

# Ecology

- **Ecology**- is the study of interrelationships of organisms to each other and to their environment.
- **Environment**- constitutes the surrounding of an organism both living (biotic) and non-living (abiotic or physical).
- The study of organisms is divided into two types:
  - i. Autecology**- the study of single species
  - ii. Synecology**- the study of many species

## **Applications of Ecology**

1. Sustainable food production
2. Conserve of natural resources
3. Pollution control
4. Control of pest and diseases
5. Ecotourism
6. Population control

## **Concepts of Ecology**

- **Biosphere**- It's the part of the earth and atmospheres inhabited by living organisms. Also called Ecosphere.
- **Habitat**- The specific locating with a particular set of condition where organisms lives. Habitat can be terrestrial land or aquatic (water).
- **Ecological niche**- Is the position an organisms occupied in a habitat. It includes the physical state. The role in the habitat.
- **Population**- Refers to all the members of a given species in a particular habitat at a particular time.
- **Community**- Refers to all organisms belonging to different species that interacted in the same habitat.
- **Ecosystem**- Is a natural unit consisting of both biotic and abiotic factors whose interaction lead to a self-sustaining system.
- **Biomass**- Is a total dry weight of a living organisms at a particular trophic factor (feeding level) per unit.
- **Carrying capacity**- Refers to maximum number of organisms an area can comfortably support without depletion of the available resources.

## **Factors in Ecosystem.**

- They are divided into two:-

### **(a) Abiotic factors**

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- Are non- living environmental factors which affect the distribution of organisms.
- They include:
  - i) Light
  - ii) Temperature
  - iii) Atmospheric pressure
  - iv) Salinity
  - v) Humidity
  - vi) Soil texture
  - vii) PH
  - viii) Wind

#### **i) LIGHT**

- Sun is the main source of energy for all life on earth.
- Plants use light energy for photosynthesis.
- Aspects of light that affect living organisms includes:-

##### ***1.wavelength quality***

##### ***2.Duration***

##### ***3.Intensity***

- In Organisms, light affects the activities.

Plants - *Photosynthesis*

- *Germination*

- *Flowering*

Animals - *Migration*

-*Hibernation*

-*Reproduction*

- **Photographic light meter** is used to measure light intensity.
- **Seechi disc**- Is used to measure light penetration in water

#### **ii) TEMPERATURE**

- Biochemical process of most organisms functions efficiently within a narrow range of temperature.
- Temperature vary due to:-
  - Seasons*
  - Altitude*
  - Latitude*
  - Diurnally*      -*Time of the day.*
- Temperature affects distribution of organisms more in the terrestrial than in aquatic habitats.
- Therefore organisms develop physiological and behavioral adaptations to cope with extreme temperature.

- For instance, very high temperature denatures enzymes.
- Temperature is measured by a **thermometer**.

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### iii) ATMOSPHERIC PRESSURE

- Atmospheric pressure on the surface of the earth varies with altitude.
- Variation in atmospheric pressure affects the amount for respiration and amount of carbon dioxide available for photosynthesis thus affecting distribution of organisms.
- Decreased atmospheric pressure increases the rate of transpiration thus need for water conservation by plants.
- It's measured using a **barometer**.

### iv) HUMIDITY

- Refers to the amount of water vapor in the atmosphere.
- High humidity is associated with much water vapor in the atmosphere.
- Humidity affects the rate at which water evaporates from the surface of organisms as in transpiration and sweating.
- This therefore affects distribution of organisms.
- Its measured by a barometer.

### v) WIND

- Wind is moving air.
- It increases the rate of water loss from organisms thus affecting distribution.
- It's important in rain formation.
- Aids formation of dunes which become habitat for growth of desert plants.
- Causes wave formation in lake/oceans which enhances aeration of water.
- Causes stunted and distort growth in plants.
- It influences dispersal and pollination in plants.
- Also influences migration in flying animals.
- It wafts scent hence determines the position of hunger and prey.
- Wind vane and windsock are to determine the direction of prevailing winds.
- Anemometer is used to determine the speed of wind.

### vi) SALINITY

- Refers to the salt concentration in water.

- This causes the division of aquatic environment into **marine, estuarine and fresh water**.
- High salinity causes water loss from organisms.
- Organisms therefore need physiological adaptations to cope especially in estuarine environments which experience very high fluctuations in salinity.

#### vii) PH ( hydrogen ions concentration)

- PH is the measure of how acidic or alkaline water is in aquatic habitat or soil solution.
- It influences distribution as some organisms may survive well in acidic basic or neutral environment.

### ***(b) Biotic factors***

- These are living factors which includes interrelationships of living organisms in the ecosystem.
- These are;

#### **(i)COMPETITION.**

- If two or more organisms in a habitat require a common resource whose availability is limited, then they are said to be in **a competition**.
- Organisms compete for resources such as food, light, space, water and mineral salts.
- **Competition is of two types:**
  - *Intraspecific- is competition between organisms of same species.*
  - *Interspecific- is competition between organisms of different species.*
- In a competition, organisms which are well adapted survive while those which are less adapted/weaker either migrate or die out.
- Competition is severe if the ecological niche of the competing organisms are close.

#### **ii) PREDATION**

- Is a food relationship in which one organism (predator)kills another (prey) for food and feeds on it either wholly or in part.

*Predators have various adaptations which include:*

- The praying mantis- has enlarged fore-limbs with spikes for capturing prey.
- Birds as hawk, kites and eagles have sharp eye-sight and talons and modified beaks.
- Lions are fast in movement have large claws and strong jaws and sharp eye sight.
- Leopard has spotted pattern which blends (camouflage) with the background.

#### Adaptations of Prey:

- a) Stick insect mimics a dry stick.
- b) Porcupine has a scary display of spines.
- c) Antelopes have swift movement for escaping from predators.
- d) Herbivores as zebra have large eyes on the side of the head which gives them a large field of vision.

### iii) PARASITISM

- *Is a relationship in which an organism obtains nutrients from another organism without killing it.*
- The organisms which lives on or in another is called **a parasite** while the one from which nutrients are obtained is called **a host**.
- A parasite benefit in terms of food and shelter from the host while causing the host harmful effects.
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- There are two types of parasites:
  - a) **Ectoparasites**- Are parasites found on the surface of the host.
  - a) **Endoparasites**- Are parasites found in the body of the host.
- Parasites
  - weaken their hosts
  - causes disease which may kill their hosts thus reducing their number and distribution.

