

Formation of different seasons

- Rotation of earth and the tilt of its axis cause annual variations in the intensity and duration of temperature, resulting distinct seasons.

Formation of major biomes

- Annual variations in the intensity and duration of temperature
- annual variations in precipitation
- Major biomes are desert, rain forest, and tundra

Key elements that lead to so much variation in the physical and chemical conditions of habitats

- Temperature
- Water
- Light
- Soil

Components that characterize the habitat of an organism

- **Abiotic** (physic-chemical)
- **Biotic** components (pathogen, parasites, predators, competitions)

Temperature

- Temperature decreases progressively from equator towards the pole and high altitudes
- Thermal springs and deep-sea hydrothermal vents are unique with $>100^{\circ}\text{C}$.
- Temperature affects the kinetics of enzymes, BMR and other physiological actions.
- **Eurythermals**: organism which can tolerate wide range of temperatures.
- **Stenothermal**: organism which can tolerate narrow range of temperatures

Water

- The productivity and distribution of plants depends on water.
- The salinity varies in aquatic environment:
 - 5% in inland waters (fresh water)
 - 30-35% in sea water
 - More than 100% in hyper saline .
- **Euryhaline:** organism which can tolerate wide range of salinity
- **Stenohaline:** organism which can tolerate narrow range of salinity.

Light

- Plants produce food by photosynthesis.
- Adaptation for photosynthesis under top canopy
- Required for photoperiodic response like flowering.
- Animals use diurnal and seasonal variations in light intensity and photoperiod as cues for timing their foraging, reproductive and migration activities.

Soil

- Properties of soil vary according to the climate and the weathering process.
- Soil composition, grain size and aggregation determine the percolation and water holding capacity of the soil.
- These characteristic along with pH, mineral composition and topography determine to a large extent the vegetation in any area.
- The sediment-characteristic determine the type of benthic animals in aquatic environment.

Homeostasis

- The process by which the organism maintains a constant internal environment in respect to changing external environment

How do organisms cope with the changing environment?

- Regulate
- Conform
- Migrate
- Suspend

Regulate

- Physiological and behavioral means ensure constant body temperature and constant osmotic concentration.
- All birds and mammals and few lower invertebrates are capable of thermoregulation and osmoregulation.
- Success of mammals is due to thermoregulation.
- We maintain a constant body temperature of 37°C.
- In summer we sweat profusely and evaporative cooling takes place to bring body temperature down.
- In winter we start to shiver to generate heat to raise body temperature.

Conform

- Majority (99%) of animals and plants cannot maintain a constant internal environment; their body temperature varies according to ambient temperature.
- In aquatic animals the osmotic concentration of body fluid varies with ambient water osmotic concentration.
- All the above animals and plants are simply called as **conformer**.

Why were conformers not evolved to become regulators?

- Thermoregulation is energetically expensive for many animals.
- Small animal like shrews and humming birds cannot afford so much energy for thermoregulation.
- Heat loss or heat gain is a function of surface area.
- Small animals have larger surface area relative to their volume, they tend to lose body heat very fast when it is cold outside; they have to expend much energy to generate body heat through metabolism.
- This is why very small animals are rarely found in Polar Regions.

Migrate

- The organisms move away temporarily from the stressful habitat to a more hospitable area and return when stressful condition is over.
- Birds migrate from the colder region to warmer region.

Suspend

- Thick walled spores are formed in microbes which germinate in favourable conditions.
- In higher plants seeds and other vegetative reproductive structures are means to tide over the stress. They reduce their metabolic activity and go into a state of '**dormancy**'.
- **Hibernation**: during winter animals like bears escape in time
- **Aestivation**: animals like snail and fish avoid summer related problems like heat and desiccation.
- **Diapause**: many zooplanktons undergo a stage of suspended development in unfavourable conditions.

Adaptation

- It is any attribute of the organism (morphological, physiological, and behavioral) that enables the organism to survive and reproduce in its habitat.

Adaptation of animal in desert

- Kangaroo rat meets their water requirement from **oxidation of fat**.
- Excrete very **concentrated urine** to conserve water.

Adaptation of plants in desert (xerophytes)

- **Thick cuticle** on their leaf surfaces.
- **Sunken stomata**, both to reduce transpiration.
- Have special photosynthetic pathway (**CAM**), stomata closed during day time and remained open during night.
- Opuntia has no leaf- they are reduced to **spines**.
- Photosynthesis takes place in **flat green stems**.

Adaptation of animals in cold climate

- ***Allen's Rule:*** mammals from colder climates generally have shorter ears and limbs to minimize heat loss.
- Seals of polar aquatic seas have a thick layer of fat called **blubber** below their skin that acts as insulator and reduces loss of body heat.

