Ministry of Higher Education and Scientific Research
University of Baghdad
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Theoretical Advanced Ecology 2020-2021

ماجستير بيئـة ـ الفصل الدراسي الاول

تدريسي المادة :

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What is ecology?

Ecology: is the study of the interactions between organisms and the living and nonliving components of their environment.

'oekolgie' = coined in 1860s by Ernst Haeckel, combining Greek words for 'household' and 'knowledge'

1st definition

The classical 1860s – Ernst Haeckel definition [*the study of the relationship between organisms and environment*.] the scientific study of the interactions between organisms and their environment .emphasizes both the living and the non-living components of the natural world.

2nd definition

Andrewartha and Birch (1954) [*the study of the distribution and abundance of organisms*.] reinforced the focus on the organism as the core of ecology. Their work clearly includes the abiotic environment as well as the biotic environment as factors influencing distribution and abundance.

3rd definition

Odum (1971) [*the study of ecosystems*] . began with the Haeckel definition, but his desire to establish a new kind of ecology, ecosystem ecology ,.

Modern definition

• 2012 – Simon Levin: 'Ecology is often organized across scales, from cells to organisms, from organisms to populations, from populations to communities, ecosystems, landscapes, and the biosphere'.

– Ecology views biological systems as wholes, not as independent parts, while seeking to elucidate how these wholes emerge from and affect the parts….Investigating the interplay among processes at diverse scales and the interaction between systems and their environments.

– Ecology, the unifying science in integrating knowledge of life on our planet, has become the essential science in learning how to preserve it.

1) **Individual organism**: at this level, ecology deals with how individuals affected by (and affect) their environment.

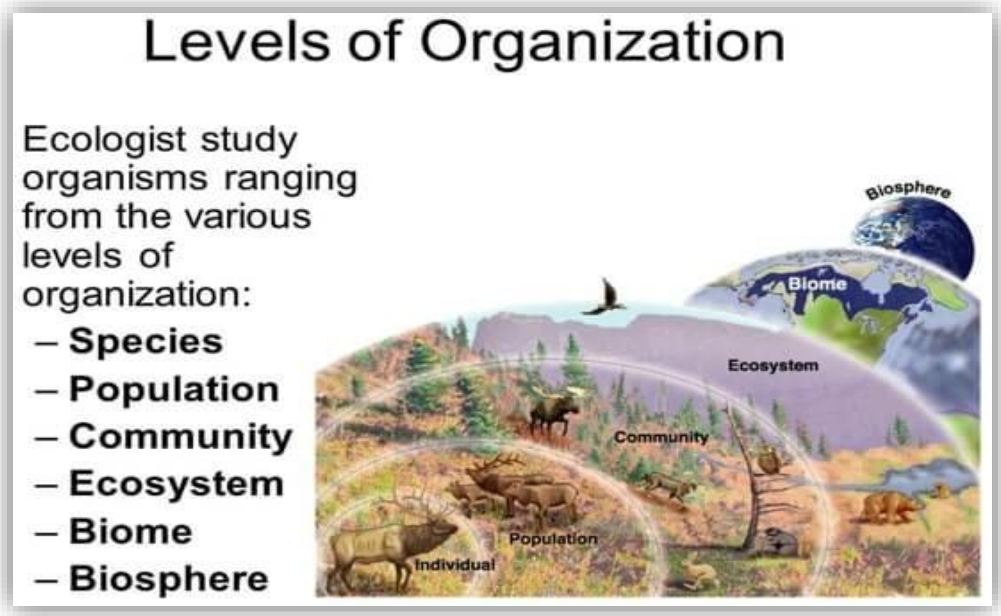
2) **Population**, consisting of individuals of the same species: deals with presence or absence of a particular species, their abundance or rarity, and trends /fluctuations in their Community.

3) **Community,** consisting of populations of different species: deals with composition and organization of the populations.

4) **Ecosystem**, consisting of the community & its physical environment: deals with pathways of energy and matter as these moves among living and nonliving elements in the ecosystem.

Levels of organization

To study how organisms interact with each other and with their physical environments, several hierarchical levels of the organization have been recognized. Ecological patterns and processes vary as a function of the level of organization at which they operate. Ecologists have identified four fundamental levels of the organization to study the interactions between organisms and their environment. These levels of organization include individual organism, population, community and ecosystem. Therefore, ecology ranges in scale from the study of an individual organism through the study of populations to the study of communities and ecosystems.



Biosphere

The largest scale of ecological organization is the biosphere: the total sum of ecosystems on the planet. Ecological relationships regulate the flux of energy, nutrients, and climate all the way up to the planetary scale. For example, the dynamic history of the planetary atmosphere's CO_2 and O_2 composition has been affected by the biogenic flux of gases coming from respiration and photosynthesis, with levels fluctuating over time in relation to the ecology and evolution of plants and animals.

Biome

Biomes are larger units of organization that categorize regions of the Earth's ecosystems, mainly according to the structure and composition of vegetation. There are different methods to define the continental boundaries of biomes dominated by different functional types of vegetative communities that are limited in distribution by climate, precipitation, weather and other environmental variables. Biomes include tropical rainforest, temperate broadleaf and mixed forest, temperate deciduous forest, taiga, tundra, hot desert, and polar desert. Other researchers have recently categorized other biomes, such as the human and oceanic micro biomes. To a microbe, the human body is a habitat. Microbiomes were discovered largely through advances in molecular genetics, which have revealed a hidden richness of microbial diversity on the planet. The oceanic microbiome plays a significant role in the ecological biogeochemistry of the planet's oceans.

Ecosystem ecology:

Ecosystems may be habitats within biomes that form an integrated whole and a dynamically responsive system having both physical and biological complexes. Ecosystem ecology is the science of determining the fluxes of materials (e.g. carbon, phosphorus) between different pools (e.g., tree biomass, soil organic material). Ecosystem ecologist attempt to determine the underlying causes of these fluxes. Research in ecosystem ecology might measure primary production in a wetland in relation to decomposition and consumption rates. This requires an understanding of the community connections between plants (i.e., primary producers) and the decomposers (e.g., fungi and bacteria). Within an ecosystem, organisms are linked to the physical and biological components of their environment to which they are adapted. Ecosystems are complex adaptive systems where the interactions of life processes form self-organizing patterns across different scales of time and space. Ecosystems are broadly categorized as terrestrial, freshwater, atmospheric, or marine. A more recent addition to ecosystem ecology are techno ecosystems, which are affected by or primarily the result of human activity.

Community ecology:

Community ecology is the study of the interactions among a collections of species that inhabit the same geographic area. Community ecologists study the determinants of patterns and processes for **two or more interacting species**. Research in community ecology might measure species diversity in grasslands in relation to soil fertility. It might also include the analysis of predator-prey dynamics, competition among similar plant species, or mutualistic interactions between crabs and corals.

Population ecology

Population ecology studies the dynamics of specie populations and how these populations interact with the wider environment. A population consists of individuals of the **same species** that live, interact, and migrate through the same niche and habitat.

A primary law of population ecology is the Malthusian growth model which states, "a population will grow (or decline) exponentially as long as the environment experienced by all individuals in the population remains constant. Simplified population models usually start with four variables: death, birth, immigration, and emigration.

An example of an introductory population model describes a closed population, such as on an island, where immigration and emigration does not take place. Hypotheses are evaluated with reference to a null hypothesis which states that random processes create the observed data. In these island models, the rate of population change is described by:

where ***N*** is the total number of individuals in the population, *b* and *d* are the per capita rates of birth and death respectively, and *r* is the per capita rate of population change.

Using these modelling techniques, Malthus' population principle of growth was later transformed into a model known as the logistic equation:

where ***N*** is the number of individuals measured as biomass density, *a* is the maximum per-capita rate of change, and *K* is the carrying capacity of the population. The formula states that the rate of change in population size **(*dN/dT*)** is equal to growth **(*aN*)** that is limited by carrying capacity **(1 – *N*/*K*).**

Where these habitat patches are large enough to support local breeding populations, the population of a species consists of a group of spatially discrete subpopulations. In 1970, population ecologist Richard Levins of Harvard University coined the term **metapopulation** to describe a population consisting of many local populations—a population of populations

Metapopulations and migration

Just as we defined a population as a group of interacting individuals of the same species occupying a given habitat, the metapopulation is a collection of local populations interacting within the larger area or region.

four necessary conditions for the term *metapopulation* to be applicable to a system of local populations: (1) the suitable habitat occurs in discrete patches that may be occupied by local breeding populations; (2) even the largest populations have a substantial risk of extinction; (3) habitat patches must not be too isolated to prevent recolonization after local extinction; and (4) the dynamics of the local populations are not synchronized.

Colonization involves the movement of individuals from occupied patches (existing local populations) to unoccupied patches to form new local populations. Individuals moving from one patch (population) to another typically move across habitat types that are not suitable for their feeding and breeding activities and often face substantial risk of failing to locate another suitable habitat patch to settle in. This dispersal of individuals between local populations is a key feature of metapopulation dynamics. If no individuals move between habitat patches, the local populations act independently. If the movement of individuals between local populations is sufficiently high, then the local populations will function as a single large population. Under this scenario, the dynamics of the various local populations may be synchronized and equally susceptible to factors that can lead to possible extinction.

Metapopulation, in ecology, a regional group of connected populations of a species. For a given species, each metapopulation is continually being modified by increases (births and immigrations) and decreases (deaths and emigrations) of individuals, as well as by the emergence and dissolution of local populations contained within it. As local populations of a given species fluctuate in size, they become vulnerable to extinction during periods when their numbers are low. Extinction of local populations is common in some species, and the regional persistence of such species is dependent on the existence of a metapopulation. Hence, elimination of much of the metapopulation structure of some species can increase the chance of regional extinction of species.

The structure of metapopulations varies among species. In some species one population may be particularly stable over time and act as the source of recruits into other, less stable populations. For example, populations of the checkerspot butterfly (*Euphydryas editha*) in California have a metapopulation structure consisting of a number of small satellite populations that surround a large source population on which they rely for new recruits. The satellite populations are too small and fluctuate too much to maintain themselves indefinitely. Elimination of the source population from this metapopulation would probably result in the eventual extinction of the smaller satellite populations.

Population VS	Metapopulation (Local Population)
• Closed Population	• Open Population
• Group of same individuals living in same places at a same time	• Group of same individual living in different places at a same time.
• Here the individuals are added only through birth and loses through death.	• Here the individuals are added through immigiration and loses through emigration.
• Interact takes place within a subpopulation.	• For interaction, migration from one local population to other patces is possible.

Ecological niche

The places organisms live in are called habitats. An **ecological niche**, in contrast, is the ecological role an organism plays within its habitat.

Ecological Niche Definition

Several branches of ecology have adopted the concept of the **ecological niche**.

The ecological niche describes how a species interacts within an ecosystem. The niche of a species depends on both biotic and abiotic factors, which affect the ability of a species to survive and endure.

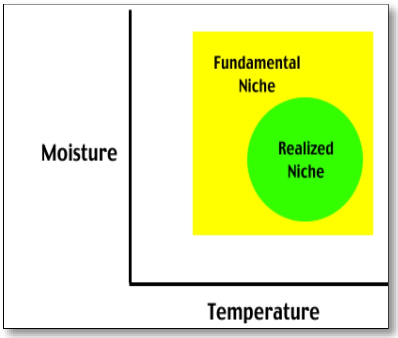
Biotic factors affecting a species' niche include food availability and predators. **Abiotic factors** affecting ecological niche include temperature, landscape characteristics, soil nutrients, light and other non-living factors.

An example of an ecological niche is that of the dung beetle. The dung beetle, as its name suggests, consumes dung both in larval and adult form. Dung beetles store dung balls in burrows, and females lay eggs within them.

This allows hatched larvae immediate access to food. The dung beetle in turn influences the surrounding environment by aerating soil and rereleasing beneficial nutrients. Therefore, the dung beetle performs a unique role in its environment.

