ECOLOGY

This is the study of inter-relations between an organism /group of organisms and their environment.

Terms used in eology

a. Biosphere: Is the part of the earth and the atmosphere where life can exist. This ranges from deep water bodies, land and few meters in the atmosphere.
b. Species: Is a group of organisms that can interbreed to give rise to viable off springs.
c. Population: A group of organisms of the same species occupying the same area at a given time eg a population of elephants in Queen Elizabeth national park
d. Habitat: Is a place where an organism lives eg land habitat is known as terrestrial and water habitat is called aquatic.
e. Ecosystem: is the basic functional unit capable of sustaining its self and consisting of plants and animals interacting with each other and the nonliving environment examples of ecosystem include Grassland ecosystem, forest ecosystem. An ecosystem must have producers, consumers and decomposer.

f. Community: Is a collection of populations of different organism occupying the same area or a group of different species of organism in the same area.
g. Ecology niche: This is a term used in relation to a particular organism. It refers to the role/profession of an organism in a given habitat eg the niche of spirogyra in a pond is to photosynthesis /to produce food.
h. Biome: These are very large ecological divisions found all over the world they have characteristic plant and animal communities eg equatorial rainforests biome, Amazon, Savannah woodland and grasslands, temperate forests etc.
i. Environment: Surrounding of an organism. **It's divided into 2 groups**:

The Biotic environment:

Consists of animal and plant communities. Therefore biotic is considered to be the living component whether micro or macro in size. These form a vital part of an environment of and are in constant interaction with it. The plant community is known as flora and animal community is fauna.

The Abiotic Environment: These are nonliving components of an ecosystem. They are supposed to be natural. These include;

1. Climatic elements of the atmosphere such as rainfall, light, temperature, Humidity, air currents (wind), atmospheric pressure, cloud cover etc.
2. Water bodies of all sizes. Some are fresh water bodies other are marine (high salt condition)

Features of these water bodies include:

Water temperature, water salinity, water currents/ waves, water pH etc

3. Edaphic (soil) factors, include soil structure, profile, texture, PH, temperature etc.
4. Lithosphere (rock types) factors or land forms eg metamorphic rocks, sedimentary rocks and igneous rocks.

RELATIONSHIPS WITH AN ECOSYSTEM

Food relationships in an ecosystem

Food is a source of energy in a chemical form. Food in an ecosystem exists as organic matter (Biomass). Biomass is the measure of the amount of living or organic materials in an organism. It considers the dry weight (minus water and other fluids in the body).
Food relations are a common form of interaction which consists of eating (consuming) and (being eaten).
Within the relation there are different modes of feeding. The modes of feeding depend on;

a. the nature of food
b. the feeding level

Green plants/Autotrophs make their own food using sunlight energy .They incorporate water and carbon dioxide into organic materials (starch) and the process is known as photosynthesis. Some of the food energy is used by the plant for its own metabolic activities eg respiration. Some of the energy is lost during transpiration in form of heat. The lost heat energy becomes part of the abiotic environment once it enters the atmosphere.

The balance of energy in the plant is available to the next trophic level made up of the herbivores, omnivores,--- lower carnivores,----top carnivores ----scavengers.
Scavengers, feed on carcasses of the animals killed by the carnivores.

From herbivores to scavengers are heterotrophs because they can't manufacture their own food. Trophic level refers to energy levels (usually in terms of food).

Within an ecosystem green plants are referred to as producers since energy enters the ecosystem through these plants

NB: since consumers do not eat all parts of the plant, it means that all the available energy is not utilized

FOOD CHAINS

A food chain is a simple method of representing food relationships existing in an ecosystem by showing organisms eating and those being eaten.

The organisms eating (eater) is the consumer. There are various levels of consumers namely:

Primary consumers 1°(herbivores)

Secondary consumer 2°(lower carnivores)

Tertiary consumers 3°(higher consumer)

Quaternary consumer 4°(scavengers)

In construction of a food chain an arrow is used to link the different levels of organisms and the direction in which the arrow points is from the organism that is being consumed to the next consumer.

