

# **Principles of Ecology**

**(Biol. 2051)**

By

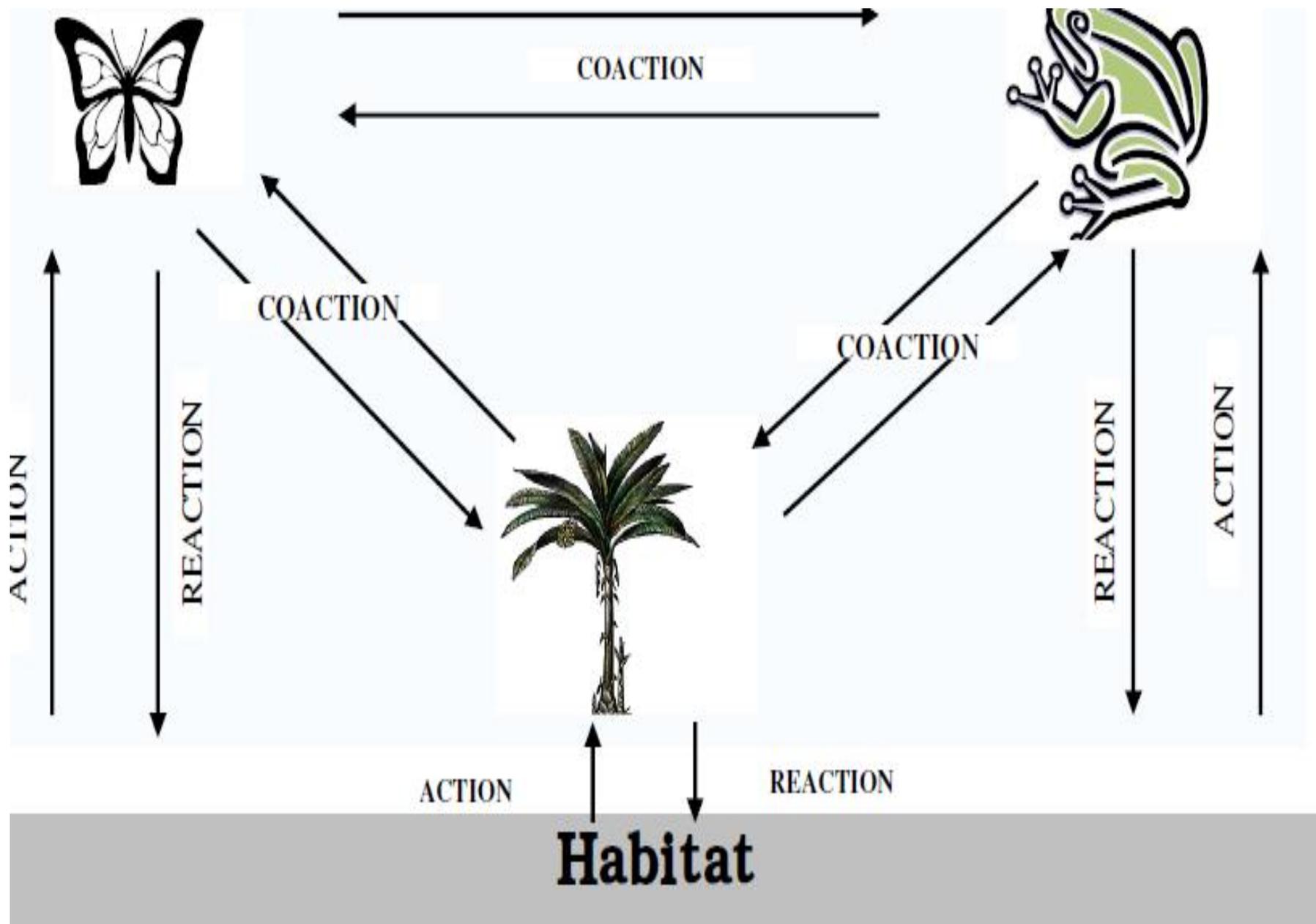
**Samuel Setew**

# Three Kinds of interactions

F.E. Clements (1920) identified three kinds of interactions in any ecosystem:

*action, coactions and reaction.*

- *Action* is any change induced from the habitat such as temperature or pH. It stimulates the organism for response.
- *Reaction* is a response coming from the organism on the environment. (Effect of organism on physical environment). Shading effect or contribution of the biota, particularly the flora to soil formation etc.
- *Coactions (effect of organism on one another)*: when organisms interact to one another that could be competition for resource or feeding relationship (symbiosis)



# Branches of Ecology

❖ There are different branches of ecology. The major subdivisions are given below based on different criteria

- 1. Based on system studied:** *marine ecology, freshwater ecology, aquatic ecology, terrestrial ecology, arctic ecology, forest ecology, etc*
- 2. Based on taxonomic or target group studied:** *Microbial Ecology, Plant Ecology, Animal ecology etc*

- 3. Based on level of organization:** Autecology (*individual organisms*) and *synecology*.
- 4. Based on mechanism or function:** *Physiological Ecology, Behavioral Ecology, Mathematical Ecology, Chemical Ecology, etc.*
- 5. Based on its application to humans:** *Restoration Ecology, Human Ecology, Behavioral Ecology, Evolutionary Ecology, Conservation Ecology, functional Ecology and many others*

# **Branches of Ecology**

- **Broadly there are two branches**
- **1. Autecology**
  - **Study about the individual organism or an individual species in experimental basis**
  - **In this life histories and behavior as a means of adaptation to the environment are usually emphasized**
- **2. Synecology**
  - **Deals with the study of groups of organisms which are associated together as an unit**
  - **This is a philosophical and deductive study often further divided in to aquatic and terrestrial ecology**
- **Apart from these there are many branches**

- **Habitat ecology**

- It deals with the study of different habitats of the biosphere eg. Marine ecology, freshwater ecology, terrestrial ecology, forest ecology, cropland ecology, grassland ecology, desert ecology etc.,

- **Conservation ecology**

- It deals with methods of proper management of natural resources such as land, water, forests, sea, mines etc.,

- **Production ecology**

- Deals with the gross and net production of different ecosystems

- **Taxonomic ecology**
  - It is concerned with different taxonomic groups
- **Human ecology**
  - The study of relationship of human with environment
- **Space ecology**
  - The study of space or extra-terrestrial environments
- **System ecology**
  - It is concerned with analysis of ecosystems by using mathematics, statistics and computer

- **Plant Ecology**
  - Study about plants of an environment
- **Animal Ecology**
  - Study about animals of an environment
- **Microbial Ecology**
  - Study about Micro-organisms of an environment
- **Mammalian Ecology**
  - Study about Mammals of any environment
- **Avian Ecology**
  - Study about birds of any environment
- **Reptelian Ecology**
  - Study about Reptiles of any environment
- **Amphibian Ecology**
  - Study about Amphibians of any environment
- **Tropical Ecology**
  - Study about the Tropical region of Earth

# Methods used to study ecology

- Ecology is a multidisciplinary science depends on variety of disciplines such as physics, chemistry, mathematics, statistics, genetics, meteorology, climatology, geology, geography, forestry, wildlife, horticulture ect.,
- Most ecologists have studied ecology from either a descriptive or analytical point of view
- **Descriptive** – what is present
- **Analytical** – why it is present

# There are two broad approaches that ecologists can take at each level of ecological organization

- **1. Indirect studies**

- Eg. Studying individual clutch size and survival probabilities when investigating the dynamics of a population

- **2. Direct studies**

- Eg. Studies on species diversity at the level of a community

- Even though ecologists follow different approaches and techniques, they often face extraordinary challenges in their research

# Ecological research methods include observation, experimentation, and modeling

Method	Description	Example
Observation	the act of watching something over time	watching a field of birds
Experimentation	can occur in the lab or in the field	involves testing a hypothesis
Modeling	Computer or math based method used to predict how changes in one variable may affect another variable	Using computer software or statistical packages to predict the results

# Introduction to Environmental Factors

- Each and every living organism has its specific surrounding, medium of environment to which it continuously interacts and remains adapted
- The environment is the sum total of physical and biotic conditions influencing the responses of the organisms
- Distribution, abundance, growth and reproduction of the organisms are controlled by certain environmental factors
- These factors, singly or in combination, ultimately limit the size that any population may attain

