how these changes could have occurred. Darwin's book On the *Origin of Species* by Means of **Natural Selection**, published in 1859 described the principles and evidence for biological evolution in great detail.

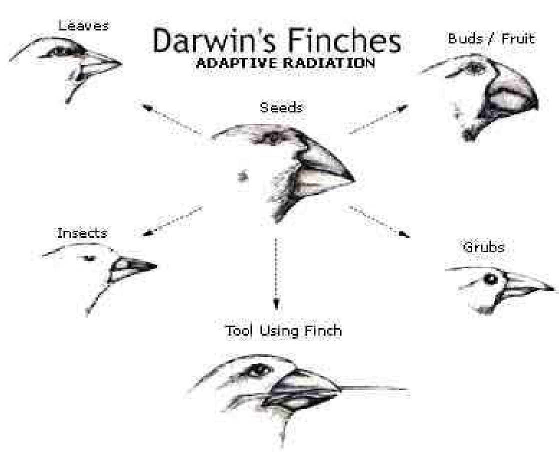


First, Darwin explained that all of the species present today were descended from earlier species that had changed over time. He called this idea **descent with modification.** **N**ext, Darwin proposed the concept of natural selection to explain how this modification could occur. Darwin knew that more offspring were produced than could ultimately survive. He also knew that offspring, even in the same litter or family had different physical characteristics. He reasoned that some individuals would possess traits that would give them an advantage in the struggle for survival. Those traits that were **advantageous would accumulate in the population** over time. Given enough time, species could change bit by bit, generation after generation and change into new forms**. New species are said to have increased fitness in the environment which means that they are better able to survive (better adapted) to their environment and thus able to produce more offspring.** We now know that the source of the "**variation" discussed** by Darwin was **genetic mutation or changes in the DNA resulting in new traits in an organism.**



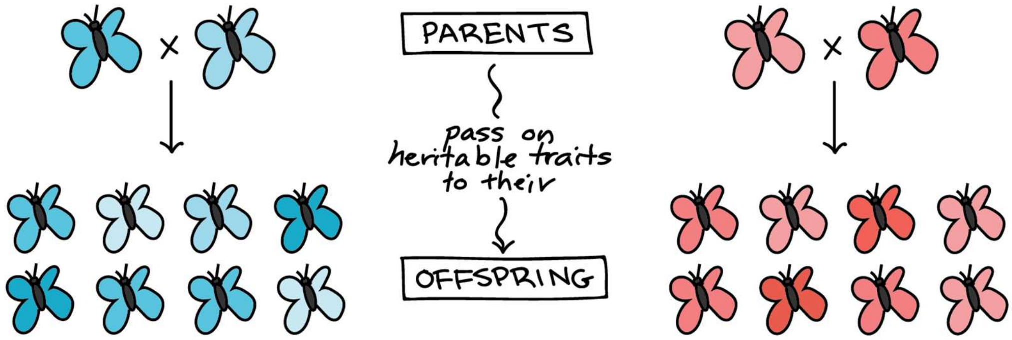
1. Geospiza magnirostris 2. Geospiza fortis
3. Geospiza parvula 4. Certhidea olivacea

