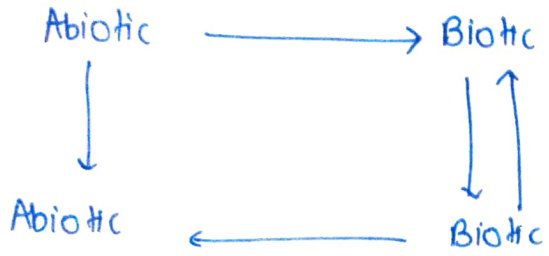
Organism and Population

Ecology = Eco + logy
(oikos) study
↳ home

Ecology is the study of interaction b/w organism and organism with environment.



Ecology is the term given by Ernst Haeckal.
Father of indian ecology = Ramdeo mishra

Type of ecology → Autecology → interaction of organism and population with environment
→ Synecology → interaction of communities.

levels of ecology

↳ macromolecule → tissue → organ → organ System → organism → Population → community → biome

↳ level of biological organisation yaha se start hoga

organism ka level of ecology yaha se start hota hai

① organism level

↳ It is a physiology ecology
(How organism interact with other organism and environment
↳ for food and survival.
↳ adaptation

② Population level: group of organism of same species living in a common geography which interact with other organism. (we talk about Birth rate, death rate)

③ Community: group of population (Food chain and food web)

④ Biome :- Many communities and abiotic factors

In this chapter we are dealing with organism and population

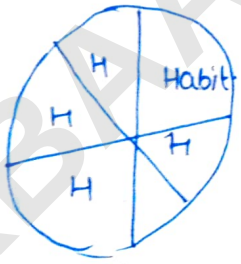
Organism level ecology

To study organism level ecology two component

① Habitat ② organism (How it show adaptation)

Q what is habitat ?

→ Concept of biome :



Biome

On earth we have diff type of biomes

On earth temperature vary due to tilt of earth axis and and variable annual precipitation (rain, snow). rotation

Tilt of Earth axis → variable T → diff. rainfall and diff. annual T

↓

Diff. climate form and diff. vegetation ← Different biome ← In india 6 type of biomes

↳ ① Desert biome ③ Arctic Tundra ⑤ Temperate Forest
② Grassland ④ Alpine forest ⑥ Tropical ||

India (six type of biome)

↓

within biome local variation occur and diff. type of habitat forms.

Some very unusual Habitat (very difficult condition)
① Mountain top ② Intestine ③ High T ④ deep ocean

Habitat → some abiotic factors
① Temp, water, light soil → affect habitat
② Some biotic which is also a part of habitat.

Abiotic factors - part of habitat

① Temperature - It is most important abiotic factor.

How temperature vary on earth ?

↓ due to
① Seasonal variation ② Temperature decrease when we move equator to pole

③ Height (bottom to top) T decreases

Enviromental lapse rate # → (ELR)

When we move to bottom to top temperature decreases by rate 6.5°C / 1km.

How temperature affect

① Distribution of animal and plants → i) Snow leopard not found in Kerala
ii) Tuna fish can't be found in beyond equator
iii) Mango not found in germany and canada.

② due to kinetics of enzymes → due to fluctuation in enzymes
↳ metabolism effect

③ Type of organism evolve :-

a) Eurythermal → It can tolerate wide range of fluctuation in T.
↳ it can move to diff. habitat
↳ ∴ wide distribution found of eurythermal.

b) Stenothermal : tolerate narrow range of T
↳ distribution is limited.

≠ Extra points # - Temperature variation in lake

In summer → lake show thermal stratification.

→ upper layer of air

Epilimnion — High T

Metalimnion

Hypolimnion

In winter →

Low Temp.

Slightly High T

Mixing of air in spring and autumn.

↳ spring and autumn me hi phytoplankton ki growth maxm hoti

Water

→ Life originated in water → water availability is very imp.

→ Water availability in desert is so much such that plant could not grow without adaptation to save water.

→ In aquatic animals and plants quality of water is important

↓

pH, dissolved minerals, salts.