## Introduction to Environmental Factors

- Every environmental factor varies through a wider range of intensity
- Each organism has their own tolerant limit (lower and upper) for the factors in which it functions efficiently
- The rate of function increased as the quantity of heat, moisture, light or other factors increased
- Above the maximum (upper) limit of the factors there is an usual decline in the rate of function of organisms

# Classification of Environmental Factors

- Environmental factors could be classified as density dependent and density independent based on their effect in relation to density
- All living things need food, water, shelter and space to survive
- As long as organisms have all of these things available to them their population will continue to grow
- However, populations cannot grow forever, some form of environmental resistance will stop the population's growth
- The form of environmental resistance is called a limiting factor since it limits the population
- However, limiting factors may also increase a population

# DENSITY DEPENDENT FACTORS

- Density dependent factors can only affect a population when it reaches a certain density.
  - For example
    - Competition
    - Predation
    - Disease
    - Parasitism
    - Crowding
    - Stress
- These factors only affect populations with high densities.

# COMPETITION

- *Can occur between many organisms that live in the same habitat.*
- *When the resources are limited in a habitat, the organisms must compete for food, water, space, and shelter.*

## DENSITY DEPENDENT FACTORS contd...

- **PREDATION** *occurs when the population density of predators is high.*
- *The predators will consume their prey and increase their own population.*
- However, the population of the prey will decrease.
- On the other hand, the lack of predation (when the population density of predators is low) will cause problems for the prey's population.
- When there are few predators, the prey's population increases very quickly and this can lead to the depletion of resources and increase disease.

## DENSITY DEPENDENT FACTORS contd...

- **DISEASE** *in a population increases with the higher density of a population.*
- *High densities makes it easier for parasites to find hosts and spread the disease.*
- *Parasitism is a relationship in which one species benefits at the expense of the other.*
- **Parasitism** is an organism that lives in or on another organism (called a host) to get nourishment.
- While the parasite benefits from this relationship the host is harmed or killed.

## DENSITY DEPENDENT FACTORS contd...

- **CROWDING** *only occurs at high densities.*
- *Over-crowding can cause depletion of resources, disease and stress.*
- **STRESS** *usually has a negative effect on populations.*
- *Stress can make organisms weak and more prone to disease.*

# DENSITY INDEPENDENT FACTORS

- Density independent factors can affect a population. For example: natural disasters, temperature, sunlight, human activities, physical characteristics and behaviors of organisms affect any population regardless of their densities.
- **NATURAL DISASTERS** *such as droughts, floods, hurricanes and fires can be devastating to aquatic life.* For example, a severe drought could lower the water levels of a lake decrease its carrying capacity. Thus, the fish population would decrease.

# DENSITY INDEPENDENT FACTORS contd...

- **Temperature** *influences the activity and growth of organisms.*
- *It also determines* which type of organisms can live in an ecosystem.
- Usually, higher water temperature increases the activity in a lake.
- However, all aquatic species have a preferred temperature range.
- If temperatures vary too much out of this range the species will either die or move to a different location.
- It also influences the chemical properties of water.
- The rate of chemical reactions in the water increases as temperature increases.

## DENSITY INDEPENDENT FACTORS contd...

- **Sunlight** *can only penetrate to a depth of 30 meters in water. Thus most photosynthesis in aquatic environments occurs near the surface. This means the density and competition increases at surface.*
- **Human Activities** *can also affect population dynamics. For instance, lakes are used for hydroelectric dams. The water level in this location often drops suddenly and the eggs die because they become exposed.*

## DENSITY INDEPENDENT FACTORS contd...

- **Physical Appearance** *of organisms can affect their population.*  
*Many organisms have adapted and evolved in order to increase their chance of survival. For example, some species of fish have colored markings to warn predators that they may be toxic. Or, some species use camouflage colors to help them hide and avoid being eaten.*
- **Behaviours** *of organisms can also affect their population. For example, some species migrate to find new food sources or to mate. Some organisms create societies or feeding territories.*

# Biotic and Abiotic Factors

**Biotic** factors :These are living factors

**Abiotic** factors:        These are non-living factors

(*i.e.* The physical and chemical conditions)

**Climatic** :        These are the average weather conditions that affect the community in an ecosystem

**Edaphic** :        These refers to the soil

# Biotic factors

These are the living features of an ecosystem that affect the other members of the community.

