Unit 2- Ecology

Ecology- is the science that study about interaction of organisms among themselves and with their physical and chemical environment

Ecosystem is the community along with the physical and chemical environment of an area

Community is all population of plant and animals species in an area

Population is a group of individuals of the same species in a specific location

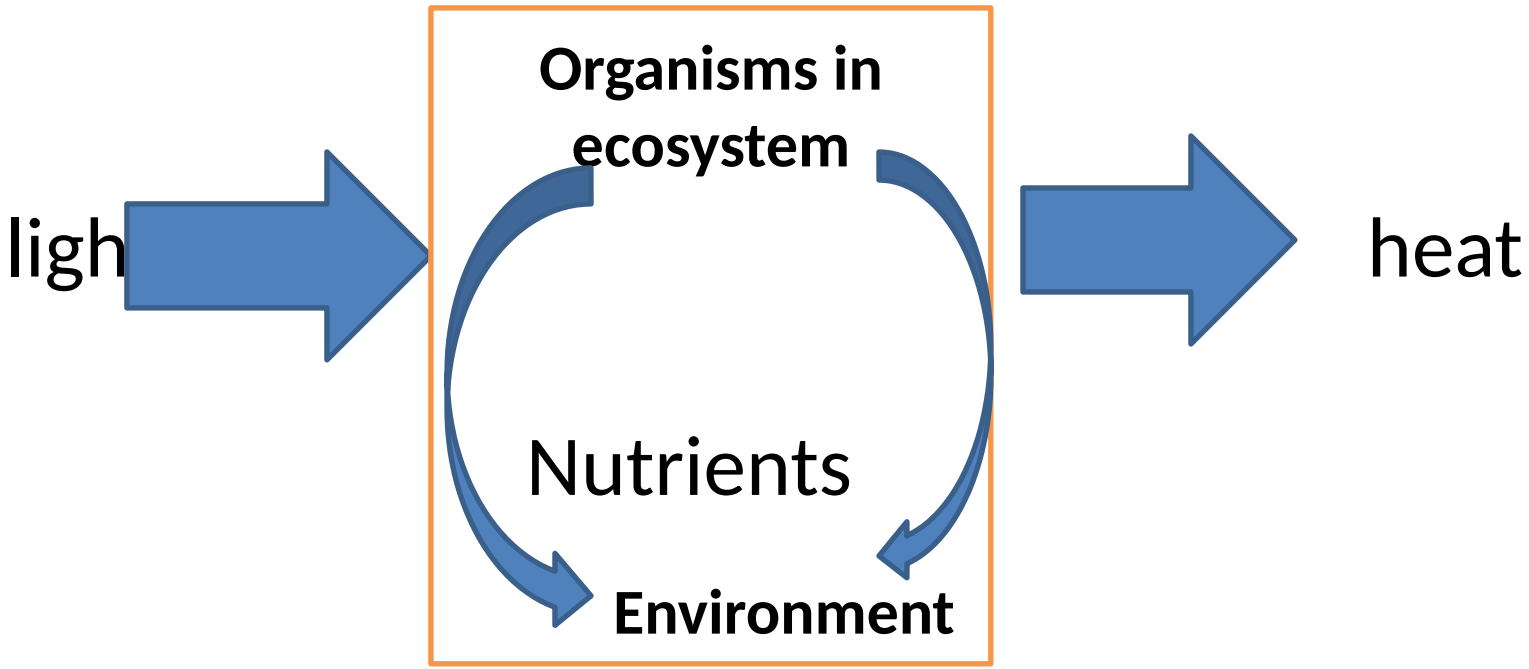
Habitat is a place where organisms live

Cycling matter through an ecosystem

Energy flow in an ecosystem and finally lost as heat and replaced as light i.e

Light energy ⊟ chemical energy ⊟ lost as heat

However nutrients recycle in an ecosystem i.e.



Materials are moved around an ecosystem when an organisms;

- Feed
- Excrete
- Respire and breath
- Die and decompose

As materials are moved along different food chains, energy is transferred from one trophic level to the other

Decomposers(bacteria and fungi) are key in returning nutrients to the ecosystem. Important mineral elements such as nitrogen, phosphorus, sulphur….. Are returned to the plants as a result of the action of decomposers

Draw fig 2:3 on page 46

Need of recycling nutrients

- ✓ There is a finite amount of each nutrient in an ecosystem and so the same nutrients must constantly be reused by recycling it
- ✓ Recycling makes nutrients available for living organisms to for growth, reproduction……
- ✓ Recycling makes use of dead organisms and waste products and turns them into usable products

1. **Carbon cycle**

✓ Carbon exist in the forms of CO2 in air.

✓ Processes that add CO2 to the envt are;

i. Respiration

ii. Combustion of fossil fuels & woods

iii. Decomposition

✓ Process that remove CO_2 from the air is;

i. Photosynthesis by algae and green plants

Main events in CO_2 recycling

- ✓ CO_2 in air absorbed by plants to make starch, sugar, protein etc
- ✓ CO_2 in plants passes to d/t consumers
- ✓ Death of plants and animals forms detritus
- ✓ Carbon in detritus is released by decomposers to the air and some sediment
- ✓ **Respiration** and **combustion** of fossil fuel releases CO_2 to the air

Draw fig. 2.5 on page 47.