Salt conc.
- ① Fresh water - 3-5 ppt
- ② marine - 30-35 ppt
- dead sea → 100 ppt

① Euryhaline :- tolerate wide variety of salinity

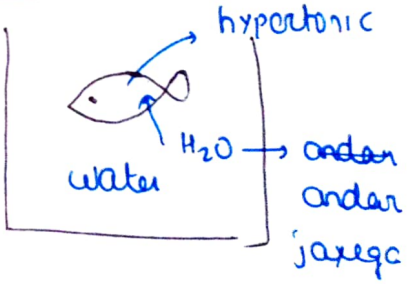
② Stenohaline :- tolerate less " " "

In Fresh water fish inside it is hypertonic

In marine fish water is hypertonic

therefore water will move outside from fish.

↳ means fresh water fish have excess water and means it is ammonotelic (excrete with more water)



† Contractile vacuole is present in fresh water single cell organism. which remove excess water from body.

Light # — sun is only source of light
(Light is related with temperature)

Light → most important role for → ① Productivity
autotroph ② Photoperiodism.

Some plant can grow in low light intensity and shadow
↳ ① Adaptations : dark colour leaf, PS I more
Chloroplast more

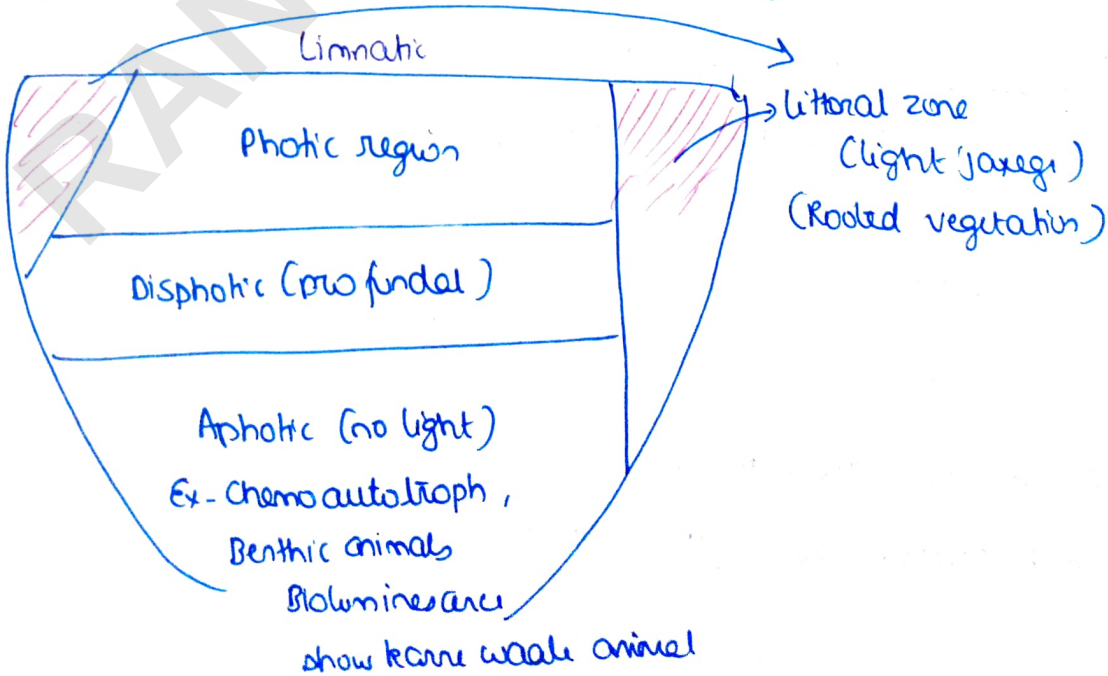
Light also affect animal → ① Foraging activity (nocturnal - night pre feedor
② Reproduction
③ Migration (acc. to day length diurnal - day freedor)
birds migrate)

Component of light

① Duration (Day length) ② Intensity ③ wavelength (UV rays harmful)

Deep Sea

deep sea > 100m → no celestial source → how light reaches ?