Altitude sickness

- When a person moves to high altitude (>3,500 meter), **altitude sickness** is developed.
- Symptoms developed are nausea, fatigue and heart palpitations.
- This is due to low atmospheric pressure of high altitudes; the body does not get enough oxygen.

Adaptation in high altitude

- The body compensates low oxygen availability by increasing red blood cell production.
- The body compensates decreased binding capacity of hemoglobin with oxygen by increasing rate of breathing.

Behavioral adaptations

- **Desert lizards** bask in the sun and absorb heat when their body temperature drops below the comfort zone in winter.
 - Move to shade when the ambient temperature starts increasing.
 - Some species burrow into the soil to hide and escape from the above-ground heat.

Population

- A group of individuals living in a well defined geographical area, share or compete for similar resources, potentially interbreed.

Population attributes

- Birth rate and death rate refers to per capita births and deaths respectively.
- **Sex ratio** is ratio between male and female in a population.
- The age distribution is plotted for a population and the resulting structure is called age pyramid.
- The shape of the pyramids reflects the growth status of the population like **growing, stable** or **declining**.
- The population size is more technically called as **population density**.

Methods for measurement of population density

- Counting the number
- Percent cover
- Biomass.
- **Pug marks** and **fecal pellets** for tiger census

Population growth

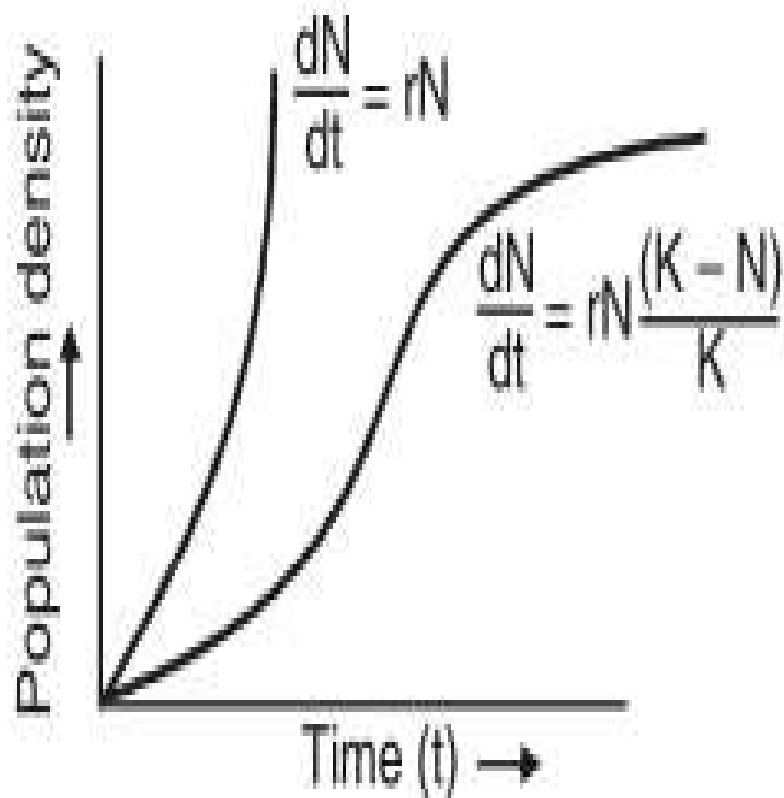
- Population growth depends on food availability, predation pressure and weather conditions.
- Population size fluctuates due to changes in following processes:
- **Natality**: number of births in given period in the population.
- **Mortality**: number of deaths in the population in given period.
- **Immigration**: the number of individuals of same species that come into the habitat from elsewhere during a given period of time.
- **Emigration**: number of individuals of the population who left the habitat and gone elsewhere during a given time period.

Population growth

- If 'N' is the population density at time 't', then its density at time $t + 1$ is :

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

- B = the number of births
I = the number of immigrants
D = the number of deaths
E = the number of Emigrants.



N = Population Density

r = Intrinsic rate of natural increase

t = Time period

K = Carrying capacity

(The maximum population size that an environment can sustain)

Exponential growth

- The Exponential growth equation is $N_t = N_0 e^{rt}$
- N_t = Population density after time t
- N_0 = Population density at time zero
- r = intrinsic rate of natural increase
- e = the base of natural logarithms
(2.71828)

Exponential growth ('J' shape curve is obtained)

- When resources are not limiting the growth.
- Any species growing exponentially under unlimited resources conditions can reach enormous population densities in a short time.

Growth is not so realistic.

