



CSIR-NET

Council of Scientific & Industrial Research

LIFE SCIENCE

VOLUME – 7

**ECOLOGY & EVOLUTION OF
APPLIED BIOLOGY**



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Evolution

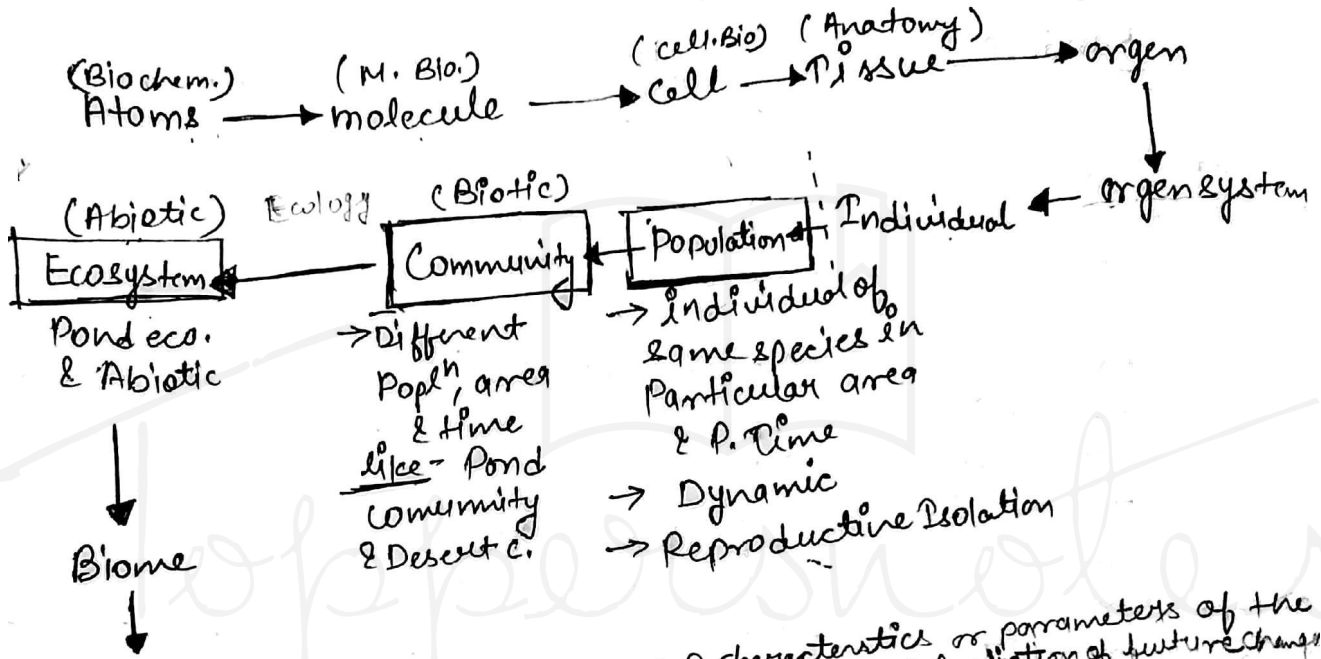
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ECOLOGY & EVOLUTION

→ To solve the questions of Ecology & Evolution apply the animals brain.
 (First use term - Feitel define = Ernst Haeckel
 Ecology - Study of interaction b/w Environment & Organism
 Ecosystem - Interaction b/w environment & organism.

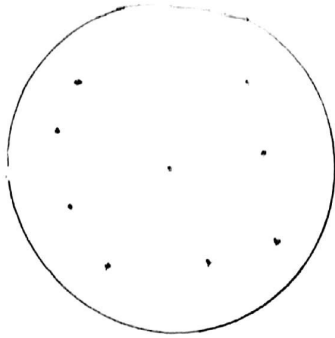


Demography :- The study of the group characteristics or parameters of the human pop^n, their changes over time & Prediction of future changes.
 ⇒ Population - Group (numbers) of individual of same species living at particular area & Particular time.
 Ex - Human pop^n of Jaipur in 2012 & 2019 it is different so pop^n is Dynamic. Pop^n of diff spp that are not capable of breeding with each other local pop^n also c'd demes.

★ Parameters of Population :-

- ① Distribution :- (Dispersion) refers to the its mainly for food. Spatial & temporal distribution pattern of individuals of a pop^n
 - ② Random (K-selected)
 - ③ cluster/clump (R-selected)
 - ④ Uniform
- In animal interaction ecology (2 type)
- ① Autoecology
 - ② synecology (Community ecology)

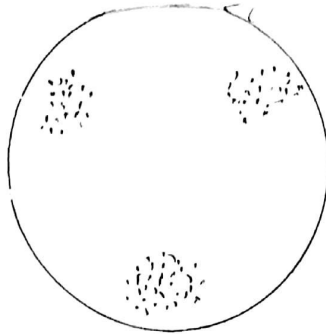
K-selected



Random

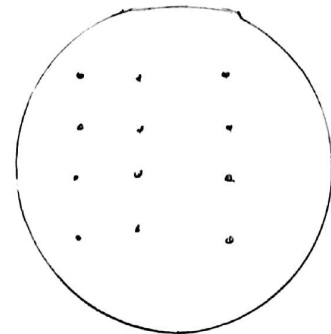
- Strong Muscular
- Body size large
- self Defend
- sound producing
- Exercise
- Maintain
- Maintain energy >> Reproductive end
- Respiration Rate more
- ATP more
- Struggle more
- Late reproduction
- Life span more
- 1-2 offspring produce
- Multiple reproductive event (Iteroporous)
- eg - Unsocial animal

r-selected



Cluster / clumped

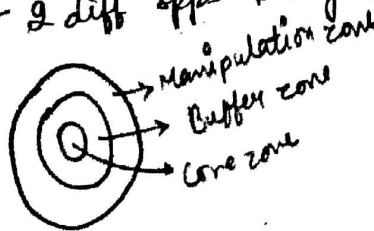
- Size small
- Struggle less
- Prod plenty (more)
- Exercise muscular is not
- Many offspring produce
- Alone survival less
- No sound
- group Defend
- Alone food search absent
- Maintain en << Reproductive one
- Reproduction more
- Respiration is less
- 6 months (Annual) life
- Single Reproductive event in life span (semelporous)
- eg. animal like ants & bees



Uniform

- (For Mutual Distance)
- eg - Agri @ cull and
- Competition occurs so distribution is uniform or some

