Ecology

From *Oikos* - home - a study of the home in which everything lives.

The investigation of the total relations of the organism both to its organic and to its inorganic environment.

The study of the interactions that determine the distribution and abundance of organisms.

The science of ecology has practical information for humans, but it is not human-centered.

Ecological studies span several levels of interactions:

the individual, the population, communities, ecosystems, the biosphere

1. the individual organism - autecology - physiological ecology - behavioral ecology
   its relation to its physical environment
   its resource requirements,
   how resource limitations affect its biology,
   its range of tolerance of other physical parameters such as light, heat, moisture, etc.
   its interactions with other members of its own species, and members of other species
2. populations of organisms
   the dynamics of groups of individuals that all belong to the same species and occupy a limited geographic area
   how and why population numbers increase, decrease, or remain stable
   what determines the range of a species
   how a population is distributed within its range
   how and why populations expand or don’t expand their range,
   how populations change through time

3. Communities - groups of populations living in an area
   often not as well defined as an individual or population since it often has indistinct physical boundaries
   some communities are easily recognizable
   cypress-tupelo swamp, a peat bog, an oak-hickory forest, a beech-maple forest, a coral reef,
   - usually made of many species and there are many types of interactions between species
   - competition for space and other resources
   - predator and prey, parasites and hosts
   - cooperative relationships (mutualisms)
   - how some organisms create environmental conditions on which other organisms depend
   - how species loss or removal affects the remaining species
   - how communities change with changes in physical parameters
   - studies of community interactions can be very diverse
4. ecosystems - a group of communities in an area that are linked through their physical environment and the exchange of animals and plants between them. Ecosystems are demarcated by the limits of resource cycling and energy flow within them. Different ecosystems do not exchange resources or species to a great extent. Example: large lakes. Many resources cycled throughout the water column and sediments, but very little, relative to the total, is transported in or out of the system. The object of ecosystem studies - how energy and resources are cycled within the system.

Although ecosystems are relatively isolated, they are interconnected to greater or lesser degrees. The accidents and activities of humans have revealed some of the connections between ecosystems. Contamination of plants and animals in habitats very remote from the sources that generate the contaminants. The "dead zone" in the Gulf of Mexico is the result of excessive resources for plants put into the system from another system.

5. The Biosphere - the earth and all its ecosystems
Each level in the hierarchy of ecological studies has distinct properties that could not have been predicted from knowledge of being predicted had one only known about the ecology of the levels below it - "emergent properties"

Properties of organisms do not completely predict the properties of populations
Properties of populations do not completely predict the properties of communities
etc.

An organism’s environment is everything external to the organism that may affect its development, survival, and reproduction.

**Abiotic environmental factors** - temperature, water, oxygen, sunlight, pH, salinity, soil structure, mineral nutrients, chemical pollutants, etc.

**Biotic environmental factors** - food, predators, parasites, symbionts, competitors of the same species and of different species, mate availability, etc.

Not all environmental factors are important to all organisms. Aquatic species may require a specific pH range. Plants require sunlight of the proper amount. Predators are influenced only indirectly by abundance of forage plants, but their prey’s survival and reproduction may be directly impacted.
Globally, the two most important factors influencing the types of organisms that live in an area are temperature and moisture. Variation in temperature and water availability produce global patterns in the types of organisms found in an area (biomes) and the diversity of organisms in that area.

A **biome** is a major ecological community.

The angle of incidence of sunlight determines the amount energy that is received per unit area.

And thus, the average annual temperature.
Warm air holds more moisture than cool air. When heated, air takes on more moisture and also rises. As air rises it cools and must drop its moisture. Globally, this creates rainforests in the tropics.

As air cools it becomes more dense and sinks. Air heated at the equator rises, cools, and descends about 30° north and south of the solar equator, creating the major deserts in the interior of continents. A **Hadley cell** is a mass of air that rises and falls in a cyclical pattern.