2. Nitrogen cycle

- ✓ There is about 80% of nitrogen in air
- ✓ Plants absorb nitrogen in the forms of **nitrate**
- ✓ The nitrates are used to make amino acids which are used to make protein, DNA, ATP etc
- ✓ Plants are eaten by animals
- ✓ Death of plants and animals forms detritus
- ✓ Waste matters of animals such as feces and urine contain nitrogen

- ✓ **Ammonification-** decomposers release nitrogen in detritus and excretory product in the forms of **ammonium ions** into the soil by ammonifying bacteria .
- ✓ **Nitrification-** ammonium ions oxidized to **nitrite** and then to **nitrate** in the soil by nitrifying bacteria
- ➢ This cycle occurs in biological system

- Nitrogen fixing bacteria

i. Free in the soil(*azotobacter and klebsiela*) reduce nitrogen gas into ammonium ions
ii. In nodules of legume plants (*rhizobium* spp) reduce nitrogen to ammonium which is used by the plants. The extra nitrogen only become available to other organisms

- **Denitrifying bacteria-** reduce nitrate to nitrogen gas that escape from the soil. Hence they reduce the nitrogen in the soil
- Example- pseudomonas

3.Phosphorus cycle

- ✓ Phosphorus is present to living organisms in the forms of **phosphate**
- ✓ Phosphate is absorbed from the soil/water by plants
- ✓ These are passed along food chains
- ✓ Death of living organisms forms detritus which are decomposed by decomposers and release phosphorous
- ✓ Phosphate enter the soil/water by weathering of rocks and fertilizers

- ✓ Phosphate dissolved in water forms sedimentary rock which releases phosphorus by make fertilizer from them in industry

Draw fig 2.8 on page 50

4. Sulphur cycle

- ✓ Plants take sulphur in the forms of **sulphate** ion which is incorporated in plant tissue to form protein(methionine, cysteine)
- ✓ These proteins passed to consumers
- ✓ Death of plants and animals forms detritus.
- ✓ Detritus decomposed and sulphur is released in the forms of hydrogen sulphide (with the smell of bad egg) by *desulphovibrio* bacteria

- ✓ In aquatic envt, hydrogen sulphide is oxidized to sulphur by photosynthetic **sulphur bacteria**. This reaction is equivalent with **hydrolysis of water**
- ✓ Hydrogen sulphide/ sulphur is oxidized to sulphite then to sulphate by the ***Thiobacillus*** bacteria
- ✓ Combustion of fossil fuel oxidize sulphur to sulphur dioxide. In the atm SO2 oxidized to sulphite and sulphate which dissolve in rain water to form sulphuric acid

Draw fig 2.9 on page 51

5. **Water cycle**

- Water is essential to all living organisms. It;
- ✓ Makes up to 70% of all cells
- ✓ Is an essential requirement of photosynthesis
- ✓ Is the bases of all transport system in organisms
- ✓ Provide a means of removing excretory products

In addition water is used in a system called **hydroponic** to grow plants in a soil free medium

- Processes that add water to the atmosphere;
  - Evaporation of water from d/t water bodies
  - Transpiration-loss of water from plants. It returns underground water to the atm. There is large underground natural reservoirs of water called **aquifers.**
  - Respiration- loss of water from animals
- Water return to the land by;
  - precipitation/ rain

Ecological succession

- ✓ The ecosystem that exist today did not always exist, there is always a change!
- ✓ Bare rock does nit remain bar for ever, lichens grow on the rock and change the abiotic condition.
- ✓ Ecological succession is the gradual process by which ecosystem change and develop over time
- ✓ Pioneer organisms- type of organisms that colonize an are for the first time. They are usually **lichens and mosses**

The essence/core/ of succession

- ✓ Organisms colonize an area-pioneer community
- ✓ They change the abiotic condition in the area
- ✓ The changed abiotic condition allow other species to colonies the area
- ✓ The new species compete with the pioneer community and become dominant
- ✓ They also change the biotic environment and more species enter and the process continue until relatively stable **climax forest** is formed

Climax community is the most complex community that can exist under the prevailing/current/ environmental condition.

Trends/features/ that are common to all succession are;

1. The total biomass of the community increase
2. The species diversity increase
3. The number of ecological niches increase
4. Food web become more complex
5. The community become more stable

Succession that are started from bare rock is called **xerosere**

Succession that are started from water is called **hydrosere**

Different area has different climax community b/c

Of Variation in;

- ✓ Climate
- ✓ Temperature
- ✓ Rainfall
- ✓ Soil type
- ✓ Soil depth etc

There are two types of succession

1. Primary succession-succession started from bare rock, previously uncolonized ground or from newly formed pond with no life.
2. Secondary succession-succession started from an area that has been destroyed by fire or human activities, or volcano etc after primary succession

Stages in ecological succession is called **seres**

Secondary succession is faster than primary succession because in secondary succession;

- ✓ It is not start form bare rock or open water
- ✓ There are d/t seeds remain in the soil
- ✓ There are roots remained
- ✓ The soil is already present

Biomes of the world

- Biosphere- is all surface of the earth, lithosphere, hydrosphere and atmosphere, where life exist. The term biosphere was first coined by **Eduard Suess**.
- Biome- is a geographical or regional area with;
  - ✓ Specific climate
  - ✓ Specific soil type and
  - ✓ Plants and animals that are adapted in similar ways to abiotic condition within an area

Temperature and precipitation(rainfall) are the most significant climatic factor that determine terrestrial biomes while salt concentration determine aquatic biomes.