The definition of a niche has changed since it was first introduced. A field biologist named Joseph Grinnell took the basic concept of the niche and further developed it, claiming that a niche distinguished between different species that occupied the same space. In other words, only one species could have a particular niche. He was influenced by species distribution.

Types of Ecological Niches



Ecologist Charles Elton's definition of niche focused on the role of a species, such as its trophic role. His tenets emphasized more on community similarity and less on competition.

In 1957, Zoologist G. Evelyn Hutchinson provided a sort of compromise of these trains of thought. Hutchinson described two forms of niche. The **fundamental niche** focused on the conditions in which a species could exist with no ecological interactions. The **realized niche**, in contrast, considered the population's existence in the presence of interactions, or competition. in other word we can say that **Fundamental niche** the niche that an organism could theoretically occupy. While **Realized niche** The niche that an organism actually occupies which could be less extensive (smaller) than the fundamental niche.

The number of different niches in an ecosystem.

- Determined by abiotic factors which could make more niches.
- Predators (organisms that actively hunt other organisms known as prey) increase niche diversity by decreasing the population size of their prey species which allows more resources for other species in that niche.
- Keystone predator is a predator that promotes a great niche diversity in its habitat
- Abiotic factors contribute to niche diversity. These include temperature changes and moisture.

The adoption of the ecological niche concept has allowed ecologists to understand the roles of species in ecosystems.

Importance of Ecological Niches

Ecologists use the concept of the ecological niche to help understand how communities relate to environmental conditions, fitness, trait evolution and predator-prey interactions in communities. This becomes ever more important as climate change affects community ecology.

Ecological niches allow species to exist in their environment. Under the right conditions, the species will thrive and play a unique role. Without the ecological niches, there would be less biodiversity, and the ecosystem would not be in balance.

Interspecies competition: Ecologists refer to *coexistence* when describing ecological niches. Two competing species cannot exist in one ecological niche. This is due to limited resources.

Competition affects the fitness of species, and can lead to evolutionary changes. An example of interspecies competition is an animal that forages for pollen or nectar from a specific plant species, competing with other such animals.

In the case of some species of ants, the insects will compete for nests and prey as well as water and food.

Competitive exclusion principle: Ecologists use the competitive exclusion principle to help understand how species coexist. The competitive exclusion principle dictates that two species cannot exist in the same ecological niche. This is due to competition for resources in a habitat.

Early champions of the competitive exclusion principle were Joseph Grinnell, T. I. Storer, Georgy Gause and Garrett Hardin in the early and mid 20th century.

Competition in a niche either leads each species to specialize in a different way, so as not to use the same resources, or leads one of the competing species to become extinct. This is another way of looking at natural selection. There are two theories used to address competitive exclusion.

In ***R** *** **Theory**, multiple species cannot exist with the same resources unless they differentiate their niches. When resource density is at its lowest, those species populations most limited by the resource will be competitively excluded.

In ***P** *** **Theory**, consumers can exist at high density due to having shared enemies.

Competition plays out even at the microbial level. For example, if *Paramecium aurelia* and *Paramecium caudatum* are grown together, they will compete for resources. *P. aurelia* will eventually overtake *P. caudatum* and cause it to go extinct.

Overlapping Niches/Resource Partitioning

Given the fact that organisms cannot exist in a bubble and must therefore naturally interact with other species, occasionally niches can overlap. To avoid competitive exclusion, similar species can change over time to use different resources.

In other cases, they can exist in the same area but use resources at different times. This scenario is called *resource partitioning*.

Resource partitioning: Partitioning means separating. Simply put, species can use their resources in ways that reduce depletion. This allows the species to coexist and even evolve.

An example of resource partitioning is that of lizards like anoles, which used different parts of their overlapping habitats in different ways. Some of the anoles might live on the forest floor; others might live high in the canopy or along the trunk and branches. Still other anoles might move away from plant environments and live in deserts or near oceans.

Another example would be dolphins and seals, which eat similar species of fish. However, their home ranges differ, allowing for a partitioning of resources.

Another example would be Darwin's finches, which specialized their beak shapes over over time in their evolution. In this way, they were able to use their resources in different ways.

Examples of Ecological Niches

Several **examples of ecological niches** exist in various ecosystems.

For example, in the jack pine forest of Michigan, the Kirtland's warbler occupies an area ideally suited for the bird. The birds prefer nesting on the ground between the trees, not in them, among small undergrowth.

But the jack pine tree must be only up to eight years old and around 5 feet tall. Once the tree ages or grows taller, the Kirtland's warbler will not thrive. These highly specialized kinds of niches can be put at great risk due to human development.

Desert plants such as succulents adapted to arid ecological niches by storing water in their leaves and growing long roots. Unlike most plants, succulents open up their stomata only at night so as to reduce water loss from scorching daytime heat.

Thermophiles are organisms that thrive in extreme ecological niches such as thermal vents with high temperatures.

Channel Islands Ecosystem

In Southern California, mere miles away from one of the most populous areas of human settlement in the United States, the chain of islands known as the Channel Islands provides a fascinating ecosystem for studying ecological niches.

Nicknamed the “Galapagos of North America,” this delicate ecosystem plays host to numerous plants and animals. The islands vary in size and shape, and they provide unique habitats for various animals and plants.

Birds: Several birds call the Channel Islands home, and despite their overlap they have each managed to occupy special ecological niches on the islands. For example, the California brown pelican nests on Anacapa Island by the thousands. The island scrub jay is unique to the Channel Islands.

Fish: Over 2,000 fish species live in the waters around these islands. The kelp beds under the ocean provide habitat for both fish and mammals.

The Channel Islands have suffered from the introduction of invasive species by European settlers, as well as from pollutants such as DDT. Bald eagles disappeared, and taking their place, golden eagles made a home. However, bald eagles have been reintroduced to the islands. Peregrine falcons underwent a similar crisis and are making a comeback.

Native mammals: Four native mammals reside in the Channel Islands: the island fox, harvest mouse, island deer mouse and spotted skunk. The fox and the deer mouse in turn have subspecies on separate islands; each island therefore hosts separate niches.

The island spotted skunk prefers habitat of different types depending on the island it lives on. On Santa Rosa Island, the skunk favors canyons, riparian areas and open woodlands. In contrast, on Santa Cruz Island, spotted skunks prefer open grassland mixed with chaparral. They play the role of predator on both islands.

The island spotted skunk and the island fox are competitors for resources on the islands. However, the spotted skunks are more carnivorous, and they are nocturnal. So in this manner, they are able to coexist in **overlapping niches**. This is another example of resource partitioning.

The island fox nearly went extinct. Recovery efforts have brought the species back.

Reptiles and Amphibians: The highly specialized niches extend to reptiles and amphibians. There is one salamander species, one frog species, two non-venomous snake species and four lizard species. And yet they are not found on every island. For example, only three islands play host to the island night lizard.

Bats also occupy niches on the islands of Santa Cruz and Santa Rosa, working as both pollinators and consumers of insects. Santa Cruz Island is a home for Townsend’s big-eared bats.

Today the islands are recovering. They now comprise Channel Islands National Park and the Channel Islands National Marine Sanctuary, and ecologists continue to monitor the many creatures that call the islands home.

Niche Construction Theory

Ecologists more recently have focused on **niche construction theory**, which describes how organisms modify their environments to make them better suited as niches. Examples of this include making burrows, building nests, creating shade, building beaver dams and other methods in which organisms alter their surroundings to suit their needs.

Niche construction arose from biologist John Odling-Smee. Odling-Smee argued that niche construction should be considered a process of evolution, a form of “ecological inheritance” passed on to descendents rather than a genetic inheritance.

There are four core principles behind niche construction theory:

1. One involves **non-random modification** of the environment by a species, helping aid their evolution.
2. Second, the "ecological" inheritance alters evolution due to **parents passing on the altering skills** to their offspring.
3. Third, new characteristics that are **adopted** become evolutionarily significant. The environments are affected systematically.
4. Fourth, what was considered adaptation is essentially the result of organisms making their environments more complementary via**niche construction**.

An example would be a seabird's feces that lead to plant fertilization and a transition from scrubland to grassland. This is not an intentional adaptation, but it has brought implications for evolution. The seabird would therefore have significantly modified the environment.

Other modifications to the environment must affect the selection pressures on an organism. The selective feedback is unrelated to genes.

Examples of Niche Construction

More examples of niche construction include nesting and burrowing animals, yeast that modify themselves to attract more fruit flies and the modification of shells by hermit crabs. Even by moving around, organisms can affect the environment, in turn influencing gene flow in a population.

This is seen on a grand scale with humans, who have so altered the environment to suit their needs that it has led to worldwide consequences. This certainly can be evidenced by the transition from hunter-gatherers to agrarian cultures, which altered the landscape in order to raise food sources. In turn, humans altered animals for domestication.

Ecological niches offer rich potential knowledge for understanding how species interact with environmental variables. Ecologists can use this information to learn more about how to manage species and to conserve them, and how to plan for future development as well.

Habitat Definition

At its simplest, a **habitat** is a home. The habitat definition in biology refers to location in the natural ecosystem an organism resides in. The habitat definition can further be described as the place organisms usually live, eat and breed in.

Habitat encompasses the geographic location plants or animals live in, combined with varying nonliving or **abiotic features** such as landscape, slope, water, etc. A habitat meets the needs of its denizens for their survival.

Habitats grouped together form an **ecosystem**, a community of organisms that interact with their environment and other species within it.

Types & Examples of Habitats

There are many **examples of habitats** in the world. Some land-based habitats include tundra, grassland, mountain ranges and forests. Numerous aquatic habitats exist as well. They include saltwater marshes, intertidal zones and the deep sea.

However, it is not uncommon for habitats to seem in contrast to the natural world. For example, some organisms can thrive in a parking lot or in the field of a farm. Additionally, some organisms may make more than one habitat in their lifetimes. A good example of this is when migratory birds travel to vastly different environments and climates to breed or winter.

Habitats are dynamic places that change at varying rates. The plants and animals that reside in habitats are adapted to them. So any rapid changes can cause problems for those species with special adaptations only suited to a particular habitat.

Habitat

The habitat of a species describes the environment over which a species is known to occur and the type of community that is formed as a result. More specifically, "habitats can be defined as regions in environmental space that are composed of multiple dimensions, each representing a biotic or abiotic environmental variable; that is, any component or characteristic of the environment related directly (e.g. forage biomass and quality) or indirectly (e.g. elevation) to the use of a location by the animal. For example, a habitat might be an aquatic or terrestrial environment that can be further categorized as a montane or alpine ecosystem. Habitat shifts provide important evidence of competition in nature where one population changes relative to the habitats that most other individuals of the species occupy. For example, one population of a species of tropical lizards (*Tropidurus hispidus*) has a flattened body relative to the main populations that live in open savanna. The population that lives in an isolated rock outcrop hides in crevasses where its flattened body offers a selective advantage. Habitat shifts also occur in the developmental life history of amphibians and in insects that transition from aquatic to terrestrial habitats. Biotope and habitat are sometimes used interchangeably, but the former applies to a community's environment, whereas the latter applies to a species' environment. Additionally, some species are ecosystem engineers, altering the environment within a localized region. For instance, beavers manage water levels by building dams which improves their habitat in a landscape.

Types of Habitat

Terrestrial habitat types include forests, grasslands, wetlands and deserts. Within these broad biomes are more specific habitats with varying climate types, temperature regimes, soils, altitudes and vegetation types. Many of these habitats grade into each other and each one has its own typical communities of plants and animals. A habitat may suit a particular species well, but its presence or absence at any particular location depends to some extent on chance, on its dispersal abilities and its efficiency as a colonizer.

