Lawrence Arum Bronsted . Lawry50@gmail.com watsap +256703923836

UNDERSTANDING 'A' LEVEL ECOLOGY

1. The table below shows mean rate of carbon dioxide production during the dark in three parts of an ecosystem. Study it and answer the questions that follow.

	Part of ecosystem		
	Leaves of plants	Stems and roots of plants	Non- photosynthetic soil organisms
Mean rate of carbon dioxide production($cm^3\ m^{-2}\ s^{-1}$)	0.032	0.051	0.045

(a) (i) What measurements would have been made in order to calculate the rate of carbon dioxide production?

Volume of carbon dioxide given off; in a known area within a set time;

(ii) Explain why measurements of carbon dioxide release in the dark were used to calculate the mean rate of carbon dioxide production of the leaves.

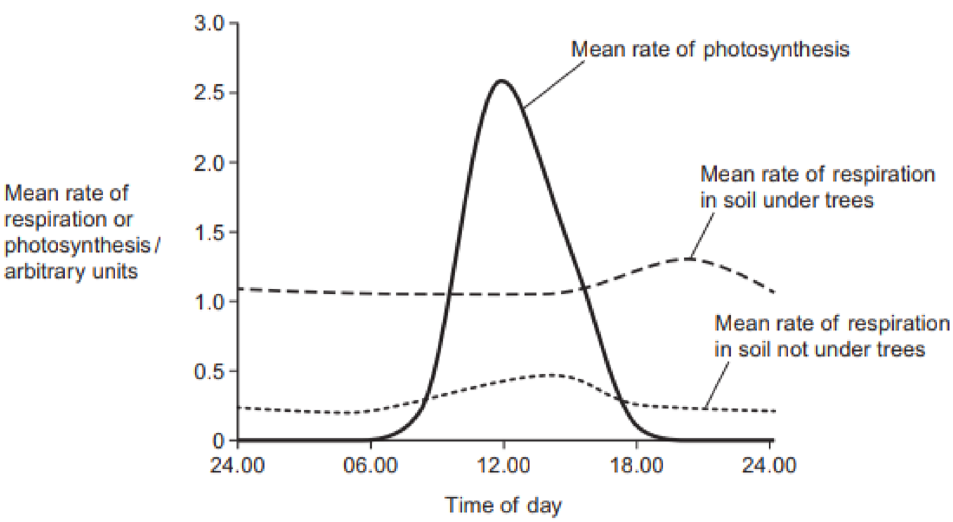
In the dark, no photosynthesis occurs; which use up the released carbon dioxide;

(iii) Using the information provided in the Table, suggest why plants may not carry out more respiration than non-photosynthetic organisms in the ecosystem.

The results in the table only includes heterotrophic organisms; and does not include animals above the ground or other soil organisms;

The results also do not account for anaerobic respiration;

(b) Graph in figure below shows the mean rate of respiration in soil under trees and soil not under trees in the same wood. It also shows the mean rate of photosynthesis in the trees. *Measurements were taken at different times of the day during the summer.*



(i) Compare the changes in the mean rate of respiration in soil under trees and mean rate of respiration in soils not under trees.

similarities

In both, mean rate of respiration in soil under trees and mean rate of respiration in soils not under trees,

- ***Peak is attained;***
- ***Remains constant from 24.00 to 06.00;***

Differences

Mean rate of respiration in soil under trees	Mean rate of respiration in soil not under trees
Higher throughout the period of study	***Lower throughout the period of study***
Higher peak attained	***Lower peak attained***
Peak attained later	***Peak attained earlier***
Remains constant from 06.00hrs to 15.00hrs	***Increases gradually from 06.00hrs to 15.00hrs***
Decreases from 21.00hrs to 24.00hrs	***Remains constant from 21.00hrs to 24.00hrs***
Increases gradually from 15.00hrs to 21.00hrs	***Decreases gradually from 15.00hrs to 21.00hrs***

(ii) Suggest an explanation for the difference in the mean rate of respiration in soil under trees and mean rate of respiration in soils not under trees between 06.00 and 12.00.

Mean rate of respiration in soil under trees is higher than in soil not under trees; because there are more roots under tree; that carry out lots of respiration; / more respiratory substrate under trees; thus more organisms carry out respiration;

Mean rate of respiration in soils not under trees increases while that in soil under trees remains constant; because soil not under trees are exposed to direct sunlight; gets warmer; providing a more suitable temperature; for efficient functioning of respiratory enzymes; rate of respiration is thus increased;

(iii) Explain the following observations

- Increase in the mean rate of photosynthesis increases the mean rate of respiration in soil under trees

Photosynthesis produces sugars; transported to roots; used for respiration;

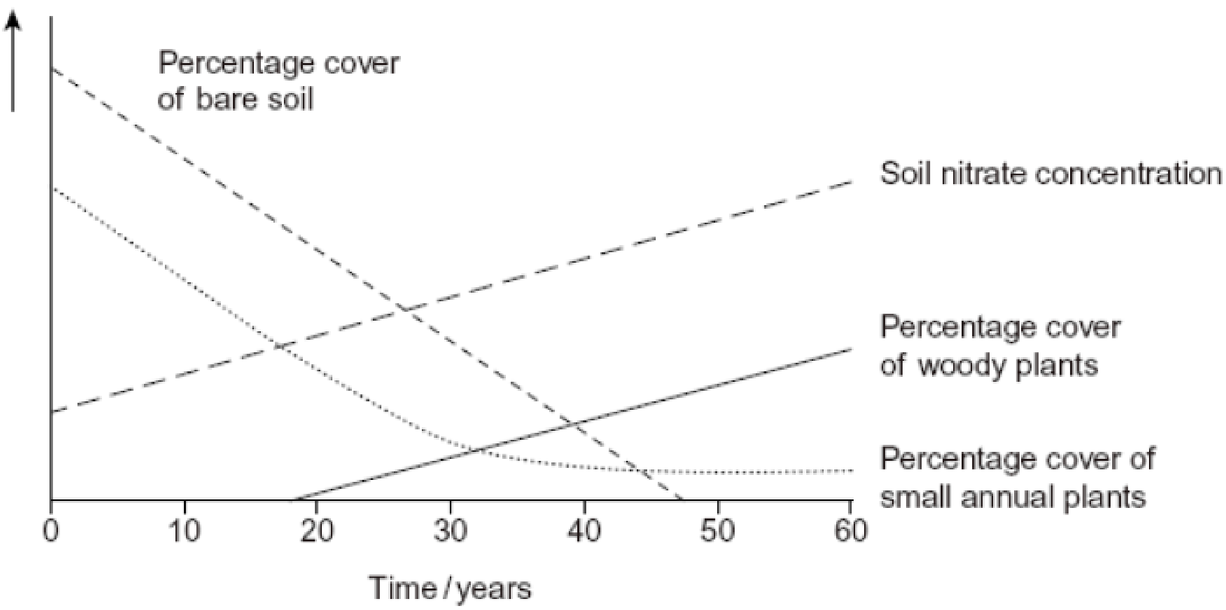
- There is a delay between increase in the mean rate of photosynthesis and increase in the mean rate of respiration in soil under trees.

  Time is taken for manufactured sugars during photosynthesis to be transported to the roots;

2. (a) What is meant by **ecological succession?**

Is a long-term directional change in the composition of a community from its origin to its climax through a number of stages brought about by the actions of the organisms themselves OR
Is a process by which plant and animal communities in a given area change gradually over time; becoming replaced by different and usually more complex communities;

(b) The graph in the figure below shows results of an investigation of succession in some abandoned crop fields over a 60-year period. Study it and answer the questions that follow.