Intraspecific struggle :- one spp's की organism के बीच struggle
 Interspecific struggle :- 2 diff spp's की organism के बीच struggle

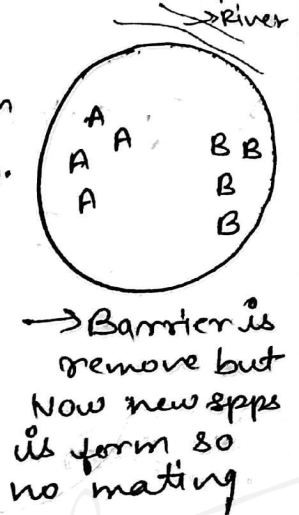
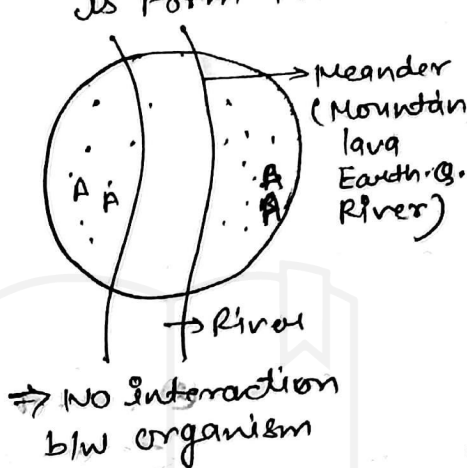
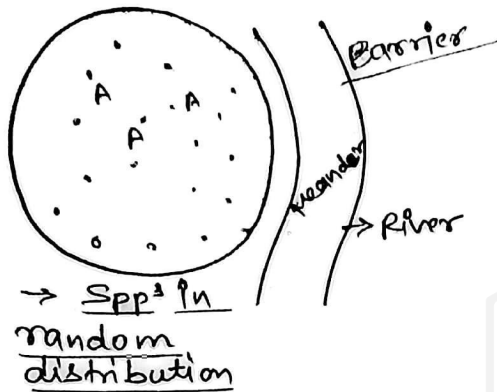


SPECIATION

→ Reproductive Isolation necessary for Speciation.
 → formation of ^{new} species is speciation.

★ **Speciation** :- formation of new species is speciation.
 → Speciation means reproductive Isolation.
 → mutation, Behaviour, Time behaviour, Natural selⁿ, Genetic drift, Env. barrier

★ **Allopatric Speciation** :- By Geographic Barrier new spp is form known as Allopatric Speciation

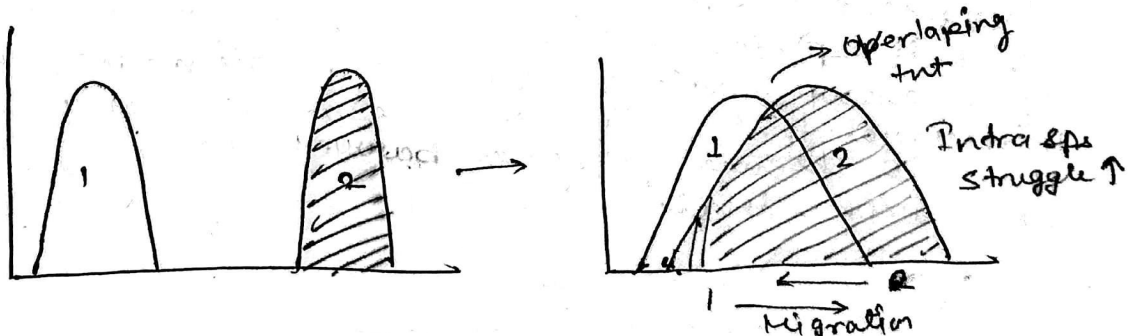
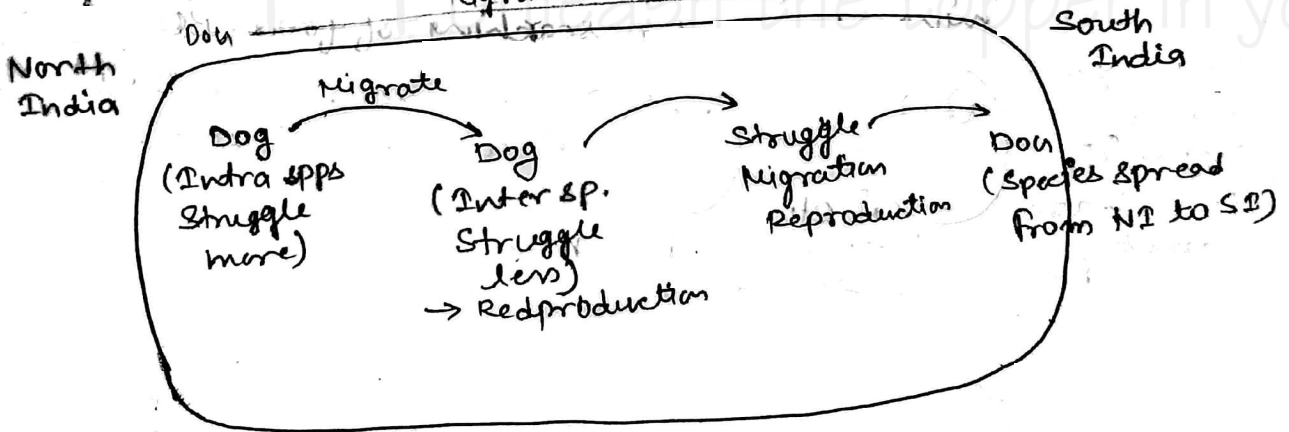


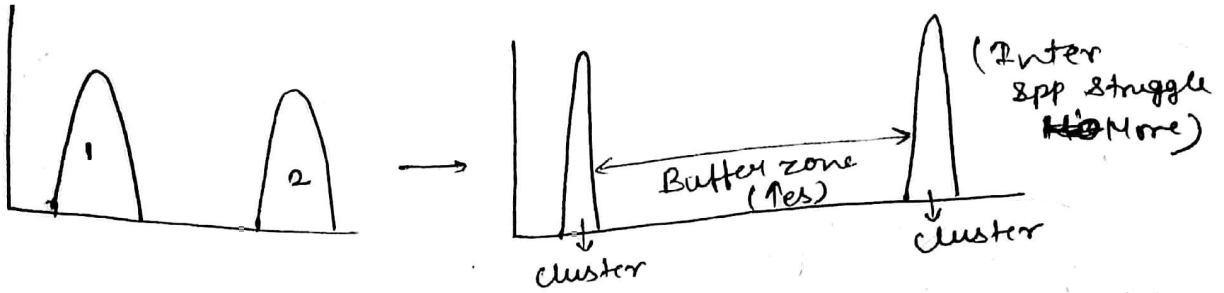
→ (organic mount = 9 time)

Geographic barrier - Mountain, lava, Ocean glacier, canyon etc.