Inside water → light penetration

Soil

↳ formation of soil → paidogenesis

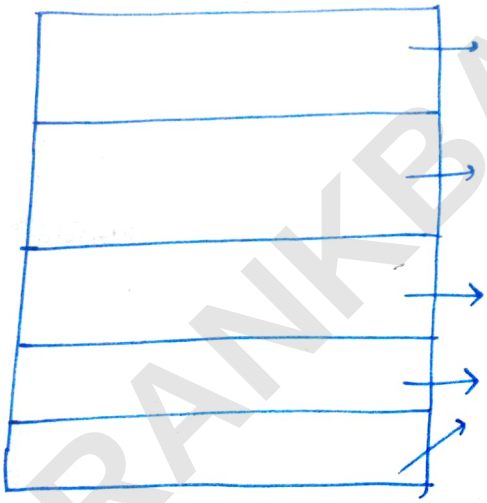
↳ soil change in diff. location → depend on a) parent rock
b) amount of weathering
c) whether it is transported or not

Soil composition # → water

↳ soil grains (45%) → sand, silt, grey clay
↳ air - (25%)
↳ 5% organic material

Best soil → Loamy soil

Vertical section of soil



A horizon = maxm soil activity

Some properties

↳ decide percolation and water holding capacity

pH, minerals also decide quality of soil

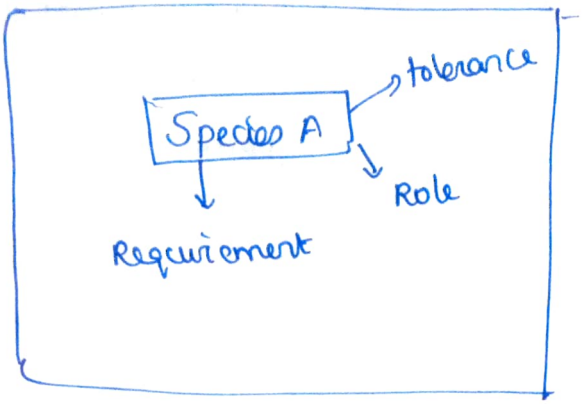
Finally decide vegetation.

decide Flora and fauna

Edaphic factors: related to soil

Topography - earth par different structure like mountain

Niche # → species spiecific . no two ~~two~~ species have same niche



Niche = role + requirement of species

Q Diff. b/w Habitat and niche ?

↳ 1 habitat can have more than one niche

one species have single niche

Cat - active in night, predator, eat mice

Owl - " , " " "

} Both have similar niche but not exact niche ⇓ called ecological equivalent

Effect of abiotic factors

→ organism level of ecology → Habitat → affect by abiotic factors

→ Organism

Abiotic factor is keep on changing → organism some mechanism evolve to cope up extreme conditions

Why abiotic factor show effect ?

With time organism evolve certain biochemical reaction and physiology mechanism.

↓

They occur in fixed condition → If these condition are available than there biochemical and physiological mechanism can occur with max. efficiency.

← This increase overall strength of organism.

Reaction mechanism evolve ↓ constant body conditions → This constant internal condition is known as homeostasis. ↓ means constant T and constant body fluid.

we need to maintain homeostasis by Thermoregulation and osmoregulation.

Analogy of thermoregulation

Our work efficiency is maxm in 25°C

In extreme summer (40°C) → we use air conditioner and thermoregulation is done

Benefit → maxm work is possible.

Ability to maintain homeostasis

① Regulators → ability to maintain homeostasis

→ Two type of regulation

→ ① Thermoregulation ② Osmoregulation

Thermoregulation

- maintain constant Body T
- warm blooded + some lower vertebrate (mammal & bird)

→ maintain by physiological mean and behavioural mean.

Osmoregulation

- ~~coz~~ constant Body T

→ land animals + some aquatic.

Thermoregulation
- done by
  - ① Physiological mean
    - a) Sweating (Outside Temp above Body T)
      - Evaporative cooling
  - ② Shivering
    - → outside temp is below body T
- Behavioural mean
  - some cold animal

Shivering and sweating is done by warm blooded animal.

Thermoregulators :-
- Warm blooded (Homoithermy) (Endothermic)
- Some cold blooded (Poikilothermal) (Ectothermic)

- Thermoregulation are of two types – all warm blooded + some cold blooded

Q Is all homothermic are regulators? → Yes

Q Is all regulators are homothermic? – No

Conformers # - change internal condition with ambient condition

→ conformers are moving away from homeostasis if external condition change.