(i) State the type succession studied in this investigation.

Secondary succession;

(ii) Apart from the abandoned crop fields, where else can the type of succession in a(i) above occur?

Burnt/ cut forests;
Heavily polluted streams;
Flooded land;

(c) Explain

(i) the change in soil nitrate concentration as shown on the graph

Throughout the 50-year period, concentration of nitrates increases rapidly to the highest; because increased decomposition of dead soil organisms; releases ammonia into the soil; converted to nitrates in the soil; by activity of nitrifying bacteria;

(ii) using the graph above, why conservation of grass lands involves management of succession.

Grassland consists of small/annual plants; which will be replaced by/ are outcompeted by woody plants; increasing the percentage cover; thus woody plants must be removed/have their growth checked;

(d). The pioneer plants were seen to germinate better than the plants that colonized the fields after 50 years when the temperature fluctuates. Explain the advantages of this to the pioneer plants.

Pioneer plants continue germinating in the early/ at start of succession; when there are few plants; with bare soil temperatures fluctuating;

(e)Explain the advantage to a plant that colonize after 50years of having high rate of photosynthesis at low light intensity.

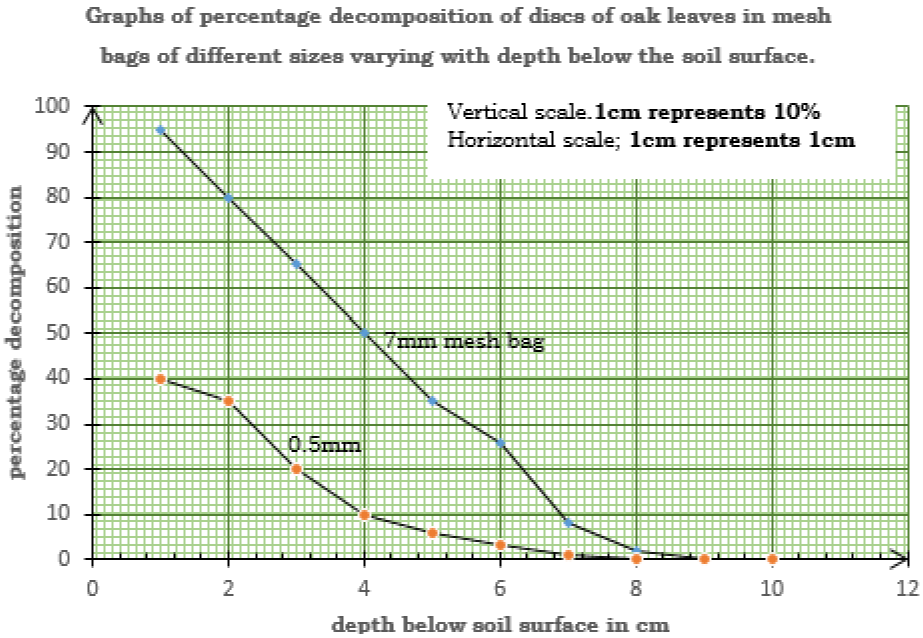
Plants will grow/survive in the shade/when overshadowed by taller plants; with little light reaching them;

3.(a) Table **1** shows variation in the rate of decomposition of discs of oak leaves in mesh bags of different sizes with depth below the soil surface in a forest habitat. Study it carefully and answer the questions that follow.

Table **1**

Depth(cm)		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
% decomposition	**7mm mesh bags**	95	80	65	50	35	26	8	2	0	0
	0.5mm mesh bags	40	35	20	10	6	3	1	0	0	0

(i) On the same axes, represent the information on a suitable graph.



(ii). Describe the effect of depth below the soil surface on the rate of decomposition of leaf discs in 0.5mm mesh bags.

Increase in depth below the soil surface from 1cm to 2cm; gradually decreases the rate of decomposition of leaf discs;

Increase in depth below the soil surface from 2cm to 4cm; rapidly decreases the rate of decomposition of leaf discs;

Increase in depth below the soil surface from 4cm to 8cm; gradually decreases the rate of decomposition of leaf discs;

Increase in depth below the soil surface from 8cm to 10cm; has no effect on the rate of decomposition of leaf discs;

(iii). Explain the relationship between soil depth and rate of decomposition of leaf discs of oak leaves.

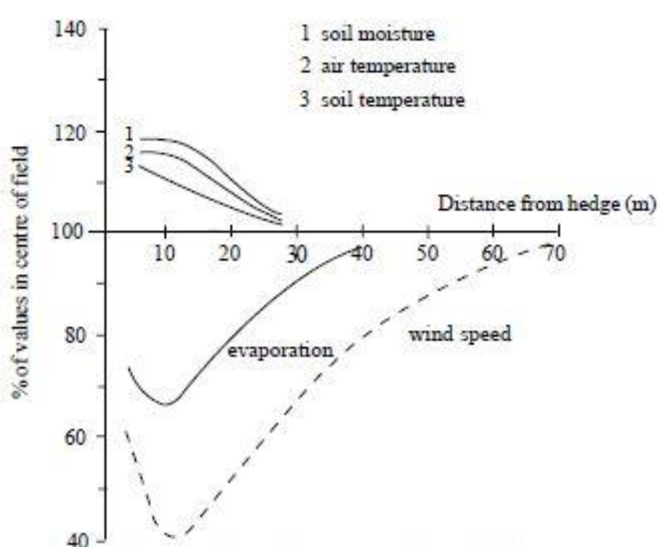
Rate of decomposition of leaf discs of oak leaves decreases with increase in soil depth below the soil surface; in both bags of different mesh sizes; because oxygen concentration decreases; decreasing on the activity of aerobic bacteria; and fungi;

Decomposition of leaf discs of oak leaves in large(7mm) mesh bag at 8cm below the soil surface is possible compared to smaller (0.5mm) mesh bag; because conditions at 8cm below soil surface allow detritivores such as earthworms to mildly survive but no aerobic bacteria and fungi;

(iv) What is the ecological significance of leaf decomposition in an ecosystem?

- ***Recycling of nutrients into the soil; maintaining soil fertility;***
- ***Removal of organic litter that would accumulate;***
- ***Increases on humus content; that forms a sticky coat around soil particles; and binds several together forming soil crumbs; greatly improving drainage; aeration of the soil; and water holding capacity;***
- ***With humus, soil acquires dark colour; thus absorbing more heat; providing warmth to soil; used during germination of seeds;***

4. Graph in the figure below shows the effects of a hedgerow on the environmental conditions in a wheat field. Study it carefully and answer the questions that follow.



(a)Describe the effects of distance from the hedge on the environmental conditions.

Increase in distance from the hedge from 5m to about 12m; soil moisture and air temperature remains constant;

Increase in distance from the hedge from 12m to 28m; rapidly decreases soil moisture and air temperature;

Increase in distance from the hedge from 5m to 28m; rapidly decreases the soil temperature;

Increase in distance from the hedge from 2m to about 12m; rapidly decreases wind speed; to a minimum;

Increase in distance from the hedge from 12m to 38m; rapidly increases wind speed;

Increase in distance from the hedge from 38m to 68m; gradually increases wind speed; to the highest;

(b)Explain the significance of the changes in the environmental conditions on the rate of growth of the wheat.

