Habitat ecology and related topics in ecology

The processes of ecosystem : Ecospehere and Biosphere

Biosphere: The living being and their surrounding environment with hydrosphere and upper portion of lithosphere, lower portion of atmosphere---- all known as Biosphere. It is the part of Ecosphere.

Ecosphere—The living being with trophosphere, atmosphere, hydrosphere and biosphere---all together is known as Ecosphere.

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. Ecological theory has also been used to explain self-emergent regulatory phenomena at the planetary scale: for example, the Gaia hypothesis is an example of holism applied in ecological theory. The Gaia hypothesis states that there is an emergent feedback loop generated by the metabolism of living organisms that maintains the core temperature of the Earth and atmospheric conditions within a narrow self-regulating range of tolerance.

Individual ecology

Understanding traits of individual organisms helps explain patterns and processes at other levels of organization including populations, communities, and ecosystems. Several areas of ecology of evolution that focus on such traits are life history theory, ecophysiology, metabolic theory of ecology, and Ethology. Examples of such traits include features of an organism’s life cycle such as age to maturity, life span, or metabolic costs of reproduction. Other traits may be related to structure, such as the spines of a cactus or dorsal spines of a bluegill sunfish, or behaviors such as courtship displays or pair bonding. Other traits include emergent properties that are the result at least in part of interactions with the surrounding environment such as growth rate, resource uptake rate, winter, and deciduous vs. drought deciduous trees and shrubs.

One set of characteristics relate to body size and temperature. The metabolic theory of ecology provides a predictive qualitative set of relationships between an organism's body size and temperature and metabolic processes. In general, smaller, warmer organisms have higher metabolic rates and this results in a variety of predictions regarding individual somatic growth rates, reproduction and population growth rates, population size, and resource uptake rates.

The traits of organisms are subject to change through acclimation, development, and evolution. For this reason, individuals form a shared focus for ecology and for evolutionary ecology.

Ecosystem is an integrated unit comprising vegetation, fauna, microbes and environment. It possesses well defined soil, climate, flora and fauna and has their own
adaptations, change and tolerance. The living planet earth, which encompasses the biosphere and its interactions with the hydrosphere and atmosphere, **is termed as ecosphere**.
Ecosystems are open systems and hence, they are not self sustaining. So, it requires continuous energy and nutrient inputs. The functioning of an ecosystem involves
a series of cycles, like water cycle, nutrient cycle, etc. These cycles are derived by the energy flow, the energy being solar energy. In general, in the ecosystem there is
flow of energy and cycling of materials both of which have consequences for community structure and the environment.

A Biosphere comprises the upper strata of earth, the lower portion of the atmosphere and the upper part of the water bodies where living things interact and energy and
materials recycle. It is the part of a planet's terrestrial system including air, land and water in which life develops, and which life processes in turn transform. It is the collective creation of a variety of organisms and species, which form the diversity of the ecosystem. From the broadest geo-physiological point of view, the biosphere is the global ecological system integrating all

living beings and their relationships, with their interaction with the elements of the lithosphere (rocks), the hydrosphere (water), and the atmosphere (air). Individual life sciences and earth sciences may use biosphere in
more limited senses (see below).

The term Biosphere after being coined by the geologist Eduard Suess in 1875 and the concept pertaining to biosphere having geological origin represents an indication of the impact of Darwin on Earth sciences. The ecological concept of the biosphere preceded with the introduction of the term ecosystem by Arthur Transley in the year 1935 . The biosphere is an important concept in astronomy, geophysics, meteorology, concept in astronomy, geophysics, meteorology, biogeography, evolution, geology, geochemistry, and generally speaking all life and earth sciences.

Biosphere is often used with more restricted meanings. For example, geochemists also give define the biosphere as being the total sum of living organisms (usually named biomass or biota by biologists and ecologists). In this sense, the biosphere is one of the four components of the geochemical model, the others being the lithosphere, hydrosphere, and atmosphere). Some consider that the semantic and conceptual
confusion surrounding the term biosphere is reflected in the current debates related to biodiversity, or sustainable development. Many appear to prefer the word **ecosphere**, coined in the 1960s-'70s. Others, however, claim this word is sullied by association with the idea of ecological crisis.

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 microbiomes. To a microbe, the human body is a habitat and a landscape.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.

Physical environments

Water

Wetland conditions such as shallow water, high plant productivity, and anaerobic substrates provide a suitable environment for important physical, biological, and chemical processes. Because of these processes, wetlands play a vital role in global nutrient and element cycles.Diffusion of carbon dioxide and oxygen is approximately 10,000 times slower in water than in air. When soils are flooded, they quickly lose oxygen, becoming hypoxic (an environment with O_2 concentration below 2 mg/liter) and eventually completely anoxicwhere anaerobic bacteria thrive among the roots. Water also influences the intensity and spectral composition of light as it reflects off the water surface and submerged particles.Aquatic plants exhibit a wide variety of morphological and physiological adaptations that allow them to survive, compete, and diversify in these environments. For example, their roots and stems contain large air spaces (aerenchyma) that regulate the efficient transportation of gases (for example, CO_2 and O_2) used in respiration and photosynthesis. Salt water plants (halophytes) have additional specialized adaptations, such as the development of special organs for shedding salt and osmoregulating their internal salt (NaCl) concentrations, to live in estuarine, brackish, or oceanicenvironments. Anaerobic soil microorganisms in aquatic environments use nitrate, manganese ions, ferric ions, sulfate,carbon dioxide, and some organic compounds; other microorganisms are facultative anaerobes and use oxygen during respiration when the soil becomes drier. The activity of soil microorganisms and the chemistry of the water reduces theoxidation-reduction potentials of the water. Carbon dioxide, for example, is reduced to methane (CH_4) by methanogenic bacteria.The physiology of fish is also specially adapted to compensate for environmental salt levels through osmoregulation. Their gills form electrochemical gradients that mediate salt excretion in salt water and uptake in fresh water.

Gravity

The shape and energy of the land is significantly affected by gravitational forces. On a large scale, the distribution of gravitational forces on the earth is uneven and influences the shape and movement of tectonic plates as well as influencinggeomorphic processes such as orogeny and erosion. These forces govern many of the geophysical properties and distributions of ecological biomes across the Earth. On the organismal scale, gravitational forces provide directional cues for plant and fungal growth (gravitropism), orientation cues for animal migrations, and influence the biomechanics and size of animals.[108] Ecological traits, such as allocation of biomass in trees during growth are subject to mechanical failure as gravitational forces influence the position and structure of branches and leaves. The cardiovascular systems of animals are functionally adapted to overcome pressure and gravitational forces that change according to the features of organisms (e.g., height, size, shape), their behaviour (e.g., diving, running, flying), and the habitat occupied (e.g., water, hot deserts, cold tundra).

Pressure

Climatic and osmotic pressure places physiological constraints on organisms, especially those that fly and respire at high altitudes, or dive to deep ocean depths. These constraints influence vertical limits of ecosystems in the biosphere, as organisms are physiologically sensitive and adapted to atmospheric and osmotic water pressure differences.For example, oxygen levels decrease with decreasing pressure and are a limiting factor for life at higher altitudes.[182] Water transportation by plants is another important ecophysiological process affected by osmotic pressure gradients.Water pressure in the depths of oceans requires that organisms adapt to these conditions. For example, diving animals such as whales, dolphins, and seals are specially adapted to deal with changes in sound due to water pressure differences.Differences between hagfish species provide another example of adaptation to deep-sea pressure through specialized protein adaptations.