Thermoconformer :- Most cold blooded + Invertebrates + Plants
↓
they can't perform thermoregulation

Osmoconformer = Aquatic plant and animals

Q why all conformer not become regulators ?

⇒ Thermoregulation, Osmoregulation] → any type of regulators → disadvantage - Energy required

Conformer → advantage energy save

By comparing cost and analysis those which are able to use energy → act as regulators.

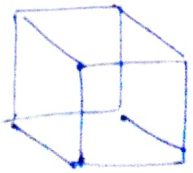
Q why small size mammal not fand in polar areas ?

⇒ Regulator + change in condition
↳ Energy consumption very high

Small size
↳ Surface area high → energy loss organ occur by surface
↓
small organism lose more heat

$\frac{\text{Surface area}}{\text{volume}} = \frac{6 \times 4}{8} = 3$

Large area =



$\frac{\text{Surface area}}{\text{volume}} = \frac{4 \times 4 \times 4}{64} = 1$

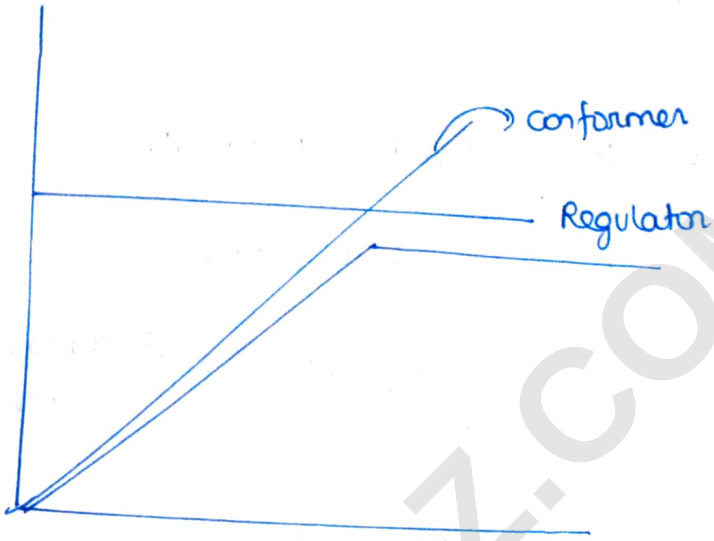
Q which organism face max. problem in homeostasis ?

→ a) small size mammal at 37°C

b) large " " " 0°C

c) small size lizard at temp. close to body T

d) large size lizard at temp. lower than body T



Effect of abiotic condition

Case I - unfavourable condition for shorter duration → migration suspension

Case II - " " " larger " → • extinction • adaptation

Migration

- organism move to unfavourable condition (hospitable condition)
- it come back when normal condition resume.
- reason for migration can be of food, reproduction (cyclostomes → move to fresh water fish) and condition → Siberian cranes (Keoladeo N.P)

longest migration - Arctic Tern

Suspension # → lower organism → Bacteria, Fungi, Algae

↳ Form resistant spore

• Plants :- → Seed → Dormancy show in unfavourable cond.
↘ tuber (vegetative reproduction)

• Animals → Hibernation → suspend its activity in winter
Aestivation → summer sleep - Ex - fish, snail

Diapause - zooplankton suspended activity.

Adaptations

→ when unfavourable condition for longer duration - organism need to adapt

→ adaptation is any attribute for survival and reproduction.

→ with time adaptations are genetically fixed

• Adimitization → short term adaptation.

Desert conditions

• Plants → ① leaf modified into spines ② Sunken stomata
③ Photosynthetic stem (phylloclade) ④ thick cuticle
⑤ CAM

• Animals - ① Kangaroo rat in North american rat
• Produce water for internal fat oxidation from
• urine concentrated

→ contain Heat shock protein → chaperonins

Cold condition.

Plant :- No special adaptation.