Eg Tilapia → Nile perch → Crocodiles → Bacteria

1ST trophic level 2nd trophic level 3rd trophic level 4th trophic level

From one level to the next level food energy is being transferred. The different levels are referred to as energy levels. Some of the food energy is utilized by respiration while some of the energy is lost through various processes namely;

a. In form of heat through defecation
b. In form of heat through urination
c. In form of heat through sweat
d. In form of heat through panting
e. In form of heat through exhalation

The amount of energy gained by the higher trophic levels keep on decreasing such that at the final level (decomposes) the amount of energy is negligible.

NB: Assuming there were no decomposers in an ecosystem, the ecosystem would be full of dead undecomposed matter.

Other examples of food chains include;

Green plant → herbivores → lower carnivores → top carnivores → scavenger

Producer 1° consumer 2°consumer 3°consumer 4°consumer (Energy levels trophic levels)

Land Food Chain

Grass → Zebra → Lion → Vulture → Bacteria

Tree leaves → Girraffe → lion → Vulture

Aquatic food chain

Water woods → mosquito larvae → Tilapia → Nile perch → Crocodile → Bacteria

Food chain on both land and water

Water weed → Tilapia → Nile perch → Vulture → Bacteria

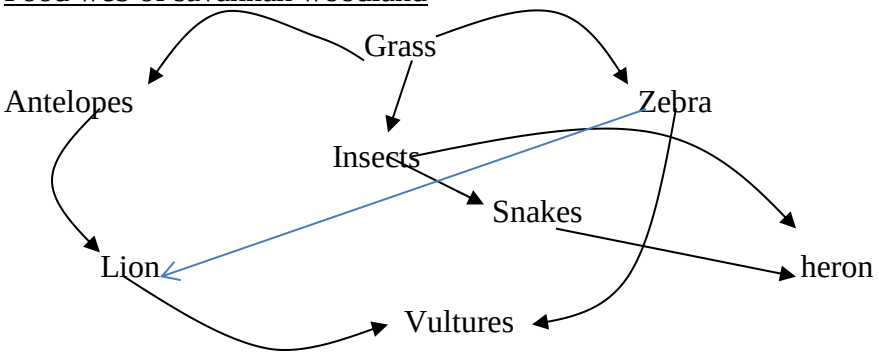
NB. Man should not be included in any ecosystem because he belongs to ecosystem

FOOD WEBS

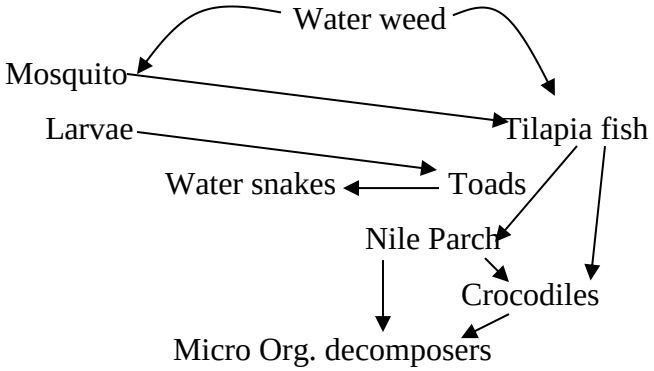
This is a complex way of representing food relations in an ecosystem. Its complex because it consists of very many food chains. This means that arrows form a network which resembles a spider web hence the term food web. (In a natural community, several food chains are interlinked to form a food web).

Several herbivores may feed on one plant. Similarly, a given herbivore may be eaten by different carnivores.

Food web of savannah woodland



An aquatic food web



ECOLOGICAL PYRAMID

An ecological pyramid is a graphical representation of food relations in an ecosystem. The graph looks/ resembles a pyramid because one end is broad and another is narrow.