Decreased evaporation/increased soil moisture decreases water stress/provides water for transport/metabolism of wheat;

Increase in air temperature increases the rate of photosynthesis;

Decreased wind speed reduces erosion of soil; and loss of water by transpiration;

Increased soil temperature increases decomposition; thus recycling nutrients back into the soil; used for growth of wheat;

NOTE. **Changes in environmental conditions used above are due to decrease in distance towards the hedge**

(c) Suggest reasons why removal of the hedgerow may be detrimental to the environment.

Loss of plant species occurs;
Loss of fruits/nuts/insects/spiders; which are food supply for birds and small mammals;
Loss of diversity of invertebrates, birds and small mammals;
High wind speed erodes away soil; causing soil infertility;
Increased water loss by plants through transpiration; slowing down crop growth;
Loss of habitat for many species;

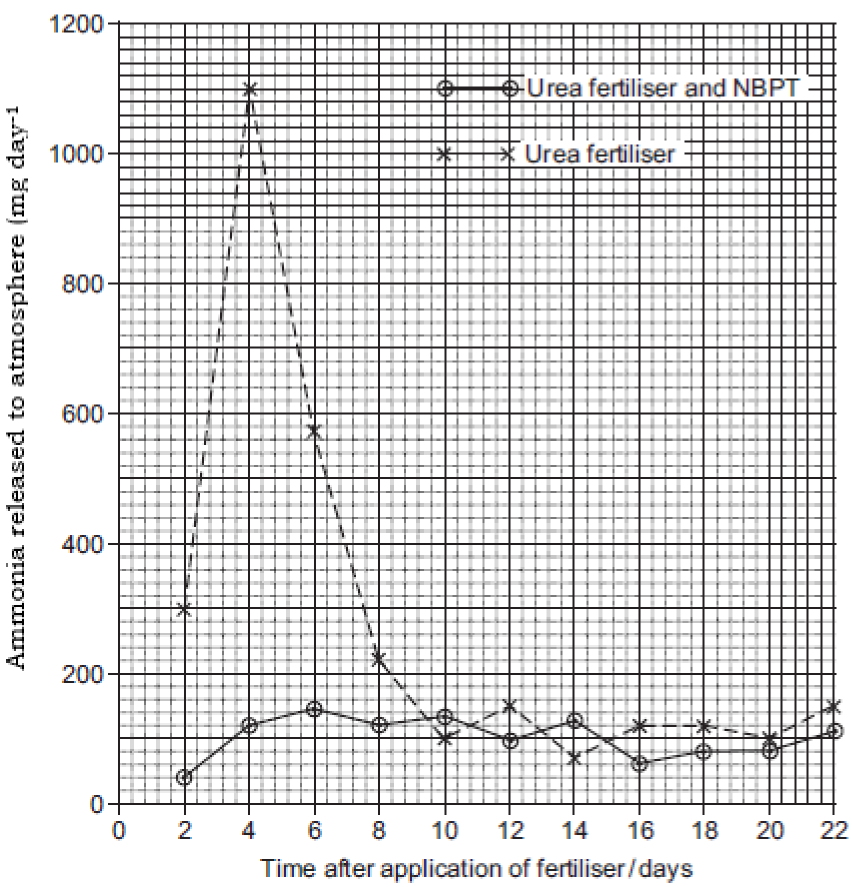
(d) How should the hedgerow be managed in order to maintain good biodiversity?

- ***Trimming it regularly to keep it at reasonable height;***
- ***Keeping hedges thick at the base;***
- ***Laying hedge correctly when needed rather than cutting back;***
- ***Coppicing /cutting back to the ground level periodically to stimulate growth;***
- ***Maintaining some trees in the hedge;***

5. The graph in the figure below shows amount of ammonia released to the atmosphere from *urea fertilizer only* and a *mixture of urea fertilizer* and *NBPT* (control experiment) added to the soil.

NBPT is an inhibitor of urease enzyme secreted by some bacteria in the soil.

Study the figure and answer the questions that follow.



(a)Describe the variation in the mass of ammonia released from the soil in which urea fertilizer only was added.

From 2days to 4days, mass of ammonia released <u>increases rapidly</u>; to a <u>peak</u>;
From 4days to 8days, mass of ammonia released <u>decreases rapidly</u>;
From 8days to 10days, mass of ammonia released <u>decreases gradually/slowly</u>;
From 10days to 22days, mass of ammonia released <u>fluctuates slowly;</u>

(b)Explain the

(i) Difference in the amount of ammonia released in the atmosphere on addition of two groups of urea fertilizer during the first 10 days.

Amount of ammonia released from soil in which mixture of urea fertilizer and NBPT was added is <u>lower</u> than that released by soil in which only urea fertilizer was added; because NBPT is a <u>competitive inhibitor</u>; thus <u>competes with urea for the active site of urease enzyme</u>; which on attaching, blocks the urea from fitting onto the active site of urease enzyme; enzyme –substrate complex is not formed; decreasing the breakdown of urea into ammonia by urease enzyme;

(ii) Increase in mass of ammonia released over the first four days in the control experiment.

Higher concentration of substrate, urea;
More bacteria;
High temperature;
More enzyme-substrate complex;

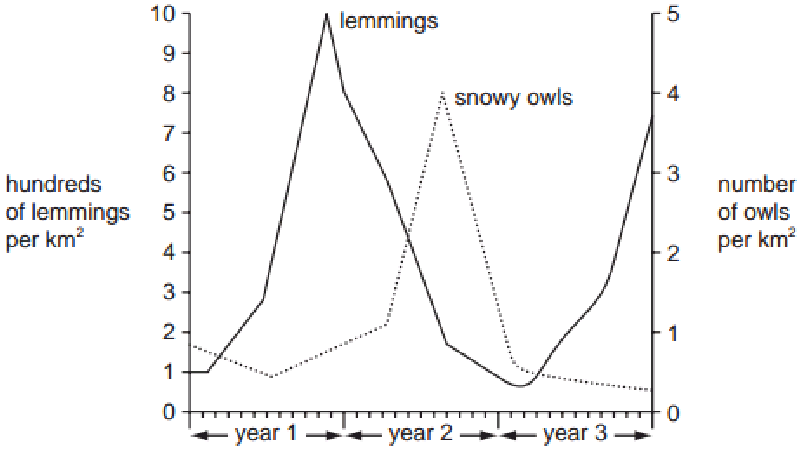
(c)Suggest how the addition of NBPT to urea fertilizer could result in increased growth of plants.

<u>Less</u> urea is broken down in the soil; thus <u>less ammonia is lost from the soil into atmosphere</u>;
<u>Much</u> ammonia remaining in the soil is thus converted to nitrates by nitrifying bacteria; used in protein synthesis; subsequently increasing plant growth;

(d)Apart from use of urea fertilizer, mention other ways in which nitrogen is added into the soil.