Finches from Galapagos Archipelago

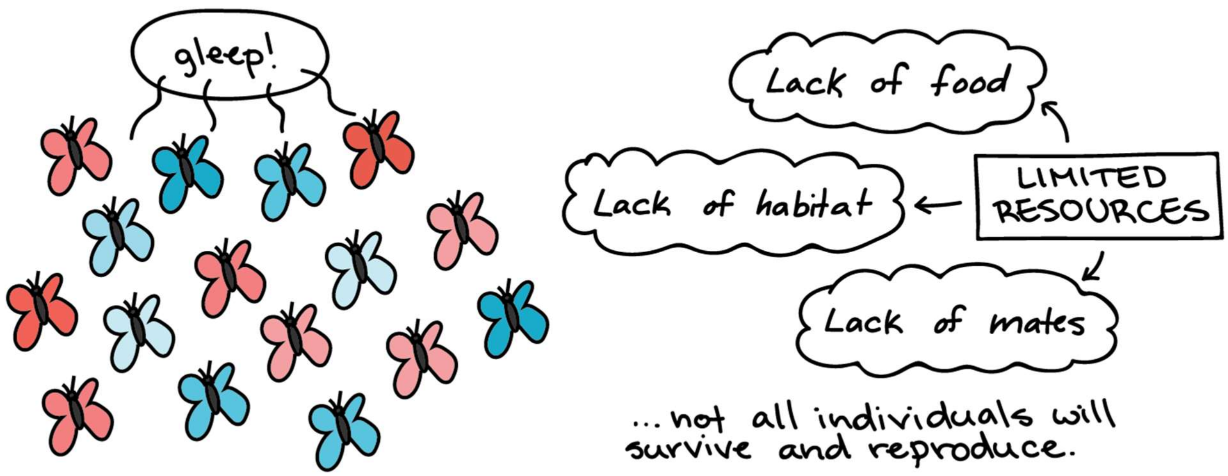


Darwin's concept of natural selection was based on several key observations:

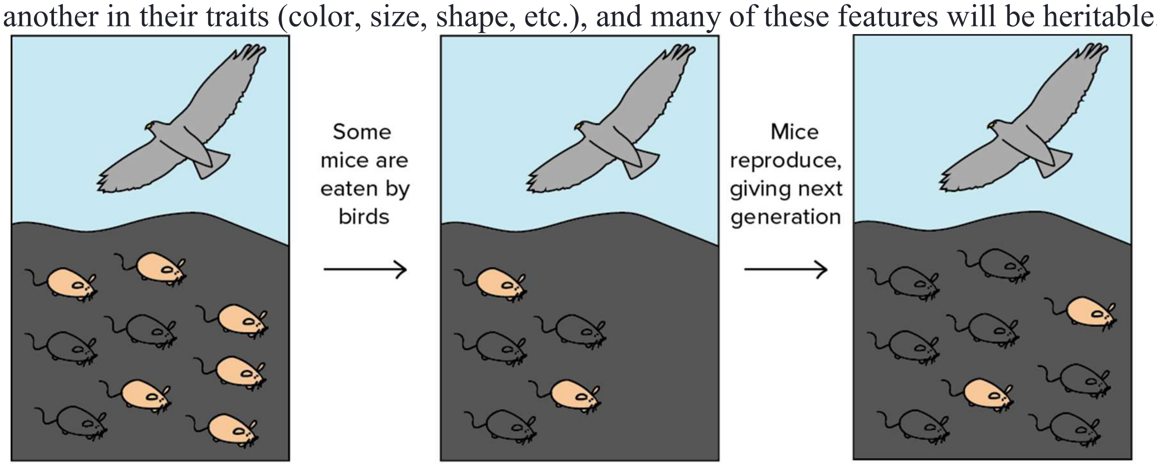
Traits are often heritable. In living organisms, many characteristics are inherited, or passed from parent to offspring. (Darwin knew this was the case, even though he did not know that traits were inherited via genes.)



More offspring are produced than can survive. Organisms are capable of producing more offspring than their environments can support. Thus, there is competition for limited resources in each generation.



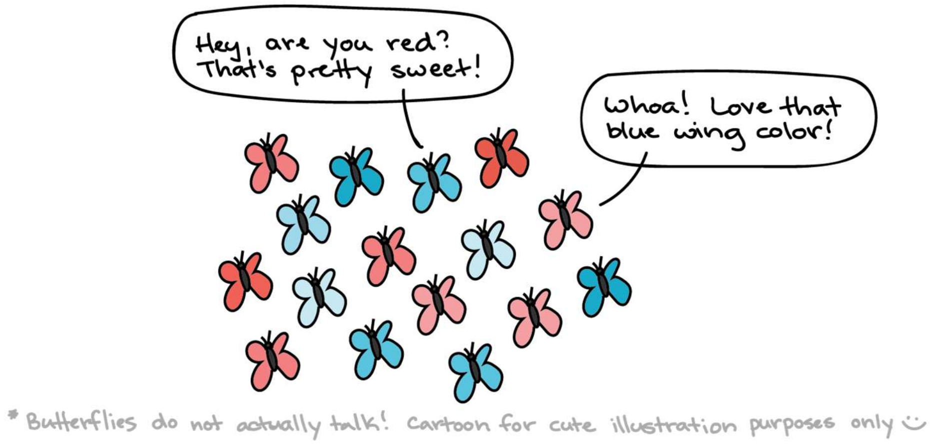
Offspring vary in their heritable traits. The offspring in any generation will be slightly different from one another in their traits (color, size, shape, etc.), and many of these features will be heritable.