Freshwater habitats include rivers, streams, lakes, ponds, marshes and bogs. Although some organisms are found across most of these habitats, the majority have more specific requirements. The water velocity, its temperature and oxygen saturation are important factors, but in river systems, there are fast and slow sections, pools, bayous and backwaters which provide a range of habitats. Similarly, aquatic plants can be floating, semi-submerged, submerged or grow in permanently or temporarily saturated soils besides bodies of water. Marginal plants provide important habitat for both invertebrates and vertebrates, and submerged plants provide oxygenation of the water, absorb nutrients and play a part in the reduction of pollution.

Marine habitats include brackish water, estuaries, bays, the open sea, the intertidal zone, the sea bed, reefs and deep water zones. Further variations include rock pools, sand banks, mudflats, brackish lagoons, sandy and pebbly beaches, and sea grass beds, all supporting their own flora and fauna. The benthic zone or seabed provides a home for both static organisms, anchored to the substrate, and for a large range of organisms crawling on or burrowing into the surface. Some creatures float among the waves on the surface of the water, or raft on floating debris, others swim at a range of depths, including organisms in the demersal zone close to the seabed, and myriads of organisms drift with the currents and form the plankton.

A desert is not the kind of habitat that favours the presence of amphibians, with their requirement for water to keep their skins moist and for the development of their young. Nevertheless, some frogs live in deserts, creating moist habitats underground and hibernating while conditions are adverse. Couch's spadefoot toad (*Scaphiopus couchii*) emerges from its burrow when a downpour occurs and lays its eggs in the transient pools that form; the tadpoles develop with great rapidity, sometimes in as little as nine days, undergo metamorphosis, and feed voraciously before digging a burrow of their own.

Other organisms cope with the drying up of their aqueous habitat in other ways. Vernal pools are ephemeral ponds that form in the rainy season and dry up afterwards. They have their specially-adapted characteristic flora, mainly consisting of annuals, the seeds of which survive the drought, but also some uniquely adapted perennials. Animals adapted to these extreme habitats also exist; fairy shrimps can lay "winter eggs" which are resistant to desiccation, sometimes being blown about with the dust, ending up in new depressions in the ground. These can survive in a dormant state for as long as fifteen years. Some killifish behave in a similar way; their eggs hatch and the juvenile fish grow with great rapidity when the conditions are right, but the whole population of fish may end up as eggs in diapause in the dried up mud that was once a pond.

Habitat Protection :

The protection of habitats is a necessary step in the maintenance of biodiversity because if habitat destruction occurs, the animals and plants reliant on that habitat suffer. Many countries have enacted legislation to protect their wildlife. This may take the form of the setting up of national parks, forest reserves and wildlife reserves, or it may restrict the activities of humans with the objective of benefiting wildlife.

The laws may be designed to protect a particular species or group of species, or the legislation may prohibit such activities as the collecting of bird eggs, the hunting of animals or the removal of plants. A general law on the protection of habitats may be more difficult to implement than a site specific requirement. A concept introduced in the Unites States in 1973 involves protecting the critical habitat of endangered species, and a similar concept has been incorporated into some Australian legislation.

International treaties may be necessary for such objectives as the setting up of marine reserves. Another international agreement, the Convention on the Conservation of Migratory Species of Wild Animals, protects animals that migrate across the globe and need protection in more than one country. However, the protection of habitats needs to take into account the needs of the local residents for food, fuel and other resources. Even where legislation protects the environment, a lack of enforcement often prevents effective protection. Faced with food shortage, a farmer is likely to plough up a level patch of ground despite it being the last suitable habitat for an endangered species such as the San Quintin kangaroo rat, and even kill the animal as a pest. In this regard, it is desirable to educate the community on the uniqueness of their flora and fauna and the benefits of ecotourism .

Adaptations to Habitats

Animals and plants possess special **adaptations** to the habitats in which they live.

For example, in cold regions such as the Arctic Circle, many animals possess thick fur or a significant amount of body fat to help insulate them from the frigid environment.

Camouflage represents another adaptation used by animals to adapt to their habitats. When animals can blend into their environments, they are less visible to predators.

Habitat vs. Niche

In ecology, **habitat and niche** refer to two separate terms. The habitat definition above refers to the unique place an organism lives. Niche, however, is a more nuanced term ecologists use when referring to organisms interacting in an ecosystem.

In ecological terms, a **niche** is the manner or role in which organisms fit into their respective ecosystems. Over time, ecologists have come to an agreement that a niche cannot have two species playing the same role within it. This is often due to competition for resources.

Sometimes this very scenario leads to extinction, but not always. Over time, two competing species could eventually evolve slight differences and therefore new niches.

Ecologists look at factors such as food, temperature, prey size, moisture, and so on in their analyses. Using two or three of these factors, ecologists can figure out how a species will respond to their environment. This refers to the fundamental niche of a species.Understanding both habitat and niche aids scientists in their quest to find ways to help conserve species.

The Impacts of Habitat Fragmentation

Conservationists work to preserve plants, animals and other organisms within their natural habitats. To monitor the condition of various habitats, conservationists assess their **biogeographical level** as well as their risk of collapse.

One of the goals of ecologists is to study how the destruction and degradation of ecosystems affects species diversity. As human populations and development increase, habitats become broken up or fragmented.

Habitat loss and fragmentation, in turn, leads to a drop in species diversity. One example would be the Brazilian Atlantic forest, which has been deforested for farming and timber.

Chopping up a habitat into smaller, disconnected “islands” leads to more edge environments, fewer places for plants and animals to live and decreased biodiversity. Studying the habitat and niche of a species can help conservationists find ways to protect species for the future.

Microecosystems :can exist in locations which are precisely defined by critical environmental factors within small or tiny spaces. Such factors may include temperature, pH, chemical milieu, nutrient supply, presence of symbionts or solid substrates, gaseous atmosphere (aerobic or anaerobic) .

Pond microecosystems

These microecosystems with limited water volume are often only of temporary duration and hence colonized by organisms which possess a drought-resistant spore stage in the lifecycle, or by organisms which do not need to live in water continuously. The ecosystem conditions appliying at a typical pond edge can be quite different from those further from shore. Extremely space-limited water ecosystems can be found in, for example, the water collected in bromeliad leaf bases and the "pitchers" of *Nepenthes*.

Soil microecosystems

A typical soil microecosystem may be restricted to less than a millimeter in its total depth range owing to steep variation in humidity and/or atmospheric gas composition. The soil grain size and physical and chemical properties of the substrate may also play important roles. Because of the predominant solid phase in these systems they are notoriously difficult to study microscopically without simultaneously disrupting the fine spatial distribution of their components.

Terrestrial hot-spring microecosystems

These are defined by gradients of water temperature, nutrients, dissolved gases, salt concentrations etc. Along the path of terrestrial water flow the resulting temperature gradient continuum alone may provide many different minute microecosystems, starting with thermophilic bacteria such as Archaea "Archaebacteria" (100+ °C), followed by conventional thermophiles (60–100 °C), cyanobacteria (blue-green algae) such as the motile filaments of *Oscillatoria* (30–60 °C), protozoa such as Amoeba, rotifers, then green algae (0–30 °C) etc. Of course other factors than temperature also play important roles. Hot springs can provide classic and straightforward ecosystems for microecology studies as well as providing a haven for hitherto undescribed organisms.

Deep-sea microecosystems

The best known contain rare specialized organisms, found only in the immediate vicinity (sometimes within centimeters) of underwater volcanic vents (or "smokers"). These ecosystems require extremely advanced diving and collection techniques for their scientific exploration.

Closed microecosystem

One that is sealed and completely independent of outside factors, except for temperature and light. A good example would be a plant contained in a sealed jar and submerged under water. No new factors would be able to enter this ecosystem.

Monitoring of the Microecosystems

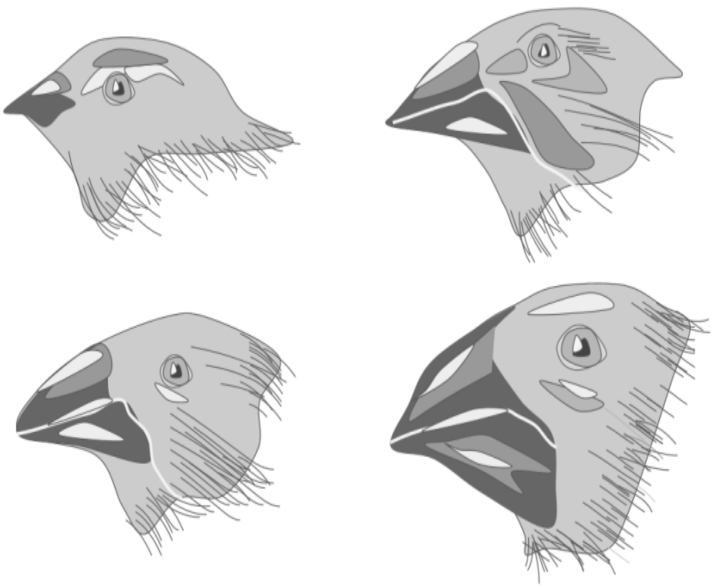
Monitoring of the Microecosystems Changes. in the microecosystems are usually measured by three methods: **(1)** Microscopic observation can be made of the number of species and individuals seen in a sample from the microecosystem.

(2) The pH of the microecosystem can be measured over a 24 hour period. The pH change observed in 24 hours relates to the rate of photosynthesis and respiration in the microecosystem.

(3) Measurement of the biomass or weight of living organisms in the microecosystem is done by filtering the contents of the flask and weighing the material trapped on the filter paper after drying to constant weight.Usually the observation method, or perhaps observation and biomass methods, can be used with the basic method of studying the microecosystem, while the pH measurement is usually used with the advanced approach to studying the microecosystems.

Character displacement:

Character displacement is defined as a situation in which two species, when living in separate geographical ranges (allopatric distributions), have nearly identical physical characteristics (i.e., beak sizes in birds, overall body sizes in lizards and snails, canine sizes in the cat family). When sympatric, however, these physical or morphological characteristics diverge in one or both species. This divergence minimizes competition for food and allows the two species to coexist. Character displacement occurs when similar species that live in the same geographical region and occupy similar niches differentiate in order to minimize niche overlap and avoid competitive exclusion. Several species of Galapagos finches. Each closely-related species differs in beak size and beak depth, allowing them to coexist in the same region since each species eats a different type of seed: the seed best fit for its unique beak. The finches with the deeper, stronger beaks consume large, tough seeds, while the finches with smaller beaks consume the smaller, softer seeds.



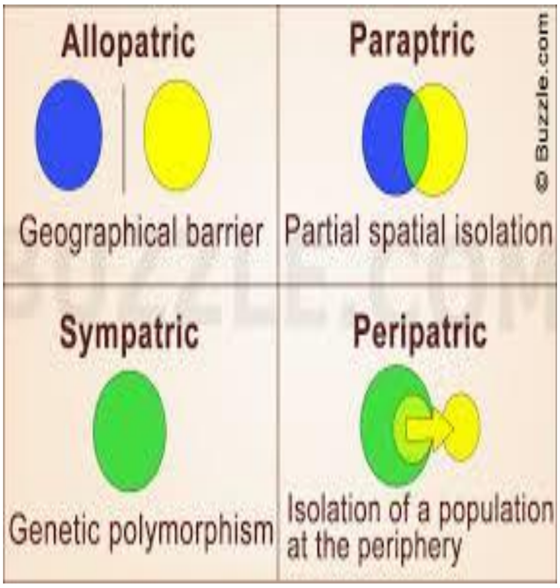
Brown and Wilson (1956) used the term character displacement to refer to instances of both **reproductive character displacement**, or reinforcement of reproductive barriers, and **ecological character displacement** driven by competition. As the term character displacement is commonly used, it generally refers to morphological differences due to competition. Brown and Wilson viewed character displacement as phenomenon involved in speciation, stating, “we believe that it is a common aspect of geographical speciation, arising most often as a product of the genetic and ecological interaction of two (or more) newly evolved, cognate species [derived from the same immediate parental species] during their period of first contact” . While character displacement is important in various scenarios of speciation, including adaptive radiations like the cichlid fish faunas in the rift lakes of East Africa , it also plays an important role in structuring communities. The results of numerous studies contribute evidence that character displacement often influences the evolution of resource acquisition among members of an ecological guild .