Drwa fig 2.16 on page 59

- There are two main types of biomes;

a. Terrestrial biomes
b. Aquatic biomes

1. Terrestrial biomes

- ✓ Terrestrial biomes are defined by temperature, rainfall, soil type and flora and fauna
- ✓ The major terrestrial biomes of the world are

1. **Desert**

- ✓ Almost no precipitation
- ✓ The temperature is hot or cold
- ✓ Soil is generally poor
- ✓ Plants such as succulents, sage brush exist
- ✓ Animals such as insects, reptiles, birds in hot desert and polar bears, seals in cold desert exist

2. **Thorn forest (scrub)**

- ✓ Precipitation vary (dry summer, rainy winter)
- ✓ Temperature vary (hot summer, cold winter)
- ✓ Soil is generally poor
- ✓ Plants-oak, shrubs exist
- ✓ Animals-Drought and fire adapted animals exist

3. Tundra

- ✓ Dry precipitation
- ✓ Cold temperature
- ✓ Permafrost(frozen soil)
- ✓ Plants- Lichens and mosses
- ✓ Animals- Migrating animals

4. Taiga (boreal forest)

- ✓ Precipitation is adequate
- ✓ Temperature is cool year round
- ✓ Soil is poor (rocky soil)
- ✓ Plants- Conifers
- ✓ Animals- mammals, birds, reptiles, insects ….

5. Temperate deciduous forest

- ✓ Precipitation is adequate
- ✓ Temp vary (cool season and warm season)
- ✓ Soil is fertile- ideal for agriculture
- ✓ Plants- Deciduous trees
- ✓ Animals- mammals, birds, reptiles, insect .....

6. Tropical montane forest

- ✓ Precipitation- about 9 month wet, always humid
- ✓ Always warm temperature
- ✓ Soil is fertile
- ✓ Plants- large deciduous trees, epiphytes …
- ✓ Animals- mammals, birds, reptiles, insects ….

8. Tropical rain forest

- ✓ Precipitation- wet all year round
- ✓ Temperature- always warm
- ✓ Poor thin soil
- ✓ Plants- the most diversified plant species exist
- ✓ Animals- diversified animals exist

Biomes of Ethiopia

a. **Tropical montane**

- ✓ Wetter portion of the western high lands
- ✓ Plants- dense vegetation, abundant forest and undergrowth(bushes)

b. Temperate grass land

- ✓ Higher altitude of the western and eastern high lands

c. Tropical dry forest

- ✓ Found in the rift valley and eastern lowlands. It also covers portion of the Danakil plain

d. Dry grass land

- ✓ Found in eastern low lands such as in Afar

2. Aquatic biomes

Aquatic biomes can be divided into two types based on salt concentration

a. Marine biomes
b. Fresh water biomes

a. Marine biomes

i. Ocean pelagic

- ✓ It is the region of an ocean where light penetrate
- ✓ High in salt concentration
- ✓ It is moving water part
- ✓ Plants- phytoplankton (microscopic algae)
- ✓ Animals- mammals, fish….

ii. Ocean abyssal

- ✓ The region of the ocean where no light penetrate
- ✓ High in salt concentration
- ✓ There is less movement of water
- ✓ Plants- seaweeds ..
- ✓ Animals- not common
- ✓ Animals- angler fish..

iii. Coral reef

- ✓ Most diverse of all marine habitat. Has many strata like a rain forest
- ✓ High in salt concentration
- ✓ There is movement of water
- ✓ Plants- seaweeds
- ✓ Animals- corals, fishes

iv. Estuarine

- ✓ Unique habitat due to mixing of salt water and fresh water
- ✓ Intermediate in salt concentration
- ✓ Extreme movement of water
- ✓ Plants- sea grass…
- ✓ Animals- shore birds, crabs…

b. Fresh water

i. Ponds and lakes

- ✓ Are stratified as top layer. Absorbs more heat and light
- ✓ Very small salt/ no at all
- ✓ They are standing water
- ✓ Plants- phytoplankton..
- ✓ Animals-fish …

iii. Streams and rivers

- ✓ Water is highly oxygenated
- ✓ No salt/ very small
- ✓ it is moving water
- ✓ Plants- algae …
- ✓ Animals- fish..

ii. Wetland

- ✓ Water is very nutrient rich
- ✓ No salt/ very little
- ✓ Standing water
- ✓ Plants –highest of all aquatic biomes
- ✓ Animals- highest of all aquatic biomes

Biodiversity

- ✓ The number of different species that are presented in an ecosystem
- ✓ A measure of the over all variability of life on planet. i.e a measure of;

a. Genetic diversity
b. Species richness
c. Ecosystem variability

- ✓ Referring to a successful species richness of an area, which is measured by index of biodiversity