A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and leave offspring.

Because black mice had a higher chance of leaving offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.



Based on these simple observations, Darwin concluded the following:

In a population, some individuals will have inherited traits that help them survive and reproduce (given the conditions of the environment, such as the predators and food sources present). The individuals with the helpful traits will leave more offspring in the next generation than their peers, since the traits make them more effective at surviving and reproducing.

Because the helpful traits are heritable, and because organisms with these traits leave more offspring, the traits will tend to become more common (present in a larger fraction of the population) in the next generation.

Over generations, the population will become **adapted** to its environment (as individuals with traits helpful in that environment have consistently greater reproductive success than their peers).

Darwin's model of evolution by natural selection allowed him to explain the patterns he had seen during his travels. For instance, if the Galápagos finch species shared a common ancestor, it made sense that they should broadly resemble one another (and mainland finches, who likely shared that common ancestor). If groups of finches had been isolated on separate islands for many generations, however, each group would have been exposed to a different environment in which different heritable traits might have been favored, such as different sizes and shapes of beaks for using different food sources. These factors could have led to the formation of distinct species on each island.

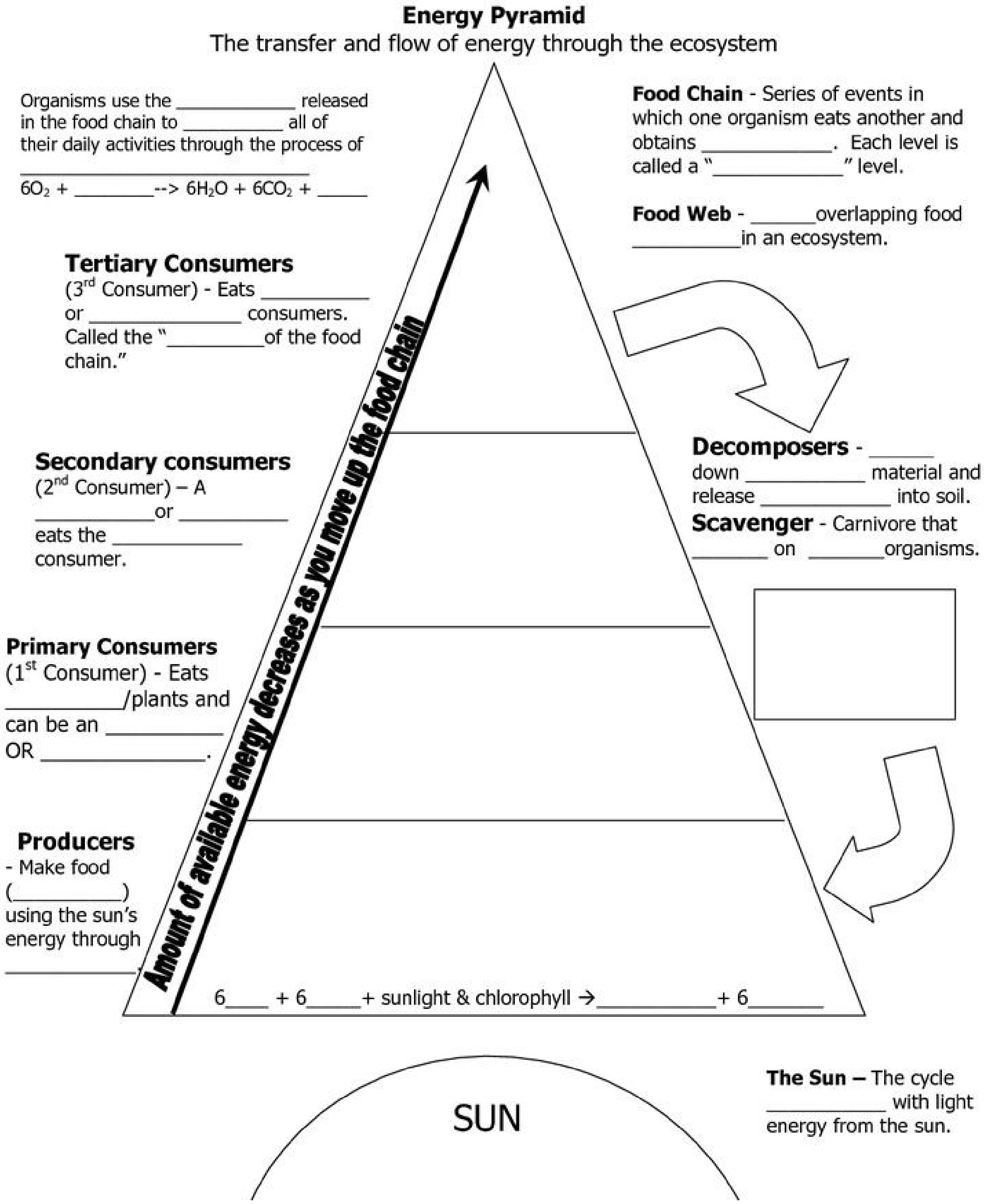
ECOLOGY

Ecology and the **Biosphere** The environment is a system of independent components affected by natural phenomena and human activity. **Ecology** is the study of how organisms interact with each other and with their environment. The **biosphere** is a term used to describe the portion of the Earth where living things are found. The Earth’s forests, grasslands, deserts, oceans, etc. are all part of the biosphere. Some parts of the biosphere may have more living organisms than others. For example there are many more organisms inhabiting the tropical rainforests than the bottom of the cold, dark ocean trenches, but both still are part of the biosphere because they support life. A **biome** is a large region of the Earth’s landmass possessing a characteristic climate and organisms. Some of the Earth’s major biomes are tropical rain forests, temperate forests, boreal forests, deserts, temperate grasslands, tropical grasslands and tundra An **ecosystem** describes all of the organisms living in a particular place and their environment. **The living component of an ecosystem is called the biotic** component and the **nonliving component is called the abiotic** component. If you were describing a forest