Animals → ① Allen rule → animals found in polar areas have shorter ear and limb

② Some mammal and fish → Blubber → insulator of heat

③ Cold Temperature → minus T → They have anti freeze protein

Physiological adaptation

. Altitude sickness → person living in plain → if move to Rohtang Pass more than 3500m

↓

Altitude sickness ← Oxygen pressure low

(Nausea, Fatigue, Heart Palpitation)

↓

oxygen acclimitise by a) Breathing rate increase b) RBC count increase c) decrease affinity of RBC with O_2

Unfavourable environment

① High T → thermal spring → archaebacteria

② Deep sea → Fish → helped by swim bladder
(Pressure ↑) Biochemical rxn.
(light less)
(dissolved O_2 less)

Behavioural adaptation

① lizard → In winter → when body T ↓ it bask in sun
(cold B.A)
→ In summer - it hide in burrows

Halophytes # (Ex- mangroves)

Adaptation - Sinker stomata, thick cuticle
- Pneumatophore
- Vivipary (seed germination on plant)

Hydrophyte

- Root pocket
- Aerenchyma
- No mechanical tissue

Oligotrophic soil (less nutritive soil)

↳ mycorrhize present

two types → ① ecto (ex- pinus) ② endo (ex- orchid)

Population ecology

Population – it is not possible in any habitat, single organism

- of one species present.
- More than one group is present.

↳ group of organism of same species living in a common geography which can share compete for resources which can interbreed.

→ There are two views regarding population ?

① Geneticist view ⇒ according to it population which is a product of sexual reproduction.

② Ecologist view ⇒ product of sexual and asexual reproduction.
Ex - Cormorants in wetland
Teakwood in forest

Some feature which is of population not of individual :-

(Ex- For individual → Birth, death occur, but for population birth rate occur)

Natural selection act on population

Population ecology - Study effect of human population and evolution.

Attributes of population # → which describe population

① Birth rate ② Death rate ③ Sex ratio ④ Population size

• Birth rate → it is calculated in form of no. of birth per capita in given time.

Example - Pond water - 20 lotus

after one year - 28 Lotus (8 new lotus)

Birth rate = $\frac{\text{Increase}}{\text{Initial no.}} = \frac{8}{20} = 0.4$ individual / lotus / per year

Per capita = 1 Lotus

Death rate :-

no of death per capita in given time.

Ex - In laboratory - 40 fruit fly

after week - 36 " "

death rate = $\frac{\text{decrease}}{\text{Initial no.}}$

$= \frac{40}{36} - 36 = 0.1$ / individual / Fruitfly

Sex ratio

• Population growth depends on no. of male and female.

• If nearly equal no. of booth → population growth evenly occur.

Age distribution

• normally age is calculated in three category (Both for male and female)

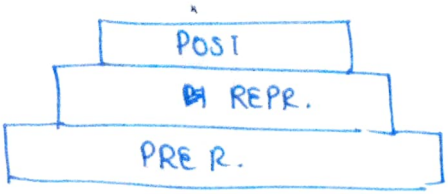
a) Pre reproductive - 0-15 years

b) Reproductive - 15-45 years

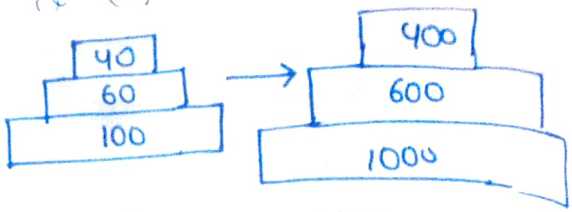
c) Post " - 45+

We observe three type of population → Expanding, Stabilising, declining

Expanding



Ex



Shape not change
but size ↑
This is of developing countries and poor countries—

- Because no planning on family
- Health facility is not good.

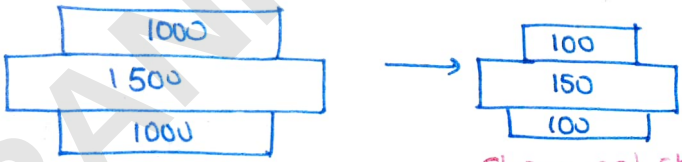
Stabilising

Bell shape curve

⇒ Developed countries
→ family planning ✓
→ Health facility good

Declining

- Highly developed country or
- in extreme condition



Shape not change

(5) Population size

Population size = population individual no. ⇒ population size tell us about habitat type, predator presence, competition present or not

Population size is also known as population density (N)

Population size is best describe by counting numbers.