1. Plants for food and shelter
2. Predators
3. Prey
4. Parasites and pathogens
5. Decomposers
6. Competitors
7. Pollinators
8. Humans

# Biotic Factors

Factor	Example
Food	The number of berries affects the number of blackbirds. The number of plankton affects the number of mussels.
Competition	Robins compete with each other for worms. Barnacles and Limpets compete for space on the rock.
Predation	Ladybirds reduce the number of greenfly. The gull reduces the number of anemones.
Humans	Provide sanctuaries, protected areas Pollution

# Abiotic factors

- Temperature
- Light intensity
- Speed of wind
- Water current
- Humidity
- Altitude
- Exposure
- pH
- Dissolved oxygen
- Salinity
- Nitrate, phosphate and other plant nutrients

# Abiotic Factors

Factor	Example
Altitude	<p>Higher altitudes are wetter, cooler and windier than lower altitudes.</p> <p>Trees cannot live at high altitudes</p>
Current	<p>Plants and animals can be washed away. They need to be able to attach to rocks e.g. seaweeds</p>
Exposure	<p>Organisms lose water when the tide is out. There is a need for a shell or mucilage to retain water.</p>

# Climatic factors

These are elements of the climate (weather) that influence the life and distribution of the organisms that live in a particular environment, it includes

1. Temperature
2. Rainfall
3. Humidity
4. Wind
5. Light intensity (including seasonal variations)
6. Day length

# Edaphic factors

These are the physical, chemical and biological characteristics of the soil that influence the community, it includes

1. Soil type,
2. Soil pH,
3. Available (soil) water,
4. Air and Mineral content,
5. Humus,
6. Soil texture and Structure.

# Edaphic Factors

Factor	Effect
Soil Type	Plants do not grow well in heavy soils due to lack of oxygen. Plants do not grow well in sandy soils due to leaching of minerals
Soil pH	Moss and heathers prefer acid soils. Most garden plants prefer neutral pH.
Soil moisture	Plants need water for photosynthesis, transpiration and general metabolism.
Mineral content	A lack of any mineral will affect the growth of the plant.

# Periodicity

- During evolution, organisms have acquired a variety of endogenous rhythms, their periods are matched with the rhythmic events in the environment
- A rhythm is a recurring process which is wave like in character, because maximum and minimum states appear at identical intervals of time
- The response of different organisms to environmental rhythms of light and darkness is termed photoperiodism

- Rhythmicity is recurrence of daily and seasonal changes according to the daily rotation and annual revolving of earth relative to the sun
- Each daily cycle inclusive of a period of illumination followed by a period of darkness is called the photoperiod

- All plants and animals possess an internal clock that controls the rhythm of behavior and keep it going with the help of internal stimuli
- This clock is entrained by external environmental stimuli, called zeitgebers or entrainers such as day length, lunar phases, tides, temperature, humidity, etc.
- The biological clocks show following general characteristics

- To keep almost the same timings at high and low temperature
- They are controlled by the physiological processes of body
- They keep normal cycle even in the absence of environmental cues and are self sustained in nature
- They function through nerves (brain) and hormones
- The types of biorhythms includes circadian rhythm, circatidal rhythm, circalunar rhythm, circanular rhythm

# Circannual rhythms

- The activity of some animals and plants is influenced by the seasons occurring once in a year
- They show circannual rhythms
- Most birds breed during spring season
- Migratory birds undertake long distance migrations every year and show cyclic changes in their body weight, gonad size, plumage and coloration
- The larvae of many insects show two phases active and inactive to arrest the growth and development

# Photoperiodism

- The appropriate appearance of seasonal events are of critical importance in the life cycles of most plants.
  - These seasonal events include seed germination, flowering, and the onset and breaking of bud dormancy.
  - The environmental stimulus that plants use most often to detect the time of year is the photoperiod, the relative lengths of night and day.
  - A physiological response to photoperiod, such as flowering, is called photoperiodism.