Index of biodiversity is a number indicating an ecosystem's biodiversity

Calculated by using for example Simpson's formula i.e

$$d=\frac{N(N-1)}{\sum n(n-1)}$$

d= index of diversity

N= total number of organisms in an area

n= total number of organisms of each species

Example: calculate the index of diversity from the following table

Species	Number of organisms of each species		
	Area 1	Area 2	Area 3
A	86	16	23
B	5	17	12
C	2	17	5

dA1=93*92/86*85+5*4+2*1=**1.16**

dA2=50*49/16*15+17*16+17*16=**3.12**

dA3=40*39/23*22+12*11+5*4=**2.37**

High ‘d’ value indicates:

- ✓ There is high species diversity in an area
- ✓ The ecosystem is stable and less hostile
- ✓ More habitats and niches available
- ✓ the ecosystem withstand environmental change to some extent
- ✓ From the table above A2 is stable and has high species diversity

Small ‘d’ value indicates:

- ✓There is low species diversity in an area
- ✓The ecosystem is hostile/harsh not stable
- ✓Change in environment brings series effects
- ✓Example pioneer community

Human influence on biodiversity

- ✓ Humans have been influencing biodiversity in two main ways:

a. Deforestation
b. Agriculture

a. Deforestation

Reasons of cutting down trees:

1. For timber production
2. To make pulps and papers
3. For construction purpose
4. For energy (fire wood and charcoal)

The structure of tropical rain forest

- ✓ Tropical rain forest is the most complex and species rich ecosystem in the world
- ✓ It covers about 7% of the earth surface and contain 25% of the known species
- ✓ It contain several layers

a. The emergent layer- composed from trees up to 50 m long
b. The canopy layer- composed from trees up to 35m long

c. Under story layer- composed from trees up to 25m long

d. Forest floor- composed from trees up to 10m long

Effects of felling/cut down/tropical rain forest

- Series reduction of species diversity
- Reduction of the rate at which CO_2 removed from the air
- Reduction of the amount of nitrogen returned to the soil
- secondary succession occurs-This result in different structure of the tropical rain forest

b. Agriculture

- ✓ When the forest is cleared for agriculture, crop yields are often poor after the first year
- ✓ As a result, more forest must be cleared.
- ✓ Agriculture brings a reduction in biodiversity for several reasons

a. The area is dominated by one species
b. Organisms live there regarded as pest and are controlled by pesticides
c. Hedgerows are removed to create bigger and productive field

Status of biodiversity in Africa

- ✓ Areas that have high plant species richness have high mammal species richness b/c:
- ➢ Many different plants means there are different habitats and niches for mammals.
- ✓ there are exceptions:

Fynbos of south Africa contain the highest concentration of plant species in the world. But, it contains a few mammal species. This is because plants grow on poor soil particularly of nitrogen, and can't support large mammals

- Facts about Africa biodiversity

a. ¼ of mammals species live in Africa

World=4700spp. Africa = 1229spp.

b. 1/5 of bird species live in Africa

World= 10,000 spp. Africa = 2000spp.

c. 1/8 of amphibian species live in Africa

World = 7601spp. Africa= 950spp.

The highest number of amphibian species are found in south America and Africa

Biodiversity in Ethiopia

✓There is high biodiversity in Ethiopia. This is b/c

a. There is wide range of altitude
b. There is wide range of climate
c. Isolation of high lands of Ethiopia
d. Presence of different biomes

- Ethiopia is the **fifth** most diverse flora in Africa
  - ✓ About 6700 plant species live in Ethiopia
  - ✓ 12% of these are endemic to Ethiopia
- There are about 11 cultivated crops which have their ***centre of genetic diversity*** in Ethiopia. Those are:

1. **Coffee** = *Coffee arabica*
2. **Tef**= *Eragrostis teff*
3. **Ensete** = *Enset venticulum*
4. **Anchote**= *Coccinia absyynica*
5. **Nug**= *Guizotia abyssinica*
6. **Gomenzer**= *Brassica carinata*
7. **Suf**= *Carthamus tintures*
8. **Sorghum**= *Sorguhm spp.*
9. **Barly** = *Hordeum spp.*
10. **Telba** = *Linum usitatissimum*
11. **Gulo** = *Racinus communis*

- Ethiopia is also a center of genetic diversity of forage plants(plants grown for animal feed)
  - ✓ About 46 legume species are endemic to Ethiopia.
  - ✓ Example, *Trifolium spp*., *lablab* …..
  - ✓ Legumes are important b/c they add nitrogen to the soil as nitrogen fixing bacteria living symbiotically with them

❖Animal diversity in Ethiopia

✓High species richness of plants. This ctreats:

a. Diverse ecological zones
b. Many ecological niches for animals

Vertebrate group	no of species	endemic	proportion
1. **Birds**	861 spp.	27 spp.	3.1%
2. **Mammals**	277spp.	22 spp.	7.9%
3. **Fish**	101 spp.	4 spp.	3.9%
4. **Reptiles**	78 spp.	3 spp.	3.8%
5. **Amphibians**	63 spp.	17 spp.	26.9%