There are 3 types of ecological pyramid which depend on what has been considered i.e

i. Pyramid of energy where the energy content at each level is considered
ii. Pyramid of number where the number of organisms at each level is considered
iii. Pyramid of biomass where the amount of organic matter at different trophic levels is considered.

An ecological pyramid is constructed from a food chain because it shows the different energy levels.

The producers are at the base then the successive trophic levels come one after another

NB: Decomposers are excluded from an ecological pyramid because;

i. In terms of numbers, they are too many
ii. The energy at this level is negligible too.

Its only the pyramid of energy that is always upright because in an ecosystem the amount of energy is greatest at the producer level but keeps decreasing as the trophic levels continue.

Pyramid of numbers / biomass may be upright, inverted, partly inverted or partly upright.

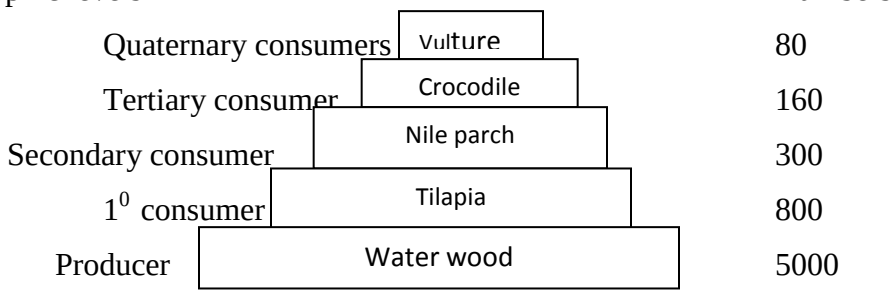
Construction of ecological pyramids

1. Form a food chain. Indicate various trophic levels which constitute different levels of the ecological pyramid

2. Use of horizontal bar. The length of the bar must be proportional to the quantity representing.
3. The producers form the base, while the other trophic levels come one after another. NB. Decomposers are excluded
4. A complete ecological pyramid should have organism at each trophic level indicated on the bar. The various trophic levels indicated to the left ie. Producers 1consumer. The quantity presented at each level on the right hand side. This could be number of organisms, the amount of energy or the biomass.
5. A complete pyramid must have a title. It must indicate the type of pyramid, state the ecosystem

   The pyramid must not be shaded and must be drawn in pencil

Pyramid of Nos for a partly aquatic / terrestrial ecosystem



COMPETITION AMONG ORGANISMS

Limited resources shared by many organisms result into competition. Limited resources may be due to presence of physical barriers

i. Over exploitation (dependence)
ii. Bad weather
iii. Natural hazards e.g fire outbreak, diseases outbreak, pest attacks, etc
iv. Migrations

There are two types of competition

1) Intraspecific competition: which is the competition between organisms of the same species
2) Inter specific competition which is the competition between organisms of different species.

   Both types are found among animals and plants

In case of animals, resources competed include;

Food, mates, habitats, space, gasses, water

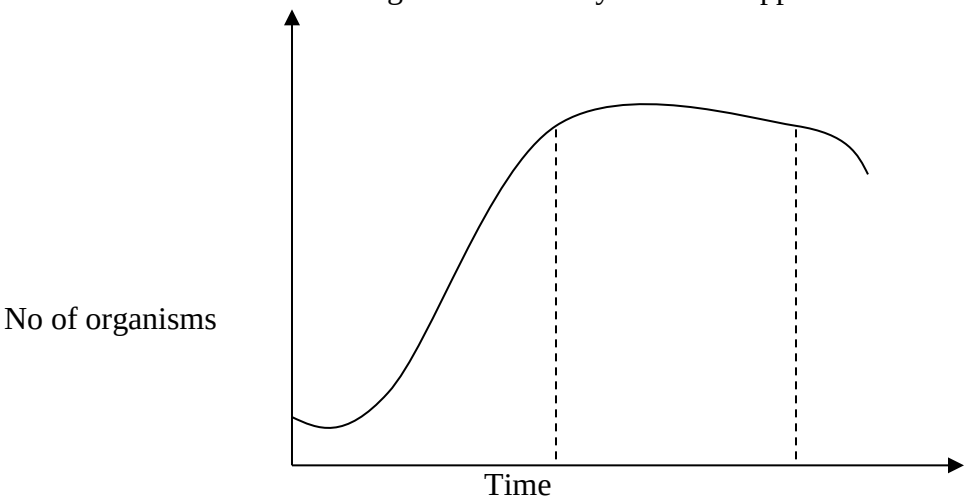
Plants can compete for nutrients, space, gases, water and light