ecosystem, then the trees and animals would be examples of biotic factors and the soil, water, and air would be examples of abiotic factors. Sometimes **abiotic factors are non-physical** things such as sunlight or temperature. An ecosystem may contain many different habitats or places where organisms live. In a forest ecosystem there is a soil habitat, a forest floor habitat, and other habitats where organisms live. All of the organisms living in a particular place are known as a community. In a forest, the soil community might include fungi, worms, moles and other organisms. The canopy community would include the trees, birds, squirrels and other organisms. A population consists of all of the members of one particular species. For example, all of the squirrels in the forest canopy would make up a population. ***Populations change over time and are affected by a great many factors.*** Usually a population will grow rapidly in what is known as **exponential growth**.
Eventually **limiting factors** such as decreasing food supply or disease causes the growth to level off in a pattern known as logistic growth. When a population levels off in this fashion, it is said that the population has reached the **carrying capacity** of the environment.
The interaction between living things with each other and their environment is a very complex system involving many components. Living things tha**t produce their own food through photosynthesis or chemosynthesis are called producers or autotrophs**. Examples of autotrophs are green plants such as the trees in forests and phytoplankton on the ocean's surface or chemosynthetic bacteria found in deep sea volcanic vents. All of these organisms produce their own food from raw materials in their surroundings. Producers are important because they convert the raw energy found in sunlight and chemicals into carbohydrates and other molecules used by consumers. **Living things that get their energy by consuming other living things are called consumers or heterotrophs**. Examples of heterotrophs are tigers, cows or mushrooms. Each one consumes a different food source, but none of them produce the food themselves. **Carnivores such as tigers are consumers** that eat meat while herbivores such as cows are consumers that eat plants. Some heterotrophs that specialize in breaking down the remains of **dead organisms are called decomposers or saprotrophs**. Mushrooms and bacteria are examples of saprotrophs. They are important in returning valuable nutrients from dead organisms back into the soil, water and atmosphere where they are available for the producers.

An **ecological pyramid** is a way of describing the energy flow in an ecosystem. In such a pyramid, the base is formed by the producers since they contain the most energy. The herbivores form the next smaller upper block of the pyramid and the carnivores form the remaining smaller upper blocks. **Less and less energy is available** to organisms with each higher step on the pyramid: The ecological pyramid above could also be described as a food chain. **In a food chain, the flow of energy is shown with a series of arrows interconnecting the parts of the system:**

Name: ___________________________



Community structure

Species richness and species diversity. Why more diverse ecosystems may be more stable. Roles of foundation

Key points:

1. A community's structure can be described by its species richness, which is the number of species present, and species diversity, which is a measure of both species richness and species evenness (relative numbers).