### iv) SYMBIOSIS

- *Is an association between two organisms of different species in which both organisms mutually benefit from each other.*
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Example

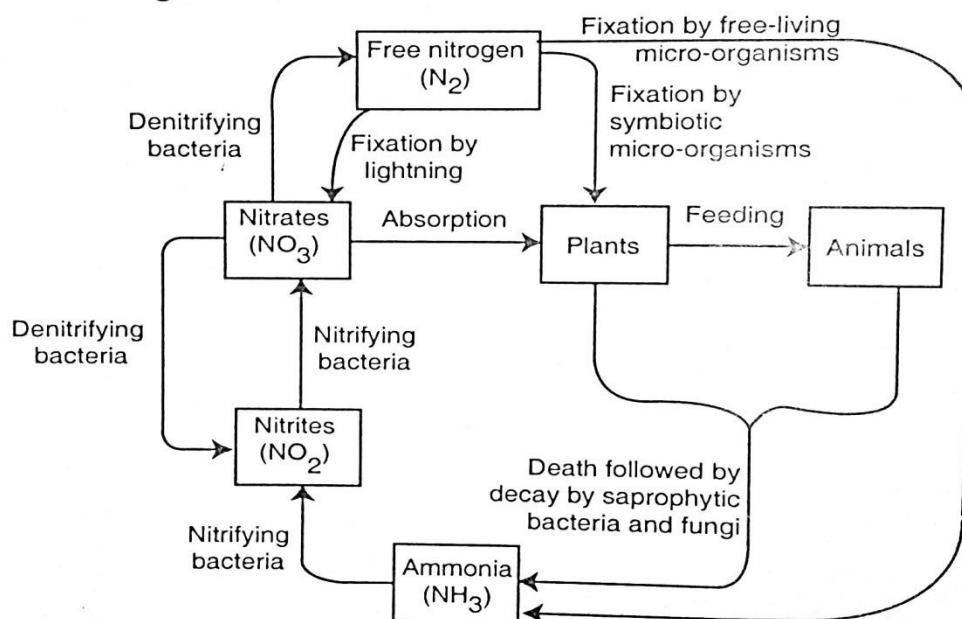
- Rhizobium which lives in the root of nodules of leguminous plants the bacterium fix nitrogen for the plant while it obtains shelter and carbohydrates.
- Bacteria and ruminants-the bacteria digests cellulose to glucose, most of which is assimilated by the herbivore. Other than glucose, the bacteria also obtain shelter in the alimentary canal of the animal.

## v) SAPROPHYTISM

- This is a type of nutrition where organisms obtain nutrients from dead organism matter hence causing decomposition.
- Such organisms are called **saprophytes**.
- They include **saprophytic bacteria and fungi**.
- Decomposition releases nutrient into the ecosystem which are made available to other living organisms.

## NITROGEN CYCLE

- Nitrogen cycle-refers to the cycling of nitrogen and its compounds in nature.



- Nitrogen is essential in the manufacture of protein by organisms. However organisms cannot utilize the free nitrogen in the atmosphere.
- Instead, plants absorb nitrogen in form of nitrate and assimilate it into plant proteins.
- Animal then obtains the nitrogen in the form of proteins by feeding on plants or other animals.

-Nitrogen must therefore be converted into a form that can be utilized by plants through the process of **nitrogen fixation**.

➤ **Biological nitrogen fixation** is done by nitrogen fixing micro- organisms which include ;

▪ Symbiotic bacteria like ***Rhizobium*** in the root nodules of legumes.

They convert nitrogen gas into ammonia which is then utilized by the plant to make protein.

▪ Free- living bacteria e.g. ***Azotobacter*** and ***Clostridium***

▪ Some algae e.g. *Anabaena*, *Chlorella* and *Nostoc*.

-These organisms fix nitrogen into ammonia which is then converted to nitrate.

➤ **Non- biological nitrogen fixation** is achieved by **lightning**.

-During thunderstorms, the lightning energy combines atmospheric nitrogen with oxygen to form nitrous acid and nitric acid. These are then chemically converted into nitrates.

- When organisms die (or their waste and droppings) saprophytic bacteria and fungi break them down into ammonia.

➤ In the process of **nitrification**, ammonia eventually converted into nitrates. This is done by several nitrifying bacteria e.g. ***Nitrosomonas*** and ***Nitrococcus*** which oxidizes ammonia into nitrites.

➤ ***Nitrobacter*** and bacteria then convert the nitrites into nitrates.

The process of nitrification enriches the soil with nitrates.

- Some soil micro- organisms reduce nitrates to nitrites, ammonia and even to nitrogen gas which are not useful to plants, the process called **denitrification**.

- Examples of such denitrifying bacteria are;

▪ ***Pseudomonas denitrificans*** and

▪ ***Thiobacillus denitrificans***.

- They utilize the oxygen released in the process for respiration.

## **ENERGY FLOW IN THE ECOSYSTEM**

- The sun is the natural source of energy.

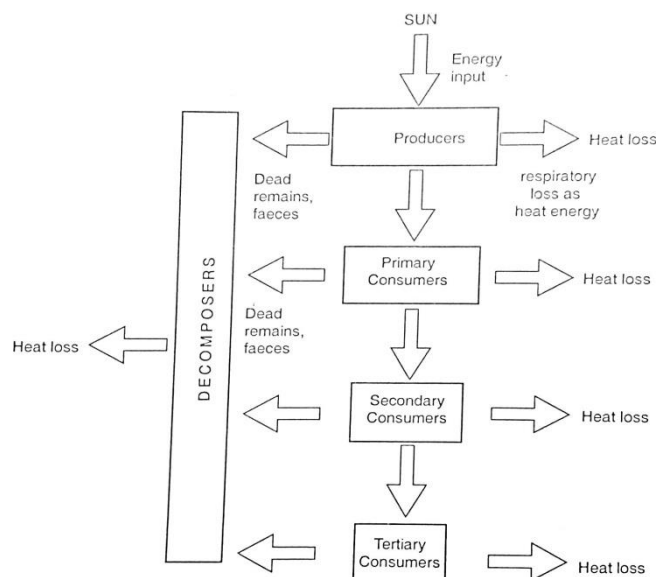
- It is this energy that is trapped by the green plants for photosynthesis.

- This process produces food which is potential energy in chemical form e.g. glucose.

- Therefore green plants are known as **producers** in an ecosystem.

- Green plants are eaten by animals e.g. herbivores.