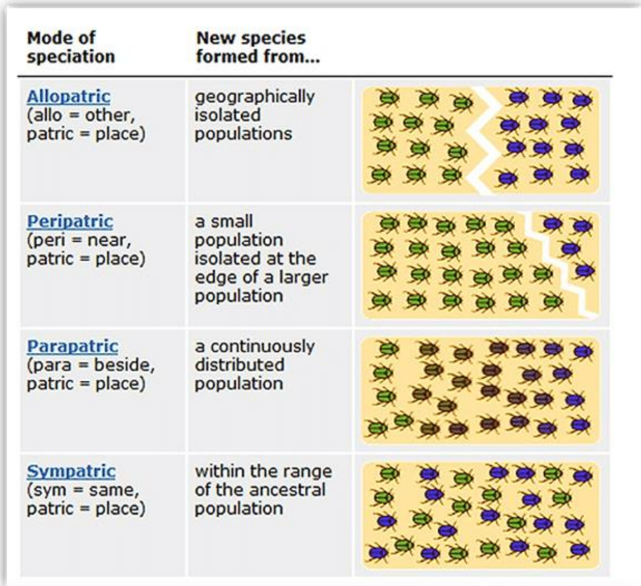
Competitive release (Grant 1972): defined as the expansion of an ecological niche in the absence of a competitor, is essentially the mirror image of character displacement. It too was described by Brown and Wilson (1956): “Two closely related species are distinct where they occur together, but where one member of the pair occurs alone it converges toward the second, even to the extent of being nearly identical with it in some characters.”

Three spine sticklebacks (*Gasterosteus* spp.) in post-glacial lakes in western Canada have contributed significantly to recent research of character displacement. Both observations of natural populations and manipulative experiments show that when two recently evolved species occur in a single lake, two morphologies are selected for: a limnetic form that feeds in open water and a benthic form that feeds at the lake bottom. They differ in size, shape and the number and length of gill rakers, all of which is related to divergence in their diet. Hybrids between the two forms are selected against. When only one species inhabits a lake, that fish displays an intermediate morphology. Studies on other fish species have shown similar patterns of selection for benthic and limnetic morphologies, which can also lead to **sympatric speciation.**

Types of speciation

Speciation can take place in two general ways. A single species may change over time into a new form that is different enough to be considered a new species. This process is known as anagenesis. More commonly, a species may become split into two groups that no longer share the same gene pool. This process is known as cladogenesis. There are several ways in which anagenesis and cladogenesis may take place. In all cases, reproductive isolation occurs.





Sympatric speciation : is the process through which new species evolve from a single ancestral species while inhabiting the same geographic region. In evolutionary biology and biogeography, sympatric and sympatry are terms referring to organisms whose ranges overlap or are even identical, so that they occur together at least in some places. If these organisms are closely related (e.g. sister species), such a distribution may be the result of sympatric speciation. Etymologically, sympatry is derived from the Greek roots ("together", "with") and ("homeland" or "fatherland"). The term was invented by Poulton in 1904, who explains the derivation. Sympatric speciation is one of three traditional geographic categories for the phenomenon of speciation.

Sympatric speciation is rare. It occurs more often among plants than animals, since it is so much easier for plants to self-fertilize than it is for animals. A tetraploidy plant can fertilize itself and create offspring. For a tetraploidy animal to reproduce, it must find another animal of the same species but of opposite sex that has also randomly undergone polyploidy.

Allopatric speciation is the evolution of species and their developed capacity. geographically isolated populations into distinct species. In this case, divergence is facilitated by the absence of gene flow, which tends to keep populations genetically similar.

Allopatric speciation, the most common form of speciation, occurs when populations of a species become geographically isolated. When populations become separated, gene flow between them ceases. Over time, the populations may become genetically different in response to the natural selection imposed by their different environments. If the populations are relatively small, they may experience a founder effect: the populations may have contained different allelic frequencies when they were separated. Selection and genetic drift will act differently on these two different genetic backgrounds, creating genetic differences between the two new species.

peripatric speciation : As in allopatric speciation, physical barriers make it impossible for members of the groups to interbreed with one another. The main difference between allopatric speciation and peripatric speciation is that in peripatric speciation, one group is much smaller than the other. Unique characteristics of the smaller groups are passed on to future generations of the group, making those traits more common among that group and distinguishing it from the others.

Parapatric speciation is the evolution of geographically adjacent populations into distinct species. In this case, divergence occurs despite limited interbreeding where the two diverging groups come into contact.

Parapatric speciation is extremely rare. It occurs when populations are separated not by a geographical barrier, such as a body of water, but by an extreme change in habitat. While populations in these areas may interbreed, they often develop distinct characteristics and lifestyles. Reproductive isolation in these cases is not geographic but rather temporal or behavioral. For example, plants that live on boundaries between very distinct climates may flower at different times in response to their different environments, making them unable to interbreed.

In sympatric speciation, there is no geographic constraint to interbreeding. These categories are special cases of a continuum from zero (sympatric) to complete (allopatric) spatial segregation of diverging groups.

In multicellular eukaryotic organisms, sympatric speciation is thought to be an uncommon but plausible process by which genetic divergence (through reproductive isolation) of various populations from a single parent species and inhabiting the same geographic region leads to the creation of new species. In bacteria, however, the analogous process (defined as "the origin of new bacterial species that occupy definable ecological niches") might be more common because bacteria are less constrained by the homogenizing effects of sexual reproduction and prone to comparatively dramatic and rapid genetic change through horizontal gene transfer.

Natural selection

is a process by which organisms that are better adapted to specific pressures of their environment tend to survive longer and produce more offspring, thus ensuring the preservation and multiplication of those favorable traits through generations, at the expense of the less advantageous ones. It is one of the key mechanisms of evolution, which affects organisms in every aspect, from their physiology and morphology, to behavior and ecology. The term was popularized by Charles Darwin .
Natural selection is known as 'the survival of the fittest'. The best adapted organisms are able to survive.The most desirable characteristics get passed down from parents to their offspring.Scientists have used fossils to look at how organisms have evolved over time. Variation exists within all populations of organisms. This occurs partly because random mutations arise in the genome of an individual organism, and offspring can inherit such mutations. Throughout the lives of the individuals, their genomes interact with their environments to cause variations in traits. (The environment of a genome includes the molecular biology in the cell, other cells, other individuals, populations, species, as well as the abiotic environment.) Individuals with certain variants of the trait may survive and reproduce more than individuals with other, less successful, variants. Therefore, the population evolves. Factors that affect reproductive success are also important, an issue that Darwin developed in his ideas on sexual selection which was redefined as being included in natural selection in the 1930s when biologists considered it relatively unimportant.

Natural selection can cause microevolution

Natural selection acts on an organism's **phenotype**, or observable features. Phenotype is often largely a product of **genotype** (the **alleles**, or gene versions, the organism carries). When a phenotype produced by certain alleles helps organisms survive and reproduce better than their peers, natural selection can increase the frequency of the helpful alleles from one generation to the next . this process can result in populations that specialize for particular ecological niches (**microevolution**) and may eventually result in speciation (the emergence of new species, macroevolution). In other words, natural selection is a key process in the evolution of a population.that is, it can cause **microevolution**.

Microevolution: Change in allele frequencies resulting from natural selection,genetic drift, gene flow, and mutation.

Macroevolution: The large-scale patterns, trends, and rates of change among families and other more inclusive groups of species.

Fitness = reproductive success

The phenotypes and genotypes favored by natural selection aren't necessarily just the ones that survive best. Instead, they're the ones with the highest overall fitness. **Fitness** is a measure of how well organisms survive and reproduce, with emphasis on "reproduce." Officially, fitness is defined as the number of offspring that organisms with a particular genotype or phenotype leave behind, on average, as compared to others in the population.

Survival is one important component of fitness. In order to leave any offspring at all in the next generation, an organism has to reach reproductive age. For instance, brown rabbits had higher fitness than white rabbits, because a larger fraction of brown rabbits than white rabbits survived to reproduce. Living for a longer period of time may also allow an organisms to reproduce more separate times (e.g., with more mates or in multiple years).

However, survival is not the only part of the fitness equation. Fitness also depends on the ability to attract a mate and the number of offspring produced per mating. An organism that survived for many years, but never successfully attracted a mate or had offspring, would have very (zero) low fitness.

Fitness depends on the environment

Which traits are favored by natural selection (that is, which features make an organism more fit) depends on the environment. For example, a brown rabbit might be more fit than a white rabbit in a brownish, grassy landscape with sharp-eyed predators. However, in a light-colored landscape (such as sand dunes), white rabbits might be better than brown rabbits at avoiding predators. And if there weren't any predators, the two coat colors might be equally fit!

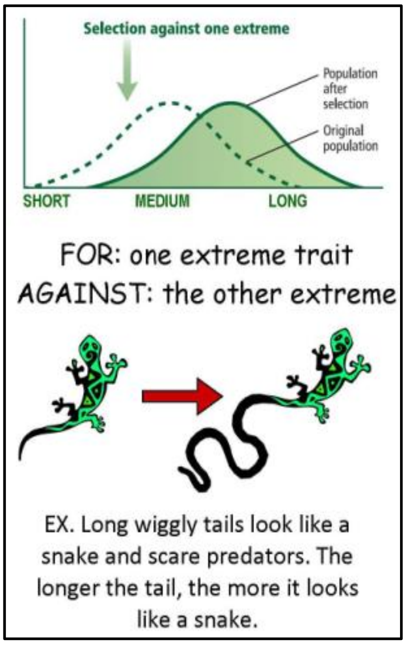
In many cases, a trait also involves tradeoffs. That is, it may have some positive and some negative effects on fitness. For instance, a particular coat color might make a rabbit less visible to predators, but also less attractive to potential mates. Since fitness is a function of both survival *and* reproduction, whether the coat color is a net "win" will depend on the relative strengths of the predation and the mate preference.

Reproductive success is defined as the passing of genes onto the next generation in a way that they too can pass those genes on. In practice, this is often a tally of the number of offspring produced by an individual. A more correct definition, which incorporates inclusive fitness, is the relative production of fertile offspring by a genotype. For example, the offspring produced as a result of normal mating are an example of reproductive success, because they too can pass their genetic material on to the next generation. Alternatively, the birth of a mule as a result of the mating of a horse and a donkey is not an example of reproductive success because the mule is sterile and thus not able to continue the germ line.

Reproductive success is part of the calculation for fitness and a key element in the theories of natural selection and evolution.

Types of natural selection by trait:

1.Directional Selection

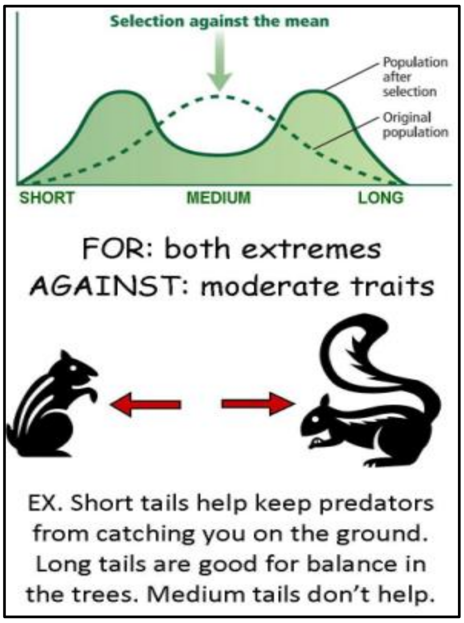


directional selection: a mode of natural selection in which a single phenotype is favored, causing the allele frequency to continuously shift in one direction.