Turbulent forces in air and water affect the environment and ecosystem distribution, form and dynamics. On a planetary scale, ecosystems are affected by circulation patterns in the global trade winds. Wind power and the turbulent forces it creates can influence heat, nutrient, and biochemical profiles of ecosystems.For example, wind running over the surface of a lake creates turbulence, mixing thewater column and influencing the environmental profile to create thermally layered zones, affecting how fish, algae, and other parts of the aquatic ecosystem are structured. Wind speed and turbulence also influence evapotranspiration rates and energy budgets in plants and animals.Wind speed, temperature and moisture content can vary as winds travel across different land features and elevations. For example, the westerlies come into contact with the coastal and interior mountains of western North America to produce a rain shadow on the leeward side of the mountain. The air expands and moisture condenses as the winds increase in elevation; this is called orographic lift and can cause precipitation.This environmental process produces spatial divisions in biodiversity, as species adapted to wetter conditions are range-restricted to the coastal mountain valleys and unable to migrate across the xeric ecosystems (e.g., of the Columbia Basin in western North America) to intermix with sister lineages that are segregated to the interior mountain systems.

Plants convert carbon dioxide into biomass and emit oxygen into the atmosphere. By approximately 350 million years ago (the end of the Devonian period), photosynthesis had brought the concentration of atmospheric oxygen above 17%, which allowed combustion to occur. Fire releases CO_2 and converts fuel into ash and tar. Fire is a significant ecological parameter that raises many issues pertaining to its control and suppression.While the issue of fire in relation to ecology and plants has been recognized for a long time, Charles Cooper brought attention to the issue of forest fires in relation to the ecology of forest fire suppression and management in the 1960s.Native North Americans were among the first to influence fire regimes by controlling their spread near their homes or by lighting fires to stimulate the production of herbaceous foods and basketry materials. Fire creates a heterogeneous ecosystem age and canopy structure, and the altered soil nutrient supply and cleared canopy structure opens new ecological niches for seedling establishment. Most ecosystems are adapted to natural fire cycles. Plants, for example, are equipped with a variety of adaptations to deal with forest fires. Some species (*Pinus halepensis*) cannotgerminate until after their seeds have lived through a fire or been exposed to certain compounds from smoke. Environmentally triggered germination of seeds is called serotiny.Fire plays a major role in the persistence andresilience of ecosystems.

Soils

Soil is the living top layer of mineral and organic dirt that covers the surface of the planet. It is the chief organizing centre of most ecosystem functions, and it is of critical importance in agricultural science and ecology. The decomposition of dead organic matter (for example, leaves on the forest floor), results in soils containing minerals and nutrients that feed into plant production. The whole of the planet's soil ecosystems is called the pedosphere where a large biomass of the Earth's biodiversity organizes into trophic levels. Invertebrates that feed and shred larger leaves, for example, create smaller bits for smaller organisms in the feeding chain. Collectively, these organisms are the detritivores that regulate soil formation.Tree roots, fungi, bacteria, worms, ants, beetles, centipedes, spiders, mammals, birds, reptiles, amphibians, and other less familiar creatures all work to create the trophic web of life in soil ecosystems. Soils form composite phenotypes where inorganic matter is enveloped into the physiology of a whole community. As organisms feed and migrate through soils they physically displace materials, an ecological process called bioturbation. This aerates soils and stimulates heterotrophic growth and production. Soil microorganisms are influenced by and feed back into the trophic dynamics of the ecosystem. No single axis of causality can be discerned to segregate the biological from geomorphological systems in soils.Paleoecological studies of soils places the origin for bioturbation to atime before the Cambrian period. Other events, such as the evolution of trees and the colonization of land in the Devonian period played a significant role in the early development of ecological trophism in soils.

Biogeochemistry and climate

Ecologists study and measure nutrient budgets to understand how these materials are regulated, flow, and recycled through the environment. This research has led to an understanding that there is global feedback between ecosystems and the physical parameters of this planet, including minerals, soil, pH, ions, water, and atmospheric gases. Six major elements (hydrogen, carbon, nitrogen, oxygen, sulfur, and phosphorus; H, C, N, O, S, and P) form the constitution of all biological macromolecules and feed into the Earth's geochemical processes. From the smallest scale of biology, the combined effect of billions upon billions of ecological processes amplify and ultimately regulate the biogeochemical cycles of the Earth. Understanding the relations and cycles mediated between these elements and their ecological pathways has significant bearing toward understanding global biogeochemistry.

The ecology of global carbon budgets gives one example of the linkage between biodiversity and biogeochemistry. It is estimated that the Earth's oceans hold 40,000 gigatonnes (Gt) of carbon, that vegetation and soil hold 2070 Gt, and that fossil fuel emissions are 6.3 Gt carbon per year.There have been major restructurings in these global carbon budgets during the Earth's history, regulated to a large extent by the ecology of the land. For example, through the earlymid Eocene volcanic outgassing, the oxidation of methane stored in wetlands, and seafloor gases increased atmospheric CO_2 (carbon dioxide) concentrations to levels as high as 3500 ppm.

In the Oligocene, from twenty-five to thirty-two million years ago, there was another significant restructuring of the globalcarbon cycle as grasses evolved a new mechanism of photosynthesis, C_4 photosynthesis, and expanded their ranges. This new pathway evolved in response to the drop in atmospheric CO_2 concentrations below 550 ppm. The relative abundance and distribution of biodiversity alters the dynamics between organisms and their environment such that ecosystems can be both cause and effect in relation to climate change. Human-driven modifications to the planet's ecosystems (e.g., disturbance, biodiversity loss, agriculture) contributes to rising atmospheric greenhouse gas levels. Transformation of the global carbon cycle in the next century is projected to raise planetary temperatures, lead to more extreme fluctuations in weather, alter species distributions, and increase extinction rates. The effect of global warming is already being registered in melting glaciers, melting mountain ice caps, and rising sea levels. Consequently, species distributions are changing along waterfronts and in continental areas where migration patterns and breeding grounds are tracking the prevailing shifts in climate. Large sections of permafrost are also melting to create a new mosaic of flooded areas having increased rates of soil decomposition activity that raises methane (CH_4) emissions. There is concern over increases in atmospheric methane in the context of the global carbon cycle, because methane is a greenhouse gas that is 23 times more effective at absorbing long-wave radiation than CO_2 on a 100-year time scale. Hence, there is a relationship between global warming, decomposition and respiration in soils and wetlands producing significant climate feedbacks and globally altered biogeochemical cycles.

Biosphere and its extent and conctituents

The planet earth along with its living organisms and atmosphere (air, land, and water) which sustains life is known as the Biosphere. The biosphere extends vertically into the atmosphere to about 10km, downward into the ocean to depth of about 35,00ft, and into about 23,000ft of the earth surface itself where living organisms have been found. The biosphere, a thin shell that encapsulates the earth, is made up of the atmosphere (a mixture of gases extending outward from the surface of the earth), lithosphere (the soil mantle that wraps the core of the earth) the hydrosphere (consists of the oceans, the lakes and streams, and the shallow ground water bodies that inter- flow with the surface water. Due to different activities, human is interfering with the natural environment which in turn affects its health in various ways.