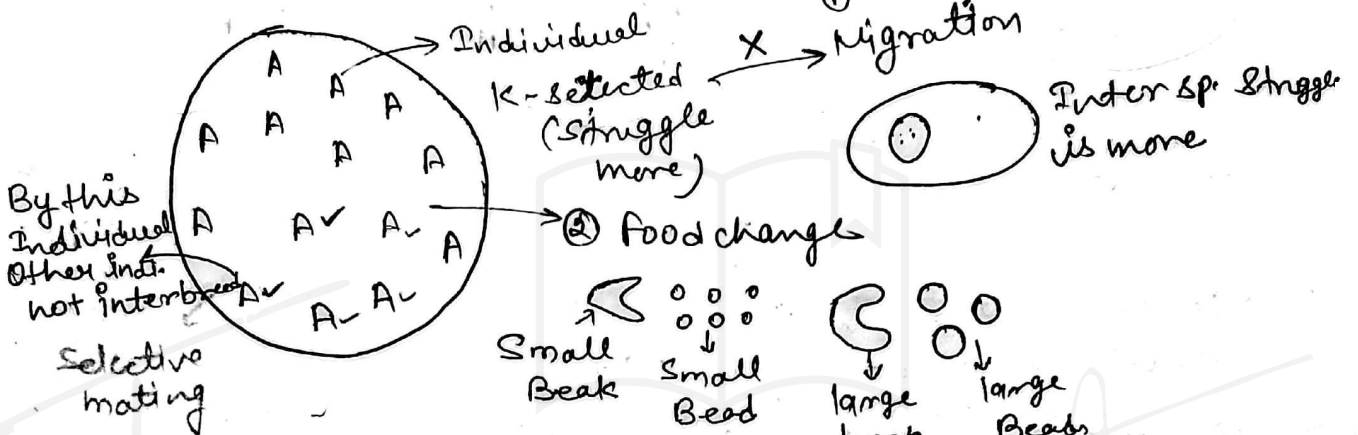
→ Climatic condition is diff so new species is form.
 → Meander - River can change its pathway of flowing.

★ **Parapatric Speciation** :- → Speciation due to high Intraspecific Struggle.
 → (Population spread in large area) → Struggle.
 → (Population spread in large area) → Struggle.
 → (Population spread in large area) → Struggle.





★ Sympatric speciation: - formation of new species by living in a same particular area.
Reason - Reproductive Isolation



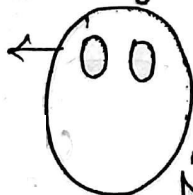
ex. American maggot fly

→ All birds beaks are different according to food. It is define by Darwin finches.

→ In a particular area beaks are different, body size is same.

③ Pining change for searching of food (Behaviour)

large eye animal Night food search



Nocturnal



Small eye animal Day food search

Diurnal

→ Island area Birds not migrate. In some Birds flying Capacity is found.

→ Sympatric = Sym=same + Patric=place.

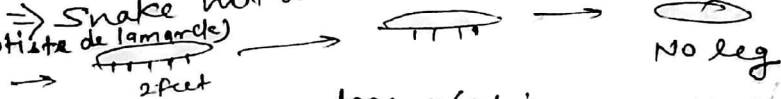
→ In this species live in some area but can't breed becay of behaviour isolation. Sympatric isolation take place b/w individual that is live in some area. In this model there is absence of physical barrier. This change at chromosome level.

EVOLUTION THEORIES

★ Evolution theories :- (Ex. cave fish (Blind) becuz. their ancestor in dark not use the legs so it is disappear)

① Lamarck (Jean Baptiste de Lamarck)

(i) Use & Disuse

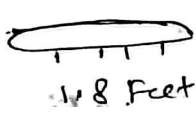
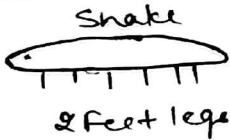


(ii) Inheritance of Acquired character → (Weismann method proof Wrong to Lamarck)

Draw back → Scientific evidence is absent

② Darwin :- Charles Robert Darwin

①



1.6 feet
1.8 feet (1.6 feet Snake easily burrow में चला जाता है But 1.8 feet को Predator Catch कर लेता है)
Can easily survive

② Natural selection :-

① offspring infinite

② Inter-Intra struggle

③ Adult - viable offspring

Variation
Inheritance
Differential

(Fittest is survive)
Struggle for existence



जिस Struggle वही है large Neck वाला जिराफ अधिक survive करता है 9 5 feet वाले की death हो जाती है

struggle is found so always variable

→ Natural selection is not depend on nature. It based on animal struggle.

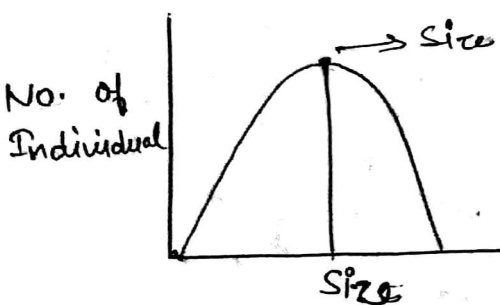
Lamarck = Philosophie zoologique Darwin = The origin of species (1859)

TYPE OF NATURAL SELECTION :-

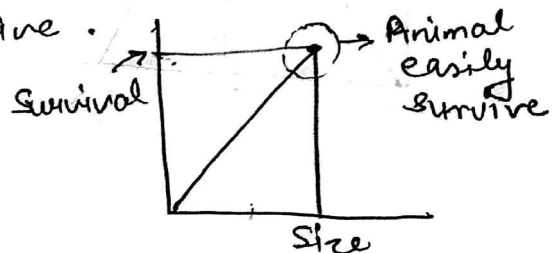
① Directional :- a particular character is select.