When the environment changes, populations will often undergo directional selection, which selects for phenotypes at one end of the spectrum of existing variation.A classic example of this type of selection is the evolution of the peppered moth in eighteenth- and nineteenth-century England. Prior to the Industrial

Revolution, the moths were predominately light in color, which allowed them to blend in with the light-colored trees and lichens in their environment. As soot began spewing from factories, the trees darkened and the light-colored moths became easier for predatory birds to spot. Over time, the frequency of the melanic form of the moth increased because their darker coloration provided camouflage against the sooty tree; they had a higher survival rate in habitats affected by air pollution. Similarly, the hypothetical mouse population may evolve to take on a different coloration if their forest floor habitat changed. The result of this type of selection is a shift in the population's genetic variance toward the new, fit phenotype.

2.Disruptive Selection



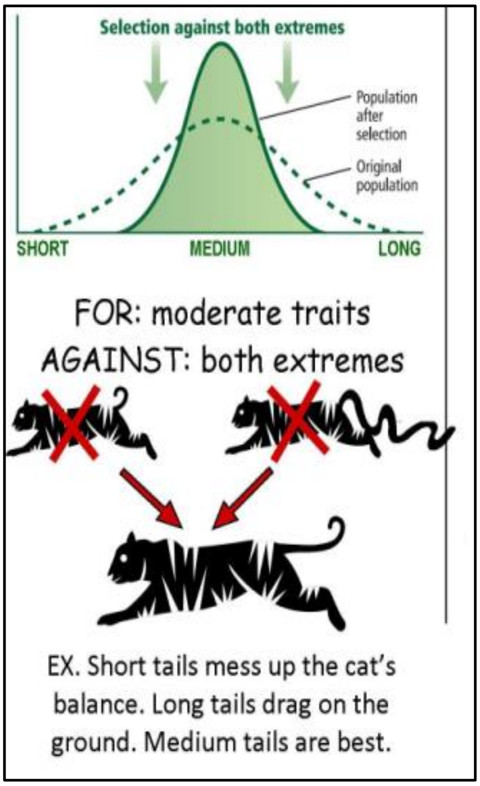
disruptive selection: (or diversifying selection) a mode of natural selection in which extreme values for a trait are favored over intermediate values.

Sometimes natural selection can select for two or more distinct phenotypes that each have their advantages. In these cases, the intermediate phenotypes are often less fit than their extreme counterparts. Known as diversifying or disruptive selection, this is seen in many populations of animals that have multiple male mating strategies, such as lobsters. Large, dominant alpha males obtain mates by brute force, while small males can sneak in for furtive copulations with the females in an alpha male's territory. In this case, both the alpha males and the "sneaking" males will be selected for, but medium-sized males, which cannot overtake the alpha males and are too big to sneak copulations, are selected against.

Diversifying selection can also occur when environmental changes favor individuals on either end of the phenotypic spectrum. Imagine a population of mice living at the beach where there is light-colored sand interspersed with patches of tall grass. In this scenario, light-colored mice that blend in with the sand would be favored, as well as dark-colored mice that can hide in the grass. Medium-colored mice, on the other hand, would not blend in with either the grass or the sand and, thus, would more probably be eaten by predators. The result of this type of selection is increased genetic variance as the population becomes more diverse.

3.Stabilizing Selection

stabilizing selection: a type of natural selection in which genetic diversity decreases as the population stabilizes on a particular trait value.

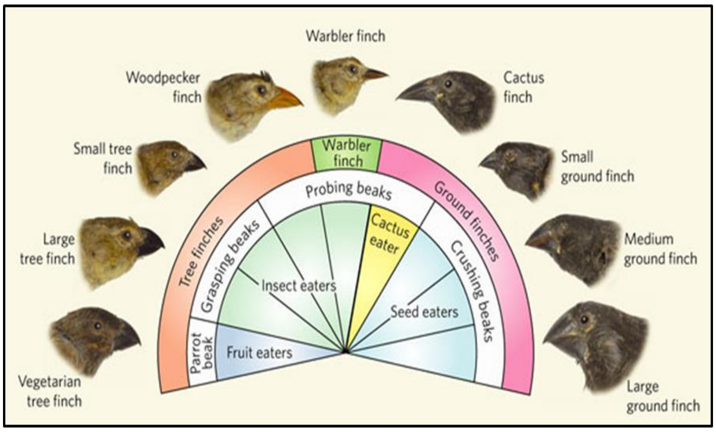


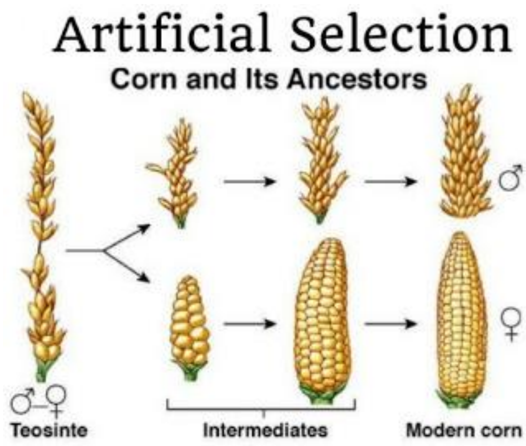
If natural selection favors an average phenotype by selecting against extreme variation, the population will undergo stabilizing selection. For example, in a population of mice that live in the woods, natural selection will tend to favor individuals that best blend in with the forest floor and are less likely to be spotted by predators. Assuming the ground is a fairly consistent shade of brown, those mice whose fur is most-closely matched to that color will most probably survive and reproduce, passing on their genes for their brown coat. Mice that carry alleles that make them slightly lighter or slightly darker will stand out against the ground and will more probably die from predation. As a result of this stabilizing selection, the population's genetic variance will decrease.

Artificial Selection

Artificial selection is not a type of natural selection, obviously, but it did help Charles Darwin obtain data for his theory of natural selection. Artificial selection mimics natural selection in that certain traits are chosen to be passed down to the next generation. However, instead of nature or the environment in which the species lives being the deciding factor for which traits are favorable and which are not, it is humans that do the selecting of traits during artificial selection. All domestic plants and animals are products of artificial selection—humans selected which traits are the most beneficial for them.

Darwin was able to use artificial selection on his birds to show that desirable traits can be chosen through breeding. There, Charles Darwin studied native finches and noticed those on the Galapagos Islands were very similar to the ones in South America, but they had unique beak shapes. He performed artificial selection on birds back in England to show how the traits changed over time. The shape of the beak is adapted to the diet and environment of the finch Each finch ate a different diet so they occupied a different niche and created less competition.





Natural selection	Artificial selection (Selective breeding)
In natural selection, nature selects the individuals with favourable variations for better survival in an environment	It is the selective breeding of domesticated plants and animals to produce offspring's with characters desirable to humans
The nature selects the best or the most favourable variation.	Man selects the desirable characteristic that is to be passed on to the next generation.
Selection pressure is exerted by environmental factors.	Selection pressure is exerted by humans
It always increases the species chance for survival in its natural environment	It may not always increases the species chance for survival in its natural environment
It takes about hundreds of years for new species to emerge.	It leads to the formation of new species in a much shorter time, may be in a few years.
In operates on a wide scale in natural populations	It involves selective breeding of economically important plant and animal populations only
It leads to great diversity in nature.	It promotes evolution of a few economically important plants and animals only.
Genetic diversity remains high	Genetic diversity is lowered
Out breeding is common, leading to hybrid vigour.	Inbreeding is common ensuring preservation of desired trait, leading to loss of vigour in offspring
Proportion of heterozygous in the population remains high.	Proportion of heterozygous in the population is reduced as inbreeding increases homozygosity
Examples: Insecticide resistance, Giraffes long neck, beaks of Darwin's Finches	Breeding of cows, sheep other domesticated animals high yielding varieties of wheat, rice etc.

Selection can also be classified according to its effect on allele frequency.

Positive selection acts to increase the frequency of an allele.

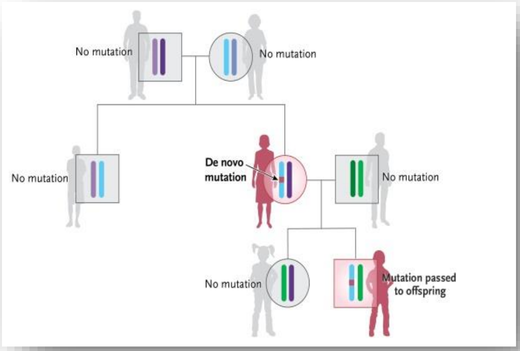
Negative selection acts to decrease the frequency of an allele. Note that for a diallelic locus, positive selection on one allele perforce implies negative selection on the other allele.

Selection can also be classified according to its effect on genetic diversity.

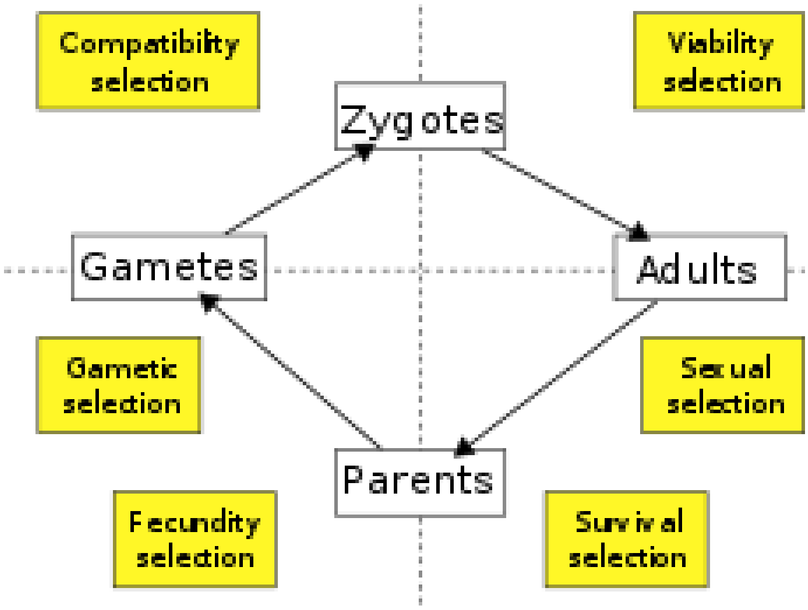
Purifying selection acts to remove genetic variation from the population (and is opposed by *de novo* mutation, which introduces new variation).

Balancing selection acts to maintain genetic variation in a population (even in the absence of *de novo* mutation). Mechanisms include negative frequency-dependent selection (of which heterozygote advantage is a special case), and spatial and/or temporal fluctuations in the strength and direction of selection.

A genetic alteration that is present for the first time in one family member as a result of a variant (or mutation) in a germ cell (egg or sperm) of one of the parents, or a variant that arises in the fertilized egg itself during early embryogenesis. Also called de novo variant, new mutation, and new variant.



Selection can also be classified according to the stage of an organism's life cycle at which it acts. The use of terminology differs here. Some recognize just two types of selection: **viability selection** (or survival selection) which acts to improve the probability of survival of the organism, and **fecundity selection** (or fertility selection, or reproductive selection) which acts to improve the rate of reproduction, given successful survival. Others split the life cycle into further components of selection . Thus viability and survival selection may be defined separately and respectively as acting to improve the probability of survival before and after reproductive age is reached, while fecundity selection may be split into additional sub-components including **sexual selection,** ***gametic selection*** (acting on gamete survival) and ***compatibility selection*** **(acting on zygote formation).**



Selection can also be classified according to the level or unit of selection.

Individual selection acts at the level of the individual, in the sense that adaptions are 'for' the benefit of the individual, and result from selection among individuals.

Gene selection acts directly at the level of the gene. In many situations, this is simply a different way of describing individual selection.