Human Activities Affecting Health and the Environment

Human activity in an ecosystem has many drawbacks, unless we are approaching it environmentally friendly. The atmosphere, fertile solids, freshwater recourse, the oceans and the ecosystems they support, play a key role in providing humans with shelter, food, safe water and the capacity to recycle most wastes, However, pressures exerted by humans, on the environment, in the form of pollution, resources depletion, land use changes and others affect environmental quality. Degradation of environmental quality can, in turn, lead to adverse human exposures and eventual health effects. The pressures excreted by the driving forces are in many instances increasing. They relate to household wastes freshwater use, land use and agricultural development, industrialization and energy use.

Adaptation

Specific life forms are adaptations of plants and animals to live in a particular habitat and to behave in a particular way. For instance the forms for four footed mammals could be grouped as:Aquatic: (fish , seal, whale);Fossorial: (Mole, shrew) ;Cursorial: (Deer, antelopes,) ; Saltatorial: (Rabbit, kangarro) ;Scansorial: (Squirrel, monkey); Areal/ volant (Bat, birds). The life form listed for mammals are largely adaptations to particular strata (water, subterranean, ground, trees, and air) within a community than to the habitat as a whole; for instance, the subterranean adaptations of mammals living in arctic tundra are similar to the subterranean adaptations of mammals living in the tropics. In addition to adaptation of stratum and habitat, there occur ecologically significant adaptations for food getting and metabolism, protection and reproduction.

Organisms respond to the external environment

Organisms respond to the environment in three principal ways:

a) Morphological adaptation

The variety of teeth found in mammals, and lizards, the variation in shape and size of gills of birds, the different mouth parts of Insets.

b) Physiological adaptations

Structural adaptation for the digestion of food, respiration circulation and excretion

c) Behavioral adaptation

It is the change in behavior of an organism to adapt itself to the conditions of the environment

Adaptive strategies of animals

The following rules summarize some of the adaptive strategies of animals:

Bergman's rule: is connected with heat loss and heat conservation. It states: As a rule, geographical species possessing smaller body sizes are good heat dissipaters. On the other hand geographical species, which have larger body sizes, are good heat conservers. Because of this those organisms possessing relatively larger body sizes are found in the warmer regions (Tropical regions).

b) Allen's rule: just like Bergman's rule this is connected with heat loss and heat conservation. According to Alen's rule, organisms possessing larger body sizes but relatively short appendage extremities or protruding parts are found in cooler regions whereas organisms possessing smaller body sizes with larger appendages extremities or protruding parts are found in the warmer regions.

c) Gloger's rule: states that races of warm-blooded animals are more dark-pigmented in the warm and humid areas whereas organisms living in the dray and cool areas are less pigmented.

d)The egg rule: the average number of eggs in a set, or clutch, laid by songbirds and several other kinds of birds increases as one moves north in latitude

Range and Limits : In the ecological distribution of animals

Probably no species of plant or animal is found ever where in the world; some parts of the earth are too hot, too dry or too something else for the organisms to survive there. Even if the environment does not kill the adult directly, it can effectively keep the species from becoming established by preventing its reproduction, or it kills off the egg, embryo or some other stage in the life cycle.

Liebig's Law (Law of the minimum)

Justus von Liebig (1803-1873) was organic chemist worked with plants (chemical foods).
An organism is seldom if ever exposed to a single factor in its environment. On the contrary, it is exposed or subjected to various factors simultaneously in its surroundings. However, some factors play greater role than the others do. In general, each species requires certain materials for growth and reproduction, and can be restricted if the
environment does not provide a certain minimum amount of each one of these materials. This phenomenon is governed by what is known as the law of the minimum,
which states, "The rate of growth of each organism is limited by whatever essential nutrient is present in a minimal amount". The law can also be stated as "the functioning of an organism is controlled or limited by essential environmental factor or combination of factors present in the least favorable amount in the environment".
Example: The yield of crops is often limited not by nutrient required in large amounts, such as water or carbon dioxide, but by something needed only in trace amounts such as boron or manganese.

Shelford's Law (Law of tolerance)

For each species, there is a range of an environmental factor with in which the species functions at or near optimum. There are extremes, both maximum and minimum towards which the functions of a species are curtailed and then inhibited. In 1913, V.E. Shelford (animal ecologist) pointed out that too much of a certain factor would act as a limiting factor just as well as too little of it. He stated that the distribution of each species is determined by its range of tolerance to variation in each environmental factor.

This led to a concept or range of tolerance. Upper and lower limits of tolerance are intensity levels of a factor at which only half of the organisms can survive (**LD50**). These limits re sometimes difficult to determine, as for instance with low temperature, organisms may pass into an inactive, dormant or hibernating state form which they may again become functional when the temperature rises above a threshold. The species as a whole is limited in its activities more by conditions that produce physiological discomforts or stresses than it is by the limits of toleration themselves. Death verges on the limits of toleration, and the existence of the species would be seriously jeopardized if it were frequently exposed to these extreme conditions.

For each species, there is a range in an environmental factor within which the species function near or at optimum. There are extremes both lower and upper towards which the function of the species is curtailed inhibited. **Shelford** pointed out that too much of a certain factor would act as a limiting factor just as well as too little of it as has been stated in the Liebig's law. This leads to a concept of range of tolerance, which states the distributio9n of each species is determined by its range of tolerance to variation in each environmental factor."

Some subsidiary principles to this law:

a) Organisms may have a wide range of tolerance for one factor and a narrow rang for another.

b) Organisms with wide ranges of tolerance for all factors are likely to be most widely distributed

c) When conditions are not optimum for a species with respect to one ecological factor, the limits of tolerance may be reduced for other ecological factors.

d) Frequently, it is discovered that organisms in nature are not actually living at optimum range of particular physical factor. In such cases, some other factor or factors are found to have greater importance.

e) Reproduction is usually a critical period when environmental factors are most likely to be limiting. Terms to express the narrowness and wideness of tolerance (prefixes) o Steno: narrow range of tolerance (example: stenothermic- narrow range of tolerance for
heat); Eury: wider range of tolerance (example: Eurythermic-wider range of tolerance)

Ecological perspectives of habitats vs biodiversity

For purposes of comparing communities and ecosystems some of the prevailing systems of analysis relate to:

(1) Species-area relations wherein the number of species encountered is proportional to a power of the area sampled.

(2) Alpha (α) diversity which is the species within a community or habitat, comprising species richness and evenness.

(3) Beta (β) diversity is the intercommunity diversity expressing the rate of species turnover per unit change in habitat.