2. Community structure is influenced by many factors, including abiotic factors, species interactions, level of disturbance, and chance events.

3. Some species, such as *foundation species* and *keystone species*, play particularly important roles in determining their communities' structure.

Introduction

Different ecological communities can be pretty different in terms of the types and numbers of species they contain. For instance, some Arctic communities include just a few species, while some tropical rainforest communities have huge numbers of species packed into each cubic meter.

One way to describe this difference is to say that the communities have different structures. Community structure is essentially the composition of a community, including the number of species in that community and their relative numbers.

Look at some of the ways that community structure can be quantified (measured numerically). Then, we'll examine factors that shape community structure, focusing especially on foundation and keystone species.

How do we measure community structure?

Two important measures ecologists use to describe the composition of a community are species richness and species diversity and species richness

Species richness is the number of different species in a particular community. If we found 303, 030 species in one community, and 300, 300, 300 species in another, the second community would have much higher species richness than the first.

Communities with the highest species richness tend to be found in areas near the equator, which have lots of solar energy (supporting high primary productivity), warm temperatures, large amounts of rainfall, and little seasonal change. Communities with the lowest species richness lie near the poles, which get less solar energy and are colder, drier, and less amenable to life. This pattern is illustrated below for mammalian species richness (species richness calculated only for mammal species, not for all species). Many other factors in addition to latitude can also affect a community's species-richness.

Species diversity is a measure of community complexity. It is a function of both the number of different species in the community (species richness) and their relative abundances (species evenness). Larger numbers of species and more even abundances of species lead to higher species diversity.

What factors shape community structure?

The structure of a community is the result of many interacting factors, both **abiotic (non-living) and biotic (living organism-related)**. Here are some important factors that influence community structure:

The climate patterns of the community's location.
The geography of the community's location
The heterogeneity (patchiness) of the environment
The frequency of disturbances, or disruptive events.
Interactions between organisms.

Foundation and Keystone species

Some species have unusually strong impacts on community structure, preserving the balance of the community or even making its existence possible. These "special" species include foundation and keystone species.]

EXAMPLE: Like the Yellowstone wolf, keeping too many deer/elk and other foraging animals form destroying the landscape and keep them from staying in one spot too long

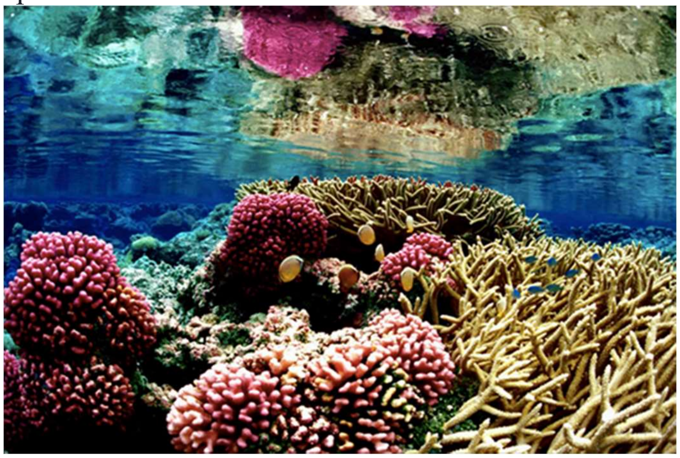
Keystone species

A **keystone species** is a species that has a disproportionately large effect on community structure relative to its biomass or abundance. Keystone species differ from foundation species in two main ways: they are more likely to belong to higher trophic levels (to be top predators), and they act in more diverse ways than foundation species, which tend to modify their environment

Foundation species

A **foundation species** plays a unique, essential role in creating and defining a community. Often, foundation species act by modifying the environment so that it can support the other organisms that form the community.

Kelp (brown algae) is a foundation species that forms the basis of the kelp forests off the coast of California. Kelps create environments that allow the survival of other organisms that make up the kelp forest community. The corals of a coral reef are another foundation species. The exoskeletons of living and dead coral make up most of the reef structure, which protects other species from waves and ocean currents. Beavers, which modify their environment by building dams, can also be seen as a foundation species.



