Lecture 9 : Population dynamics and role of biotic factors

Attributes of a population

i. **Density** : Population size per unit area
ii. **Birth rate (Natality)** : Rate at which new individuals are added to the population by reproduction
iii. **Death rate (Mortality)** : The rate at which individuals are lost by death.
iv. **Dispersal** : The rate at which individuals immigrate into and emigrate out of the population.
v. **Dispersion:** the way in which individuals are distributed in space. It may be of 3 types.
   a) Random distribution
   b) Uniform distribution
   c) Clumped distribution

vi. **Age distribution**: the population of individuals of different ages in the group.
vii. **Genetic characteristics** : adaptiveness, reproductive fitness, persistence.
viii. **Population growth form**: the way in which population changes / grows as a result of natality, mortality, and dispersal.

Population dynamics.

Populations grow in two contrasting ways. They are

i. J- shaped growth form (Fig 1a)
ii. S- Shaped or sigmoid growth form (Fig 1b)

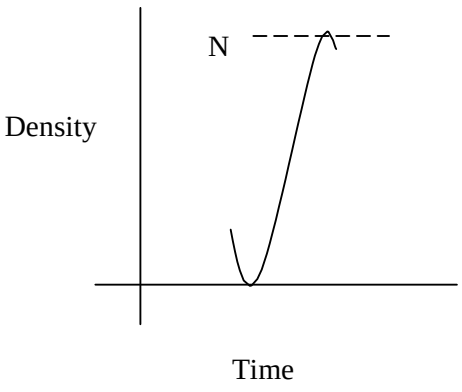

Fig. 1a. J- shaped growth form

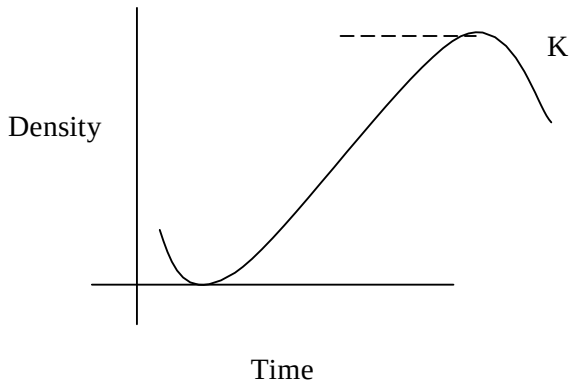

Fig. 1b. S - shaped growth form.

In the J - shaped growth form, the population density increases in exponential or geometric fashion; for example 2,4,8,16,32 … and so on until the population runs out of some resource or encounters some limitation (limit N, Fig 1a). Growth then comes to a more or less abrupt halt and density declines rapidly. Populations with this kind of growth form are unstable. Their reproductive rate is high and survival rate is less and so they are r strategists. Factors other than density regulates the population.(eg; Aphids).

In the S-shaped growth pattern (Fig 2) the rate of increase of density decreases as the population increases and levels off at an upper asymptote level K, called the carrying capacity, or maximum sustainable density. Their reproductive rate is less and survival rate is more. So they are K strategists. This pattern has more stability since the population regulates itself.(eg Hymenopterans).

The population growth rate or change is worked out using the formula,

$$N_t = N_0 e^{(b-d)t} - E_t + I_t$$

Where N_t = number at the end of a short time period

N_0 = number at the beginning of a short time period

e = base of natural logarithm = 2.7183

b= birth rate

d= death rate

t= time period

E= emigration

I = immigration.

Life table: Life tables are tabular statements showing the number of insects dying over a period of time and accounting for their deaths.

Example of a life table for a lepidoperan insect

Stage	Number living beginning of stage	Number dying by end of stage	Cause of death	Percent reduction during stage
Egg	200	10.0	Parasites	
		20.0	Other	15
Early larva	170	136.0	Dispersal	80
Late larva	34	13.6	Parasites	
		6.8	Disease	
		10.2	Other	90
Pupa	3.4	0.3	Parasites	
		0.5	Other	25
Adult	2.5	0.5	Miscellaneous	20

Factors influencing population growth.

a) Biotic factors or density dependent factors.
b) Abiotic factors or density independent factors.

Biotic factors

1) **Competition** : For at least part of the lifetime the members of an insect species are likely to be competing with one another or with members of another species for limited resources like food, mates, suitable site for oviposition or pupation. Such competition operates whenever the population is increasing and the resources are limited.

a) Intraspecific competition: When members of population of the same species compete for resources we call it intraspecific competition. Examples are as follows

- Cannibalism in American bollworm larvae
- Cannibalism in later stage grubs of Chrysopid
- Crowding in aphids result in alate (winged) form for migration
- Reduction in fecundity (egg laying) in rice weevil, *Sitophilus oryzae* during overcrowding
- Crowding in honeybees leads to swarming

b) **Interspecific competition**. This is the competition occurring between members of two or more species. Two or more competing species with identical requirements cannot coexist in a same place for a long time. The elimination of one species by another as a result of interspecific competition has come to be known as the **competitive exclusion principle or Gause's principle**.

- For example when flour beetles *Tribolium castaneum* and *Tribolium confusum* were grown in the same jar of flour, one species eliminates the other. Under high temperature and RH conditions T. castaneum eliminates T.confusum and vice versa under low temperature and RH conditions.
- Accidental introduction of oriental fruit fly *Dacus dorsalis* into Hawai eliminated Mediterranean fruit fly *Ceratitis capitata.*

2) **Predators and Parasites**

Predators : Predators are free living organisms that feed on other animals, their prey, devouring them completely and rapidly.

- Predators may attack immatures and adults.
- More than one individual of prey required for predator to reach maturity

- Major insect predators are birds, fish, amphibians, reptiles, mammals and arthropods

Parasites: An organism that is dependent for some essential metabolic factor on another throughout its all life stages, which is always larger than itself

- A parasite weakens or kills the host while feeding
- Many parasites on asingle host
- Requires only one part of one host to reach maturity

Eg. Virus, fungi, bacteria, protozoa, nematodes and other arthropods.

Parasitoid: An insect parasite of an arthropod that is parasitic in its immature stage killing the host in the process of development and adults are free living.

Interactions between predator and prey are different from the parasite host relationship in that the predator and prey maintain equilibrium more dynamically than the parasite and its host. The parasites I n general when the rate of parasitism is high, cause death and result in elimination of hosts. But the predator never eliminates the prey completely.