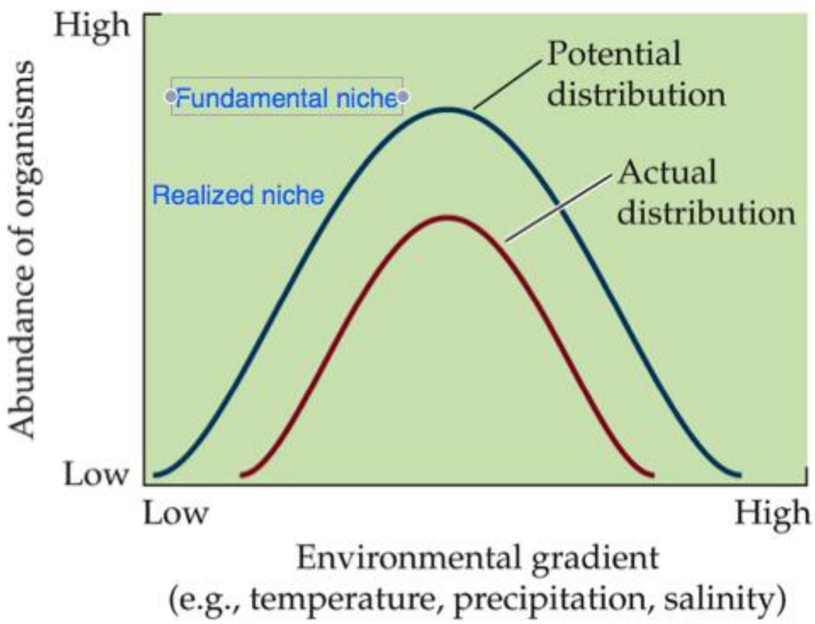
(4) Gamma (γ) diversity is the overall diversity at the landscape level, which includes both α and β diversities. It is expressed as $\gamma = \alpha \times \beta \times \theta$, where α is the average value of β diversity and θ is the total number of habitats or communities in the landscape unit (Schlutes and ricklef, 1993; Singh and Khurana, 2002).

Concept and definition of ecological Niche

The concept of the ecological niche has had a long history of development and interpretation in ecology. Grinnell (1917, 1924, 1928) was the first to coin the term "Niche" who highlighted the niche as the functional role and position of an organism in its community. Afterwords, Elton (1927) regarded the niche as the fundamental unit of an organism or a species population in a community emphasising its place in the biotic environment, its relations to food and enemies , It also highlights the the status of the species in its community mostly determined by sizes and food habits."Odum (1971) defined **ecological niche** as **"the position or status of an organism within the biotic community and ecosystem "** because of the structural adaptations, physiological responses, and specific behavior (inherited and learned) of the concerned organism. The habitat of an organism is the place where it lives whereas the ecological niche include not only the space occupied by an organism but also its functional roles in the community(its trophic position) and also its position in environmental gradients(temperature, pH, soil nutrients etc.) Three different types of ecological niche viz. spatial or habitat niche; the trophic niche and the multidimensional niche or hypervolume niche. **Spatial or habitat Niche:** niche mainly adheres to the concept of habitat providing more emphasise on the physical space occupied by an organism. The concept ' niche as put forward by Hutchinson(1957) relies more on to space rather a microhabitat coordinating behavioral manifestations also. It is an multydimensional hypervolume enclosing the complete range of ecological conditions for the successful survivility of organisms . G.E.Hutchinson suggested that the niche could be visualized as a multidimensional space or hypervolume within which the environment permits an individual or species to survive indefinitely.and designated as hypervolume niche. Hutchinson(1965) also distiguished between the fundamental niche--the maximum abstractly hypervolume when the species is not constrained by competition or other limiting biotic interactions----and the realized niche---a smaller hypervolume occupied under particular biotic constrains. Connel suggested that both high and low levels of disturbances would lead to result reduced diversity.

Detailed conceptual treatise of Ecological Niche

Among the first to use the term niche was **Grinnell** (1917, 1924, 1928). He viewed the niche as the functional role and position of an organism in its community.Later **Elton** (1927) defined an animal's niche as "its place in the biotic environment, its relations to food and enemies"and as "the status of an organism in its community." Further, he said that "the niche of an animal can be defined to a large extent by its size and food habits." One of the most influential treatments of niche is that of **Hutchinson** (1957). Using set theory, he treats the niche somewhat more formally and defines it as the total range of conditions under which the individual (or population) lives and replaces itself. Hutchinson's examples for niche coordinates are nonbehavioral and have thus emphasized the niche as a place in space rather like a microhabitat. Hutchinson defines an organism's niche as an **n-dimensional hypervolume** enclosing the complete range of conditions under which that organism can successfully replace itself. Hutchinson designates the entire set of optimal conditions under which a given organismic unit can live and replace itself as its **fundamental niche**, which can then be represented as a set of points in environmental space. The fundamental niche is thus a hypothetical, idealized niche in which the organism encounters no "enemies" such as competitors or predators and in which its physical environment is optimal. In contrast, the actual set of conditions under which an organism exists, which is always less than or equal to the fundamental niche, is termed its **realized niche**. The realized niche takes into account various forces that restrict an organismic unit, such as competition and perhaps predation.Hutchinson's distinction between the fundamental niche and the realized niche is one of the most explicit statements that an animal's potential niche is seldom fully utilized at a given moment in time or a particular place in space. This distinction has proven useful in clarifying the roles of other species, both competitors and predators, in determining the niche of an organism.



Odum (1959) defined the ecological niche as "the position or status of an organism within its community and ecosystem resulting from the organism's structural adaptations, physiological responses, and specific behavior (inherited and/or learned)." He emphasized that "the ecological niche of an organism depends not only on where it lives but also on what it does." The place an organism lives, or where one would go to find it, is its habitat. For Odum the habitat is the organism's "address," whereas the niche is its "profession." **Weatherley** (1963) suggested that the definition of niche be restricted to "the nutritional role of the animal in its ecosystem, that is, its relations to all the foods available to it." However, some ecologists prefer to define the term niche more broadly and to subdivide it into components such as the "food niche" or the "place niche."

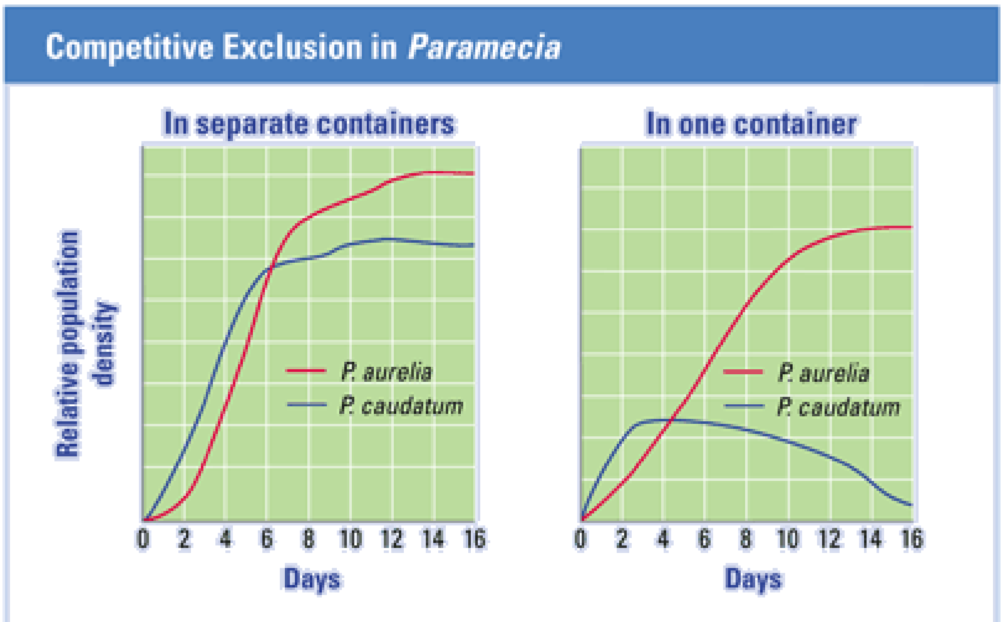
Following earlier terminology, the ecological niche is defined as **the sum total of the adaptations of an organismic unit,** or as all of the various ways in which a given organismic unit conforms to its particular environment.