- Herbivores are usually referred to as **primary consumers**.
- They in turn, are eaten by carnivores usually referred to as **secondary consumers** e.g. dogs.
- The secondary consumers are eaten by **tertiary consumers** e.g. leopard.
- When the leopard dies it's eaten by a vulture which is referred to as **quaternary** consumer.
- These feeding levels eg(producers) are referred to as **trophic levels**.
- When living organisms die they are decomposed by bacteria and fungi which are referred to as **decomposers**.
- The energy flows from one trophic to the next e.g. from producers to the primary consumers.
- This passage of energy from one trophic level to the next result in loss of some energy
  - In the form of heat.
  - During processes as respiration, excretion or defecations.



- When organic materials are fully decomposed, all the energy is lost. Thus energy flows through an ecosystem it is not recycled.

## **DECOMPOSERS**

- Decomposers obtain their energy from dead bodies of organisms and their wastes. Decomposers include:
  - a) *Saprophytic bacteria*
  - b) *Fungi*
- The decomposers break down organic matter into simple substances which are made available for re-use by other organisms.
- Thus materials are recycled in the ecosystem.



## FOOD CHAINS

**A food chain** is a linear representation of energy flow in the ecosystem from producers to other organisms.

- A food chain is composed of two or more trophic level (ie producers and consumers. )

Illustration of food chain

**Producer** → **Primary consumer** → **Secondary consumer**

Specific examples of food chains

1. Grass → Grasshopper → Bird
2. Napier grass → Goat → Human
3. Kikuyu grass → Mouse → Snake → Hawk
4. Algae → Mosquito larva → Tilapia perch → Nile → Human

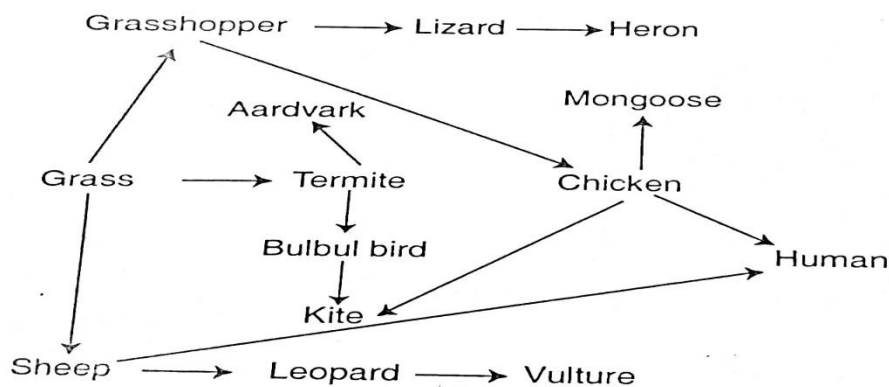
When decomposers are included in the food chain they are usually placed at the end of the food chain.

Litter → Earthworm → Frog → Snake → Bacteria and Fungi

## FOOD WEBS

**A food web** is an association in a community concerned with energy flow consisting of several interconnecting food chain.

-Below is an illustrated food web obtained from a terrestrial habitat. The producer is the African savanna grass (*Cymbopogon afronardus*)



### Sample questions

(a) From the food relationship above, isolate any two food chains in which human is a tertiary consumer.

(b) Identify the organism with the highest number of predators.

(c) Suggest the possible short term effects on this ecosystem if all the kites migrated away.

## Ecological Pyramids

- The efficiency of energy transfer from trophic level to the next can be summarized diagrammatically in the form of pyramids.

### Advantages of using a pyramid.

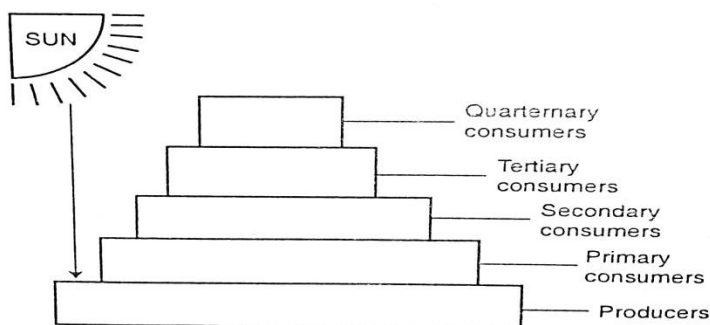
1. They give a simplified pictorial representation of feeding relationship.
2. Shows direction of energy flow in the ecosystem.
3. Useful in comparing different ecosystem.
4. Useful in showing seasonal variations or changes in components of the ecosystem.

### Types of ecological pyramids

- i) Pyramids of numbers.
- i) Pyramids of biomass.
- ii) Pyramids of energy.

#### i) PYRAMID OF NUMBERS

- This illustrates a progressive decrease in the number of organisms constituting any trophic level (feeding level) in a food chain.
- The greatest number is in the producers followed by a progressive decrease towards the quaternary consumers.
- When these numbers are drawn to scale, the food relationship produces a pyramid-shaped histogram or pictogram called **Pyramid of numbers**

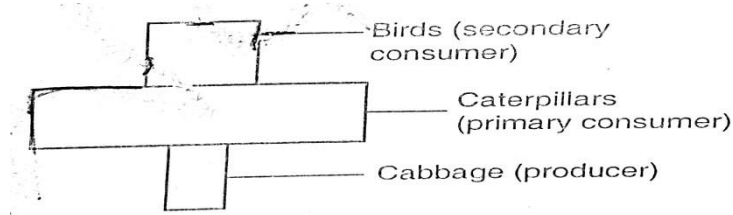


### Interpretation of Pyramid of Numbers.

- The body size of organisms increases at each trophic level from the base to the apex of the pyramid as their number decreases.
- At each trophic level, much of the energy obtained is lost in respiration and thus fewer organisms can be supported at the succeeding level.

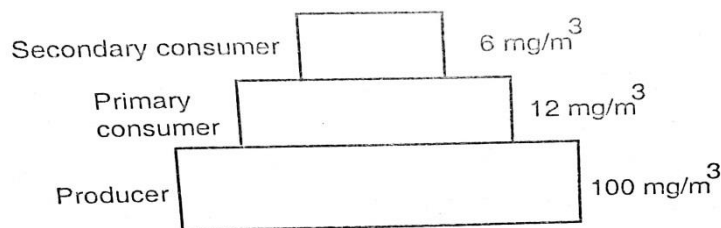
### Inverted Pyramid of Numbers

- In some cases the number of organisms will not decrease at each succeeding level. For example *Several caterpillars feeding on one cabbage plant.*



### ii) PYRAMID OF BIOMASS

- The biomass of an organism is its constant dry weight.
- When biomass measurements are carried out in a given ecosystem of known dimensions and components, the statistical representation also produces a pyramid-shaped histogram as shown below.