Results of competition

1) Emigration: Moving out of the population
2) Extinction of some species
3) Elimination of weak and un healthy from the population
4) Low output / yields

Carrying capacity

Is the maximum number of organisms an ecosystem can support.

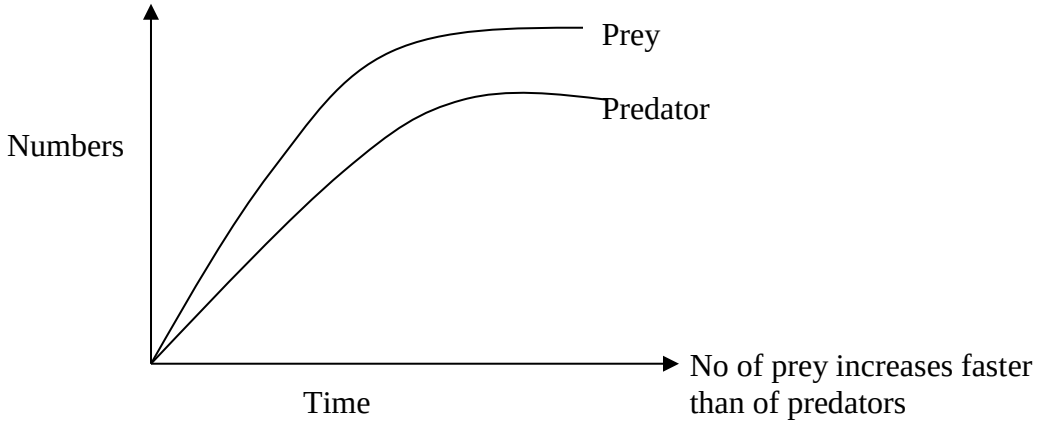


Prey – predator relationship

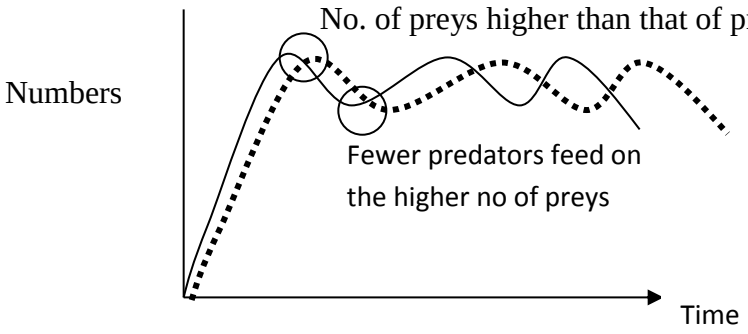
Prey is the animal eaten and the predator is the animal consumer e.g herbivorous and carnivorous. Predators depend on live prey and the prey has to be ambushed, seized, killed and then eaten.