- ***Planting leguminous plants, whose root nodules have nitrogen fixing bacteria that fix atmospheric nitrogen into the soil;***
- ***Oxidation of atmospheric nitrogen by electrical charges during lightening, forming oxides that are later washed to soil;***
- ***Fixation by free living bacteria in the soil (azotobacter);***

6.Figure below shows changes in the population of snowy owls and lemmings over a three-year period



(a). Giving a reason, identify the prey and predator.
Predator- snowy owls;
Prey-lemmings;
In a natural ecosystem, <u>food (prey) must be in plenty to sustain the population of the predators.</u>

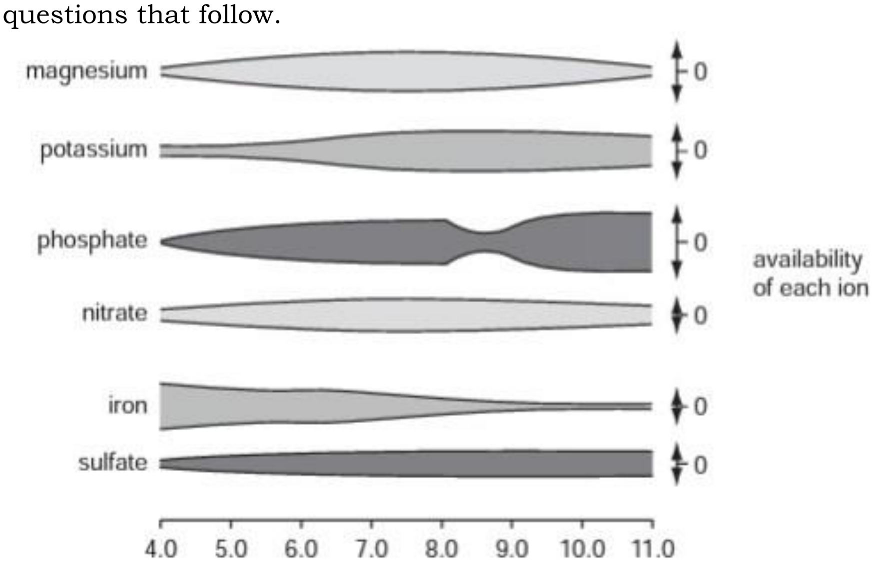
(b). Describe the pattern of population of lemmings over the three-year period.
Initially, population of lemmings remains constant;
From about 2months to 6months, population of lemmings increases gradually;
From 6months to 10months, population of lemmings increases rapidly; to a peak;
From 10months to 1year and 8months, population of lemmings decreases rapidly;
From 1year and 8months to 2years and 2months, population of lemmings decreases gradually; to a minimum;
From 2years and 2months to 2years and 9months, population of lemmings increases gradually then increases rapidly from 2years and 9months to 3years;

(c) Explain the pattern of the population of lemmings over the first two years.
In the first 10 months, population of lemmings increases, because population of snowy owls(predator) is still low; thus reproduce, increasing in number;
From 10months to 2years and 2months, population of lemmings decreases because population of snowy owls(predators) increases; thus greatly fending on lemmings;

(d) Of what significance is the relationship between lemmings and snowy owls to the ecosystem?
Predation eliminates the unfit (aged, sick, weak); allowing the remaining prey access to the available food supply; and also improving on their genetic stock; thus enhancing chances of reproductive success, and longtime survival to pass the desired traits to their offsprings;

(f) What other factors would affect the population of snowy owls in the ecosystem?
Disease outbreak;
Accumulation of wastes;
Intraspecific competition;
Infection by parasites;

7.The figure below shows the availability of ions in soils at different pH. Study it carefully and answer the questions that follow.



(a). Name the ion that is **least** available in soils of

(i) pH 4.0
Phosphate;

(ii) pH 11.0.
Iron;

(b) Give reasons for your answers in (a) above.
In acidic pH, phosphate ions react with Aluminium and iron(III) ions, forming <u>less soluble compounds;</u> making it <u>un available to in the soil;</u>
In alkaline pH, iron <u>precipitates;</u> <u>decreasing its solubility;</u> subsequently decreasing its availability in the soil

(c)How can a farmer improve on the availability of the ions in (a) above?

- ***Phosphorus-containing fertilizer can be applied in or close to the seed row at planting; to facilitate early season uptake of phosphate ions by plant roots; before allowing to react with the soil cations;***
- ***Manufacture of a compound nutrient fertilizer granules containing nitrogen, phosphorous and Sulphur-containing fertilizer; for application to alkaline soils; to cause slight acidification of soil adjacent to the granules; enhancing the solubility of iron;***
- ***Foliar application of soluble iron fertilizer compounds to iron deficient crops; grown in high pH soils;***

(d) Plants grown in soils of pH 10 are stunted and their leaves are yellow. State which ions are deficient and explain how their deficiency lead to symptoms above.

Magnesium ions;

Are used in chlorophyll synthesis; thus deficiency of it, little/no light is absorbed by plants; little/no photosynthesis occurs; allowing production of little/no sugars available for growth;

Nitrate ions

Are used for synthesis of amino acids; built up into proteins; suitable for synthesis of membrane and enzymes;

(e) Other than nutrient availability, give two effects of soil pH.

- ***Extremes of soil pH, inhibits the activity of soil micro-organisms especially the nitrifying bacteria.***
- ***Affects the prevalence of certain plant pathogens e.g. At low soil pH, fungal plant diseases are more prevalent than bacterial diseases e.g. potato scab caused by bacteria, Streptomyces scabies is prevalent in soil with high pH, while club root disease caused by fungi, Plasmodiophora brassicae prevail in soils with low pH;***

8. The water hyacinth *Echhornia crassipes* is a weed growing on many waters of Uganda. In the biological control of the weed on Lake Victoria, a fungal pathogen and weevils are employed.
The characteristics of the fungus and the weevils in relation to their feeding behavior is shown in Table below.

UNEB 2016(2)

Fungus	**Weevils**
Feeds on the water hyacinth alone	Feeds on other plants other than the water hyacinth
Attacks only the green parts of the plant	Attacks all parts of the plant

The level of destruction of the weed by the fungus and the weevils under varying water conditions in temperature, turbidity and speed of water are shown in the figures below. Study them carefully and the answer the questions that follow.

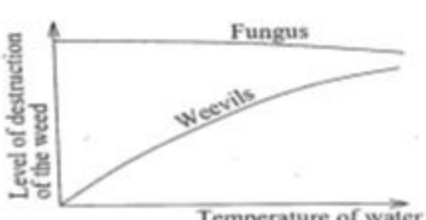


Fig. 1

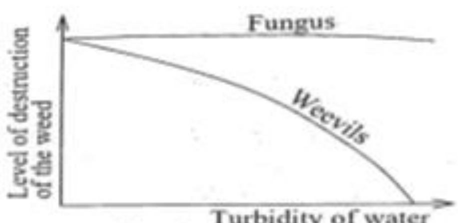


Fig. 2

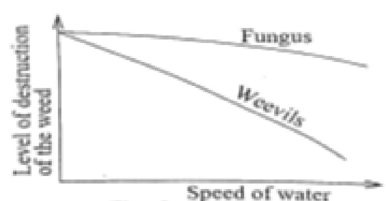


Fig. 3

(a) From the figures above, describe the level of destruction of the weed by each of the organisms under different conditions of water.

(i) Fungi

Level of destruction of the weed remains almost constant with increase in both temperature; and turbidity of water;

Level of destruction of the weed gradually decreases with increase in speed of water;

(ii) Weevils

Level of destruction of the weed increases with increase in temperature of water;

Level of destruction of the weed decreases with increase in both turbidity of water; and speed of water;

(b) From the information provided, suggest explanations for the level of destruction of the weed by each organism under different conditions of water.