Group selection acts at the level of groups of organisms. The mechanism assumes that groups replicate and mutate in an analogous way to genes and individuals. There is an ongoing debate over the degree to which group selection occurs in nature.

Finally, selection can be classified according to the resource being competed for.

Sexual selection results from competition for mates. Sexual selection can be ***intrasexual***, as in cases of competition among individuals of the same sex in a population, or ***intersexual***, as in cases where one sex controls reproductive access by choosing among a population of available mates. Typically, sexual selection proceeds via fecundity selection, sometimes at the expense of viability**.** Sexual Selection

The selection pressures on males and females to obtain matings is known as sexual selection. Sexual selection takes two major forms: intersexual selection (also known as 'mate choice' or 'female choice') in which males compete with each other to be chosen by females; and intrasexual selection (also known as 'male–male competition') in which members of the less limited sex (typically males) compete aggressively among themselves for access to the limiting sex.


Sexual selection in elk: This male elk has large antlers to compete with rival males for available females (intrasexual competition).in addition, the many points on his antlers represent health and longevity, and therefore he may be more desirable to females (intersexual selection).

Ecological selection is natural selection via any other means than sexual selection. Alternatively, natural selection is sometimes defined as synonymous with ecological selection, and sexual selection is then classified as a separate mechanism to natural selection. This accords with Darwin's usage of these terms, but ignores the fact that mate competition and mate choice are natural processes.

Note that types of selection often act in concert. Thus Stabilizing selection typically proceeds via negative selection on rare alleles, leading to purifying selection, while directional selection typically proceeds via positive selection on an initially rare favored allele.

Ecological selection covers any mechanism of selection as a result of the environment, including relatives (e.g., kin selection, competition, and infanticide).

Natural Disasters That Effect Ecosystem:

Earthquakes, landslides, volcanic eruptions and natural bush fires all affect the many different ecosystems on our planet. Initially, these disasters negatively affect the biodiversity of wetlands, forests and coastal systems by causing the spread of invasive species, mass species mortality and loss of habitat. In the short term, select ecosystem degradation reduces the ability of forests to sequester carbon, which exacerbates climate change. Over time though, many types of natural disasters play an integral role in rejuvenating the very ecosystem that they once destroyed.

Finally, it is useful to assess the impacts of natural disasters by type of disasters. Because of their great spatial extent and longevity, major floods and droughts generally create the greatest environmental impacts, whereas earthquakes, hurricanes, thunderstorms, and winter storms cover less territory and their effects on the ecosystem are less pervasive and long-lasting.

Flood

Annual flood pulses help regulate and maintain these ecosystems by promoting exchanges of water, sediment, nutrients, and organisms between the rivers and their floodplains. Moreover, infrequent great floods and droughts help maintain habitat and species diversity.

Droughts

Unlike floods, droughts generally damage ecological systems and yield few offsetting benefits. In fact, the most subtle and enduring impacts of droughts occur in the environment. The cumulative stress on wetlands, wildlife, forests, ground water, and soils cannot be measured accurately, and many effects occur slowly and over a period of years, making them extremely difficult to quantify.

The problems generated by droughts begin with changes in the quantity and quality of water available in the hydrologic system. Drought damages both plant and animal species by depriving them of food and water, increasing their susceptibility to disease, and increasing their vulnerability to predation. As with floods, droughts produce a loss of biodiversity, and often increase erosion of dried soils when rain eventually comes. Droughts also degrade water quality, shifting salt concentration, pH levels and dissolved oxygen, while increasing water temperatures. Even air quality is diminished because of increased dust and pollutants. Droughts also lead to more wildfires, while adversely changing salinity levels in coastal estuaries and reducing the flushing of pollutants.

Hurricanes and Tropical Storms

Hurricanes and tropical storms create environmental damages within paths that vary from 50 to 150 miles in width. The environmental consequences largely consist of damages to trees and underbrush in the storm path. At the same time, the long-term ecosystem damages of these storms are uncertain. To be sure, during coastal storms in particular there is often significant erosion of shores and beaches. In the long run, however, nature generally has adapted to these events, so the extent of negative impacts of these events is not clear.

Severe Local Storms

Severe local thunderstorms such as a major tornado striking Wichita or a thunderstorm producing large hailstorms in Dallas—are often labeled as natural disasters due to the attendant loses of life and economic losses, but in general these events are localized. They are not events that create serious, large-scale damages to the natural ecosystem. Nonetheless, it is possible that the *cumulative* environmental impacts of severe storms over a period as short as a year can be significant. Broad areas can suffer from numerous forest fires triggered by cloud-to-ground lightning. High winds and hail cause localized damages to plants and forests, although the total losses are considered to be relatively minor on a regional or national scale.

Heavy rains that lead to flash floods also can be environmentally damaging, at least locally. They increase soil erosion rates, and if they occur in mountainous areas the resulting flood can create massive damages to ecosystems in narrow mountain valleys.

Earthquakes

Although the dominant losses from earthquakes are to structures and potentially to humans, these events can also result in adverse environmental consequences. Examples include flora and fauna damaged by the shocks and shifts in land surfaces, as well as alterations in local hydrologic systems. For example, the famed New Madrid earthquake in the central United States in the 19th century changed the course of the Mississippi River and created a cutoff lake. In the most affected areas, trees, shrubs, land cover, and habitats can also be destroyed. There are currently no estimates of the environmental or ecosystem losses from earthquakes (although the national, long-term impact is probably not great).

High Winds

Strong and persistent synoptic scale (non-storm) high winds can sweep over large areas and cause damage to trees and plants. High winds can also help promote large-scale fires, typically in dry western areas. Recent wind-driven fire catastrophes in California accounted for insured property losses of $1.5 billion in October 1992, rated as the third largest fire loss in the nation's history . Major brushfires enhanced by strong winds occurred in California in October 1993 and again in November 1993, together causing $815 million in insured property losses . These huge, wind-driven fires consumed all underbrush, ground cover, and trees over hundreds of square miles, but there is no known report documenting the value of these losses to the natural or landscape environments.

High winds and waves caused by severe extra tropical cyclones damage beaches and shoreline ecosystems. This is a problem mainly along the East Coast when strong "Nor'easters" strike along shores ranging from 500 to 1,000 miles in length and in the Great Lakes, where winter storms create waves that severely erode beaches. However, these shoreline effects also can be viewed as an inherent part of nature to which coastal ecosystems have adapted.

Volcanic activity

The eruption of volcanoes and subsequent lava flow has an immediate negative effect on surrounding ecosystems, but through the process of primary succession, the forest habitat begins the process of re-colonization almost immediately. Many plants in the form of seeds and spores and animal species, particularly insect life such as crickets and spiders, arrive from adjacent areas to take up residence. These life forms are specifically adapted to survive in the severe conditions following a lava flow and spearhead the succession process. The progeny of these pioneer species change the original sterile conditions to the point where a new and normally more diverse forest ecosystem has developed within a 150 year period.

Wildfires

These uncontrolled and violent infernos, travelling at speeds in excess of 20 kilometers per hour, are capable of destroying everything in their path. The perfect conditions for wildfires include drought, heat and frequent thunderstorms. Once these fires exist, they can burn for weeks and do great damage to the ecosystem that they travel through. Despite the initial destruction of habitats, wildfires play an integral part in rejuvenation an ecosystem by consuming decaying matter, destroying diseased trees and related vegetation, creating conditions for new seedlings to germinate and by returning nutrients to the forest floor.

Tsunami

Once referred to as tidal waves, a tsunami represents an extremely high wave of water that moves from out at sea towards land. Because of the enormous volume of water and energy that travels inland, extended areas along the coast are immediately devastated as these natural disasters strike the coastal ecosystems. Underwater landslides, earthquakes and volcanic eruptions can all cause tsunamis, by displacing gigantic waves that are sustained by gravity as they travel towards land at over 800 kilometers per hour. Tsunamis are also caused as the ocean floor suddenly deforms due to tectonic earthquake activity and vertically displaces the immense volume of water lying above it. While out at sea, tsunamis have a small wave height, but extended wavelength of up to 200 kilometers. The height of these waves rises dramatically, though, as the tsunami reaches land and the resulting damage to coastal ecosystems can be cataclysmic. As coral reefs, mangrove forests and wetlands are all dependent upon each for nutrient supplies, the destruction of one will ultimately affect the overall coastal ecosystem. The destruction of coral reef fish populations leads to the elimination of other species that depended on them as a food source, while on land, the soil that was exposed to salt sedimentation, becomes infertile, resulting in the loss of biodiversity in the form of coastal forests and the animal life that they supported.

Ecosystem Homeostasis

Ecosystems are huge and complex. They contain networks of animals, from the largest mammals to the smallest insects; plants; fungi; and various microorganisms. All of these life forms interact and affect one another. Bears and birds eat the fish, shrews eat insects, and caterpillars eat leaves. Everything in nature works in a delicate balance. But scientists like technical terms, so this balance of nature is more commonly referred to as **ecosystem homeostasis**.

shrew

Ecosystems are capable of maintaining their state of equilibrium. They can regulate their own species structure and functional processes. This capacity of ecosystem of self regulation is known as homeostasis. In ecology the term applies to the tendency for a biological systems to resist changes. For example, in a pond ecosystem if the population of zooplankton increased, they would consume large number of the phytoplankton and as a result soon zooplankton would be short supply of food for them. As the number zooplankton is reduced because of starvation, phytoplankton population start increasing. After some time the population size of zooplankton also increases and this process continues at all the trophic levels of the food chain. Note that in a homeostatic system, **negative feed back** mechanism is responsible for maintaining stability in a ecosystem. However, homeostatic capacity of ecosystems is not unlimited as well as not everything in an ecosystem is always well regulated. You will learn about the scope and limitations homeostatic mechanisms when you gain more knowledge about ecosystems. Humans are the greatest source of disturbance to ecosystems

Large number of phytoplankton
↓
Increase population of zooplankton due to excess food available
↓
Reduction in phytoplankton
↓
Population of zooplanktons decrease due to starvation
↓
Population of phytoplankton starts increasing due to less consumption

Homeostasis in ecosystem

An ecosystem maintains a biological equilibrium between the different components and is referred as a homeostasis. It keeps on changing with the time and is not static. The balance is maintained by the number of factors. These include the carrying capacity of the environment and the capacity for recycling of the waste. The effect of density on the reproductive potential deals with the self-regulation. The one component of ecosystem keeps a check on the population of the other component and this system is referred as a feedback system. The feedback systems are of different types. They can be positive or negative. The increase in the population of the organisms at the different levels increases the population of organisms at a lower level and is known as the **positive feedback**. For example, when the population of plants increases it leads to increase in the population of herbivore animals. It increases the population of frogs and birds. Similarly, the increased population of insectivorous animals acts on the herbivorous insect by the process of predation. This is known as the **negative feedback**.

Ecosystems have complex food webs:

A food chain follows one path of energy and materials between species. A food web is more complex and is a whole system of connected food chains. In a food web, organisms are placed into different trophic levels. Trophic levels include different categories of organisms such as producers, consumers, and decomposers. Producers are the basic trophic level while top predators are the peak level. Producers are autotrophs, meaning they produce their own food through photosynthesis or chemosynthesis . Consumers are animals that eat producers and are split into many different categories: primary consumers, secondary consumers, tertiary consumers, and more. Primary consumers are herbivores that eat plants. Secondary consumers eat the herbivores. Tertiary consumers eat a variation of the primary and secondary consumers. There may be more levels of consumers until eventually the top predator is reached. The relationship between trophic levels (e.g. primary producers, herbivores, primary predators, and top predators) is shown in Figure 1. It is important to note that consumers can be carnivores, animals that eat other animals, and also omnivores, animals that consume many types of food. Decomposers are also part of the food web and include organisms that feed on all varieties of dead plants and animals.