Practices that are threatened Ethiopian biodiversity

a. Practice with direct effects

1. Deforestation
2. Fuel wood collection, charcoal and illegal logging
3. Overgrazing stock animals

5. Introduction of improved crop variety

6. Overhunting

7. Introduction of alien invasive species- have high competition and some inhibit the growth of other species

b. Practice with indirect effects

1. High population growth
2. Undervaluation of biodiversity resources
3. Unsustainable exploitation by legal and institutional system
4. Disregard of communal (range) land management system- prefer intensive practice

Regarding biodiversity of Ethiopia, it is easy to paint a picture of **doom(destruction)** and **gloom (darkness)** with no hope on the horizon

But;

The Ethiopian govt try to do its best particularly:

- ✓ The eastern tropical montane forest of Ethiopia recognized as hotspot for biodiversity conservation b/c of
- ❑ Exceptionally high concentration of endemic species
- ❑ High habitat loss

- ✓ The Ethiopian institution of biodiversity conservation put forward **biodiversity action plan** in to **two** categories:

a. Ecological consideration

- Accelerate recovery of degraded forest
- Establish corridors to enhance biodiversity
- Establish buffer zone
- Planting native woody species
- Establishment of tree plantation
- Establish area enclosure
- Eradicate alien invasive species

b. Socioeconomic consideration

- ❖ Allow meaning full participation by stakeholders
- ❖ Consider local socioeconomic needs in choice
- ❖ Strengthen local organization
- ❖ Make land & tree owner secured
- ❖ Formulate policies that promote sustainable utilization and conservation of biodiversity

Why is biodiversity loss a concern?

- Millennium Assessment finding suggests that biodiversity loss contribute to:

1. **Increasing insecurity of food supply**

- lack of availability of many food sources

2. **Increasing vulnerability/exposure**

- Biodiversity help in physical protection. Example **coral reefs and mangrove forest** protect shores from flooding

3. Worsening health

- lack of balanced diet and medicine

4. Worsening social relations

- Impending/suspend religious and social ceremonies that normally bind people
- Cause resentment/offensive towards groups that profit from their damage

5. Less freedom for choice and action

- ✓ Loss of biodiversity means loss of choice

Example

- Local fishers may depend on **mangroves** as breeding ground for local fish population.
- Loss of mangroves lead to:
  - loss of control over local fish stock
  - Loss of livelihood (means of securing the necessity of life) they have been pursuing
  - Loss of the one they value/importance

- The concept of **having choice available** is an essential constituent of the **freedom of choice aspect of well-being**(healthy, happy…….)
- The benefits that humans **gain** from biodiversity are collectively called **ecosystem services.**
- It includes:

a. Supporting of nutrient recycling, soil formation and primary production
b. Provision of food, fresh water, wood and fiber and fuel

c. Regulation of climate, food and diseases and water purification

d. Cultural value (aesthetic, spiritual, educational, recreational …)

- **constituents of well-being includes:**

1. **Security** (personal, resource access, disaster)
2. **Basic materials for good life** (adequate livelihood, foods, shelter, access to goods)
3. **Health**(strength, feeling well, clean water, air)
4. **Good social relations** (social unity, mutual respect, ability to help others….)

- **Reduction in biodiversity** results **in reduction of ecosystem services** and hence **reduction of well being.**
- Reduction in number of species lead to less complex ecosystem which is less stable and more prone/suffer/ to collapse.

- If we do nothing, and allow species extinctions to continue at the present rate, then there will be a serious reduction in biodiversity by **2050**
- We are losing **10%** of our biodiversity every **50** years.
- Current extinction rate is up to **1000X** times higher than the fossil record
- Future extinction rate will be **10X** higher than present extinction rate.

- We have to conserve biodiversity
- ✓ **Conservation-**is the **sustainable** use of resources including **preservation** and **restoration** of ecosystem.
- ✓ We have to plant trees at an individual, community level to **restore our degraded environment.**
- ✓ Once the tree planted, it is possible to coppicing(cutting trees at about 10-15cm) **every year after twenty years.**

Guidelines of conservation

a. **Research**-to know what to do
b. **Minimum intervention**-balance within and b/n ecosystem
c. **Repair rather than replace**-better and easier

Ecological principle of conservation

1. Biodiversity is supported by protection of any species and varieties of species
2. Habitat maintenance is fundamental/key to species conservation
3. Large areas contain more species than smaller ones with similar habitat
4. Habitat disturbance reshape characteristics of population, communities and ecosystem
5. Climate change will affect all ecosystem

Population

- Is all individuals of the **same species** in a particular habitat at specific time.
- Every population has characteristic features such as:
- ✓ Size: no of individuals
- ✓ Density: no of individuals/area
- ✓ Dispersion: evenly/unevenly distributed
- ✓ Sex ratio: male to female ratio
- ✓ Demography (proportion of young, middle age or old)
- Population is dynamic not static

How can several populations live in the same area? The strategies are:

1. Each may exploit a different **habitat** and have different **niche**

- ✓ Habitat is an area where population live and obtain resources
- ✓ Niche is role of population in its habitat (habitat + demands made)
- ✓ Example: in a pond d/t population occupy d/t areas in the pond. Some occupy the bottom, some on the surface & other in middle of the pond