(i) Fungus

Level of destruction of the weed remains almost constant with increase in temperature of water; because fungus attacks only the green parts of water hyacinth; most of which is inside water; thus not affected by varying temperature of water;

Level of destruction of the weed gradually decreases with increase in speed of water; because moving water may cause brushing of leaves against each other; subsequently brushing off some fungus from leaves;

Level of destruction of the weed remains almost constant with increase in turbidity of water; because most of fungi is outside water; thus not affected by turbidity reflecting the quality of water

in terms of dissolved oxygen;

(ii) Weevils

Level of destruction of the weed <u>increases</u> with increase in temperature of water; because weevils <u>attack all parts of water hyacinth</u>; thus <u>increased/warm temperatures increase their metabolism</u>; thus increasing feeding;

Level of destruction of the weed <u>decreases</u> with increase in turbidity of water; because with increased turbidity, (i)amount of dissolved oxygen decreases; thus decreasing the metabolic activity of weevils; and (ii) visibility of edible parts also reduces;

Level of destruction of the weed <u>decreases</u> with increase speed of water; because fast moving water may dislodge some weevils; attached on the water hyacinth plant together with their leaves;

(c) From the information provided, give advantages that the;

(i) fungus has over weevils in destroying the weed.

Fungus is specific; allowing maximum destruction of the weed; while weevils feed on other plants, thus reducing the effect on the weed(hyacinth);

Fungus is <u>not</u> affected by temperature of water; turbidity of water; and <u>less</u> affected by speed of water;

(ii) Weevils have over fungus in destroying the weed.

Weevils attack all parts of the weed; allowing for complete destruction of the weed; with the fungus only attacking green parts of the hyacinth, leaving some parts undamaged;

(d) What are ecological effects of the water hyacinth on Lake Victoria?

- ***Its growth on the surface of water causes shading; restricting development of photosynthetic algae (primary producers) which forms a basis of the aquatic food chain;***
- ***Restricted growth of photosynthetic algae deprives the water of dissolved oxygen; resulting into the death of aquatic aerobes;***
- ***Decay of dead weeds use up dissolved oxygen; increasing the biochemical oxygen demand(BOD);***
- ***Shallow water breeding fish competes with water hyacinth;***
- ***Can be a habitat for dangerous species like snakes;***
- ***Are food to aquatic organisms;***
- ***Filters of water in other areas;***

(e) What are the advantages of employing biological control as a means of checking the population of the water hyacinth?

- ***Cheap;***
- ***Has little environmental impacts/does not cause pollution;***
- ***An effective long term control***;

9.(a) What is meant by the following ecological terms?

(i) Indicator species

Are organisms that by their presence, abundance and absence signal a change in the biological conditions of a particular ecosystem;

(ii) Biotic index

Is a scale for showing the quality of an environment by indicating the types of organisms present in it;

OR

Is a numerical expression coded according to the presence of bio indicators differing in their sensitivity to environmental conditions;

(iii) Endangered species

Is a species very likely to become extinct; owing to its continued decrease in numbers;

(b) Explain the use of biotic indices in monitoring environmental changes.

Biotic indices compare relative frequency of indicator species; with their change over time marking a change in the environmental condition within an ecosystem;

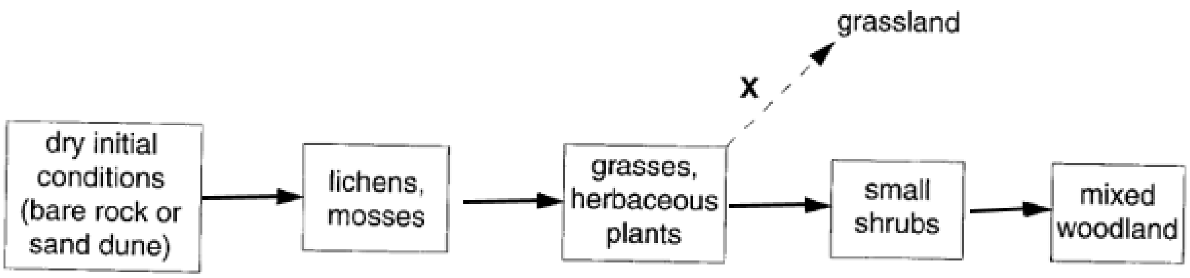
<u>High biotic index</u>; signals abundance of pollution sensitive organisms/unpolluted environment;

<u>Low biotic index;</u> indicates absence of indicator species; and abundance of pollution tolerant organisms /denotes a polluted environment;

(c) What are the advantages of in situ conservation of endangered species?

- ***Allows species live in an environment to which they are highly adapted; thus occupying their natural positions in the food chains;***
- ***Prevents environmental loss of natural habitats; thus availing for other endangered species;***
- ***Larger populations are protected and maintained simultaneously;***
- ***Increased chances of population recovery;***
- ***Costs of conservation efforts are low;***
- ***Species are provided with chance to adjust to the prevailing environmental conditions such as drought, pathogens, temperature fluctuations, thus evolve into a better adapted life form;***
- ***Maintains animal's normal behavior (offsprings usually acquire skills from parents and peers around***;

10. The figure below shows a primary succession in a temperate climate.
X represnts an example of deflected succession.



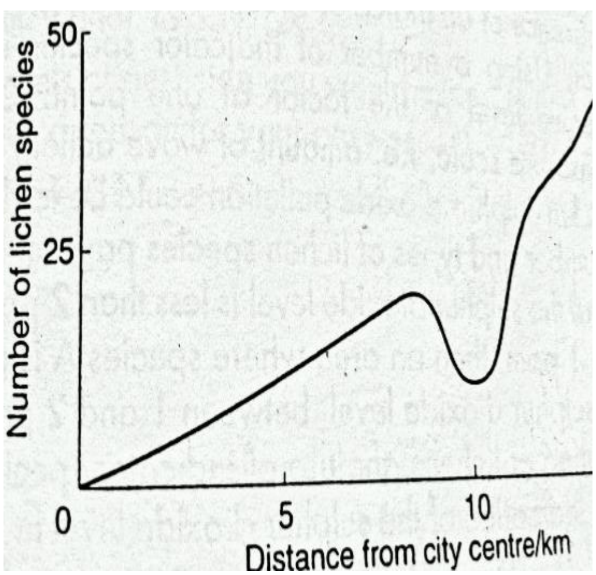
(a) (i) Outline **two** characteristic features of a deflected succession
Original climax community is not reached;
Relatively stable community (plagioclimax) results from human interferences;

(ii). Suggest how deflected succession **X** could be caused.
Grazing by animals;
Controlled burining;
Mowing;
Water drainage;
Weeding/coppicing;
Application of selective herbicide;
Deforestation;

(b) Explain the role of pioneer plants in succession on a bare rock or sand dune.
Secretion of acids that break down rocks into small pieces;
Decomposition adds more organic matter/humus; to the small pieces of rock forming soil;
Fixation of nitrogen into new soils;
Some form dense mat that traps tiny particles of rocks, bits of organic debris and water;
Form mico habitats for insects and other small animals; by creating more organic matter on death, and decay;
Change soil pH;

(c) Explain how biomass change during a primary succession.
Increases; plants (shrubs and trees) at later stages are larger than those in earlier stages(seres); with more developed roots ; leaves; and more wood;

11. Graph in the figure below shows number of lichen species growing along a 20km transect from the urban centre. Study it carefully and answer the questions that follow.