Tropical rainforest, subtropical deserts, temperate forests, and arctic deserts are caused primarily by global patterns of air circulation due to heating of air in the tropics.
The rotation of the earth, along with the rising and falling of air creates the major wind patterns over the surface of the earth - the tradewinds, and westerlies.

Wind patterns and local topography determine many local weather phenomena. High rainfall occurs on the windward side of mountains. The leeward side has a “rain shadow.”

Prevailing winds set up oceanic gyres - clockwise in the north and counter clockwise in the south.

Water moving away from a shoreline causes upwelling. Water drawn up from the deep ocean is cold and nutrient rich. This creates areas of high aquatic productivity off the western coasts of continents and relatively cool dry climates along the coast.
The earth’s axis is tilted 23.5° relative to its plane of revolution around the sun. This creates seasonal patterns of heating. In the summer, the angle of incidence is relatively low in the northern hemisphere. In the winter the angle of incidence is low in the southern hemisphere.

Thus, the northern hemisphere is warmer in the summer and tends to have more rainfall. The opposite is true for the southern hemisphere.

The tilt of the earth causes seasonal patterns of rainfall.

At the equator there are two major rainfall seasons annually. Areas 23° north and 23° south have a single rainy season.
The combination of temperature and rainfall are the primary determiners of the distribution of biomes. Often the distribution correlates with latitude, but high altitude locations commonly have biomes that are common at low elevations at higher latitude.

Tropical wet forest - high temperature and rainfall
Very high species diversity
Tall dense-canopy trees - many with shallow prop-roots - very little light and few plants on forest floor.
Soils are often nutrient poor and organic material on the forest floor is rapidly decomposed and nutrients are recycled.
Intense biotic interactions - predation, parasitism, competition.
Many plants depend on animals for pollination and seed dispersal.
Tropical dry forest - high temperature and seasonal rainfall.

Very high species diversity.

Trees are deciduous - loosing leaves in dry season

Plants commonly depend on animals for pollination and seed dispersal.

Intense biotic interactions - many plants are thorny for defense.

Tropical savannah and scrub forest - little rainfall that occurs seasonally

Fires are frequent

Many plant species are deciduous, fire-adapted and have specializations for living in dry conditions - such as deep tap-roots.

Large herbivorous animals may be common and many plants have spines or thorns as defense.
Desert - low unpredictable rainfall - less rainfall than potential evapotranspiration.

Adaptations for living with little water are common in both plants and animals - few or no leaves, many animals and plants aestivate (hibernate) during dry periods.

Many plants have very long-lived seeds that will germinate when rainfall is sufficient to make establishment likely.

Mediterranean or chaparral - found along the western coasts of continents - due to upwelling of nearby sea.

Rainfall occurs mostly in the winter. Plants are adapted to dry summers - have few or small leaves.

Fires are common.
Temperate grassland or prairie - low rainfall and hot summers.
Fires are common and there are few woody species - grasses and herbs are common. Wind pollination is common.
Grazing mammals are common.

Temperate broadleaf forest - moderate rainfall and seasonal variation in temperature.
Most plants are deciduous and rates of decomposition are low which results in a rich organic soils (humus).
Thick canopy with sparse undergrowth.
Many wind-pollinated species.
Coniferous forest - found in cool regions with moderate to high rainfall and in areas where rainfall occurs principally in the cooler months.

Most species are evergreen with needle-like leaves that minimize water loss during the dry season. Rates of decomposition are low and the soils are often poor.

Fires and fire-adapted species are common.

Wind pollination is common.

Tundra - found where temperatures exclude most trees - high altitudes and high latitudes.

Mosses, lichens, and herbs are common.

The soil is frozen for much of the year and deep layers are permanently frozen.

At high latitudes, the growing season is very short and the winters are dark.

Plants are small with very rapid growth during favorable times.

Very low species diversity.

Rodents are common.