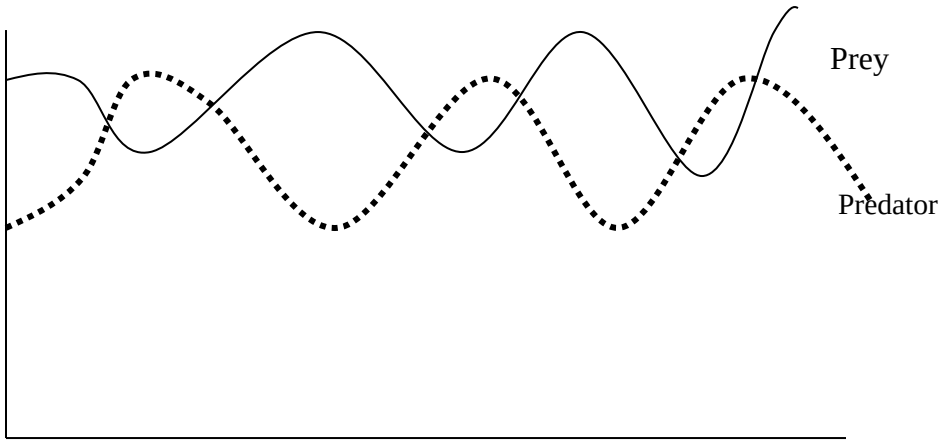
NB. Scavengers keep close to the predator e.g Hyena, Vulture, and Marabustock. These feed on carcasses (dead body/ remains of animals)

Changes in prey/ predator population with time (In different ecosystems where there is no competition)



Where there is competition





ECOLOGICAL SUCCESSION

Is the gradual replacement of the community of organisms in one area or another. It may take millions of years. Once the plants have established themselves eg will attract animals since they are the producers. Succession occurs in stages known as SERAL STAGES. The first community of plants is referred to as the PIONEER COMMUNITY. This keeps its self under harsh conditions. This place has very low rainfall, very high temperature, nutrients are scarce and the surface on which it grows lacks soil (rocks) eg lichens which are highly adapted to these un favourable conditions. As the successive communities colonize the area, the previous community has made the conditions more favourable for growth.

They break/weather the surface rock to form soil. They conserve and trap moisture and as they die, they decay and contribute nutrients to the soil. In the process of succession there is a transition from simpler communities to more complex communities and this occurs through the process of colonization.

Colonization is mainly by disposal of seeds, spores, fruits and any vegetative part of a plant.

Types of succession

1) Primary succession

The primary community colonizes and establishes on a bare surface which has never had any community existing. It has got several stages

First stage (Gutose lichen's stage). It is a thin layer of lichens on the surface.

Stage two. (Foliase lichen) .This means leafy

Stage three. (The moss). It is plenty with a lot of rain

Stage four (Herb) its made up of non woody plants eg dodo, commelina etc

Stage five (shrub) it's made up of woody plants.

Stage six (climax forest community) it's made up of highly developed big trees. It starts with few trees which are scattered and have stunted growth due to unfertile soils. Their leaves fall and decay and this increase the soil fertility. The forests trap rain water using their leaves. Invertebrates and rodents are attracted hence braking down the litter. New species of trees colonize the area and have a faster rate of growth. The trees grow closer to form a forest. A typical forest has got a number of layers. The big trees form the

emergent layer followed by the canopy layer and then the under growth (shrubs and herbs).

The temperatures are moderate with enough rainfall and high humidity. The litter becomes a habitat for invertebrates e.g. earth worms and termites which improve the soil with their droppings. When they die, decay and add humus to the soil. They create tunnels in the soil improving the soil drainage and aeration. They mix the soil, earth worms break down plant materials as they feed.

2) **Secondary Succession**:

It occurs when a previously existing community is completely destroyed and a new community re-establish its self.

Natural pests attacks, fire outbreak, volcanic eruption, flooding, droughts.

Human hazards include; - Bush clearing and burning

Wars,

Deforestation

Excavations (mining and constructions)

POPULATION

A population is a group of organism of the same species (able to breed among themselves) occupying the same area.

Characteristics of a Population

i. It must have a specified number of organisms (population size) which can be expressed as; -

Total Population: Includes number of all organisms e.g. 1200 elephants in queen Elizabeth National park.

Population density: Number of organisms per unit space i.e. area or volume (cubic units)

1200 Elephants in 40 km^2

Therefore; population density = 1200/ 40 = 30 Elephants per k^{m2}

The population size can be determined using various methods;

a) Direct method.

Drive and count. Used on big mammals in a park, here animals are counted from a moving track/ land rover using binoculars; you can also use an air craft and keep counting in a sample space.