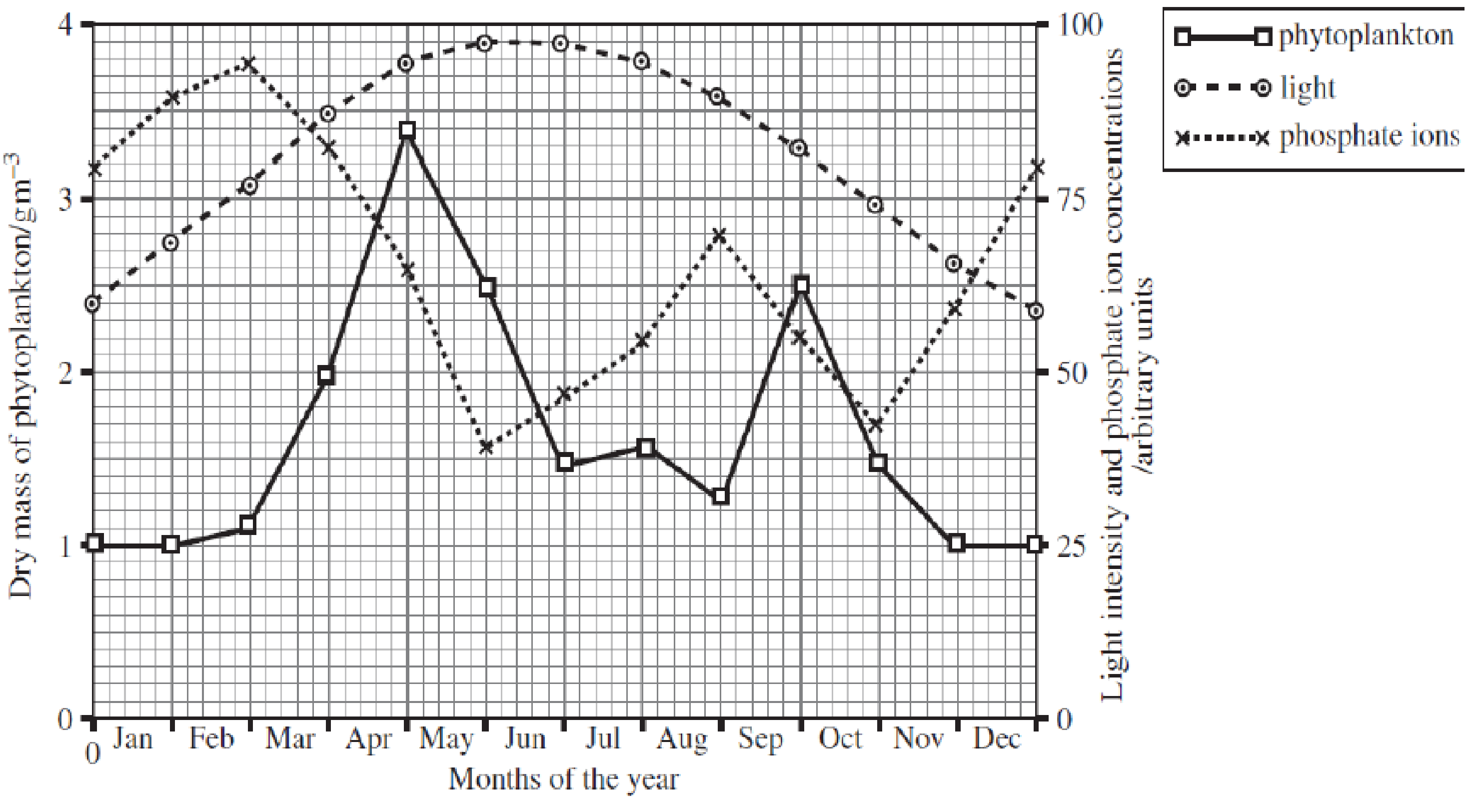


(a) Explain the relationship between the distance from the city centre and the number of lichen species.
<u>As distance from the city centre increases except at distance of 10km from city centre, number of lichen species increases;</u> because number of industries and households that would burn fossil fuels especially oil decreases; levels of toxic_Sulphur dioxide that would kill the algal component of the lichens diminishes; allowing the survival of both more and less tolerant species of lichens to suphurdioxide;

(b) Suggestion an explanation for the change in the lichen species at a distance of 10km from the city centre.
Number of lichen species decreases; because high levels of toxic suphurdioxide from burning of fossil fuels by a large industry or households in a small town at this distance from the city centre, kills the algal component of the lichens;

(c)Describe the
(i) relationship in the Lichen
In the lichen, <u>algae</u> carry out photosynthesis; producing oxygen; and carbohydrate to the <u>fungus</u>; while the fungus absorbs water and mineral salts used by the algae; provides carbon dioxide to algae; protects the algae from intense sun light; and drying out;
(ii) role played by lichen in primary succession.
Hyphae of fungal component of the lichen attach to rocks; hold moisture that would drain away;
Secretes lichenic acid that erode the rock into soil; ***suitable for next stage of succession***;

12. The graph in the figure below shows the abundance of phytoplankton (microscopic plants) throughout one year in the surface water of a lake. The changing amounts of light and phosphate ions in the water are also shown in the graph. *Phosphate ions are necessary for growth of phytoplankton.*



(a) Describe the relationship between dry mass of phytoplankton with the following over the year.

(i) Light intensity.

At low light intensity, dry mass of phytoplankton is low;
As light intensity increases, dry mass of phytoplankton increases;
As light intensity decreases the dry mass of phytoplankton decreases;

(ii) Phosphate ion concentration.

When the dry mass of phytoplankton is low at the start in Jan, the phosphate ion concentration was high;
As dry mass of phytoplankton increases between March and May, phosphate ion concentration decreases up to late May;
As phosphate ion concentration decreases between March and May, dry mass of phytoplankton decreases up to July; subsequently increasing phosphate ion concentration up to sept.;
As phosphate ion concentration increases between May and September, dry mass of phytoplankton increases up to October;
As dry mass of phytoplankton increases between September and October, decreases phosphate ion concentration; subsequently decreasing the dry mass of phytoplankton;
As dry mass of phytoplankton decreases between October and November, phosphate ion concentration increases up to December;

(b) Explain the changes in the phytoplankton population during the months of May and September.

From May to July, phytoplankton population <u>decreases rapidly</u>; because of <u>decreased</u> phosphate ion concentration; and <u>much light</u> in march and April that <u>favoured much productivity</u>; <u>competition for the limited phosphate ion concentration</u> results, subsequently causing <u>death of phytoplanktons</u>;
In September phytoplankton population <u>increased rapidly</u>; to a <u>peak</u>; because of <u>high phosphate ion concentration</u>; and <u>favourable light intensity</u>;

(c) The zooplankton peaks twice during the year. During which months are these peaks most likely to occur. Explain your choice.

June and November; because zooplankton populations peak after phytoplankton population; since they feed on phytoplankton;

13. (a) Distinguish between **Bioaccumulation** and **Biomagnification** as used in population control.

Bioaccumulation is <u>storage of some molecules of chemicals (pesticide) in specific organs or tissues in unexpectedly higher levels</u>; while Biomagnification is the <u>increase in concentration of chemicals (pesticides) as they are passed along the food chains and webs;</u>

(b) The Table below shows amount of DDT measured in parts per million (ppm) found in a variety of organisms associated with a large fresh water lake.

Site of DDT measurement	Amount of DDT(ppm)
Water	0.0003
Phytoplankton	0.006
Zooplankton	0.04
Herbivorous fish	0.39
Carnivorous fish	1.8
Fish-eating birds	14.3

(i) Calculate the concentration factor from water to herbivorous fish.

Concentration factor $= \frac{\textit{amount of DDT in herbivorous fish}}{\textit{amount of DDT in water}}$;

$= \frac{0.39}{0.0003}$;

= 1300 times;

(ii) What principle is illustrated by the data?

Biomagnification of DDT along a food chain;

(iii) Briefly explain the changes in DDT levels in the different organisms.