2. Different organisms can share the same habitat but make different demands/niche/ on the habitat

- Example: both **blue tits/bird**/ and **great tits** forage in tree for **insect** and its **larvae**.
  - ✓ When on or the other species present, they forage about the same height
  - ✓ When both are present in the same tree they forage in different height

Factors that influence the size of population are:

1. **Natality**-birth rate; ↓natality, ↓ pop. no
2. **Mortality**- death rate;↓mortality, ↑pop.no
4. **Migration**:

- ❖ Movement into an area-immigration

  ↑immigration, ↑ pop.size

- ❖ Movement out of an area-emigration

  ↑emigration, ↓ pop.size

5.Biotic factors:

- ❖ Predation: ↑predation, ↓pop.size of prey
- ❖ Diseases: ↑disease, ↓pop.size
- ❖ Intra-specific competition-b/n same species
- ❖ Inter specific competition-b/n d/t species

Generally, ↑competition, ↓pop.size

- ✓ **Abiotic factors**-effects of physical environments such as light, temp. CO_2, space, O_2 etc

How does competition affect pop.size?

A. Competition between members of the same species can operate in two main ways:

1. Reduce **fertility** of the pop. b/c of reduced resources and hence reduce pop.size
2. The stronger get available resources and the weak lack and die hence reduce pop.no

Examples:

- ✓ Competition b/n gypsy moth caterpillar for food
- ✓ Competition b/n sunflower for nutrient

B. Competition b/n different species can operate in three main ways:

1. One of the two species out compete the other which may die out. This is called **competitive exclusion principle** which states if two species occupy the same habitat and the same niche one species out compete the other and make locally extinct. This principle was supported by **Gause** experiment on paramecium.

Gause concluded that if two species utilize the same resource in the same way, then one will totally outcompete the other, which will become locally extinct

2. Both species suffer a reduction as both equally compete
3. The two species may manage to coexist and use the resources wisely

Examples:

- ✓ Competition b/n barnacle species (balanus and chthalamus)for space
- ✓ Competition b/n paramecium spps (P.aurelia and P. caudatum) for nutrition
- ✓ Competition b/n Ethiopian wolf and domestic dog

Population growth

- ✓ All population show the same pattern of growth
- ✓ There are two types of population growth:

a. Arithmetic popn. Growth

- ✓ The number increase by the same fixed amount in each period/time
- ✓ Example: 20,25,30,35,40…….
- ✓ It is sustainable in nature
- ✓ Slow increase of pop. Size
- ✓ The rate of growth is fixed at every time

b. Exponential growth

- ✓ The population double in each period/time
- ✓ Example: 20,40,80,160……..
- ✓ The rate of growth is accelerated
- ✓ Fast increase of pop. Size
- ✓ It is not sustainable in nature
- ✓ Growth of bacteria shows this trend

Remember: there is **no pure** exponential or arithmetic population growth in nature

- Most population developed through four main stages/phases.

1. **Lag phase**

- ✓ Population establishing itself
- ✓ They start to adapted a new environment
- ✓ Some organisms die others reproduce
- ✓ As a result, number of pop. remain low or static or increase slowly.

2. Log phase

- ✓ All individuals are adapted to the new environment
- ✓ Pop. starts to reproduce rapidly due to available resources
- ✓ As a result, the number of population increases rabidly either arithmetically or exponentially
- ✓ Natality rate is greater than mortality rate

3. Stationary phase

- ✓ The **carrying capacity** reached
- ➢ **Carrying capacity** of a population is the number of pop. that the environment is capable of supporting at that time
- ✓ The same number are dying as are produced i.e
- ✓ Mortality rate is equal to natality rate
- ✓ As a result, the number of pop. remains constant; fluctuate about a mean level.

4. Decline/death phase

- ✓ Nutrients exhaust/used up
- ✓ A new disease strikes or toxic excretory products accumulate and harm individuals of a population

As a result, the number of population decline rapidly i.e

Mortality rate is greater than natality rate

Draw fig 2:39 on page 86

Human population

- ✓ 10,000 years ago human population size was about 5 million
- ✓ Currently (2016) human population size is about 7.4 billion
- ✓ Human population increasing quickly over the past two hundred years because of:

a. Increased quality and quantity of food
b. Decreased impact of infectious disease
c. Improved sanitation and medical care

- ✓ High growth rate is one factor in preventing slow development b/c it is more difficult to:
  - ➢ Implement education program, health program and sanitation …..
- ➢ Around 2200, the human population estimated to be 12 billion.
- ➢ But the **carrying capacity** of the earth is around **10** billion.
- ➢ As a result the population is subject to various **biotic and abiotic factor** that control pop. Size.

- However human population is subject to **demographic transition** which affect
  - ✓ Growth rate
  - ✓ Death rate
  - ✓ Life expectancy

and believed to control population size.

Demographic transition: is transformation of countries from having **high birth rate** and death rate to **low birth and death rate**.

There are **five stages** in demographic transition.