Ecological niche and interspecific competition:

The niche concept has gradually become linked to the phenomenon of interspecific competition, and it is increasingly becoming identified with patterns of resource utilization. Niche relationships among competing species are frequently visualized and modeled with bell-shaped **resource utilization functions** (RUFs) along a continuous resource gradient, such as prey size or height above ground.

Niche overlap occurs when two organismic units use the same resources or other environmental variables. In Hutchinson's terminology, each n-dimensional hypervolume includes part of the other. Overlap is complete when two organismic units have identical niches; there is no overlap if two niches are completely disparate. Usually, niches overlap only partially, with some resources being shared and others being used exclusively by each organismic unit. If overlap is complete, competition occurs, and competition is assumed to be intense and to result in survival of only a single species in contested niche space. To avoid competition, species may resort to niche differentiation through resource partitioning and character displacement.

The term niche differentiation , synonymous with **niche segregation**, **niche separation** and niche **partitioning**, refers to the process by which competing species use the environment differently in a way that helps them to coexist. The competitive exclusion principle states that if two species with identical niches (ecological roles) compete, then one will inevitably drive the other to extinction. Russian ecologist **Georgy Gause** formulated the law of competitive exclusion based on laboratory competition experiments using two species of *Paramecium*, *P. aurelia* and *P. caudatum*. The conditions were to add fresh water every day and input a constant flow of food. Although *P. caudatum* initially dominated, *P. aurelia* recovered and subsequently drove *P. caudatum* extinct via exploitative resource competition. However, Gause was able to let the *P. caudatum* survive by differing the environmental parameters (food, water). Thus, the Gause law is valid only if the ecological factors are constant.



When two species differentiate their niches, they tend to compete less strongly, and are thus more likely to coexist. Species can differentiate their niches in many ways, such as by consuming different foods, or using different parts of the environment.

Types of niche differentiation :

Temporal partitioning: Temporal resource partitioning occurs when two species eliminate direct competition by utilizing the same resource at different times. This can be on a daily scale (e.g. one species of spiny mouse feeds on insects during the day while a second species of spiny mouse feeds on the same insects at night, Kronfeld-Schor and Dayan 1999) or on a longer, seasonal scale. An instance of the latter would be reproductive asynchrony, or the division of resources by the separation of breeding periods. An example of reproductive asynchrony would be two competing species of frog offsetting their breeding periods. By doing this, the first species' tadpoles will have graduated to a different food resource by the time the tadpoles of the second species are hatching (Lawler and Morin 1993).

Spatial partitioning: Spatial resource partitioning occurs when two competing species use the same resource by occupying different areas or habitats within the range of occurrence of the resource. Spatial partitioning can occur at small scales (microhabitat differentiation) or at large scales (geographical differentiation). Microhabitat differentiation occurs when two competing species with overlapping home ranges partition a resource. Two examples would be different species of fish feeding at different depths in a lake or different species of monkey feeding at different heights in a tree. Geographical differentiation is when two competing species have non-overlapping home ranges and thus partition resources. An example might be given with monkeys again: two competing species of monkey using the same species of fruit trees, but in different areas of the forest.

Morphological differentiation*:* The final type of differential resource utilization is morphological differentiation or niche complementarity. Morphological differentiation happens when two competing species evolve differing morphologies to allow them to use a resource in different ways. A classic example of this is a study detailing the link between bumblebee proboscis lengths and flower corolla lengths (Pyke 1982). In this study, the long-proboscis bee species would preferentially feed on the long-corolla plants, the medium-proboscis bee species would feed on the medium-corolla plants, and so on. By evolving different proboscis lengths, several competing bee species are able to partition the available resources and coexist. This has also been termed as **Character displacement**.

A prominent example of morphological differentiation for niche separation that lead to pronounced Character displacement is the example of the evolution of the Darwin's finches.

Lotka-Volterra Model of Predation:

The Lotka-Volterra model describes interactions between two species in an ecosystem, a predator and a prey. When considering two species, the model will involve two equations, one which describes how the prey population changes and the second which describes how the predator population changes.

We begin by looking at what happens to the predator population in the absence of prey; without food resources, their numbers are expected to decline exponentially, as described by the following equation:

$$\frac{dP}{dt} = -qP \qquad \text{…………..} (1)$$

This equation uses the product of the number of predators *(P*) and the predator mortality rate (*q*) to describe the rate of decrease (because of the minus sign on the right-hand side of the equation) of the predator population (*P*) with respect to time (*t*). In the presence of prey, however, this decline is opposed by the predator birth rate, *caíPN*, which is determined by the consumption rate (*aíPN*, which is the attack rate[a'] multiplied by the product of the number of predators [*P*] times the number of prey [*N*]) and by the predatorís ability to turn food into offspring (c). As predator and prey numbers (*P* and *N*, respectively) increase, their encounters become more frequent, but the actual rate of consumption will depend on the attack rate (*a'*). The equation describing the predator population dynamics becomes

$$\frac{dP}{dt} = ca'PN - qP \qquad \text{…………..} (2)$$

P	number of predators or consumers
N	number of prey or biomass of plants
t	time
r	growth rate of prey
a'	searching efficiency/attack rate
q	predator or consumer mortality rate
c	Predator’s or consumer’s efficiency at turning food into offspring (conversion

	efficiency)

The product *ca'P* is the predator's numerical response, or the per capita increase as a function of prey abundance. The entire term, *ca'PN*, tells us that increases in the predator population are proportional to the product of predator and prey abundance.

Turning to the prey population, we would expect that without predation, the numbers of prey would increase exponentially. The following equation describes the rate of increase of the prey population with respect to time, where r is the growth rate of the prey population, and *N* is the abundance of the prey population:

$$\frac{dN}{dt} = rN \qquad \text{………….. (3)}$$

In the presence of predators, however, the prey population is prevented from increasing exponentially. The term for consumption rate from above (*a'PN*) describes prey mortality, and the population dynamics of the prey can be described by the equation

$$\frac{dN}{dt} = rN - a'PN \qquad \text{………….. (4)}$$

The product of *a'* and *P* is the predator's functional response, or rate of prey capture as a function of prey abundance. Here the term *a'PN*reflects the fact that losses from the prey population due to predation are proportional to the product of predator and prey abundances.

Equations (2) and (4) describe predator and prey population dynamics in the presence of one another, and together make up the Lotka-Volterra predator-prey model. The model predicts a cyclical relationship between predator and prey numbers: as the number of predators (*P*) increases so does the consumption rate (*a'PN*), tending to reinforce the increase in P. Increase in consumption rate, however, has an obvious consequence-- a decrease in the number of prey (*N*), which in turn causes *P* (and therefore *a'PN*) to decrease. As *a'PN*decreases the prey population is able to recover, and *N* increases. Now *P* can increase, and the cycle begins again. This graph shows the cyclical relationship predicted by the model for hypothetical predator and prey populations.