Total: average no. per sample space x number of samples in the area.

Challenges / weatness

- This method is very expensive and tiresome
- Its risky especially working with dangerous animals
- The animals may tend to run away from noisy items like an aircraft.
- Method work best in an open area.

b) Capture, Mark, release and recapture method.

It can be used for rodents, birds, fish and insects. These organisms must have a confined movement i.e there should be minimum movement in animals into and out of the population. There is little change in the population i.e. few are born and few die.

Steps

i. Capture by trapping without killing by various evenly distributed traps.
ii. Mark using ink that cannot be rubbed/ erased, tag / ring and count.
iii. Release and allow them to freely mix with other organisms
iv. Recapture by trapping and record,

i.e. Total recapture = N_2

Marked among N_2 = N_3

Apply Lincoln index. Where, Population in an area = $\frac{N_1 \times N_2}{N_3}$

e.g.

40 in an area

20 captured = N_1

Marked and recaptured = 08 – N_3

Total recapture = 18 – N_2

Therefore, $\frac{N_1 \times N_2}{N_3} = \frac{20 \times 18}{8}$

$= \frac{45}{}$

Flying insects: use light traps mainly carried out at night

- The light is suspended at night
- A large white sheet of cloth spread underneath. The sheet attracts large number of them which fall on the cloth.

c) Collect and count

Crawling insects - use a water trap

- use a pit fall trap

Water trap is mainly used for aphid

⇒ Water is placed in large trough

⇒ The trough is placed under a plant so that the insects keep falling in the water where they are collected and then counted.

Pit fall trap is mainly used for insects like ants and termites.

⇒ Dig a pit in the path of insects

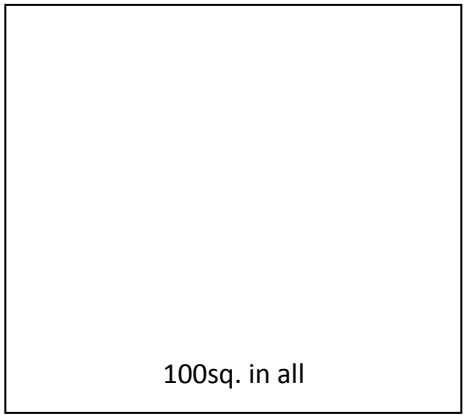
⇒ Put a beaker into the pit. The top of the beaker should be at the same level as the ground and count them.

SOIL ORGANISMS (EARTHWORMS)

Dig to loosen the soil where the animals are spray with potassium permanganate solution. It irritates the earth worms which move to surface. They are picked and counted.

PLANTS

Use of quadrant: A quadrant is a square area randomly chosen and usually of size one square meter ($1m^2$) and used for studies on population of organisms. Such an area is determined using a square wooden frame known as a quadrant. It can be randomly thrown to mark a square metre of an area. The area is divided into small squares. The % coverage of each vegetation type is determined.



10squares.

10squares

Read about a belt transect/ transect line.

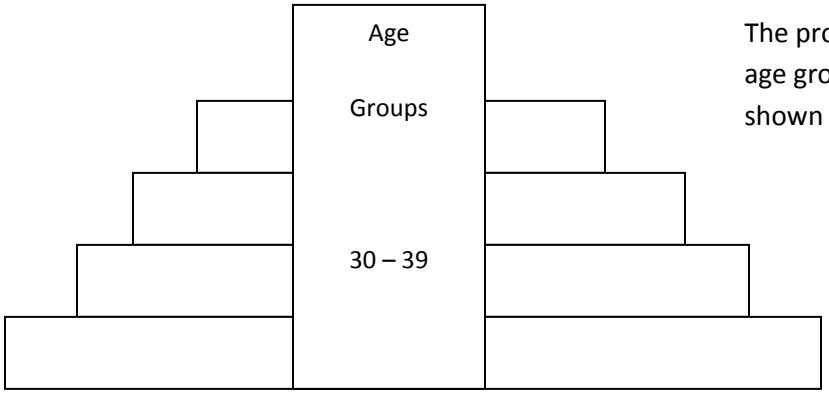
2. Sex – age Population structure

A population may be divided by age and sex into 3 categories

⇒ Pre reproductive (the young)