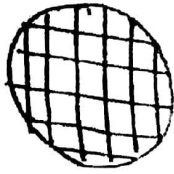
→ It provide Homogeneity

Like - long height Neck Ziraft, legless snake

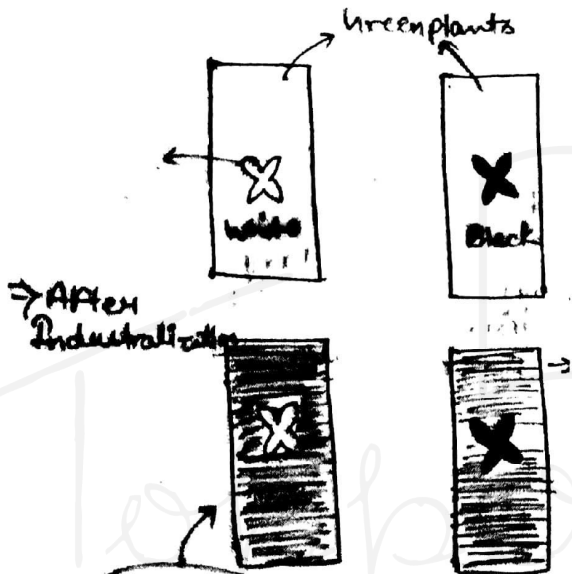
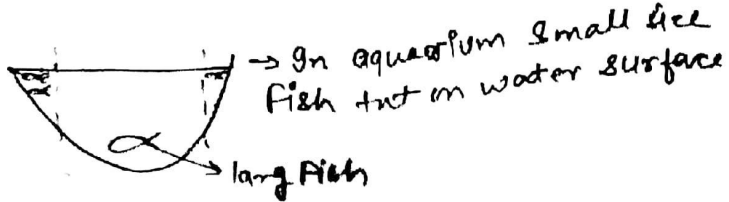


Size is more (Natural selection)
small size Neck animal is not survive.





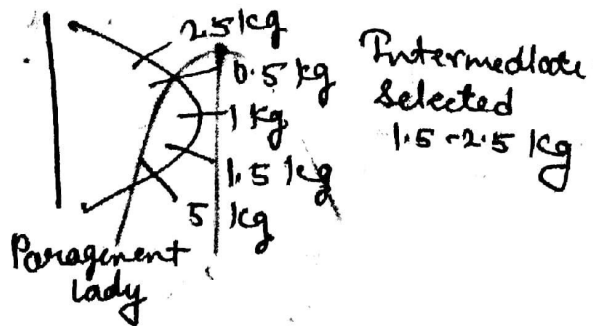
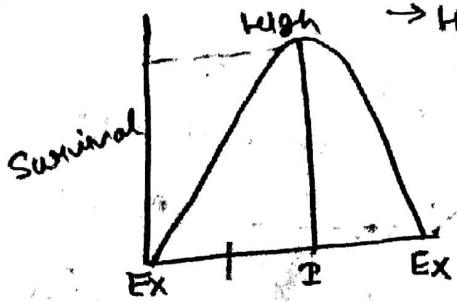
(Large) Adult → Small size Fish is naturally select because large size Fish is catch in Fish net.
(Small) Adult → Small size Fish has their no.



Predation
→ Predator catch white colour

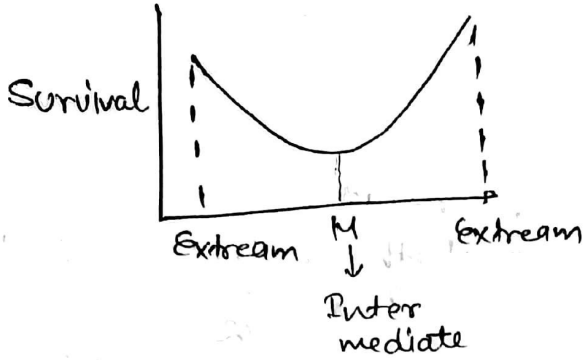


② Stabilizing: - / Centripetal selection of Intermediate character are selected eg. Height of human people
→ Homogenous population is form
Transporter
↓
It is selected by Homogenous population form



The chance of surviving intermediate is than extrem

★ Disruptive selection :-



→ Extream character is more survive than Intermediate
 like - Black & white Rat
 Black Rat - Night
 White Rat - Day



→ By this variation - Diversification occur so c/d Diversifying.

Variation → Diversifying (separation is found)

★ Fluctuating selection :-

→ Organism no. is fluctuate.

eg. HIV virus In some time no. is ↑ es & some time ↓ es



→ Predator & Prey fluctuating selection.

- ① Altruism
- ② Reciprocal Altruism
- ③ Mating Behavior
- ④ Imprinting

Behavioral ecology

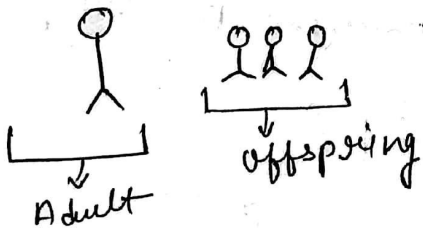
★ Altruism :- (or self lessness)

Discovery - Auguste Comte

Natural selection - survival of fittest

Altruism - Surrender of fittest

Altruism & Natural selection related to each other.



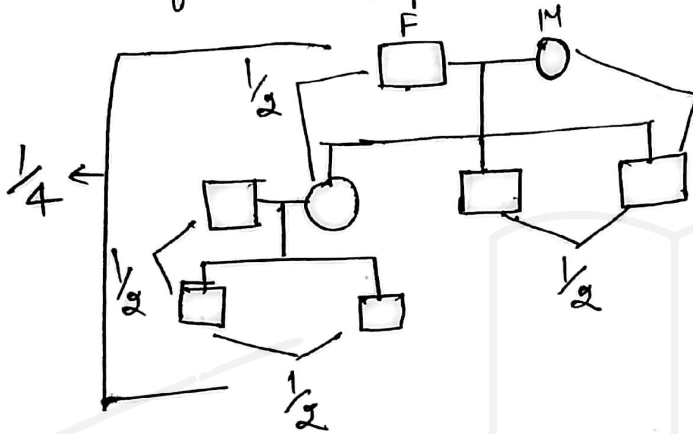
→ Adult avoid inter & Intra sp. struggle
 → Adult self defend कर लाता है
 But offspring defend नहीं कर
 लाता है
 → So Altruism में वही organism
 sacrifice करेगा जिसका progeny
 के साथ More relation है

Kin-selection theory :-
 → Hamilton is describe the relation b/w Altruism & Natural selection.