Those are:

Stage 1: pre-industrial stage

- High birth rate and death rate
- Stable or slow natural increase of population
- Example, uncivilized countries like Afgahnistan

❖ **Natural increase:** is the difference b/n crude birth rate and crude death rate

Stage 2: mechanization of agriculture/urbanization

- ✓ High birth rate and rapid fall of death rate
- ✓ Very rapid natural increase of population
- ✓ Examples: Egypt, Kenya, India

Stage 3: mature industrial age

- ✓ Falling birth rate and slow fall of death rate
- ✓ Slow increase in natural increase
- ✓ Example: Brazil, china

Stage 4: Post industrial age

- ✓ There is low birth rate and death rate
- ✓ Stable or slow natural increase
- ✓ Examples: USA, Japan, France, UK

Stage 5: post industrial age

- ✓ There is very low birth rate and low death rate
- ✓ natural increase is slow decrease.
- ✓ Example Germany, Greece

Generally;

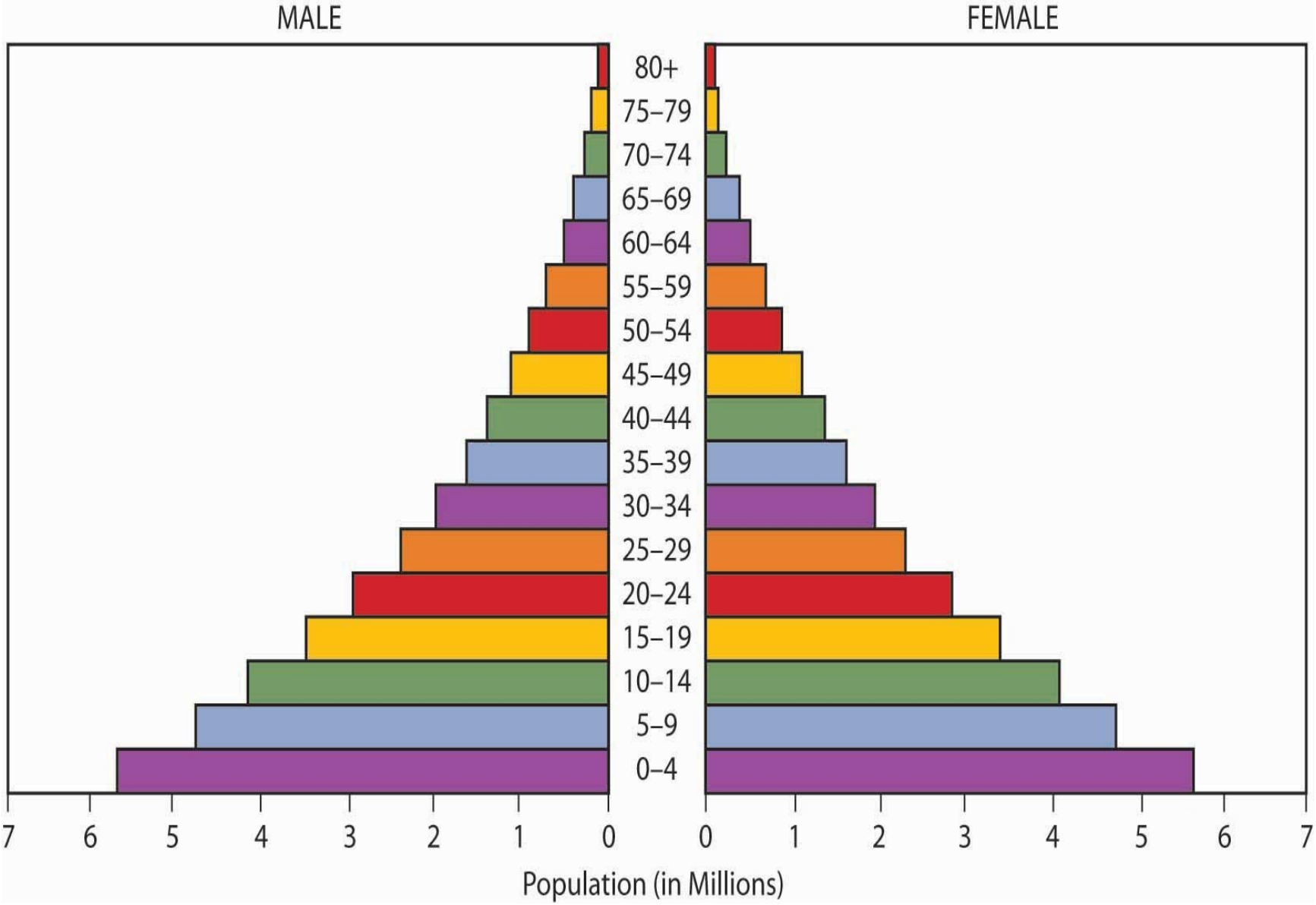
- In the second and third stage of demographic transition, death rate fall before birth rates. This creates a period when the population is increasing.
- In the final stage of demographic transition, birth rate and death rate are low and the population is stable with either slow increase or slow decrease.
- Most developed countries are in one of the two final stages of demographic transition

- Most developing countries are in one of the two middle stage (mechanization of agriculture/urbanization or mature industrial stage). As a result most of population growth is occurring in developing countries.
- Rapid growth slows the transition to the later stage.