- The producers have the highest biomass per unit area in a decreasing order towards the quaternary consumers.

## **Population**

- A group of organisms belonging to the same species in particular habitat at a particular time. e.g. population of buffalo in Nakuru national park.

### Characteristics of population.

1. **Density**- Refers to the number of individuals per unit area e.g. 50 antelopes per square kilometer.
2. **Dispersion**- is a spread or distribution of organisms in a habitat.
3. **Population growth**- Refers to the rate of increase in numbers.

### Factors influencing population growth rate

- Availability of food
- Space
- Pest, disease and predators

## Population estimation methods.

- Total population can be determined by actual body count.
- Sometimes it may not be possible to count every organism as some are very mobile.
- These problems are usually solved by taking a representative sample from which the habitat comes from.
- **A Sample**- Is a small number of individual taken from a habitat that is representative of the whole production.

### Methods of Population Estimation.

1. Quadrant method.
2. Line transect method.
3. Belt transect method.
4. Capture- recaptures method.

#### 1. QUADRANT METHOD.

- **A quadrant**- Is a square frame of known area made of wood or metal.
- A standard quadrant is usually one square metre. However smaller quadrants can be used if the area of study is small.
- The quadrant can further be divided into small squares by tying on wire.

The choice of the quadrant size to be used depends on.

- *Area of the habitat.*
- *Nature of the study*

N/B A quadrant is suitable for:-*Small plants as grass, herbs and Small slow moving animals.*

#### Procedure for Using a Quadrant.

- i) *Select a suitable study size.*
- ii) *Mark the study area and measure its size.*
- iii) *Stand in the middle of study area, hold the quadrant on the left and throw it at random within the study area.*
- iv) *Where the quadrant lands identify and count all living organisms enclosed within the boundaries of the quadrant and record the number of each species identified.*
- v) *Make several throws of the quadrant and repeat step for each quadrant thrown.*
- vi) *Record all your results in a table.*

## 2. LINE TRANSECT METHOD.

- A line transect method may be used to find out the distribution of species in an area.
- A line transect is taken by running a rope across the plot and marking off equidistant points. Counts are made at each point (stations)
- Only the plants along the line are identified, counted and recorded.
- Large number of transects are needed for a more accurate result.

N/B-A line transect is usually important when studying transition in habitat and population through an area.

## 3. BELT TRANSECT METHOD.

- A belt transect is taken by running two ropes parallel to each other along the area of the plot.
- Counts are made between the rope and at marked points.
- Fewer belts are required to give a more realistic picture of the distribution and abundance of plant species in an ecosystem compared to line transect.
- Quadrant can be used together with belt transect.
- A belt transect is more suitable to the estimation of plant populations.

## 4. CAPTURE AND RECAPTURE METHOD.

-This method is used to estimate the total number of individuals in a population by repeated sampling.

### Procedure in capture-recapture method

- Select the study area and determine its size.
- Chose the organism to be studied.
- Using the appropriate technique for the organisms capture, catch the organism, count, mark and release them back to the habitat.(record this first number marked and released as first marked(FM))
- After about 24 hours re-examine the study area and collect as many organisms as possible including those already marked. Record this as second capture (SC) and those with paint marks as marked recaptured (MR)
- Thus if P represents total population, then;

$$P = \frac{FM \times SC}{MR}$$

*Key*

*FM = First number marked*

*SC = Second capture*

*MR = Marked recaptured*      *P = Total population*

### Assumptions of capture –recapture method;

- i) *No organism moves in or out of the area between the two counts.*
- ii) *The released animals mix freely the remaining population.*
- iii) *The mark does not alter the animal behaviour.*
- iv) *The marked animals will have enough time to mix with the rest.*
- v) *The population numbers does not vary during the study period.*

N/B

- For marking a light coloured, quick drying water proof paint should be used.
- This method is suitable for high mobile animals like insects, birds, small mammals and fish.

### Sample question

*-To estimate the population size of mosquitoes in Shikoti village, KEMRI researchers caught 400 mosquitoes which they marked and released. After 24 hours, 200 mosquitoes were caught out of which 80 had the marks.*

*(a) Suggest the possible instrument that might have been used for capturing and marking the insects.*

*(b) Estimate the population size of the mosquitoes in the village.*

## **Adaptations of Plants to Various Habitats.**

**An adaptation-** *is a change in an organism that increases its chance surviving a specific environment.*

- These changes may be structural, behavioural or physiological.
- There are four groups of plants namely:
  - Xerophytes.
  - Mesophytes.
  - Hydrophytes.
  - Halophytes.

### **1) XEROPHYTES.**

- These are plants that adapted to withstand a dry habitat or to endure condition of prolonged drought as in arid and semi-arid areas.
- These habitat are characterized by the following conditions:
  - *Unpredictable and poorly distributed rainfall.*
  - *Very high temperature but low night temperature.*

- *They are windy.*
- *Low humidity.*

### **Adaptations of Xerophytes to their habitats.**

1. Leaves reduced in size are modified to spines to reduce surface area over which transpiration occurs.
1. Shedding of leaves during drought to reduce surface area exposed to transpiration.
2. Thick waxy cuticle on leaves to minimize the rate of cuticular transpiration.
3. Sunken stomata in leaves which accumulate moisture in sub-stomatal air space leading to low diffusion.
4. Leaves folded to reduce rate of transpiration by not exposing stomata to environmental factors.
5. Reduced number of stomata that lower the rate of transpiration.
6. Some have deep roots to absorb water from deep in soil.
7. Reversed stomata rhythm (opening the stomata at night and closing them during the day time) to prevent excessive loss of water by transpiration.
8. Some xerophytes store water in large parenchyma I.e. baobab and cactus.
9. Some have very short life cycle to avoid drought hence survive as seeds or as underground penetrating organs e.g corns.

## **II). MESOPHYTES**

- These are plants living under normal conditions of water supply or in well-weathered soil.
- Mesophytes are predominantly found in such ecosystem as savannah, rainforest and reserve forest.

### **The habitat of mesophytes have the following characteristics:**

- *Adequate rainfall ranging from 950 mm- 1800 mm that is distributed throughout the years.*
- *Humidity is relatively high.*
- *Thick clouds are common.*
- *Moderate to high temperature with low diurnal less.*
- *Less wind.*
- *Shallow water table.*

### **Adaptations of mesophytes to their habitats.**

1. Others that cannot compete for light are adapted for photosynthesis under low light intensity (they form an undergrowth).