$$rb \geq c$$

r = relatedness
 b = benefit
 c = cost

→ relatedness cost \leq benefit \Rightarrow organism sacrifice \Rightarrow benefit



relatedness
 ⇒ Father / Mother → Daughter & Son = $\frac{1}{2}$
 ⇒ Great Grand Father - GGS GGD = $\frac{1}{8}$
 ⇒ Uncle / Aunt - N/N = $\frac{1}{4}$
 ⇒ GF/GM = $\frac{1}{4}$

→ b/w mother & father no relation ⇒ Brother-sister = $\frac{1}{2}$
 ⇒ Cousin = $\frac{1}{8}$

Q. Cost is .21

Ans

$r = \frac{1}{2}$

$r = \frac{1}{4}$

$r = \frac{1}{8}$

$.5 \times 1 > .21$ sacrifice \Rightarrow benefit

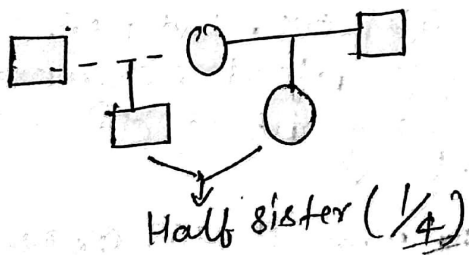
$.25 \times 1 > .21$ sacrifice \Rightarrow benefit

GGS-GGD sacrifice \Rightarrow benefit

Q Cost is 0.6

F-Son \rightarrow X

M-D/S \rightarrow X



Q Cost is 0.40

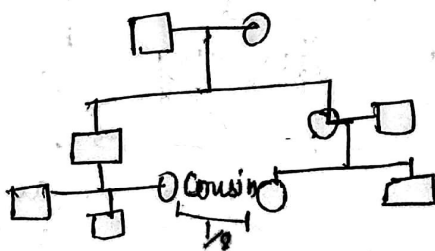
F-S ✓ B-S ✓

F-D ✓

Uncle - N/N

$$\frac{1}{4} \times 1 = 0.25 < 0.4$$

→ Sacrifice \Rightarrow benefit



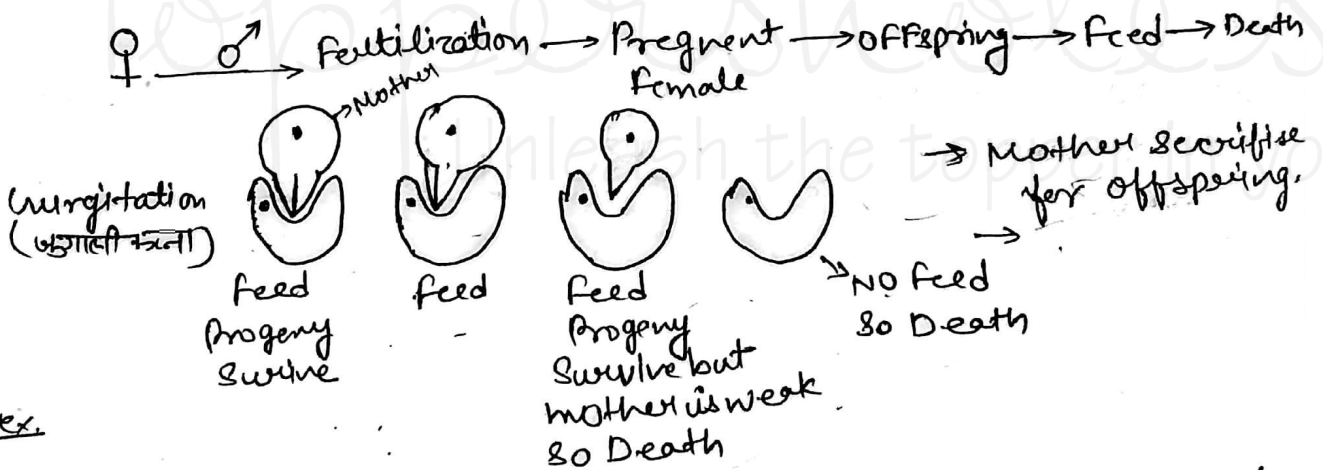
→ Altruism is surrender of fittest. A Natural selection is survival of fittest.

 → In Altruism the fittest person & Individual sacrifice its life to save the life of less fit individuals to natural selection. but so Altruism is opposite actually it is not. The relation b/w Altruism & Natural selection was given by Hamilton in his Kin-selection theory or Inclusive fitness theory.

$$rb \geq c \quad \text{benefit } \uparrow = \text{cost } \downarrow$$

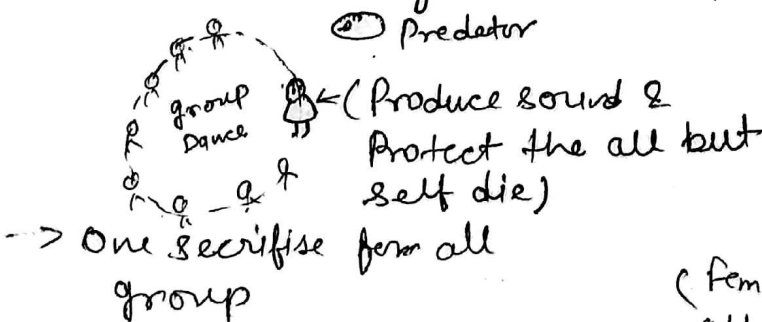
⇒ Accⁿ to Hamilton 2 type of fitness.

- ① Personal fitness:- Offspring produce by individual. (Parent & 2nd care)
 - ② Inclusive fitness:- Offspring produce by near & support. (Other memb & 2nd care)
- eg - Vampire bat eg - Adelle penguins

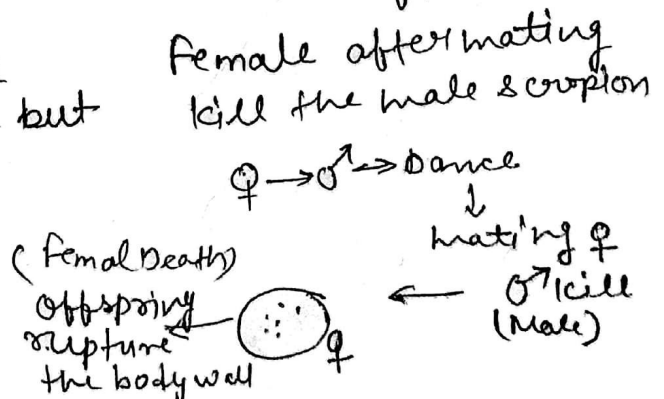


ex.