Ecological Guilds :

Root ,1967 defined **ecological guild** as a group of species that exploit the same class of environmental resource in a similar way. R.L.Smith, 1996, defined ecological guild as a group of different species foraging or feeding in a similar habitat for exploiting or using environmental resources in a simmilar way.The study of biological diversity involves not only describing the great variety of biodiversity patterns on the earth from genes to ecosystems, but also to find out what these diverse living entities are or what their function is. Another aspect of functional diversity is the formulation of the "guild concept" which is a pattern of convergence. Guilds are functional groups of organisms whose members exploit environmental resources in a similar way. Species at the same tropic level that use approximately the same environmental resources are considered to be a guild of competing species. The nectar-feeding guild of birds, for example is represented by hummingbirds (Trochilidae) in the new world tropics, by sunbirds (Nectarinidae) in the African and Asian tropics, by honey eaters (Meliphagidae) in Australia and by honeycreepers (Drepanididae) in the Hawaii Islands. All are convergently similar in having a long thin beak that enables them to probe deep into flowers.

Difference between Guilds and Niche : Experimental proofs

The concepts of guilds rest on functional manifestations of some species which are related based on their phylogeny and resource requirements. Niche denotes the functional roles of an individual species where guilds relate the functional roles of a group of species. Both the terms niche and guilds are applied for potential competitors and partitioners. The members of guild however exploit the resources together in such a way that minimizes niche overlap and competition. For examples; Exploiting same resources lead to overlapping of niche and competition. But exploitation of resources in such a way where the competition is minimized.

Ecological equivalents:

Unrelated organisms occupying similar niches and habitats but in the different geographical regions may resemble to each other morphologically and this designated as ecological equival;ents..These ecologically equivalent species may be taxonomically different, but they perform similar functions as a result of convergent evolution.Two species designated can be designated as ecological equivalent only when they occupy same or similar niche in different geographical areas as they can not permenently occupy the same niche in same community . These two species are referred to as ecological equivalent Asiatic lion (Panthera leo parsica) and african lion (Panthera leo leo) are examples of eecological equivalent.

Habitat Fragmentation vis-a-vis Habitat Heterogenity:

Alteration of habitats by human activity is the greatest threat to the richness of life on earth.

The most visible form of habitat alteration is the destruction or removal of a habitat, but in habitat fragmentation, once continuous landscape gets divided into odd bits and pieces. A superficial view of habitat fragmentation portrays a large area of homogenous habitat being broken up into small pieces. At a landscape scale of analysis (a few kilometer across), the distribution of vegetation types typically corresponds to changes in elevation which reflect the level temperature and intensity of precipitation, gradients , of sloping , and other ecological aspect such as amount in soil moisture and nutrients , This heterogeneity vividly displayed in mountainous regions, but also exists in different relatively flat landscapes including the river basins. .

Development of metapopulation and their roles

A group of conspecific populations occuping different habitats at the same time is known as metapopulation. Several natural disturbances such as fires, storms, floods etc generate conditions which culminate with the creation of habitat heterogeneity in different landscapes such as forests, wetlands etc and beyond that also modify the physical environment. As a consequence of habitat fragmentation ,disturbance mediated patchiness, habitat quality for species varies spatially , and many species may be distributed as metapopulations , systems of local populations linked by dispersal.

Metapopulations have important implications for patch dynamics and heterogeneity of reserves. When similar habitat patches are spatially separated across a reserve, individual species may have a metapopulation structure, with populations occurring in different suitable patches. The patch dynamics perspective assumes the dispersal among similar successional patches is possible, countering local extinction processes. Murphy etal (1990) point out that the metapopulation perspective may be more critical for small biota, such as annual plants, invertebrates, and small vertebrates, than for the mega vertebrates championed as the umbrella species under which many other species are protected

Within the geographic distribution of a species, however, the environmental conditions are typically not uniformly favorable for the successful survival, growth, and reproduction of individuals. Rather, suitable habitat forms a network of patches of various shape and size within the larger landscape of unsuitable habitat (Figure). 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.
In this definition , 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. In order to understand the dynamics of difference of this collective of local populations from that of a single, continuous population , it is needed to understand the degree of dependence to which the dynamics of the various local populations are connected. The models of population dynamics presented assume that populations are closed— no immigration or emigration— and therefore that population growth is solely a function of the processes of birth and death . Using this framework, the dynamics of each local population would be independent, and the dynamics of the metapopulation (the collective of local populations within the region) would simply be the sum of the dynamics exhibited by the local subpopulations.
If movement of individuals to and from local populations has a signifi cant infl uence on their dynamics, then a new and broader framework is necessary. For example, Paul Ehrlich and colleagues at Stanford University in California have been studying for three decades the population dynamics of checkerspot

butterfl ies (genus *Euphydryas*) occupying areas of serpentine soils in the vicinity of San Francisco Bay. The most extensively studied population is that of the bay checkerspot butterfl y (*Euphydryas editha*) on Stanford University's Jasper Ridge Biological Preserve. The colony of butterfl ies was found to consist of three localized populations, suffi ciently isolated to have independent dynamics. The dynamics of the three local populations on Jasper Ridge have been documented since 1960 . It was Noted that one of the
populations (area G) went extinct in 1964, was reestablished in 1966, and then went extinct again in 1974. The reestablishment of the population in area G after local extinction (extirpation) was a result of emigration from the other two populations occupying Jasper Ridge. Had the subpopulations been closed
(no immigration), area G would have remained unoccupied.
In this example, however, the local populations did not function in isolation; they interacted via dispersal (immigration and emigration) with the other subpopulations within the larger area of Jasper Ridge. In other words, they functioned as a metapopulation, and an understanding of the regional dynamics of
the species requires an understanding of processes operating at the level of the local population(s) as well as at the scale of the metapopulation.

Four conditions that defi ne a metapopulation

Many populations exhibit a patchy spatial distribution . But Ilkka Hanski of the University of Helsinki,
a leading ecologist in the area of metapopulation biology, has shown that Colonization (Fig-a and b) 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 suffi ciently 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.
At intermediate levels of dispersal, a dynamic emerges where the processes of local extinction and recolonization achieve some balance, where the metapopulation exists as a shifting mosaic of occupied and unoccupied habitat patches. The metapopulation concept is therefore closely linked with the processes of population turnover—extinction and establishment of new populations—and the study of metapopulation dynamics is essentially the study of the conditions under which these two processes are in balance.