2. Majority of mesophytes show leaf mosaic that minimizes overlapping and overshadowing of leaves so that all leaves are exposed to light for photosynthesis.
  3. Have broad leaves with thin cuticle to enhance transpiration.
  4. Have many stomata on both leaf surfaces to encourage higher rate of transpiration.
  5. Some are shallow rooted hence develop prop or buttress roots or prop roots for extra support e.g. *Ficus natalensis*.
  6. Some have thick waxy cuticle to lower the rate of transpiration.
  7. Some shed their leaves during drought to reduce the surface area for water loss.
  8. Climbers as lianas twine themselves around large trees in order to reach sunlight.
  9. Their leaves are shiny to reflect sun rays.
- Some plants called epiphytes grow on large tree trunks in order to be exposed to sunlight.

### III). HYDROPHYTES

-These are plants which normally grow wholly or partially in fresh water.

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#### **Their habitat are characterized by the following conditions:-**

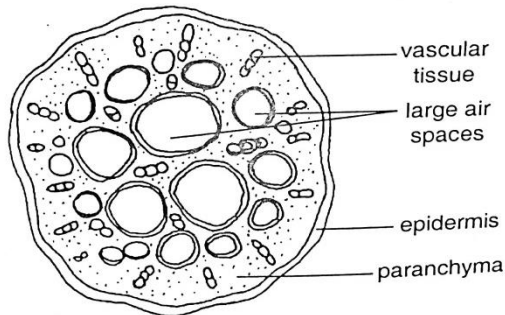
- *They have low concentration of dissolved gases such as oxygen and the water medium of low density.*
- *Wave and currents are usually common.*
- *Lights is less abundant under water.*

#### **Adaptations of Hydrophytes to their Habitat**

1. Emerged hydrophytes such as water lily have broad leaves with many stomata on the upper surface to increase transpiration.
2. Submerged hydrophytes such as *Ceratophyllum* plant have high dissected leaves to increase surface area for photosynthesis and gaseous exchange.
3. Have leaves with numerous chloroplasts to increase the surface area for photosynthesis.
4. Have developed roots which lack root hairs to reduce absorption of water.
5. In emerged hydrophytes the flowers are raised above the water to allow pollination to take place.
6. Have elaborate tissues in leaves and stems to store air for buoyancy and gaseous exchange.



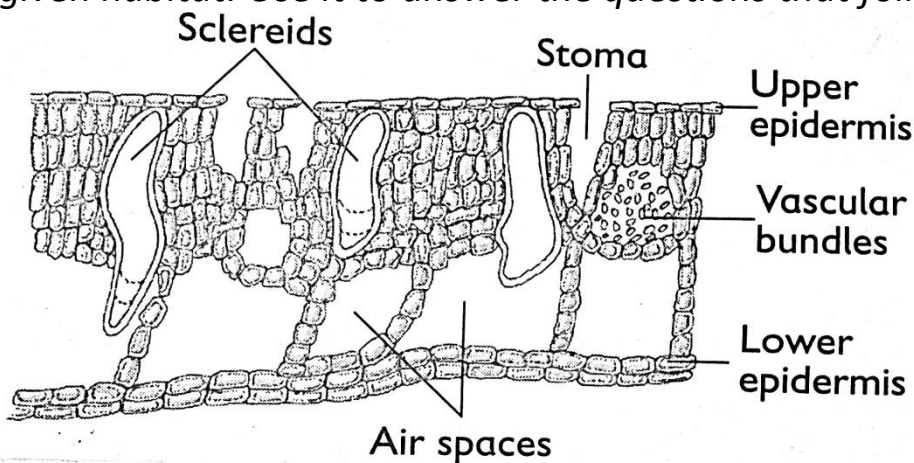
7. They have poorly developed xylem vessels because they absorb water from the aquatic environment by diffusion.
8. The upper surface of the leaves of emergent and floating hydrophytes is glossy or waxy to keep them water-proof.
9. Their leaves lack cuticle to facilitate easy diffusion of gases and penetration of light.



*A transverse section through the stem of a hydrophyte to show the aerenchyma*

**Sample question**

1. Below is a transverse section of a leaf obtained from a plant from a given habitat. Use it to answer the questions that follow.



**a. Identify the likely habitat where the sample plant could have been obtained.**

Aquatic/water

**b. Name the type of plant based on the habitat identified in (a) above.**

Hydrophyte

**c. From the diagram, identify any three characteristics to support your answer.**

- Large air spaces
- Stomata only on the upper surface
- Leaf lacks the cuticle on the surface

**c. State any two roles of the sclereids .**

- Offer mechanical support.
- Air-filled to offer buoyancy.

#### **IV.) HALOPHYTES**

- These are plants which are able to tolerate very salty conditions in soil and marine water.

**These habitat are characterized by the following conditions:-**

- *They have high concentration of mineral salts.*
- *They have low concentration of dissolved gases especially in marine water.*
- *Light intensity is low in marine water.*
- *Current and waves are common.*
- *Temperatures on marine environment are generally high.*

N/B

- Halophytes are faced with a problem of absorbing water from a medium which has a very high salt concentration.
- The water is thus not easily available to the plant making that plant experience a physiological drought.
- They overcome this problem in several ways.

#### **Adaptations of Halophytes to their Habitat.**

1. They have root cells which concentrate a lot of salts in them and this enables them to take in water by osmosis in the normal water.
2. Some plants have salt glands that secrete excess salts.
3. They possess succulent tissues to store water for use.
4. Some plants like the mangrove have pneumatophore (breathing roots) which emerges above the water to obtain atmospheric oxygen for transpiration.
5. Mangrove growing on mud flat has buttresses roots for support and anchorage
6. Some sea plants have a type of root that hold them firmly to the substratum to prevent them from being swept away by strong tides and waves.

# Pollution

*This is the introduction of foreign materials, poisonous compound and excess nutrients/energy to the environment in harmful quantities.*

**A pollutant**-is a substance mainly waste that contaminates air, water and soil.

## (a) AIR POLLUTION

### Sources and effects of Air pollution

i) **Sulphur (iv) oxide** produced from food preserving, sulphuric acid manufacturing industries, mining and burning of some fossil fuels.

Effects.

- Cause respiratory diseases and affects gaseous exchange.
- Dissolves in rain water causing acid rain which kills plants and corrodes iron roofing.

ii) **Aerosols**-Includes pesticides, insecticides, perfumes, air fresheners and spray paints. The main pollutant in aerosols includes copper, lead and CFCs(chlorofluorocarbons)

- Copper aerosols-causes irritation of respiratory system.
  - causes poisoning of water plants and fish.
  - is non-biodegradable hence accumulating in the ecosystem
- CFCs in fridges and perfumes cause depletion of ozone layer leading to increased UV radiation that causes skin cancer.

iii) **Smoke and fumes** (contain CO<sub>2</sub>, CO and carbon) produced in areas with heavy industries and motor vehicle burning fossil fuels.