But in some cases counting no. is not possible or meaningless

For ex – a) Parthenium along with Banyan tree
(200) (1)

Acc. to number parthenium is more but contribution of Banyan is more ⇒ Counting number is meaningless.
⇓
For them → ① area cover ② biomass

b) Bacteria is millions in number → counting not possible.

c) In oceans no. of fish is calculated by relative density not absolute density.

d) Indirect method :- Tiger census is by pugmark and pellet

Population Growth

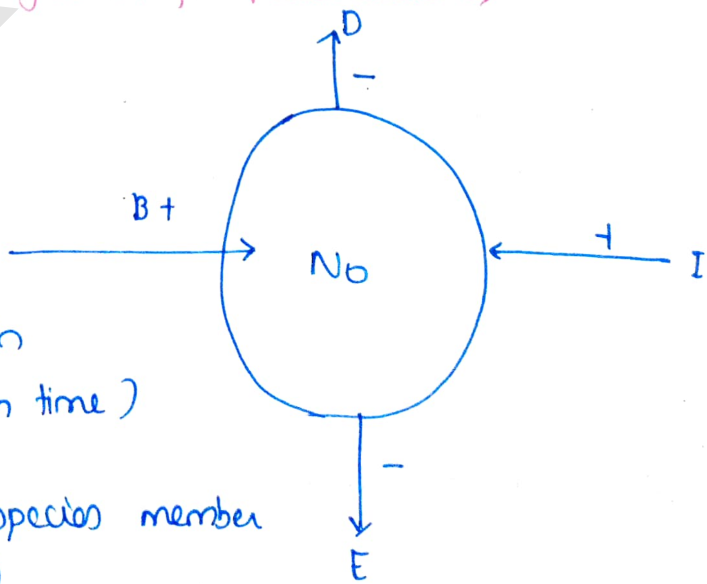
→ ~~Due to~~ population change occur in a habitat.

→ Population is affected by – ① Resources ② Predator Pressure ③ Reduced weather

For measuring population growth few parameters →

N_0 = initial population

N_t = Final "



① Natality – (Birth) –

② Mortality (no. of death in population in given time)

③ Immigration – (Same species member enter from elsewhere)

④ Emigration → same species member go elsewhere

$N_1 = N_0 + (B+I) - (D+E)$

In a stable old city main growth occurs by (B-D)
But in newly colonise city → Immigration mainly responsible

Growth model

In most of the population we see two type of growth pattern

① Exponential growth model

② Logistic " "

① Or Exponential Growth modal

- For impeded growth → continuous supply of food resource
  ↓
  any population can grow more

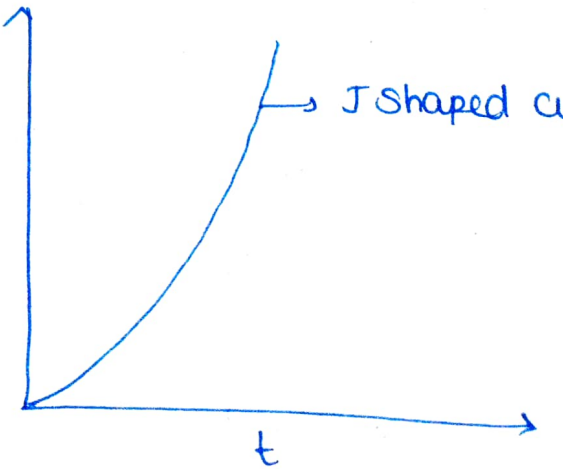
b = birth rate, d = death rate

Derived $r = b - d$, r = intrinsic rate of natural increase

r depend on biotic and abiotic factor.

$\frac{dN}{dt}$ = change in population density

$\frac{dN}{dt} = (b-d)N$



Even if value of r is very low any population can achieve very high no.