Logistic growth model

- $dN/dt = rN (K-N / N)$
- Where N = Population density at time t
- r = Intrinsic rate of natural increase
- K = Carrying capacity

Logistic Growth

- When responses are limiting the Growth.
- Resources for growth for most animal populations are finite and become limiting.
- The logistic growth model is a more realistic one.
- Sigmoid curve is obtained.

Predation

- Organisms of higher trophic level (predator) feed on organism of lower trophic level (prey).
- Herbivores are not very different from predator.
- Predator acts as a passage for transfer of energy across trophic level.
- Predators keep prey populations under control.
- Exotic species have no natural predator hence they grow very rapidly. (**prickly pear cactus** introduced in Australia created problem)
- Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species. (**Pisaster** starfish field experiment)

Defense developed in animals against predators

- Insects and frogs are cryptically coloured **(camouflaged)** to avoid being detected by the predator.
- Some are poisonous and therefore avoided by the predators.
- **Monarch butterfly** is highly distasteful to its predator (bird) due to presence of special chemical in its body. The chemical is acquired by feeding a poisonous weed during caterpillar stage.

Defense developed in plants against predators

- **Thorns** in Acacia, Cactus are morphological means of defense.
- Many plants produce and store some chemicals which make the herbivore sick if eaten, inhibit feeding and digestion, disrupt reproduction, even kill the predators.
- **Calotropis** produces poisonous cardiac glycosides against herbivores.
- Nicotine, caffeine, quinine, strychnine, opium etc. are produced by plant actually as defenses against the grazers and browsers.

Competition

- Interspecific competition is a potent force in organic evolution.
- Competition generally occurs when closely related species compete for the same resources that are limiting.
- Totally unrelated species could also compete for the same resources.
 - In American lakes visiting flamingoes and resident fishes have their common food, zooplanktons.
- Resources need not be limiting for competition to occur.
 - **Abingdon tortoise** in Galapagos Islands became extinct within a decade after **goats** were introduced on the island, due to greater browsing ability.

Competitive release

- A species, whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its distributional range dramatically when the competing species is experimentally removed.

Gause's '***competitive Exclusion Principle***'

- Two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior will be eliminated eventually.

Connell's Elegant Field experiment

- On the rocky sea coasts of Scotland, Superior barnacle ***Balanus*** dominates the intertidal area and excludes the smaller barnacle ***Chathamalus*** from that zone.

Resource partitioning

- If two species compete for the same resources, they could avoid competition by choosing different times for feeding or different foraging pattern.
 - **MacArthur** showed that five closely related species of warblers living on the same tree were able to avoid competition and co-exist due to behavioral differences in their foraging activities.

Parasitism

- Parasitic mode of life ensures free lodging and meals.
- Some parasites are host-specific (one parasite has a single host) in such a way that both host and parasite tend to co-evolve.

Parasitic adaptations

- Loss of unnecessary sense organs.
- Presence of adhesive organs or suckers to cling on to the host.
- Loss of digestive system
- High reproductive capacity
- Parasites have one or more intermediate host or vectors to facilitate parasitisation of its primary host.
- Liver fluke has two intermediate hosts (snail and a sheep) to complete its life cycle.

Effects on the host

- Parasite always harms the host.
- They reduce the survival, growth and reproductive ability of the host.
- Reduce population density of the host.
- They make the host more vulnerable to the predators, by making it physically weak.

Ectoparasite

- feeds on the external surface of the host.
 - Lice on human
 - Ticks on dog
 - Marine fish infested with copepods
 - ***Cuscuta*** a parasitic plant growing on hedge plants.

Endoparasites

- live inside the host body at different sites.
 - Life cycle is more complex.
 - Morphological and anatomical features are greatly simplified.
 - Highly developed reproductive system.

Brood parasitism

- Special type of parasitism found in birds.
- The parasitic bird lays eggs in the nest of its host and lets the host incubate them.
- The egg of the host is very similar with the egg of the host.
- Cuckoo lays eggs in the nest of the crow.

Commensalism

- one species benefits and the other is neither benefited nor harmed.
- Orchids growing as an ***epiphyte*** on a mango branch.
- Clown fish living among tentacles of sea anemone.
- Barnacles on back of whales.
- Cattle Egret and grazing cattle.

Mutualism

- Interaction between two living organism, both are equally benefited, no one is harmed.
- **Lichen:** a mycobiont and a Phycobiont.
- **Mycorrhiza:** relationship between fungi and root of higher plant.
- Pollinating insects and flowering plants.
- **Fig trees** and its pollinating agent **wasp**.

Sexual deceit

- Mediterranean orchid **Ophrys** employs '**sexual deceit**'.
- Petal of the flower resembles the female bee.
- The male bee attracted to what it perceives as a female, 'pseudocopulates' with the flower but does not get any benefits.