Invasive species are species that have been introduced into areas outside their native range and can cause—or have caused—harm in their new area.

Invasive species may outcompete native species for resources or habitat, altering community structure and potentially leading to extinctions.

Asian carp illustrate the potential impact of invasive species. Introduced into the United States by humans, these fish species have colonized waterways and may threaten native fish populations, and fisheries, in the Great Lakes.

Take a look at the photo below. Just another pretty morning drive in the hills of Tennessee! But wait a minute ... those trees ... they're covered with something. Look closer, and you'll see that almost the entire landscape is covered with a thick, green blanket. This blanket is made up of an invasive plant called kudzu.

A hillside in Tennessee that is blanketed with the vine kudzu, which covers trees, shrubs, and ground.

Kudzu is one dramatic example of what can happen when a species gets introduced into a new ecosystem where it has abundant resources and few predators. The kudzu plant was introduced to the United States from Asia in the late 1800s as an ornamental plant, and it and was planted widely in the South in the early 1900s to reduce soil erosion. What the people who planted this vine did not know was that it would rapidly take over the landscape, growing as much as a foot a day and enshrouding ground, shrubs, trees, and even houses and old cars in a suffocating girdle of vines

Purple loosestrife

Zebra mussels

Common buckthorn

Garlic mustard

Emerald ash borer

European starling

Ecological succession

Succession as progressive change in an ecological community. Primary vs. secondary succession. The idea of a climax community.

Succession is a series of progressive changes in the composition of an ecological community over time.
In **primary succession**, newly exposed or newly formed rock is colonized by living things for the first time.
In **secondary succession**, an area previously occupied by living things is **disturbed**—disrupted—then recolonized following the disturbance.

Introduction

Have you ever looked at a landscape with a complex, diverse community of plants and animals—such as a forest—and wondered how it came to be? Once upon a time, that land must have been empty rock, yet today, it supports a rich ecological **community** consisting of populations of different species that live together and interact with one another. Odds are, that didn't happen overnight!

Ecologists have a strong interest in understanding how communities form and change over time. In fact, they have spent a lot of time observing how complex communities, like forests, arise from empty land or bare rock. They study, for example, sites where volcanic eruptions, glacier retreats, or wildfires have taken place, clearing land or exposing rock.

In studying these sites over time, ecologists have seen gradual processes of change in ecological communities. In many cases, a community arising in a disturbed area goes through a series of shifts in composition, often over the course of many years. This series of changes is called ecological succession

Succession

Ecological *succession* is a series of progressive changes in the species that make up a community over time. Ecologists usually identify two types of succession, which differ in their starting points:

In ***primary succession*****,** newly exposed or newly formed rock is colonized by living things for the first time.

- In ***secondary succession*****,** an area that was previously occupied by living things is disturbed, then re-colonized following the disturbance.

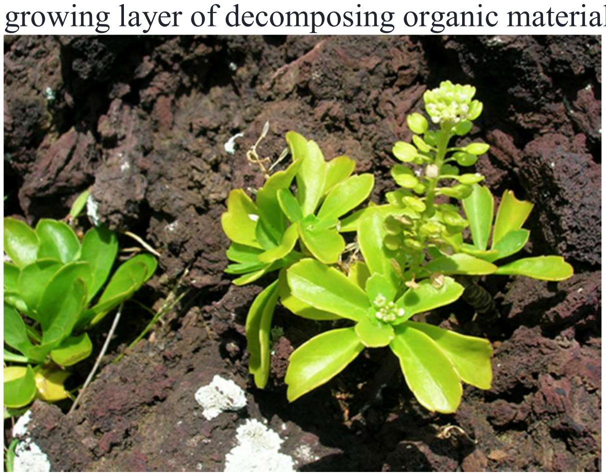
Succession often involves a progression from communities with lower species diversity—which may be less stable—to communities with higher species diversity—which may be more stable, though this is not a universal rule.

Primary succession and pioneer species

Primary succession occurs when new land is formed or bare rock is exposed, providing a habitat that can be colonized for the first time.

For example, primary succession may take place following the eruption of volcanoes, such as those on the Big Island of Hawaii. As lava flows into the ocean, new rock is formed. On the Big Island, approximately 32 acres of land are added each year. What happens to this land during primary succession?