In 1981 - Human population → r = 0·0205

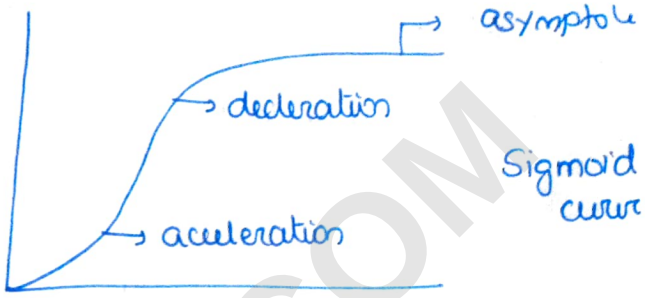
even elephant population can increase with high no.
↳ who breeds 6 times in 90 years

$N_T = N_0 e^{rt}$ → integral form

Logistic Growth curve # → In reality resources are not unlimited.

- Competition for resources
- this curve is more realistic
- $\frac{dN}{dt} = rN\left(\frac{N-K}{K}\right)$

K = carrying capacity
↓
it is population density supported by nature through resources.



K depends upon.

① Type of species (K = elephant → low
K = small rabbit → high)
② Size of habitat
③ Life span

= Any population can not cross K. It can't be greater than K.

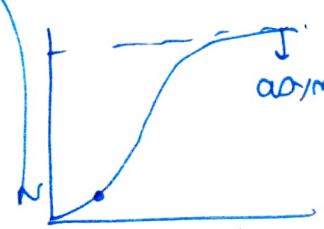
Case I - when population size low

$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$ [K >> N]
↓
neglecting N

$\frac{dN}{dt} = rN$ → like exponential

Case II

Case II - when N approach or equal to K.



$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$

$\frac{dN}{dt} = 0$ → N = constant

Q Which is not possible ?

a) $N = k$ b) $N > k$ c) $k << N$

Extra points to remembered :

(1) Niche (2) Autecology (3) Synecology

(4) Ecotype - - within species genetically different and morphologically different and adapted for different habitat.

(5) Ecophene : They are morphological and anatomical difference but genetically similar.
(Ecad)

Life history variation

Every organism evolve to maximise its reproductive fitness.

↓

Some organism reproduce once in a life

↓

Some reproduce many times

↓

Some produce many progeny, some few

Population Interaction

- No population can exist independently without interaction with other population. → Even plants which are autotrophic need to interact (Ex - some microbe interact with root)

Interaction two aspects

↙ Duration of interaction

↘ Interaction is beneficial (+) detrimental (-) and no effect

Name of interaction	species A	species B
① Predation	Predator (+)	Prey (-)
② Competition	(-)	(-)
③ Parasitism	(+) Parasite	Host (-)
④ Commensalism	+	0
⑤ Mutualism	+	+
⑥ Ammensalism	(-)	0

Ammensalism

→ species A = 0, species B = -

Example - Staphylococci (-) Fungi (0)
↳ Penicillium

② Smoother crop (Ex - Sunflower)
when they grow they don't allow any other crop to grow.

Allelopathy # - Penicillum produce harmful chemical (Allelochemical) which kill Staphylococcus → Allelopathy called

Predation # → Example - ① lion eating deer ② Crow eating grass ③ cattle grazing on grass

Predation has three roles :-

① Transfer energy to higher trophic level
② It control population density of Prey
③ It maintain biodiversity

Control population density of Prey

Prickly pear cactus introduced in Australia in 1920 → it spread very fast

population is ↲
bring under control by introducing a moth (Cactoblastis)

Maintain biodiversity # - American pacific ocean coast → intertidal area.

Starfish species pisaster reduce interspecific competition ← Experimentally pisaster remove → within a year 10 invertebrate extinct

Some mechanism to protect prey (In nature)

① Behaviour of predator is prudent → Predator only kill when required

Some adaptation is in prey

Adaptation in animals

① Camouflaged - Blend with surrounding

Criptically coloured prey - Ex - Grass hopper (Green)
Stick insect (colour is brown)

② Warning colouration → bright colour to avoid prey

③ Mimicry → Model - poisonous, can't be eaten
mimic - copy model

① Poison in insect - Monarch butterfly is poisonous
- It acquire poison when larva feed on poisonous weed

Adaptation in plants # to ~~pre~~ avoid predation

→ Plant can't run from predator

→ 25% insect → phytophagus (eat plant)

Plant evolve some anatomical and morphological adaptation

↓

thorns (cactus, acacia)

Some biochemical adaptation in plants ⇒ Calotropis produce cardiac glycosides which is distasteful to plant predator.