→ Varex monkey



⇒ Scorpion → not example of Altruism



Q. Imagine 20 offspring ~~by~~ you produce by you 15 parental care survive to reproduce 5 survive even though you neglect them you have given your life to an heroic (deat) that secure the life of 8 cousin for, 4 nephews & 2 half siblings. How would have died if you have not save that. Calculate the Inclusive fitness?

Ans Inclusive fitness = Direct fitness + Indirect fitness
 ||
 Parental Care || Altruism behaviour

$$\left[\text{no. offspring survive by Parental care} \times \text{relatedness} \right] + \left[\text{no. of offspring by A.B.X relatedness} \right]$$

$$= 15 + 5 \times \frac{1}{2} + \left[8 \times \frac{1}{8} \right] + 4 \left[\frac{1}{4} \right] + 2 \left[\frac{1}{4} \right]$$

$$= 10 + 1 + 1 + 0.5$$

$$= 12.5$$

Q. You save the life of 5 nephews, but in doing this you loose the opportunity to produce 2 offspring. Calculate the Inclusive fitness.

$$- 2 \times \frac{1}{2} + 5 \left[\frac{1}{4} \right]$$

$$= -1 + 1.25$$

$$= 0.25$$

[Type I] Iteroparous → breed several time during their life span.

[Type III] Semelparous → breed only once (the term semelparous & annual are not strictly synonyms. Semelparous refers to the type of reproductive event, whereas annual refers to the life span.)

[Type II]

Note:- Some spp have one type of survivorship curve early in life and another type as adult

like - Herring gulls have a type III survivorship curve early in life & Type II curve as adult.

SEXUAL SELECTION

- Sexual selection opposite to natural selection
- ♂ Frog (Deep voice) → Attract → Female (Both)
→ Predator
- ♀ Frog is attracted towards deep sound & Predator is also attracted. It seems that it is opposite to natural selection but it is not.

- ♂ Peacock (More feather) → Attract → Female
→ Predator
- Female के पास egg की Fertilize करने की choice होती है।
→ Peacock में more feather होने पर वह Female को attract करता है। But उसके साथ Predator को भी attract करता है। फिर भी more feather वाली progeny मिलती है क्योंकि mating partner भी fittest को ही मिलेगा।

[2.] Growth :-

no. is increase and decrease of organism.

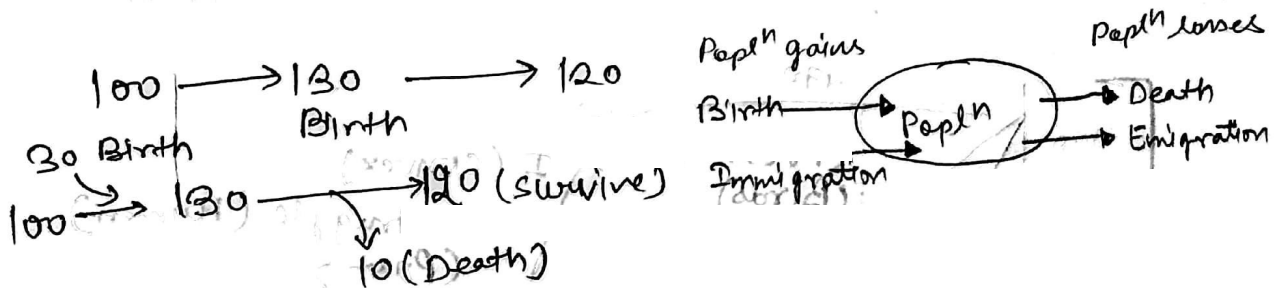
+ve growth

(2012) (2013)
100 → 120

Time = 1 year

$$G = \frac{P_{\text{final}} - P_{\text{initial}}}{\text{Time}_{\text{final}} - \text{Time}_{\text{initial}}}$$

$$= \frac{120 - 100}{2013 - 2012} = \frac{20}{1} = 20 \text{ Individ/Year}$$



-ve growth :-

100 → 130 → 80
50 (Death)

→ Growth is -ve because organism no. is decrease.

Birth Rate

Natality

Absolute (N = total potential)
Realised = 1/2
Form 1 & 2 progeny

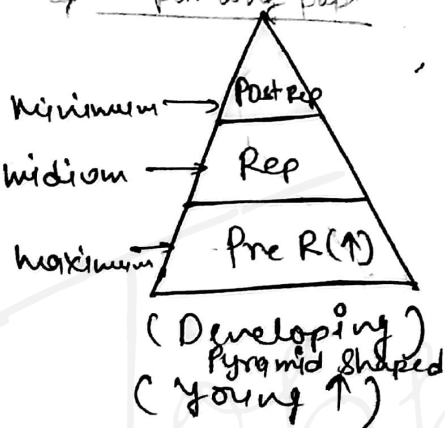
1252
40 x 9 + 3
= 40 progeny

③ Age distribution :-

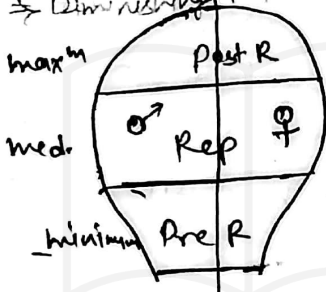
Poplⁿ → Pre-reproductive
→ Reproductive
→ Post-Reproductive

→ A group of individuals in each which are all roughly of same age is called a cohort.

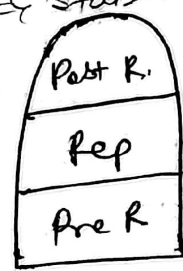
⇒ Expanding poplⁿ



⇒ Diminishing poplⁿ

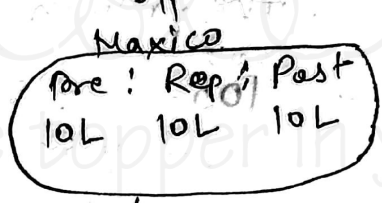


⇒ Stable poplⁿ



Bell shaped (equal)