- **Carbon**-Affect visibility due to 'smog' on roads.
  - Settle on leaves blocking stomata thus hinder photosynthesis
  - Smog causes intense eye irritation, headaches and breathing difficulties
- **Carbon (II) oxide**-Causes respiratory poisoning by combining with haemoglobin leading to oxygen deficiency suffocation and finally death.
- **Carbon(IV) oxide**-Prevents layers of warm air from escaping to the atmosphere causing greenhouse effect leading to global warming.

iv) **Oxides of Nitrogen**-Released from industrial burning of fossil fuels, vehicle exhaust fumes and nitric acid manufacturing industries.

- Dissolves in rain water forming acid rain eroding iron roofs.
- Poisonous-Affects respiratory system of animals when inhaled.
- Nitrogen (IV) oxide is carcinogenic.

v) **Noise**-Undesirable sound produced by machines in factories, heavy vehicles, aeroplanes, loud speakers and jua kali workshops.

- Affects hearing-humans become insensitive to low pitched sounds.
- Is an irritant.
- Causes stress in animals.

vi) **Dust**-Produced in quarries, dusty roads, cement/lime producing industries.

- Settle on leaves hindering photosynthesis.
- Clog respiratory surfaces interfering with gaseous exchange.
- Causes eye irritation
- Reduces visibility.

### **Control of Air pollution**

- Industries should be built away from residential areas.
- Develop and encourage the use of renewable energy sources eg solar and wind energy.
- Encourage the use of lead and sulphur- free fuels in motor vehicles and industries
- Developing CFC free aerosols and appliances.
- Use biological control methods to control pests, diseases and weeds.
- Banning smoking in public places.
- Encouraging the use of public means of transport as opposed to private cars to minimize consumption of fossil fuels.
- Encouraging the use of ear muffs in industries and jua kali workshops that generate loud noises
- The government should be a signatory to international treaties as Kyoto protocol
- Fitting automobiles with catalytic converters and the industries with long chimneys with scrubbers to reduce emissions of oxides of nitrogen, sulphur and carbon.
- Masses should be educated on the need for sustainable environmental management.

## (b) WATER POLLUTION

### **Sources and effects of Water pollution**

**(i) Untreated sewage**-From urban centres that gets discharged into water bodies for domestic use. These contain several microbes, faecal matter and urine as well as detergents containing phosphates.

- Water pollution may cause epidemics of water-borne diseases as cholera, typhoid and amoebic dysentery.
- Eutrophication-ie increase in the fertility or nutrient content in water bodies due to decomposition of faecal organic matter and detergents.
  - This reduces the amount of dissolved oxygen, due to rapid decomposition resulting into suffocation and death of aquatic animals.
  - there occurs an overgrowth of aquatic plants as water hyacinth.

**(ii) Industrial wastes**-Which contains toxic metallic compounds of mercury, arsenic, cyanide and cadmium as well as acids and solid particles which are discharged into water bodies.

- Mercury interferes with melanin formation and cause poisoning in man resulting into blindness, paralysis and death.
- Some of these elements accumulate in the liver, kidney and bones where they interfere with the physiological functions of these organs.
- The solid particles in these wastes clog gills of fish causing death.
- Some are toxic hence cause death of aquatic animals directly or indirectly by eutrophication and bio-concentration

**(iii) Oil spillage**-This occurs in oceans from oil tanker accidents, offshore oil wells, refineries and damaged war ships.

- Oil layer on water reduces oxygen supply to the water; this may lead to the death of aquatic life forms.
- Marine organisms such as fish are killed by clogging their respiratory surfaces.
- Marine birds get their feathers clogged hence have difficulty in flight.
- Oil coats photosynthetic phytoplanktons till they die
- Reduces light penetration into water hence photosynthesis of submerged plants is hindered.

**(iv) Agrochemicals**-These includes inorganic fertilisers, fungicides, herbicides and pesticides. Pesticides as DDT contain CFCs which are non-biodegradable.

- Most of these chemicals contain heavy metals as copper and mercury which affect the respiratory activities of aquatic animals.

- Some of these chemicals as DDT accumulate along food chains becoming lethal at higher trophic levels.
- Nitrates and phosphates in fertilisers cause eutrophication.

**(v) Heat**-Industries discharge hot water directly into water bodies. Some of the effluents may react among themselves releasing heat into water.

- Heat reduces the amount of dissolved gases in water i.e. oxygen and CO<sub>2</sub>
- High temperatures may kill the living organisms directly.

### **Control of Water pollution**

- Proper treatment and discharge of sewage.
- Treatment of industrial waste before discharge into water.
- Use of controlled amount of agro-chemicals.
- Organic farming and biological control should be encouraged.
- Avoid spillage of oils and other chemical into water.
- Stiffs penalties for oil spillage.
- Uses of pseudomonas bacterial that naturally feeds on oil breaking it down.
- Discourage the use of leaded petrol and the use of lead in water pipes.
- Appropriate soil erosion control methods should be put in place.

### **(C) SOIL POLLUTION:**

#### **Sources and effects of Soil pollution**

**(i) Oxides of sulphur (e.g sulphur (iv)oxide)** enter the soil through precipitation as acid rain.

- Acid rain alters the soil pH therefore affecting plants that cannot tolerate an acidic soils.
- Acid rain may however promote the growth of plants that tolerate acidic conditions.
- Acid rain also causes leaching of minerals leading to loss of soil fertility.

**(ii) Aerosols**- Most aerosols sprayed to control pest and diseases in plants and animals contain heavy metals e.g. copper and mercury. The chemicals fall to the ground

- They are taken up by plants where their concentration increases. The toxicity increases when eaten by animals leading to the death of animals.
- The chemicals kill the soil micro-organisms as decomposers and nitrogen fixing bacteria thus lowering the soil fertility.

**(iii) Petroleum products-** Spilled on land due to oil tanker accidents.

- Soil organisms fail to obtain oxygen in oil saturated soils and therefore die.
- Coating of plant leaves or respiratory surfaces of animals leading to their death.

**(iv) Inorganic fertilisers-** Agricultural inorganic fertilisers contain phosphates and nitrates.

- These increase soil acidity so that soil micro-organisms cannot inhabit such soils.
- Formation of soil organic matter slows down and eventually stops  
-The soil becomes exhausted hence plant and animal life ceases.  
-In addition, the soil structure is changed hence encouraging soil erosion

**(v) Solid waste-**Include house-hold and industrial wastes.

-Some are biodegradable e.g. food residues and paper while others are non-biodegradable e.g. glass, rubber and plastic.