Metapopulation dynamics Is a balance between colonization and extinction

The fundamental idea of metapopulation persistence is a dynamic balance between the extinction of local populations and recolonization of empty habitat patches. In 1970, Levins proposed a simple model of metapopulation dynamics, where metapopulation size is defi ned by the fraction of (discrete) habitat patches (P) occupied at any given time (t). Within a given time interval, each subpopulation occupying a habitat patch has a probability of going extinct (e). Therefore, if P is the fraction of patches that is occupied during the time interval, the rate at which subpopulations will go extinct (E)
is defi ned as
$E = eP$
The rate of colonization of empty patches (C) depends on the fraction of empty patches ($1 - P$) available for colonization and the fraction of occupied patches providing colonists (P), multiplied by the probability of colonization (m), a constant that refl ects the rate of movement (dispersal) of individuals between habitat patches. Therefore, the colonization rate will be

$C = [mP(1 - P)]$

It can be inferred that of metapopulation growth in a manner analogous to that of the normal population growth where the change in the population (ΔN) over a given time interval (Δt)

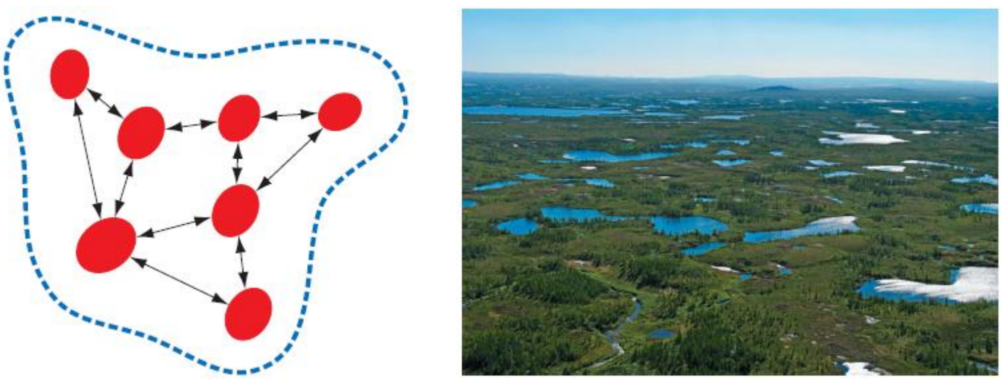
can be expressed as the difference between the rates of birth and death ($\_N/\_t = b - d$) . The change in metapopulation,

defi ned as the fraction of habitat patches occupied by local populations through time ($\Delta P/ \Delta t$) can therefore be defi ned as the difference between the rates of colonization C and extinction E :

$\_P/\_t = C - E$

or $\_P/\_t = [mP(1 - P)] - eP$

The model of metapopulation growth functions in a manner similar to the logistic model, in that growth is regulated in a density dependent fashion . This characteristic is probably not immediately apparent (at least to most of us) just by looking at the above equation, but it is much easier to see if we examine the equation graphically.



(a) (b)

Figure 12.1 (a) In the metapopulation concept, the distribution of a species (defined by the dashed line) is composed of a group of sub- or local populations (red circles) that are linked by dispersal (movement of individuals represented by arrows). (b) The ponds dotting the tundra landscape of Siberia (Russia) are an example of the metapopulation concept. The ponds represent a network of habitat patches of various size and shape for aquatic organisms. These habitat patches exist within a larger landscape of unsuitable habitat (land). The populations of aquatic organisms inhabiting these ponds represent distinct, spatially discrete local populations that form part of the larger metapopulation over the region.

QUANTIFYING ECOLOGY 12.1 Equilibrium Proportion of Occupied Patches

When the rate of local population extinction (E) is equal to the rate at which unoccupied habitat patches are being colonized (C), the metapopulation size, as measured by the proportion of habitat patches occupied (the number of local population), will be at equilibrium (see Figure 12.3). By setting $\Delta P/\Delta t$ equal to zero, we can solve for the equilibrium value **P**:

$$\frac{\Delta P}{\Delta t} = 0$$

$$[mP(1 - P)] - eP = 0$$

Using simple algebraic substitution, we can solve for P (the equilibrium value **P**)

$$mP(1 - P) = eP$$

by dividing both sides of the equation by P

$$m(1 - P) = e$$

then dividing both sides of the equation by m

$$1 - P = \frac{e}{m}$$

and subtracting 1 from both sides

$$-P = -1 + \frac{e}{m}$$

then multiplying both sides of the equation by -1

$$\mathbf{P} = 1 - \frac{e}{m}$$

For the metapopulation to persist, the equilibrium value **P** must be greater than zero, so the probability of extinction (e) cannot exceed the probability of colonization m.

1. In what way is the concept of **P** (the equilibrium proportion of occupied patches) similar to the concept of carrying capacity (K) presented in Chapter 11?

increases. Conversely, if the value of P exceeds P, the rate of extinction exceeds the rate of colonization and the size of the metapopulation (number of occupied patches) declines. So just as in the logistic model—in which the population density (N) tends to the equilibrium population size represented by the carrying capacity (K)—in the metapopulation model, the metapopulation density, P (proportion of patches occupied), will tend to the equilibrium metapopulation size represented by P.

The equilibrium value of P is a function of the probabilities of extinction (e) and colonization (m):

$$P = 1 - \frac{e}{m}$$

We calculate the equilibrium value mathematically from the metapopulation growth equation by setting the growth rate equal to zero: $\Delta P/\Delta t = 0$ (see Quantifying Ecology 12.1: Equilibrium Proportion of Occupied Patches).

The niche preemption hypothesis

This hypothesis states that the most successful or dominant species within the biotic community tend to preempts the most of the habitable space. The next most successful species then claims the next largest share of space, and the least successful occupies what little space is left.

The log -normal hypothesis

This hypothesis first mentioned by Preston, 1962 , highlights that the niche space occupied by a species is determined by a number of ecological attributes such as food, space , biotic association , micro-climate and other related parameters that affect the growth and propagation of one species in the face of competition with another. The log-normal distribution most closely resembling the distribution of importance values (density , diversity, mode of interactions etc) obtained from communities rich in species.

Habitat and its ecological dimension

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 amontane 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.

Definitions of the niche date back to 1917,but G. Evelyn Hutchinson made conceptual advances in 1957by introducing a widely adopted definition: "the set of biotic and abiotic conditions in which a species is able to persist and maintain stable population sizes."The ecological niche is a central concept in the ecology of organisms and is sub-divided into the *fundamental* and the *realized* niche. The fundamental niche is the set of environmental conditions under which a species is able to persist. The realized niche is the set of environmental plus ecological conditions under which a species persists.The Hutchinsonian niche is defined more technically as a "Euclidean hyperspace whose *dimensions* are defined as environmental variables and whose *size* is a function of the number of values that the environmental values may assume for which an organism has *positive fitness*."

Biogeographical patterns and range distributions are explained or predicted through knowledge of a species' traits and niche requirements.Species have functional traits that are uniquely adapted to the ecological niche. A trait is a measurable property, phenotype, or characteristic of an organism that may influence its survival. Genes play an important role in the interplay of development and environmental expression of traits. Resident species evolve traits that are fitted to the selection pressures of their local environment. This tends to afford them a competitive advantage and discourages similarly adapted species from having an overlapping geographic range. The competitive exclusion principle states that two species cannot coexist indefinitely by living off the same limiting resource; one will always out-compete the other. When similarly adapted species overlap geographically, closer inspection reveals subtle ecological differences in their habitat or dietary requirements.Some models and empirical studies, however, suggest that disturbances can stabilize the co-evolution and shared niche occupancy of similar species inhabiting species-rich communities.The habitat plus the niche is called the ecotope, which is defined as the full range of environmental and biological variables affecting an entire species.

Niche construction

Organisms are subject to environmental pressures, but they also modify their habitats. The regulatory feedback between organisms and their environment can affect conditions from local (e.g., a beaver pond) to global scales, over time and even after death, such as decaying logs or silica skeleton deposits from marine organisms. The process and concept of ecosystem engineering is related to niche construction, but the former relates only to the physical modifications of the habitat whereas the latter also considers the evolutionary implications of physical changes to the environment and the feedback this causes on the process of natural selection. Ecosystem engineers are defined as: "organisms that directly or indirectly modulate the availability of resources to other species, by causing physical state changes in biotic or abiotic materials. In so doing they modify, maintain and create habitats."