Equilibrium and Non-equilibrium

All living things must remain in balance, or **equilibrium**, also known as homeostasis. Our bodies maintain a balance of many things such as temperature. If we are too hot we sweat and if we are too cold we shiver. Our temperature must remain in equilibrium.

Even larger collections of living things like **ecosystems** must be in balance too. An ecosystem is a collection of living and non-living things in an area. There are lots of types of ecosystems we already know, such as a forest or a meadow. Any collection of living and non-living things in an area is an ecosystem, even a small ecosystem like your backyard.

For example, let's say we have a really simple ecosystem: lions eat gazelles, and gazelles eat wild grasses. If in one particular year the population of lions increases, the population of gazelles will decrease because there are more lions hunting them. With less gazelles, the population of wild grasses will increase. The following year, perhaps there are no longer enough gazelles to feed the lions. That will cause the lion population to go down again, and with plenty of grass around, the gazelle population will boom. This will go back and forth in a continuous cycle. Since these cycles cause populations to move up and down in a particular range, this is an example of an ecosystem in equilibrium.

How do you get a stable ecosystem:

We're going to answer this question in three parts. First, maintaining a stable ecosystem in terms of the principles of an ecosystem and the negative factors that can make it not as stable. Then the response will move into maintaining a stable ecosystem in terms of predators and prey relationships and species diversity. And lastly, we will discuss how an ecosystem balances its self.

1. **Keeping a stable ecosystem goes along with maintaining homeostasis**.

In order to maintain homeostasis the ecosystem must establish a "dynamic equilibrium", simply meaning "the conditions of the ecosystem are held more or less constant by negative feedback systems operating within the ecosystem". This would cause negative feedback because it would throw off the homeostasis of the ecosystem because more things would be produced, or more things would be eaten, depending on the situation. For example, say all of the sharks are taken from an ecosystem, making the population of sting rays grow, causing the population of shell fish to decrease, throwing off the homeostasis of that ecosystem. Thus, in order to keep a stable ecosystem the principles listed above must be maintained at equilibrium.

2.There are many factors that come into play when studying how an ecosystem maintains balance.

Species must learn to adapt to adverse situations. Learning to adapt means that species who have the most practical genes for their living environments have a better chance of reproducing. This creates an abundance of the gene and helps species adapt.

3. **Species diversity is an important factor for balancing an ecosystem**.

Relationships such as predator/prey and host/parasite help to balance. Without gaining benefit from other species and helping each other out, an ecosystem will lose stability. Niche Partitioning deals with how different species use different resources. This become very important in the balance of an ecosystem. Different species rely on others to survive and when everything works together it creates balance (ecosystem).

Population dynamics

A **population**: is a summation of all the organisms of the same group or species, which live in a particular geographical area, and have the capability of interbreeding.

Individuals living in the same area are referred as local populations. They all experience similar ecological processes at a particular stage of the life cycle. Similar populations of a species occupying different geographical areas are called sister populations. Population is a dynamic unit. Number of individuals may increase or decrease due to many factors due to birth rate, death rate, migration etc. Variation is expressed as population size and population density in a given area at a particular time. In a geographical area, the population is further divisible into sub-groups called demes. The chances of sexual communication are more between the members of same deme than between the members of different demes. Due to this ability, there is free flow of genes in a species.

Population of an area is described on the basis of three parameters:

A- Number and kind of individuals of a species.
B- A given space or an area.
C- Time.

The population has the following characteristics:

1. Population Size and Density:

Total size is generally expressed as the number of individuals in a population.

Population density is defined as the numbers of individuals per unit area or per unit volume of environment. Larger organisms as trees may be expressed as 100 trees per hectare, whereas smaller ones like Phytoplanktons (as algae) as 1 million cells per cubic meter of water. In terms of weight it may be 50 kilograms of fish per hectare of water surface. Since, the patterns of dispersion of organisms in nature are different, population density is also differentiated into **crude density** and **ecological density**.

a. Crude density:

It is the density (number or biomass) per unit total space.

b. Ecological density or specific or economic density:

It is the density (number or biomass) per unit of habitat space i.e., available area or volume that can actually be colonized by the population.

This distinction becomes important due to the fact that organisms in nature grow generally clumped into groups and rarely as uniformly distributed. For example, in plant species like *Cassia tora*, individuals are found more crowded in shady patches and few in other parts of some area. Thus, density calculated in total area (shady as well as exposed) would be crude density, whereas the density value for only shady area (where the plants actually grow) would be ecological density.

2. Population dispersion or spatial distribution:

Dispersion is the spatial pattern of individuals in a population relative to one another. In nature, due to various biotic interactions and influence of abiotic factors, the following three basic population distributions can be observed:

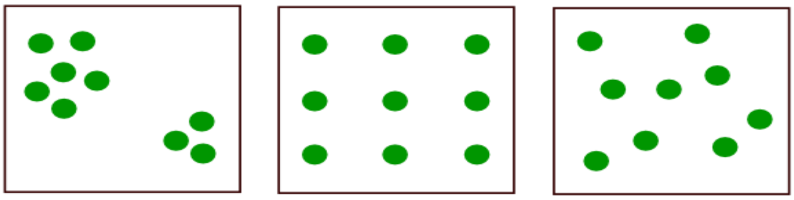
(a) Regular (Uniform) dispersion:

Here the individuals are more or less spaced at equal distance from one another. This is rare in nature but in common is cropland. Animals with territorial behavior tend towards this dispersion.

(b) Random dispersion:

Here the position of one individual is unrelated to the positions of its neighbors. This is also relatively rare in nature.

(c) Clumped dispersion: Most populations exhibit this dispersion to some extent, with individuals aggregated into patches interspersed with no or few individuals. Such aggregations may result from social aggregations, such as family groups or may be due to certain patches of the environment being more favorable for the population concerned.



3. Age structure:

In most types of populations, individuals are of different age. The proportion of individuals in each age group is called age structure of that population. The ratio of the various age groups in a population determines the current reproductive status of the population, thus expecting its future. From an ecological view point there are three major ecological ages in any population. These are, **pre-reproductive**, **reproductive** and **post reproductive**. The relative duration of these age groups in proportion to the life span varies greatly with different organisms.

Age pyramids:

The model representing the proportions of different age groups in the population of any organism is called age pyramid. According to Bodenheimer (1938), there are following three basic types of age pyramids.

(a) A pyramids with a broad base (or triangular structure):

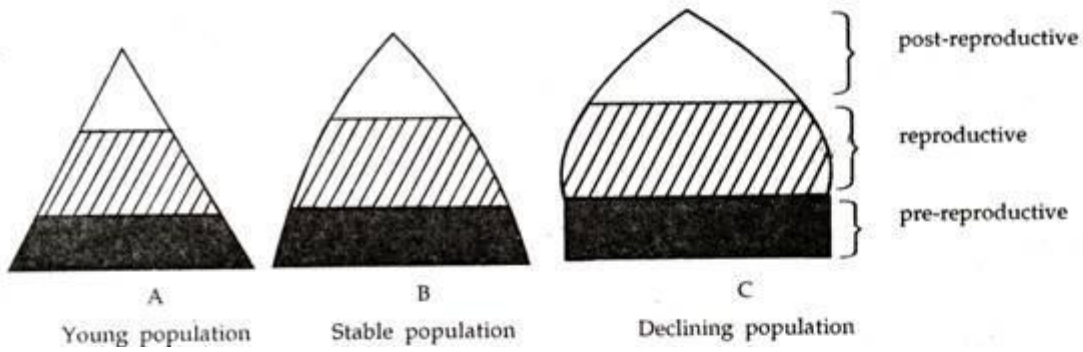
It indicates a high percentage of young individuals. In rapidly growing young populations birth rate is high and population growth may be exponential as in yeasty house fly, Paramecium, etc. Under such conditions, each successive generation will be more numerous than the preceding one, and thus a pyramid with a broad base would result (Fig. A).

(b) Bell-Shaped Polygon:

It indicates a stationary population having an equal number of young and middle aged individuals. As the growth rate becomes slow and stable, i.e., the pre-reproductive and reproductive age groups become more or less equal in size, post-reproductive group remaining as the smallest (Fig. B).

(c) An urn-shaped structure:

It indicates a low percentage of young individuals and shows a declining population. Such an urn-shaped figure is obtained when the birth rate is drastically reduced the pre-reproductive group dwindles in proportion to the other two age groups of the population. (Fig. C).



4. Natality (birth rate):

Population increase because of natality. It is simply a broader term covering the production of new individuals by birth, hatching, by fission, etc. The natality rate may be expressed as the number of organisms born per female per unit time. In human population, the natality rate is equivalent to the birth-rate. There are two types of natality.

(a) Maximum natality: Also called as absolute or potential or physiological natality, it is the theoretical maximum production of new individuals under ideal conditions which means that there are no ecological limiting factors and that reproduction is limited only by physiological factors. It is a constant for a given population. This is also called fecundity rate.

(b) Ecological or realized natality: Also called realized natality or simply natality, it is the population increase under an actual, existing specific condition. Thus it takes into account all possible existing environmental conditions. This is also designated as fertility rate.

Further, the rate at which females produce offspring is determined by the following three population characteristics:

(a) The number of young produced on each occasion.
(b) The time between one reproductive event and the next and
(c) The age of first reproduction.

Thus, natality usually increase with the period of maturity and then falls again as the organism gets older.

- **Natality Rate** – number of births per 1000 individuals per year.

- **Calculations where natality is a factor**
- Natality rate: number of births/unit of time/Average Population
- For wildlife management: $N1 = N0 + (B - D) + (I - E)$

Where:

N1 = number of individuals at time 1
N0 = number of individuals at time 0
B = number of individuals birth
D = number of individuals that died
I = number of individuals that immigrated
E = number of individuals that emigrated between time 0 and time 1.

- Intrinsic rate of increase: $(dN/dt)(1/N) = r$

r= intrinsic rate of increase
(dN/dt) = rate that population increases
N = population size

Just for your information

5. Mortality (death rate):

Mortality rate is “a measure of the number of deaths in a population per 1000 inhabitants / individuals during a determinate period of time, normally a year”. This could be calculate in that way:

M= D/P * 100

M: Mortality , **D:** Deaths , **P**: Population , The results could be: More than 30% = High Mortality, Between 15% and 20% = Average Mortality , Less than 15% = Low Mortality. However, Like natality, mortality may be of following types:

(a) Minimum mortality: Also called specific or potential mortality, it represents the theoretical minimum loss under ideal or non-limiting conditions. It is a constant for a population.

(b) Ecological or realized mortality: It is the actual loss of individuals under a given environmental condition. Ecological mortality is not constant for a population and varies with population and environmental conditions, such as predation, disease and other ecological hazards.

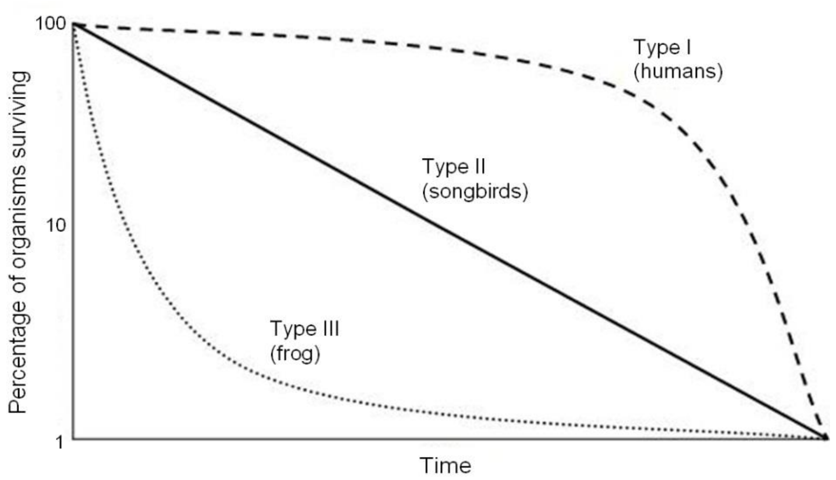
A survivorship curve

A **survivorship curve** is a graph showing the number or proportion of individuals surviving to each age for a given species or group (e.g. males or females). There are three generalized types of survivorship curves:

- **Type I** survivorship curves are characterized by high age-specific survival probability in early and middle life, followed by a rapid decline in survival in later life. They are typical of species that produce few offspring but care for them well, including humans and many other large mammals.
- **Type II** curves are an intermediate between Types I and III, where roughly constant mortality rate/survival probability is experienced regardless of age. Some birds and some lizards follow this pattern.
- In **Type III** curves, the greatest mortality (lowest age-specific survival) is experienced early in life, with relatively low rates of death (high probability of survival) for those surviving this bottleneck. This type of curve is characteristic of species that produce a large number of offspring. This includes most marine invertebrates. For example, oysters produce millions of eggs, but most larvae die from predation or other causes; those that survive long enough to produce a hard shell live relatively long.