First, weathering and other natural forces break down the substrate, rock, enough for the establishment of certain hearty plants and lichens with few soil requirements, known as **pioneer species**, see image below. These species help to further break down the mineral-rich lava into soil where other, less hardy species can grow and eventually replace the pioneer species. In addition, as these early species grow and die, they add to an ever-growing layer of decomposing organic material and contribute to soil formation.



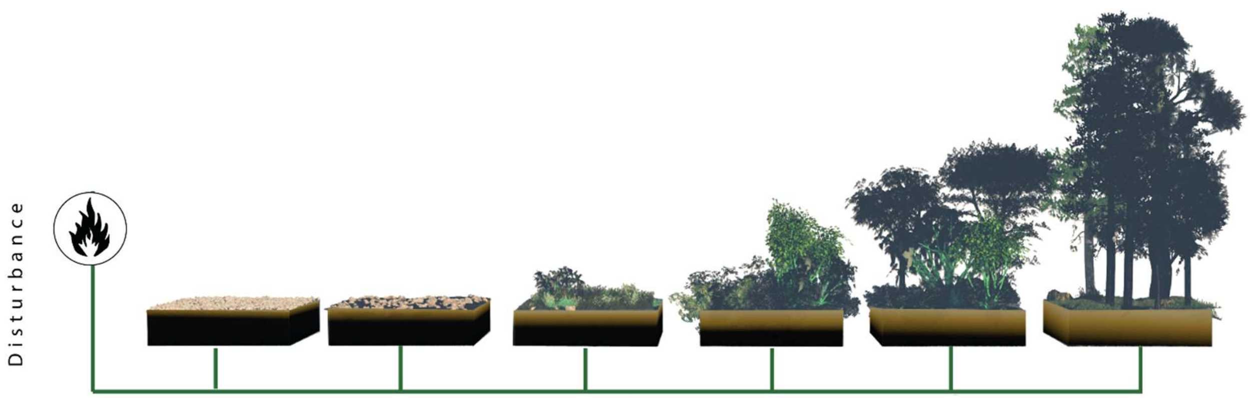
Photograph of succulent plants colonizing lava during primary succession on Maui. During primary succession on lava in Maui, Hawaii, succulent plants are pioneer species.

Secondary succession

In **secondary succession**, a previously occupied area is re-colonized following a disturbance that kills much or all of its community.

A classic example of secondary succession occurs in oak and hickory forests cleared by wildfire. Wildfires will burn most vegetation and kill animals unable to flee the area. Their nutrients, however, are returned to the ground in the form of ash. Since a disturbed area already has nutrient-rich soil, it can be recolonized much more quickly than the bare rock of primary succession.

Before a fire, the vegetation of an oak and hickory forest would have been dominated by tall trees. Their height would have helped them acquire solar energy, while also shading the ground and other low-lying species. After the fire, however, these trees do not spring right back up. Instead, the first plants to grow back are usually annual plants—plants that live a single year—followed within a few years by quickly growing and spreading grasses. The early colonizers can be classified as pioneer species, as they are in primary succession.



Over many years, due at least in part to changes in the environment caused by the growth of grasses and other species, shrubs will emerge, followed by small pine, oak, and hickory trees. Eventually, barring further disturbances, the oak and hickory trees will become dominant and form a dense canopy, returning the community to its original state—its pre-fire composition. This process of succession takes about 150 years.

The path and endpoint of succession

The early ecologists who first studied succession thought of it as a predictable process in which a community always went through the same series of stages. They also thought that the end result of succession was a stable, unchanging final state called a climax community, largely determined by an area's climate. For instance, in the example above, the mature oak and hickory forest would be the **climax community**.

Today, the idea of a set path for succession and a stable climax community have been called into question. Rather than taking a predetermined path, it appears that succession can follow different routes depending on the specifics of the situation.

Also, although stable climax communities can form in some cases, this may be uncommon in many environments. Ecosystems may experience frequent disturbances that prevent a community from reaching an equilibrium state—or knock it quickly out of this state if it manages to get there.


Climax Communities are NOT always big hardwood trees such as oaks and maples!!!
Desert Climax Community
Beach Climax Community
Grasslands Climax Community
Taiga Climax Community