Some plant store - Nicotine, quinine, caffiene, Styp Strychine

Biochemical adaptation → infect digestion of predator
↓
don't eat prey.

Competition

• According to Darwin interspecific competition is responsible for evolution of new species / organic evolution.

Old definition - it is a type of interaction where two closely related species compete for resources

But this is not always true-

→ Two example to show :- competition not occur always in b/w closely related
Resources not always limited.

Ex - ① South American lake - visiting flamingoes which complete with nature & native fish for zooplankton.
(Flamingo and fish are not closely related)

② Galapogas island → Abingdon tortoise present. When goat introduce, tortoise extinct within 10 decades. In this food is not limited → but goat presence lead to extinction of tortoise → Interference competition
↓
In presence of one animal ⊙ / feeding of one animal interfere with other.

New definition # Competition is a type of interaction where two species decrease reproductive fitness (r) of each other.

Any support to this definition → competitive release

Two species → Species A → inferior
↘ Species B → superior

In presence of superior species no. of inferior is low
When we remove superior experimentally, no. of inferior increase.

Conell's Field experiment # → Rocky coast of scotland

Barnacle (Arthropoda) → ① Cathamalus (inferior)
→ ② Balanus (superior)

Balanus exclude cathamalus
→ related to competitive release

Effect of competition

① decrease r
② Exclusion of species - Cause competitive exclusion principle
Two species competing for same resources can not co-exist independently when resources are limited.

Nature not likes extinction
• other option to avoid competition.

① # Co existence # - To avoid competition
change - ① Pattern feeding
② Time feeding

Ex - MacArthur observe 5 species of warblers (birds) change their feeding pattern for co existence.

Parasitism

Parasitism ensure free ~~heat~~ meal and shelter
→ Parasitism present in large taxonomic group (Bohot saare)

Co evolution → Parasite evolve to cause maximum harm to ~~heat~~ host
↳ host evolve to resist parasite

Ectoparasite → not specific

Endospecific → specific

Some adaptation in parasite # →
1. Sense organ absent.
2. High reproductive ability
3. Sucker and hook present
4. Glands absent
5. Bisexual
6. Some evolve digenetic life cycle (two host)

Ex = Liver Fluke (Fish, Snail)
malarial parasite

Effect of parasitism →
1. cause disease to host
2. host ko weak karega
3. can interfere with reproductive tract
4. host life span ko decrease

Type of parasite

① Ectoparasite
- outside body of host
→ Ex = lice in human
ticks in dogs
copepod in marine fish

② Endoparasite
- Present inside host (liver, gall B., lungs)
→ Complete life cycle
→ Anatomically and morphological get simple
→ more advanced in reproduction.
Ex - Liver fluke, amoeba.

③ Holoparasite
→ completely depend on host

④ Hemi-parasite
→ partially depend on host

R O C A → All four Holoparasite
Rafflesia, Orobanche, Cuscuta, Arceuthobium

L V S S → All are partial parasite
Loranthus, Viscum (Stem); Striga, Santhalum (root)

Cuscuta → leaf and chlorophyll absent completely depend on host

③ ⑤ Hyper parasite :- (parasite on parasite)
(Bacteriophage is present on E.coli)

⑥ Brood Parasitism → Parasite (cuckoo bird) → lay egg in nest of host (crow)

Commensalism

① Epiphyte grow on mango tree branch → Benefit shelter

② Barnacle grow on whale → when whale move to new places Barnacle gets food.

③ Cattle egret with cattle → when cattle graze on grass insect come out eaten by bird

④ Sea anemone (coelentrata) has tentacle present clown fish

⑤ Shark has pilot fish for food in body

Mutualism

① Protocorperation :- Benefit to both (non-obligatory)

Ex - Crocodile and plover bird eat flesh in teeth of croco.

Example of mutualism

① Lichen ③ Yucca plant and moth

② Mycorrhiza ④ Fig and wasp

Sexual deceit / Pseudocopulation

Orchid (ophrys) → Flower similar to female bee

↓

male pseudocopulate