The number or proportion of organisms surviving to any age is plotted on the y-axis, generally with a logarithmic scale starting with 1000 individuals, while their age, often as a proportion of maximum life span, is plotted on the x-axis.

In mathematical statistics, the survival function is one specific form of survivorship curve and plays a basic part in survival analysis.



Biotic Potential:

Each population has the inherent power to grow. When the environment is unlimited, the specific growth rate (i.e., the population growth rate per individual) becomes constant and maximum for the existing conditions. The value of the growth rate under these favorable conditions is maximal, is characteristics of a particular population age structure, and is a single index of the inherent power of a population to grow.

It may be designated by the symbol **r** which is the exponent in the differential equation for population growth in an unlimited environment under specific physical conditions. The index **r** is actually the difference between the instantaneous specific natality rate **b** and the instantaneous specific death rate **d** and may thus be expressed :

$$\mathbf{r = b - d}$$

The Overall population growth rate under unlimited environmental conditions (r) depends on the age composition and the specific growth rates due to reproduction of component age groups. Thus, there may be several values of r for a species depending upon population structure. When a stationary and stable age distribution exists, the specific growth rate is called the intrinsic rate of natural increase or r max. The maximum value of r is often called by the biotic potential or reproductive potential.

Chapman (1928) coined the term biotic potential to designate maximum reproductive power. He defined it as "the inherent property of an organism to reproduce to survive, i.e., to increase in numbers. It is a sort of algebraic sum of the number of young produced at each reproduction, the number of reproduction in a given period of time, the sex ratio and their general ability to survive under given physical conditions." Thus with the term of biotic potential, one is able to put together natality, mortality and age distribution.

But under natural conditions, this is a rare phenomenon, since environmental conditions do not permit unlimited growth of any population. It size is kept under natural check.

Population growth models

The term population growth refers to how the number of individuals in a population increases or decreases with time. This growth is controlled by the rate at which new individuals are added to the population through the processes of birth and immigration and the rate at which individuals leave the population through the processes of death and emigration.

We refer to populations in which immigration and/or emigration occur as **open populations.** Those in which movement into and out of the population does not occur (or is not a significant influence on population growth) are referred to as **closed populations**.

- ✓ **Population growth reflects the difference between rates of birth and death**

Suppose we were to monitor a population of an organism that has a very simple life history, such as a population of freshwater hydra growing in an aquarium in the laboratory. We define the population size as $N(t)$, where t refers to time. Let us assume that the initial population is small, so that the food supply within the aquarium is much more than is needed to support the current population. How will the population change through time? Because no emigration or immigration is allowed by the lab setting, the population is closed. The number of hydra will increase as a result of new "births" (note that hydra reproduce asexually by budding). Additionally, the population will decrease as a result of some hydra dying. Because the processes of birth and death in this population are continuous ,we can define the proportion of hydra producing a new individual per unit of time as *b,* and the proportion of hydra dying per unit of time can be *d.* If we start with *N* (*t*) hydra at time *t*, then to calculate the total number of hydra reproducing over a given time period, Δ *t* (the symbol Δ refers to a "change"), we simply need to multiply the

proportion reproducing per unit time by the total number of hydra and the length of the time period. However, the equation below represent the growth of population

$$\Delta N/\Delta t \text{ (growth)} = (b - d)\, N$$

Where , N is the initial population size

A. *Exponential Growth (J-shaped growth curve).*

If a population were suddenly presented with an unlimited environment, it would tend to expand exponentially. In other word the organisms reproduce continuously at a constant rate all the time – like humans.

The equation for population growth can be Written

$$\Delta N/\Delta t = r_{max} N$$

Where:

ΔN = the change in number of individuals

Δt = the change in time

r = is the net reproductive rate =The difference between birth rate (b) and death rate (d).

b = the average of birth rate (includes immigrations)

d = the average of death rate (includes emigrations)

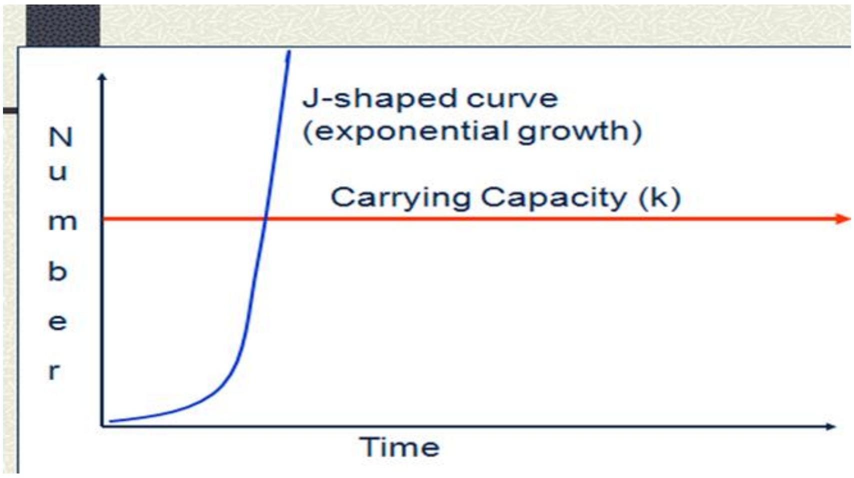
N=is the initial population size

When conditions are optimal, r is at its highest value (r max), called the specific rate of increase.

Real populations do not grow exponentially for long because of environmental limitations. This Environmental limitations include :

1.Food 2. Water 3.Space 4. Diseases 5. Density 6.Oxygen

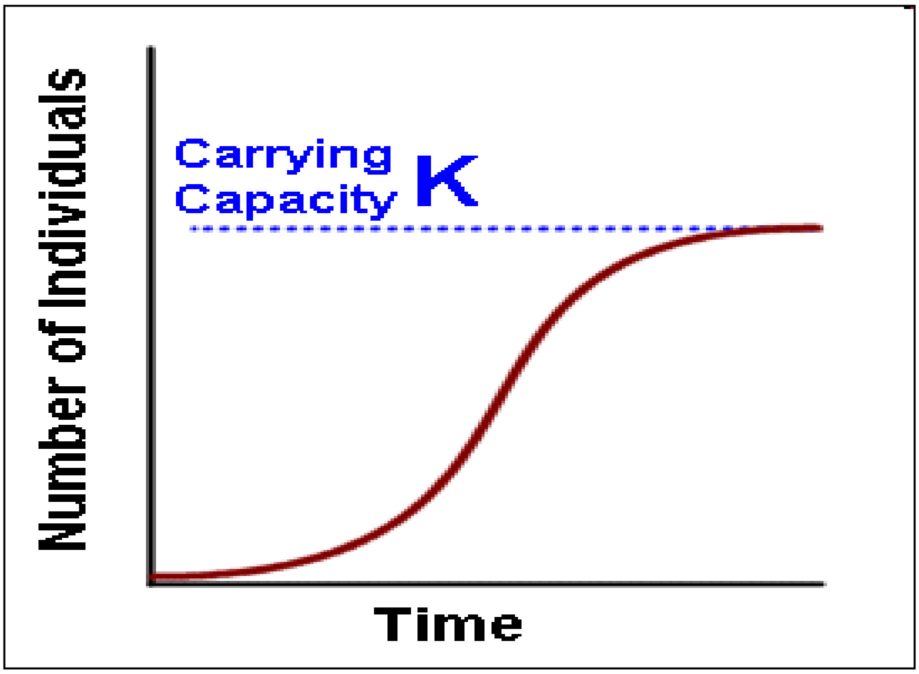
The exponential growth model is applicable only to initial growth after colonization of an unexploited habitat so it is a transient phenomenon. Natural population growth more closely an S-shaped curve.



J-shaped growth curve

B. Logistic Growth (S-shaped growth curve)

The population in this pattern grows and then eventually levels off as the carrying capacity is reached. As population density increases, competition for available resources among its members increases (and disease etc). The effects of increasing competition on the population begin to slow the rate of growth until growth rate becomes zero and the population is at a theoretical equilibrium level with its environment. In general all populations will follow this pattern eventually. .



S-shaped growth curve

Carrying Capacity (K) , is the maximum number of individuals that the environment can support. The logistic growth equation is:

$\Delta N/\Delta t = r\ max\ N\ (K\text{-}N/K)$

where:

r max = Maximum rate of increase under ideal conditions.

When N nears K, the right side of the equation nears zero.

- N/K = Environmental resistance.

3.1.3: Reproductive strategies

There are a wide range of reproductive strategies employed by different populations/species**.**

3.1.3.1: *r*/*K* selection theory

The terms *r-selection* and *K-selection* have been used by ecologists to describe the growth and reproductive strategies of various organisms.

1. *K-strategist*: They are called *k*-selected (for carrying capacity), because they are adapted to thrive when the population is near its carrying capacity. However, Population growth in *K*-selected species behaves according to the logistic growth equation. Species that follow this pattern usually.

1.Long life

2.Slower growth

3.Later maturity

4.Few, large offspring

5.High parental care and protection

6.Adapted to stable environment

7.High trophic level

2.r-strategist**:** They are called *r*-selected species (for *rate* of increase). Population growth in *r*-selected species behaves according to the exponential growth equation. By contrast with k- selected when populations of are far below the carrying capacity, resources may be

abundant. Costs of reproduction may be low , and selection will favor individuals with highest reproductive rates. Species that follow this pattern usually.

1. Short life 2.Rapid growth 3. Early maturity 4.Many small offspring

5.Little parental care and protection 6.Adapted to unstable environment

7.Low trophic level

3.1.3.2:Semelparity and Iteroparity

Semelparity and iteroparity refer to the reproductive strategy of an organism.

1.Semelparity –

The word semelparity comes from the Latin *semel* 'once, a single time' and *pario* 'to beget'. A species is considered semelparous if it is characterized by a single reproductive episode before death. A classic example of a semelparous organism is Pacific salmon which lives for many years in the ocean before swimming to the freshwater stream of its birth, spawning, and dying. Other semelparous animals include many insects, including some species of butterflies, and mayflies, and some molluscs such as octopus.

2.Iteroparity –

The term iteroparity comes from the Latin *itero*, to repeat, and *pario*, to beget. Individuals that normally experience several or many such reproductive events. During each period of reproductive activity the individual continues to survival and possibly growth, and beyond each it therefore has a chance of surviving to reproduce again. Results in overlapping generations. An example of an iteroparous organism is a human—though people may choose only to have one child, humans are biologically capable of having offspring many times over the course of their lives. Iteroparous vertebrates include all birds, most reptiles, virtually all mammals, and most fish. Among invertebrates, most mollusca and many insects (for example, mosquitoes) are iteroparous. This distinction is also related to the difference between annual and perennial plants. An annual is a plant that completes its life cycle in a single season, and is usually semelparous. Perennials live for more than one season and are usually (but not always) iteroparous.