- They are a nuisance and destroy the aesthetic value of the environment.
- They offer breeding grounds for pests, rodents and insect vectors which in-turn pose health hazard to human beings.
- Non-biodegradable solid wastes limit soil aeration thus inhibiting micro-organism activity.

### **Control of Soil pollution**

-Recycle solid wastes e.g. polythene papers, plastic containers, glass bottles and scrap metals.

-Disposal of biodegradable household wastes into a compost pit to form manure for organic farming.

- Addition of lime to farm to counteract the effects of agro-chemicals.
- Compacting and incinerating solid wastes as old clothes.
- Use of biodegradable materials and chemical.
- Discourage the excess use of agrochemicals .
- Biological control of pests and diseases to be encouraged.
- Encourage pipeline transportation of petroleum products to minimize risk of spillage.
- Enforce appropriate legislation on proper solid waste management.

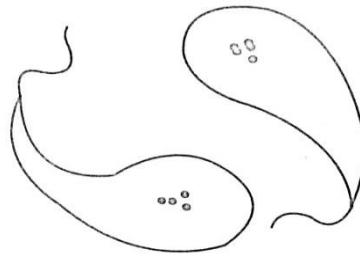
## Human Diseases.

- **A disease** is a disordered state of a tissue, organ, organ system or the whole organism during which its function are not carried out normally.
- Diseases result from genetic diseases nutritional deficiencies or infection by other organisms and viruses.

### (a) Bacterial Diseases:

#### 1. CHOLERA:

- Caused by a bacterium known as ***Vibrio cholerae***.
- The bacteria are normally found in infected water and are passed on by flies to food thereby contaminating the food.
- People living in unhygienic condition are likely to contract the disease.
- It is spread rapidly and can cause an epidemic.
- The incubation period varies between 1 to 6 days.



*Vibrio cholerae* bacteria

#### Symptoms:

- The bacteria secrete an enzyme called **mucinase** which digests the inner lining of the intestines causing irritation
- Severe watery diarrhoea
- Vomiting.
- Severe abdominal pain (cramps) due to loss of body salts.
- Great body dehydration
- Loss of appetite.
- In extreme cases death can occur within 24 hours of infection..

#### Prevention and Treatment.

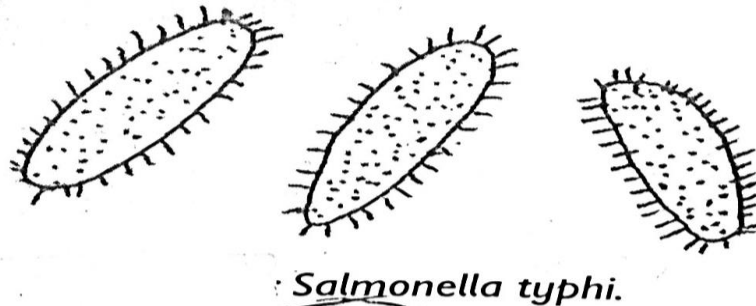
- Proper sanitary and disposal of faeces.
- Drinking water should be boiled or chlorinated.
- Cooking food properly.
- Washing fruits and vegetables properly before eating.



- Isolate patients and treat them as soon as possible.
- Administering oral rehydration salts before treatment.
- **Treatment** –involve administration of antibiotics

## 2. TYPHOID.

- Caused by a bacterium called ***Salmonella typhi***.
- These bacteria are passed out in either urine or faeces which may cause contamination of water supply from rivers, dams and other domestic water supplies.
- Healthy individuals can be infected by taking contaminated water or food.
- Sometimes bacteria can be present in sweat and saliva and so the clothes and beddings of the patient can be a source of infection to others.
- It incubation period last for about two weeks.



### **Symptoms.**

- Develops fever and weakness.
- Severe diarrhea.
- Stomach cramps.
- Vomiting.
- Severe headache.
- Dehydration.
- The bacteria attacks wall of the intestines and cause patches of sores.
- In severe attack the sores may burst and cause perforation in the intestines.
- Death may result if not treated early enough.

### **Prevention and Treatment.**

- Proper disposal of faeces and urine to prevent spread of the bacteria.
- Domestic water should be boiled or chlorinated.
- Frequent washing of hands.
- Cooking food properly.
- Administering fluids to prevent dehydration.

- Fruits should be washed before eating.
- Regular medical check-ups.
- Vaccination with attenuated (weakened) bacteria.
- Treating patients using antibiotics.

## **(b) Protozoan Diseases**

### 1. **AMOEBIC DYSENTERY:**

- It is caused by a protozoan called ***Entamoeba histolytica***.
- When the amoeba cysts are ingested the cyst's membrane is digested and the Protozoa are released.
- Upon reaching the large intestines and the colon, the parasite multiplies.

#### **Symptoms:**

- Ulcers in the large intestine caused by the parasite's enzyme- histolysin
- Diarrhea (amoebic dysentery) with traces of blood.
- Dehydration.
- Fever.
- Vomiting.
- Abdominal pains-Severe pain occurs when passing stool.
- The infection may become systemic (enter the blood) reaching other body tissues as liver, lungs and brain where it produces abscesses which are fatal.

#### **Prevention and Treatment.**

- Cooking and storing food properly.
- Boiling drinking (the parasite not killed by chlorination).
- Cleaning fruits and vegetables before eating.
- Good personal hygiene.
- Proper faecal disposal.
- **Treatment**-Involves the use of amoebicides to kill the parasite.

### 2. **MALARIA.**

- Malaria is a disease caused by protozoan parasite called ***Plasmodium***.
- They are four different species of plasmodium namely:
  - *Plasmodium malariae*,
  - *Plasmodium vivax*,
  - *Plasmodium ovale*,
  - *Plasmodium falciparum*.

### **Mode of transmission**

- It is transmitted from an infected person by a female anopheles mosquito (vector). The mosquito bites an infected person; it sucks blood containing the parasites.
- Inside mosquito the plasmodium develops into infective stages. On biting a healthy person, it passes on the infective plasmodia from its salivary glands into his/her blood stream.
- The incubation period lasts between 7-10 days during which it invades the liver cells where they multiply.
- They are then released into the blood stream where they attack and destroy the blood red blood cells.