⇒ Reproductive (mature)

⇒ Post reproductive (old)



The proportion of males and females in age groups determined and rep. as shown

3. <u>Population is dynamic</u>

i. Increase/ rise

Population increase by,

⇒ Birth of new individuals (increase in natality rate in case of animals) or seed germination / Veg. propagation.

⇒ Movement of organisms into the population (Immigration)

ii. Decrease / decline

1. Death of organisms (increase in mortality)
2. Movement of organisms out of the population (Emigration) / seeds and fruits disposed out of the area.

4. <u>Population Disposal</u>

Describes the movement (daily/ seasonal) of animals into (Immigration) or out of (Emigration) the population

These movements are referred to as migrations;

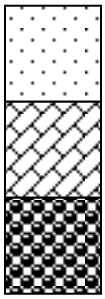
Reasons for migration

⇒ A biotic factors e.g. change in climate

⇒ Biotic factors .i.e. human activities like wars, hunting etc

5. <u>Population distribution pattern</u>

There are three main population distribution patterns. These depend on the distribution of resources in the area and physical factors.



Organism spaced out and evenly distributed – sparsely distributed

Crowded in particular areas – clumped / aggregated

Uniform (mixture of 1 and 2)

Factors affecting population of organisms

1. Food a nutrients: Availability of food and nutrients loads to rapid population growth
2. Diseases: May cause death of many organisms hence reducing the population
3. Pests: May destroy large plantations leaving the ground bear. Such as the army worms.
4. Factors of human diseases and animal diseases may result into emigrational such as miombo woodland in Tanzania which has very high population of tsetse flies.
5. Arow readily available water will be highly colonized by plants and animals.
6. Natural hazards such as flooding, fire outbreak, earth quakes, volcanic activities may wipe out a community in a given area. They may also lead to emigration in case of animals.
7. Competition for nutrients among organisms will also affect the population. Plants compete for water, carbon dioxide, sunlight, mineral salts, space, etc. These which can't compete favorably will die off. In case of animals emigration will take place.
8. Pre predators relationships (covered)

Factors for exponential human population growth

1. High fertility rate especially in the human female. The human female has got the potential for conceiving every month and is easily to receive a male at any time.
2. Sufficient resources
3. Improved maternity facilities and sanitation leads to low death rates.
4. Improvement in technology especially in Agriculture
5. Early marriages.
6. Traditional beliefs since children are a source of prestige and wealth (practice of polygamy).

7. No observation of birth control methods.
8. Political stability which has led to decrease mortality rate.

Ways in which population is being controlled include;

⇒ Use of birth control methods

- Abortion
- Use of spermicidal
- Vasectomy
- Tube ligature
- Use of diaphragm

⇒ Practice of monogamy

⇒ Outbreak of incurable diseases which are not by chance e.g. Aids, Cholera etc

⇒ Government policies which limits number of children per family

⇒ Formal education. Some can't get married until they are through with education

HUMAN POPULATION STUDIES: (Man and his environment)

The world population at present stands at about 6 billion, the most exponential growth has been in the past century (20^{th}). This population has exceeded the resources available. This is a big challenge to most countries.

There are two types of resources; -

i) Non – Renewable resources.

These are resources that can't be replaced once exhausted e.g. Minerals.

ii) Renewable.

These can be replaced / they can't be exhausted e.g. water replaced through the water ayole, forests through a forestation.

However, the rate at which the resources are being exploited is faster than the rate at which they are replaced. This is due to over exploitation of resources and it has resulted into extinction of certain species of plants and animals.

In order to cater for the demands of the over increasing population, man has carried out various activities such as industrialization which has led to pollution.