The ecosystem engineering concept has stimulated a new appreciation for the influence that organisms have on the ecosystem and evolutionary process. The term "niche construction" is more often used in reference to the under-appreciated feedback mechanisms of natural selection imparting forces on the abiotic niche. An example of natural selection through ecosystem engineering occurs in the nests of social insects, including ants, bees, wasps, and termites. There is an emergent homeostasis or homeorhesis in the structure of the nest that regulates, maintains and defends the physiology of the entire colony. Termite mounds, for example, maintain a constant internal temperature through the design of air-conditioning chimneys. The structure of the nests themselves are subject to the forces of natural selection. Moreover, a nest can survive over successive generations, so that progeny inherit both genetic material and a legacy niche that was constructed before their time.

Dispersal / Habitat Fragmentatiojn /Ecological corridor

Dispersal involves the movement of organisms across space, and, thus, its influence on community dynamics depends on the size and composition of the communities where the dispersers come from and of those in which they disperse to (Holyoaket al. 2005).As such, the community consequences of dispersal can only be addressed in relation to the action and results of other processes, selection and drift in particular. The construction of theoretical community models addressing the role of dispersal usually specifies whether organisms are distributed continuously across space or indiscrete patches .The latter type of distribution will be adopted here for the sake of simplicity and clarity.

With respect to the relative sizes of the source and recipient communities for dispersers, two kinds of models represent the ends of a continuum. Mainland-island models assume one-way dispersal from a source community of effectively infinite size (the mainland) to one or more smaller, discrete local communities (the islands, or localities). These models assume that community dynamics in small localities are sufficiently rapid relative to those on the mainland, such that the composition of the pool of dispersers is effectively constant. In contrast, island models assume a network of small local communities linked by dispersal among them, with no distinct mainland.

Such networks of local communities may be called “metacommunities” (Holyoak et al. 2005). Dispersal can interact with drift and speciation. In a mainland-island model with local drift but no speciation or selection, dispersal increases local species richness and causes local community composition to converge with that of the mainland. For a given level of dispersal, the number of new species introduced per unit of time will decrease as local species richness increases, because fewer and fewer of the dispersers will represent new species in the locality. With fixed local community size, greater species richness necessitates smaller population size per species, so that the rate of species extinction increases with species richness, at some point equaling the rate of species introduction, and thus determining an equilibrium number of species whose identities none the- less change through time. This is the simplest form of the theory of island biogeography (MacArthur and Wilson 1967).

Ecological Succession:

"Ecological succession" is the observed process of change in the species structure of an ecological community over time. Within any community some species may become less abundant over some time interval, or they may even vanish from the ecosystem altogether. Similarly, over some time interval, other species within the community may become more abundant, or new species may even invade into the community from adjacent ecosystems. This observed change over time in what is living in a particular ecosystem is "ecological succession".

Every species has a set of environmental conditions under which it will grow and reproduce most optimally. In a given ecosystem, and under that ecosystem's set of environmental conditions, those species that can grow the most efficiently and produce the most viable offspring will become the most abundant organisms. As long as the ecosystem's set of environmental conditions remains constant, those species optimally adapted to those conditions will flourish. The "engine" of succession, the cause of ecosystem change, is the impact of established species have upon their own environments. A consequence of living is the sometimes subtle and sometimes overt alteration of one's own environment. The original environment may have been optimal for the first species of plant or animal, but the newly altered environment is often optimal for some other species of plant or animal. Under the changed conditions of the environment, the previously dominant species may fail and another species may become ascendant.

Ecological succession may also occur when the conditions of an environment suddenly and drastically change. A forest fires, wind storms, and human activities like agriculture all greatly alter the conditions of an environment. These massive forces may also destroy species and thus alter the dynamics of the ecological community triggering a scramble for dominance among the species still present.

Types of Ecological Succession:

Ecological succession happens for a few different reasons:

Primary succession is initiated when a new area that has never previously supported an ecological community is colonized by plants and animals. This could be on newly exposed rock surfaces from landslides or lava flows.

Secondary succession occurs when an area that has previously had an ecological community is so disturbed or changed that the original community was destroyed, and a new community moves in. This is more common than primary succession and is often the result of natural disasters such as fires, floods, and winds, as well as human interference such as logging.

Steps of Ecological Succession:

The complete process of a primary autotrophic ecological succession involves the following sequential steps, which follow one another:

1. Nudation:

The process of succession begins with the formation of a bare area or nudation by several reasons, such as volcanic eruption, landslide, flooding, erosion, deposition, fire, disease, or other catastrophic agency. New lifeless bare areas are also created by man, for example, walls, stone quarrying, burning, digging, flooding large land areas under reservoirs, etc.

2. Invasion:

The invasion is the arrival of the reproductive bodies or propagules of various organisms and their settlement in the new or bare area. Plants are the first invaders (pioneers) in any area because the animals depend on them for food. The invasion includes the following three steps:

(1) Dispersal or migration:

The seeds, spores or other propagules of the species reach the bare area through the agency of air, water or animals. The process starting from the time a propagule leaves the parent plant to the time it arrives the bare area is called migration.

(2) Ecesis:

This is the successful establishment of migrated plant species into the new area. It includes germination of seeds or propagules, growth of seedlings and starting of reproduction by adult plants only a few immigrant propagules are capable of doing this under primitive hard conditions, and thus most of them disappear.

(3) Aggregation:

This final stage of invasion, the successful immigrant individuals of a species increase their number by reproduction and aggregate in a large population in the area and in consequence individuals of the species come close to each other.

3. Competition and reaction:

As the numbers of individuals of a species increase due to multiplication and all aggregate at the limited place, the competition for space and nutrition is started among them (intraspecific competition). They also compete with individuals of other species that may enter the area (interspecific competition).

All individuals also interact with the environment. Consequently, due to increased intra-and interspecific competitions and other type of biotic and abiotic interactions, the environment is modified and progressively becomes unsuitable for the existing community which sooner or later is replaced by new invaders or another community (seral community).

Finding the modified environment more suitable more species enter the area and compete with the previous occupants. This results in a balance among the species in which the former species is brought down to a subdominant status or is completely eliminated. The addition of organic matter, nutrients and more moisture in the substratum by small plants make it suitable for larger ones.

Increase availability of food allows various kinds of animals to join the community and the resulting interactions further modify the environment and pave the way for fresh invasion by other species of plants and animals to move on the process of succession.

4. Stabilization or climax:

Eventually a stage is reached when the final terminal community becomes more or less stabilized for a longer period of time and it can maintain itself in the equilibrium or steady state with the climate of that area. Theoretically at least, this last seral stage is mature, self-maintaining, self-reproducing through development stages and relatively permanent. The vegetation is tolerant of the environmental conditions it imposed upon itself.

This terminal community is characterized be equilibrium between gross primary production and total respiration, between the energy captured from sunlight and energy released by decomposition, between the uptake of nutrients and the return of nutrients by litter fall.

It has a wide diversity of species, a well-developed spatial structure, and complex food chains; and its living biomass is in a steady state. This final stable community of the sere is the climax community, and the vegetation supporting it is the climax vegetation.