### **Symptoms:**

- High regular fever.
- Chills and shivers accompanied by sweating.
- Headaches. -Muscles and joint pains.
- Loss of appetite. -Frequent vomiting.
- Enlargement of liver and spleen. -Anaemia.
- In severe attacks, convulsions in children are observed.

### **Prevention and Treatment.**

- Draining stagnant water.
- Spraying ponds with paraffin or oil to suffocate the larval stages.
- Spraying mosquitoes with insecticides to kill them.
- Sleeping under treated mosquito nets.
- Using mosquito repellants as creams and coils.
- Biological control as breeding the fish species( e.g. *Gambusia affinis*) that feeds on mosquito larvae.
- Developing vaccine against malaria.
- Using anti-malarial drugs.

## **( c) Parasitic Worms:**

### **1.Ascaris lumbricoides:**

- This is a parasitic roundworm which belongs to the phylum Nematoda.
- It infects small intestines of pigs and human beings. It may also occur in other organs of the body.
- It is characterized by brownish yellow color with mouth parts having 3 lips.
- The male is about 25 cm (Female 35cm) long and diameter about 0.4 cm.

### **Modes of Transmission:**

- Adult female lays eggs in the small intestines of the host.
- The eggs are passed out with the faeces and may be swallowed by a new host through contaminated food and water.
- When they are swallowed by a host, the eggs shells are dissolved releasing the larvae. These penetrate the intestinal wall and enter the blood stream.
- They move to the liver and then to the heart and lungs. In the alveoli of the lungs, they grow and moult twice.
- The larvae then migrate up to the trachea where they cause irritation and so are coughed out and may be swallowed down into the oesophagus, stomach and small intestines where they finally mature to adults.

### **Effects of the Parasite On the Host.**

1. During migration of the larvae they cause irritation in the trachea that lead to lung damage and infection with other diseases.
2. If the infection is heavy, a lot of digested food is consumed by the parasite in the intestines and this leads to malnutrition in the host, especially in children.
3. Sucks blood and cause anaemia to the host.
4. Intestinal blockage- victims develop large round stomach.
5. The worms may enter the bile duct, pancreatic duct and appendix causing further complication.

### **Adaptive characteristics of *Ascaris lumbricoides* to its Parasitic mode of life.**

1. Two hosts to ensure that it always has a ready host for survival.
2. Lays many eggs to increase chances of survival even when some are destroyed.
3. Eggs have protective shell to survive unfavorable environmental conditions.
4. Has thick elastic cuticle to protect it against the digestive enzymes of the host enabling it to survive in the alimentary canal.
5. Has tissues tolerant to lower oxygen concentration in the gut:
6. Has a muscular larynx through which it sucks digested food from the host's intestine into its own gut.

### **Prevention:**

- Proper sanitary disposal method should be adopted especially availability and proper use of toilets.
- High standards of personal hygiene.
- Hygienic handling and cleaning of fruits and vegetables is necessary.
- Drinking water should be boiled.

### Treatment:

- Use of drugs to kill the worms or inactivate the eggs.

## **2. SCHISTOSOMIASIS (BILHARZIA)**

- This is a parasitic disease of the blood caused by a flatworm of the genus *Schistosoma*. There are three species of *Schistosoma* that affect human beings.

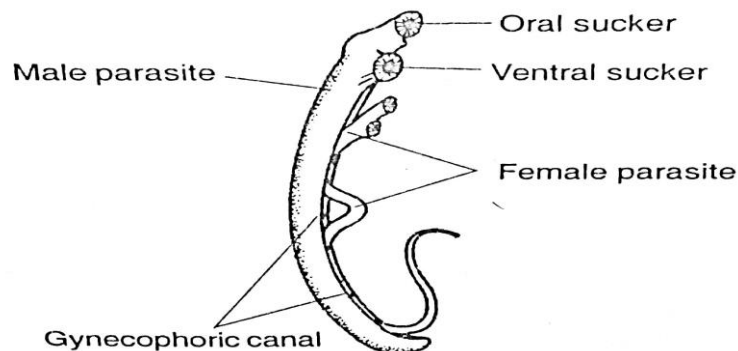
- They include:

***Schistosoma mansoni*.**

***Schistosoma haematobium*.**

***Schistosoma japonicum*.**

- The parasite is found in free water canals, lakes, rivers, dams, rice-growing fields and other similar habitats.



### **Modes of Transmission:**

- The parasite is spread when people drink water contaminated by a larval form called **Cercariae**.
- Also the parasite can penetrate the skin when bathing or wading through water containing the larvae.
- Once in the body they get into the blood stream and migrate to the liver where they mature into adults.
- After coupling of the adult worms, eggs are shed into the blood vessels or alimentary tract.
- When the faeces or urine containing eggs are disposed of into water, the eggs hatch into larvae called **miracidia**.
- The miracidia finds and penetrate the water snails such as ***Biomphalaria*** and ***Bulinus***.
- From the snails, the infective stage Cercariae emerge and can now infect human beings who stand, bath or drink in such water.

### **Effects of Parasites On its Host.**

- i). Damage the host's skin when penetrating and this causes itching.
- ii). Adult *Schistosoma* releases chemical substances in the blood which causes fever.
- iii). The sharp spines which they use to tear the veins and enter into the intestines or the urinary bladder causes blood to appear in urine or stool which can lead to anaemia.
- iv). The person also experiences abdominal pains and diarrhea.
- v). If untreated, the disease can result in death due exhaustion or by infection from other diseases due to reduced immunity.

### **Adaptive Characteristics of Schistosoma.**

- i). It has suckers for attachment so that they are not dislodged.
- ii). Has two hosts (snail and human being) that increase its chances of transfer to several hosts and from one place to another.
- iii). The cercariae larvae and eggs have glands that secrete lytic enzymes which soften tissues to allow for penetration into the host.
- iv). The adult in blood produces chemical substance which protect it against the host's defense mechanism.
- v). Separate sexes to ensure that the eggs produced by the female are fertilized before they are shed into the blood vessels.
- vi). some larval forms e.g. Cercariae are encysted and can remain dormant and viable until they come into contact with a human being.

### **Prevention and Treatment.**

1. Proper sanitary disposal of both faeces and urine.
2. Deep pit latrines or flush toilets should be used.
3. Urine and faeces should **not** be disposed off into rivers, dams and other water bodies.
4. Drinking water should be treated or boiled in order to kill eggs, miracidia and Cercariae.
5. People should not bath or swim in water infested with snails.
6. People should wear protective shoes and clothes and avoid walking bare feet in swampy areas.
7. Snails should be killed by spraying the water with chemicals that kill snails (molluscicides).
8. Infected persons should receive proper medical treatment.

***The End***