→ Very Rare

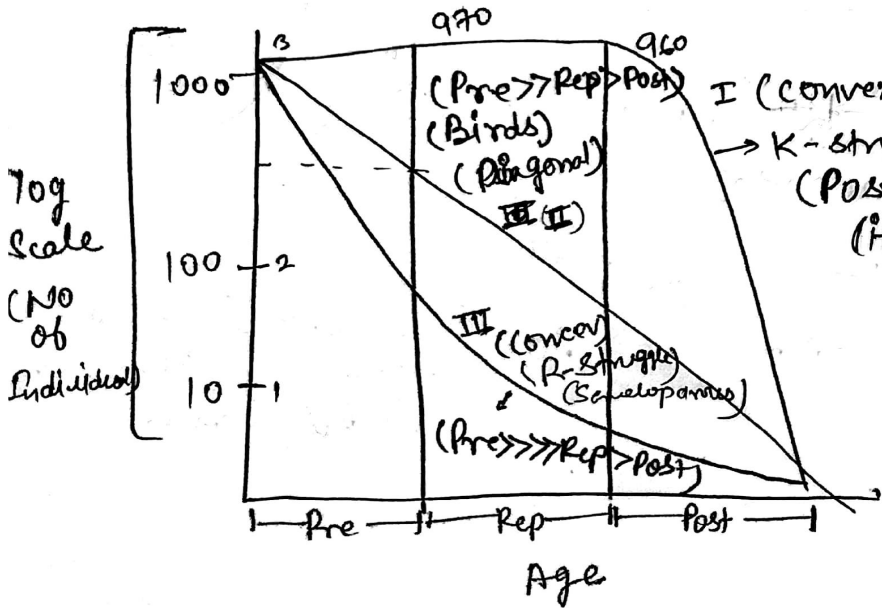


Post Rep > Rep > Post

→ Old ↑
→ young ↓
(Europe)
Post > Rep > Pre

↓ census

④ Survivalship curve :-

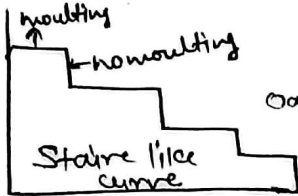


I (convex) → K-struggle (Humen)
(Post > Pre > Rep)
(Iteroparous)

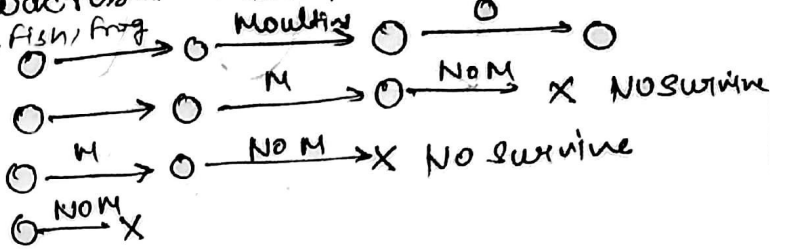
Semilog :- Half on X-axis ^{Normal} Half on Y-axis
log type so this curve is semilog.

$\log(10) = 1$ $\log 100 = 2$ $\log 1000 = 3$

Concave = Mosquito / Fly, die in young age, produce large no. of offspring
Pre \gg Rep $>$ Past R
→ little parental care

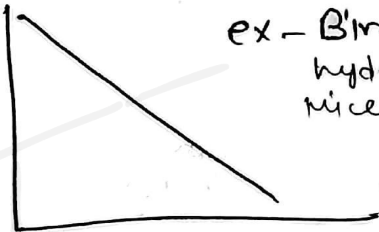


ex - Goats, trees, fish, frog
Oak trees
Bamboo
oyster



Diagonal

→ constant mortality, Age independent



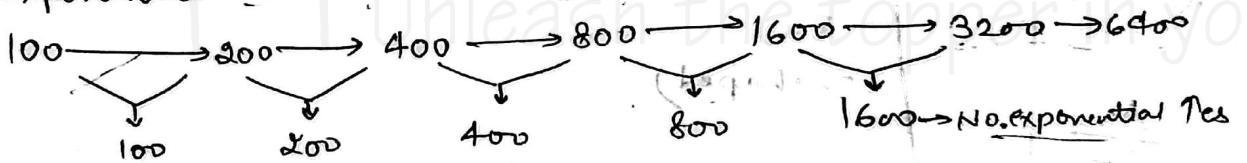
ex - Birds, Hydra, mice
Pre reproductive \gg Rep $>$ Past
(Death more)
(mortality rate is constant)

GROWTH

→ The maximum no. of offspring born per individual
This is also known as geometric growth.
(2, 4, 8, 16, ...)

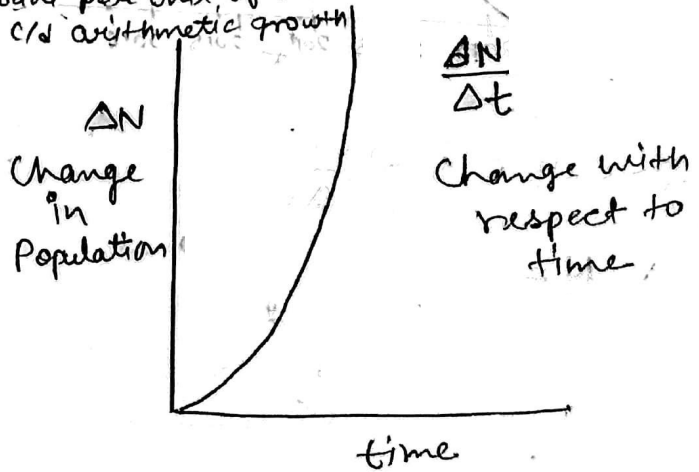
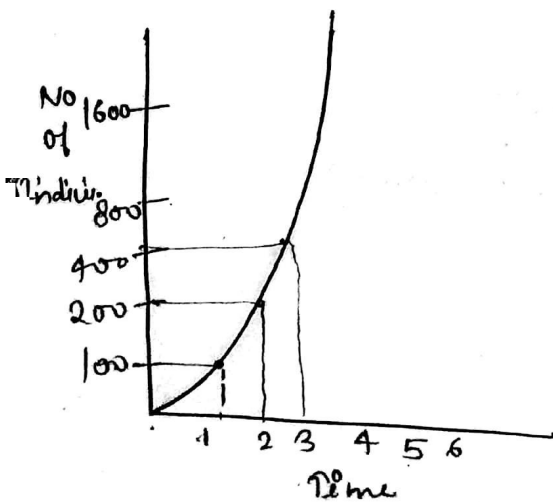
→ Exponential curve:-

Follow 2^n rule!