POLLUTION

In any undesirable change in the environment caused by human activities/ naturally. Pollutants are substances that cause pollution. Pollutants include; - Smoke, (exhausted fumes), Domestic wastes, Agriculture wastes, Industrial wastes and noise.

Types of Pollution

1. Air Pollution

Occurs when pollutants are released into the air, Pollutants can occur naturally and natural pollutants include; - dust, smoke and ash occurred by bush fire, insect droppings etc.

A major source of human caused pollution is the burning of fossil fuels (coal, oil, and natural gas, petrol for transport, electricity generation and industrial use).

Pollutants given off include; -

i. Sulphur dioxide which is formed from combustion of fossil fuels containing sulphur. High levels of Sulphur dioxide may reduce lung function and causes respiratory illness. In the atmosphere, sulphurous acid is easily converted to sulphric acid which is the major acid component of acid rains and irritates the respiratory system.

ii. Lead. It mainly comes from combustion of leaded petrol. It causes anaemia and damages the nervous system especially in children.

2. Deforestation

Is the cutting down of forests, Trees use $C0_2$ as a raw material for photosynthesis and give out 0_2 and. High concentration of gas such as $C0_2$, Nitrogen oxides, and methane leads to greenhouse effect (global warming).

Global warming: Heat energy from the sun fall on earth, some is absorbed by the earth, then reflected back into space. Gases such as $C0_2$, $N0_2$ and CH_4 form a thick layer which insulates the earth hence trapping heat energy. Therefore causing a rise in the earth's temperature (Global warming)

Other causes of air pollution include bombs which emit gases into the atmosphere

2. Noise pollution

Is un wanted sound . Offensive noises include road traffic, aircraft, air conditioners, bombs etc. It can result into stress, pressure, deafness etc

3. Water pollution.

Is due to the discharge of untreated agricultural, industrial and domestic wastes into water bodies.

Agricultural wastes include:

Inorganic fertilizers which contain phosphates and nitrates which serve as nutrients for Algae. Algae blocks penetration of light into water bodies. Water plants die, fish and other organisms die of suffocation.

Pesticides transported by rain water from farms to nearby water bodies is absorbed by aquatic plants. Non-biodegradable chemicals accumulate along the food chain. Top consumers reproductive ability is affected or may cause death.

Industrial wastes include:

Crude oil spilled from wrecked tankers or seeping from ships reduces light penetration hence killing water plants. It also reduces dissolved water in water killing aquatic animals.

Soluble heavy metals which are poisonous accumulate in food chains eg (mercury, lead etc)

Hot water discharged from power stations raise the metabolic rate of fish and oxygen consumption.

Textile factories discharge dye into water bodies, polluted water bodies become coloured. The dye may be acidic or alkaline hence changing the water PH. This affects aquatic life.

Domestic waste such as detergent discharged at as surface of rivers and lakes thereby reducing the amount of oxygen in water.

4. Soil Pollution

Improper disposal of domestic solid wastes such as garbage ,metals, cans, plastic containers and polythene materials cause soil pollution. Plastic and polythene materials are non biodegradable.

The sewage we produce at home may also cause harmful effects to the soil such as bleaching solution that may change the pH level of the soil and its toxic. Man's activities such as deforestation, bush burning, poor farming methods (zero grazing ,monoculture) may lead to soil erosion ,flooding etc.

Exercise

1.Discuss the causes of air pollution (not less than 15 points)

2.Discuss the causes of soil pollution

3.Discuss the causes of water pollution

4. a) How has the continued use of polythene bags caused soil pollution.

b) list any steps taken to prevent pollution caused by polythene material.

5. With examples explain the economic importance of bacteria (not less than 10 points)

CONSERVATION

These are activities aimed at maintaining the atmosphere .habitats ,wild life and and to ensure that the natural resources are used in such a way that provides sustainable yield.

Afforestation

Re-afforestation

Good farming methods such as crop rotation, mulching terracing

Treating industrial wastes before discharging them into water bodies.

Burning of polythene and plastic materials.