DDT level in water is relatively low; owing to diffusion of some it into the phytoplankton; where it remains and accumulates in any fatty material;

From phytoplankton to Fish-eating birds, amount of DDT increases; because organisms consume a larger weight of one above them/at a previous trophic level; thus DDT accumulates within their tissues; and is not excreted;

(iv) From the data above, why isn't DDT an ideal pesticide?

Accumulates in tissues of organisms as it passes along a food chain;

14. The Table below shows the number of invertebrates that were collected from the litter of adjacent grassland and woodland areas.

Invertebrates	Grassland	Woodland
spider	5	12
Beetles	13	3
Worms	0	15
Mollusks	0	6
Millipedes	0	5

(a) Suggest any reasons why more invertebrates were found among the litter of the woodland than the grassland.

Volume of litter in woodland is higher than in the grassland; more microhabitat is availed for the invertebrates than in the grassland.

Amount of food in wood litter is higher than in grassland;

Microclimate conditions in the woodland are more stable than in the grassland;

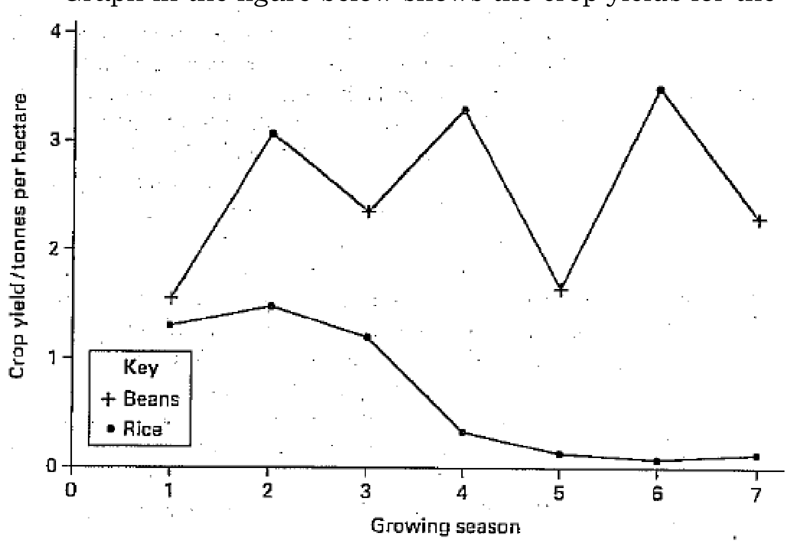
(b) Give the structural adaptations that enable the beetles to exist in the grassland.

- ***Water proof/hard/tough exoskeleton that protects them from desiccation;***
- ***Well-developed sensory organs (eyes, cerci and antennae); for detection of stimuli in their environment;***
- ***Mouth parts modified for various modes of feeding; thus fend on a variety of food;***
- ***Efficient locomotory structures for their rapid distribution or escape from predators***;

(c) What are the characteristics of millipedes that enable them survive in the woodland?

- ***Water-proof/tough/hard exoskeleton; for protection;***
- ***Dull coloured body for camouflage in the litter;***
- ***High reproductive rate to increase their chances of survival;***
- ***Abundant food in form rotting organic matter readily available in the wood litter;***
- ***Ability to sham death by coiling to avoid predation***;

15. In an investigation of crop yields in a rain forest, an area of the forest was cleared, two experimental plots marked and treated as follows.
On one plot, rice was grown continuously. On the other plot, rice and beans were altered.
No fertilizer was added to either plot.
Graph in the figure below shows the crop yields for the two plots over a period of time.



(a) Compare the crop yields for the two plots over the experimental period.

- ***In the plot where rice and beans were altered, crop yield fluctuates; while in the plot where rice was grown continuously, crop yield increases from the 1st to 2nd season, decreases from 2nd to 7th season;***
- ***In the plot where rice and beans were altered, crop yield is higher than in the plot in which rice was grown continuously throughout the experimental period***;

(b) Explain why the

(i) yield decreases when rice was grown continuously.

Rice removes minerals from the soil;
(ii) The crop yield was maintained when rice and beans were altered.
Beans are legumes; thus have root nodules containing nitrogen- fixing bacteria; after decomposition of bean plants, nitrates are availed to rice;
(c) What would be the effect on the biomass of decomposers when the rainforest was converted to permanent agriculture? Explain how this would affect nutrient recycling.
Biomass of decomposers decreases; recycling of nutrients/minerals would decrease; because with few decomposers, little break down of organic material occurs; releasing less nitrates for plants;
16. The Table below shows mean values for primary productivity for four ecosystems.

Ecosystem	**Primary productivity ($KJm^{-2}yr^{-1}$)**
Temperate deciduous forest	26000
Tropical forest	40000
Temperate grass land	15000
Intensively cultivated land in a temperate region	30000

(a) What is meant by **primary productivity**?
Amount of energy and organic material stored in primary producers;
(b) Suggest explanations for the difference in primary productivity between,
(i) tropical forest and temperate forest.
Primary productivity of a tropical forest is higher than that of temperate forest; because tropical rain forests have higher/more consistent temperatures, higher rainfall all year; higher plant density; greater light intensity; more ever green plants/fewer deciduous plants;
(ii) Temperate grass land and intensively cultivated land.
Primary productivity of intensively cultivated land is higher than that of temperate grass land; because in an intensively cultivated land, selection of crops for high yields occur; pests and diseases are controlled that would destroy crops; fertilisers are applied to maximize yields; supply of water by irrigation; new plants are planted immediately after harvest;
(c) Describe how you would estimate the fresh biomass of the producers in a grassland ecosystem.

- ***A quadrat of given size; is randomly thrown many times in a grass land;***
- ***Remove all plants from the quadrat;***
- ***Remove soil/animals from plants;***
- ***Weigh to find fresh mass per known quadrat number;***
- ***Obtain mean value, and multiply appropriately to find mass per area of grass land;***
- ***Remove one plant, weigh and multiply by number of plants***;

(d) Suggest why productivity of an ecosystem is measured in units of energy rather than units of biomass.
Water contents of biomass varies; Biomass includes inorganic components; while productivity in energy units is a true reflection of energy capture by producers;
17. (a) Distinguish between **Resource partitioning** and **character displacement**.

Resource partitioning	Character displacement/Niche shift
Dividing up of limited resources between different species co-existing in the same ecological niche; e.g. ***(i) Five species of insect eating birds, warblers co-existing in spruce trees feed on insects in different regions of the tree.*** ***(ii) Different species of eagles in a forest feeding at different times of the day i.e. bald headed eagles , in early morning and evenings with white breasted eagles towards noon;***	***An evolutionary divergence of features/characteristics when similar species inhabit the same environment than when they are isolated;*** *The characters can be morphological, ecological behavioral or physiological;* ***e.g.*** ***(i) Development of different beak sizes by finches co-existing in Galapagos island; allowing each finch to feed on seeds of different sizes;***

(b) Outline how niche differentiation may be achieved.

- ***Eating different foods; e.g. Five species of insect eating birds, warblers co-existing in spruce trees feed on somewhat different insect species;***
- ***Feeding in different places (Vertical separation); e.g. feeding on seeds found under desert shrubs or in the open; feeding on bugs on the top or bottom of trees;***
- ***Feeding at different times***; ***e.g. feeding on insects active at night versus those active during day.***

(c) Figures **1** and **2** show the results of experiments carried out on two species of flour beetle, *Tribolium* and *Oryzaephilus*, which were grown together in slightly different environments.
In figure **1**, *Tribolium* and *Oryzaephilus* were grown in plain flour culture while in figure **2**, they were grown in a culture which had glass tubings. For each experiment, four adult beetles of each species were introduced in the culture and the population size of each species was determined at regular intervals. Study the information and answer the questions that follow.