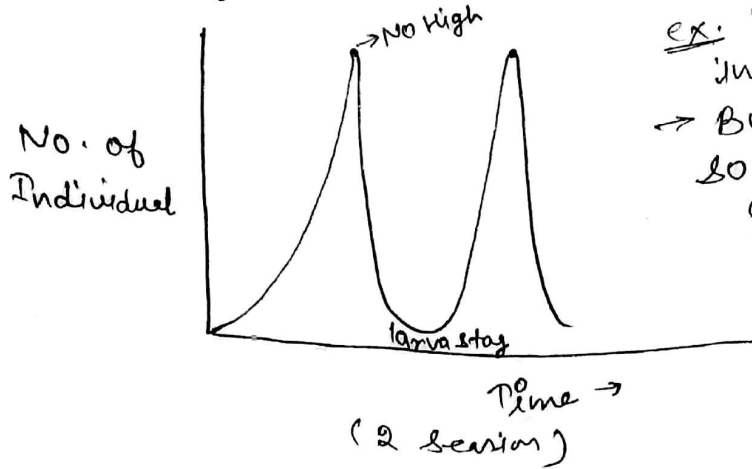


→ No. of Individual is exponential increase
J-shaped curve

→ A pattern of growth that rises at a constant amount per unit of time (i.e. 1, 2, 3, 4 or 1, 3, 5, 7)
is called arithmetic growth

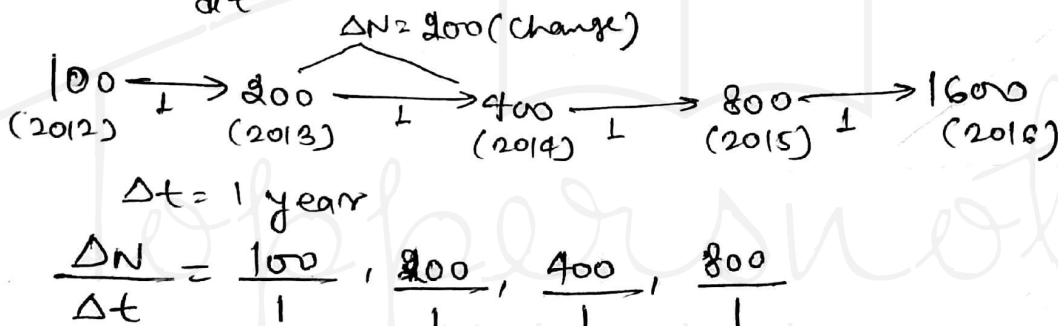


→ Exponentially Pop. It is r-selected

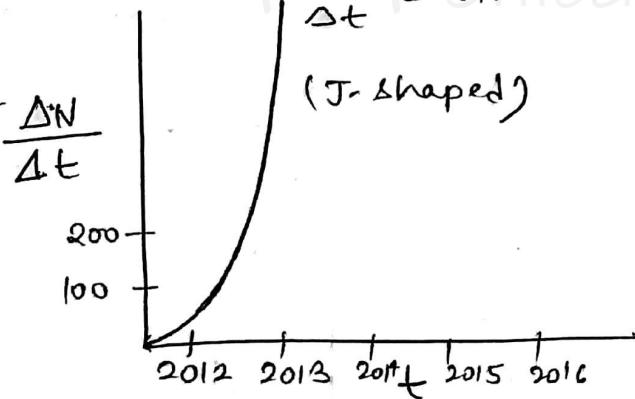


Ex: Dengu virus no. exponential increase then sudden decrease
→ But some in larva stage so next generation exponential growth Pop.

→ Change in Individual & $\frac{dN}{dt}$ is also J-shaped curve but $\frac{dN}{dt}$ graph b/w t & N is change.



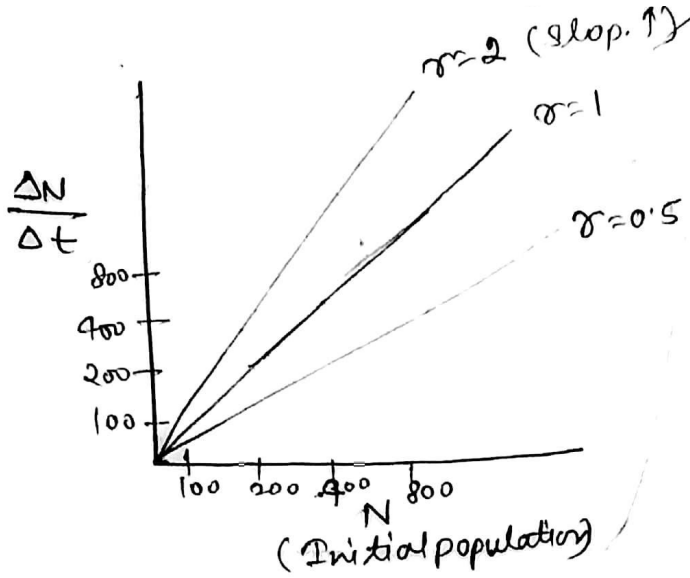
★ Curve b/w $\frac{\Delta N}{\Delta t}$ & time



★ Curve b/w $\frac{\Delta N}{\Delta t}$ & N (No of Initial)

N = 100	200	1000
= 200	400	2000
400	800	

↳ Sstrate curve)



$$\frac{\Delta N}{\Delta t} \propto N$$

$$\frac{\Delta N}{\Delta t} = \underset{\substack{\downarrow \\ \text{Slope}}}{r} N$$

$r =$ Intrinsic rate
 $r = b - d$

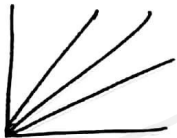
$$y = mx$$

$$\frac{dN}{dt} = \underset{\substack{\downarrow \\ \text{Slope}}}{r} N$$

$$r = (\text{Birth} + \text{Immigration}) - (\text{Death} + \text{Emigration})$$

$b > d = r$ is +ve
 $d > b = r$ is -ve

$y = mx$



→ Exponential becay food is plenty (more food)

Exponential curve
 r -selected = 100 $\xrightarrow{\text{1 year Fast growth}}$ 200 \rightarrow 400 \rightarrow 800 \rightarrow 1600 \rightarrow 3200
 K -selected = 100 $\xrightarrow{\text{slow growth}}$ 200 \rightarrow 350 \rightarrow 600 \rightarrow 750 \rightarrow 750

750 ← 730 ← 750 ← 760 ← 755 ← 750 ← 730 ← 780
 C. Capacity

→ r -selected exponentially ↑ but K -selected very slow increase

→ In K -selected after on point graph is fluctuate so it is a maximum capacity of peplⁿ is known as Carrying Capacity
 Carry Capacity = 750

→ In r -selected life span is very low like - Insect but in K -selected life span is high & no is fluctuate so sigmoid curve.