In demographic transition the relative number of children, middle age and old age change. This change is illustrated by age pyramid.

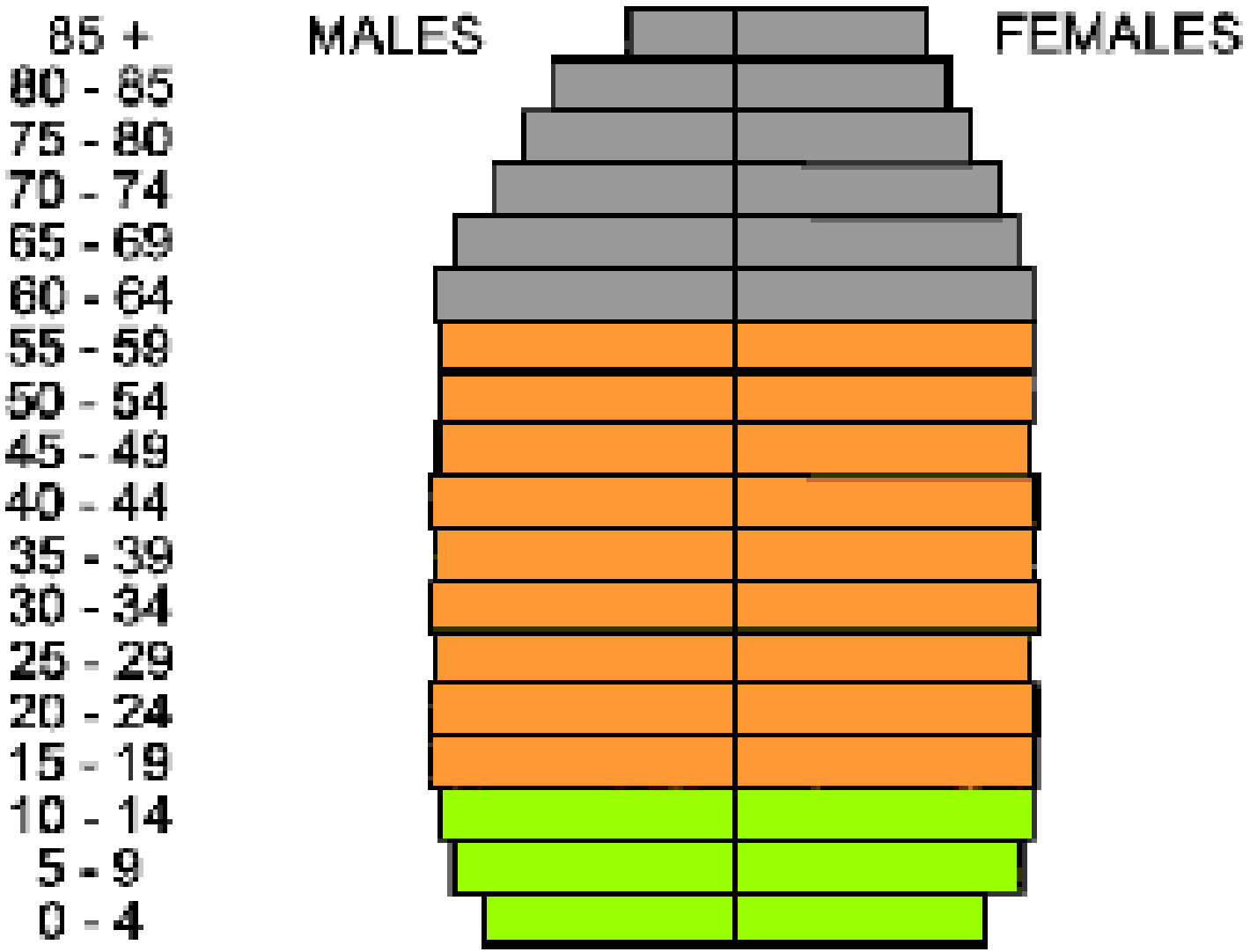
a. Age pyramid of developed countries

- ✓ Triangular in shape
- ✓ Broad at the base: indicating there are more children than the middle and old age
- ✓ Narrow tip: shows short life expectance i.e many are born less reach the maximum age


MALE
FEMALE
80+
75–79
70–74
65–69
60–64
55–59
50–54
45–49
40–44
35–39
30–34
25–29
20–24
15–19
10–14
5–9
0–4
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
Population (in Millions)

b. Age pyramid of developed countries

- ✓ Rectangular in shape: this means
  - ➢ The proportion of children, middle age and old age are nearly equal.
  - ➢ Life expectancy is high; most born children reach maximum age


85 +
80 - 85
75 - 80
70 - 74
65 - 69
60 - 64
55 - 59
50 - 54
45 - 49
40 - 44
35 - 39
30 - 34
25 - 29
20 - 24
15 - 19
10 - 14
5 - 9
0 - 4
MALES
FEMALES

To reduce global population of human:

a. Mortality should increase- this is the ‘do nothing’ b/c we can’t kill human legally
b. Natality must decrease- we have to control the number of children being born.

Note: ***migration*** has no role in reducing global population.