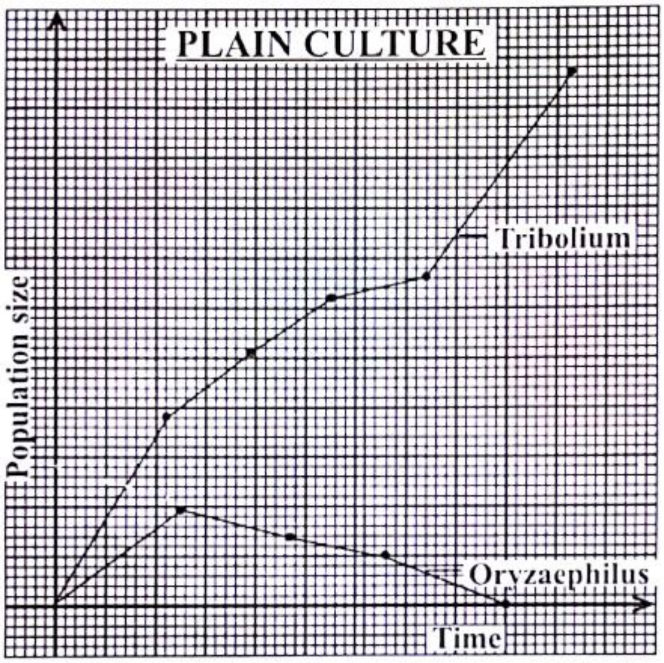


Fig. 1

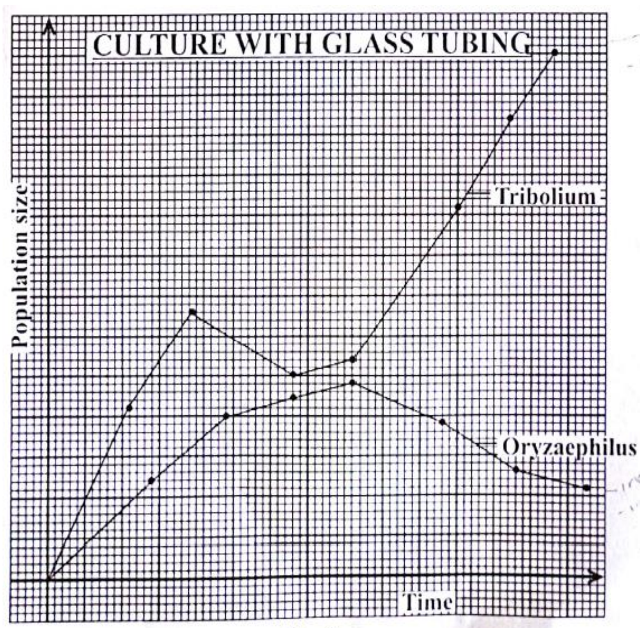


Fig. 2

(i) Compare the population growth during the time of the experiment for *Tribolium* and *Oryzaephilus* beetles in

- Figure **1**

Similarities

Population growth for both *Tribolium* and *Oryzaephilus*,

- ***Increase at the beginning;***
- ***Attained maximum;***

Differences

- ***Tribolium shows a rapid increase at first while Oryzaephilus had a gradual increase;***
- ***Tribolium showed a gradual increase while Oryzaephilus showed a gradual decrease with time;***
- ***Tribolium showed a rapid increase to a maximum point while Oryzaephilus showed a gradual decrease to extinction/minimum/zero;***
- ***Oryzaephilus attains its maximum earlier than Tribolium;***
- ***Oryzaephilus attains peak while Tribolium has no peak;***
- ***Population size increase for Tribolium is always higher than that for Oryzaephilus throughout;***
- ***Throughout population size of Tribolium increases but that of Oryzaephilus increases and then decreases thereafter;***

- Figure **2**

Similarities

Population growth for both *Tribolium* and *Oryzaephilus*,

- ***Increase at beginning;***
- ***Attain peaks;***
- ***Increases gradually in middle;***

Differences

- ***Tribolium started with a rapid increase while Oryzaephilus increases gradually;***
- ***Tribolium showed a rapid decrease while Oryzaephilus showed a slight increase;***
- ***The slight increase in Tribolium is followed by a rapid increase while Oryzaephilus decreased gradually at the end;***
- ***Tribolium attains peak earlier than Oryzaephilus;***
- ***Tribolium has a higher peak than Oryzaephilus;***

(ii) Explain the population growth of the two species in,

- Figure **1**

Tribolium has a faster growth rate compared to Oryzaephilus; that's why population is higher; when the number of Tribolium grow rapidly in a short time, it puts Oryzaephilus at a disadvantage in terms of competition for resources; extinction/absence of Oryzaephilus gave opportunity to Tribolium to increase to maximum/highest; because flour is both habitat and food/reduced competition/predation

- Figure **2**

Glass tubings provide advantage to Oryzaephilus to <u>grow faster</u>; Tribolium decreases when Oryzaephilus was approaching maximum/peak; due to <u>increased interspecific competition</u>; Reduction in population size of Oryzaephilus reduced interspecific competition; for Tribolium to rapidly increase to the highest; Oryzaephilus remains at a low population size than Tribolium; because Tribolium is <u>a better competitor</u>; No extinction for both species due to <u>microhabitat</u>/resource partitioning provided by the glass tubing;

(iii) Suggest what is being demonstrated by the interaction of the two species in;

- Figure **1**

<u>Gause's (competitive) exclusion principle</u>; two species with same ecological niche; cannot co-exist; so weaker one is out competed to extinction/ is eliminated;

- Figure **2**

There can be a competitive advantage for one species in a particular environment/resource partitioning; allowing poor competitors to survive; permitting co-existence; that occur when niche overlap occur;

(iv) From the interaction of the species in figures 1 and 2, explain the effects of interspecific competition

Harm to both species; because they are unable to exploit resources as they could in absence of others/without competition;

Spacing of individuals/immigrations; allowing receiving of enough resources;

Allows niche differentiation/reduced niche overlap;

(v) Suggest what would happen if;

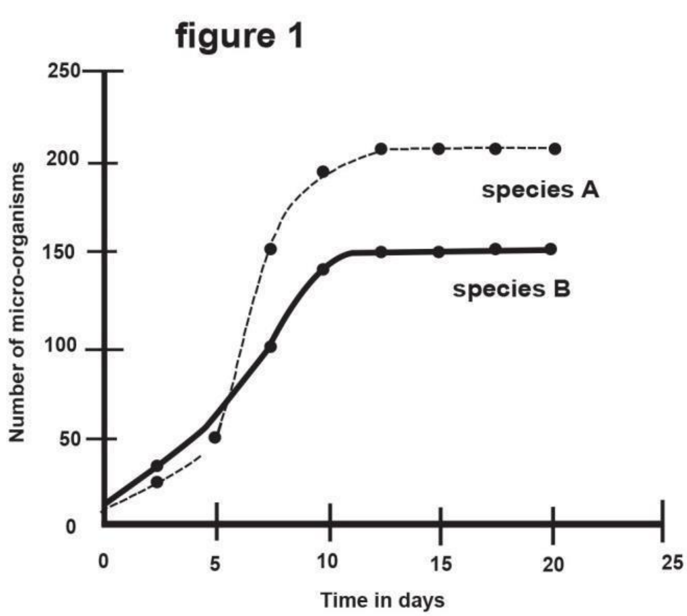
- The experiment in figure **2** was continued for some time

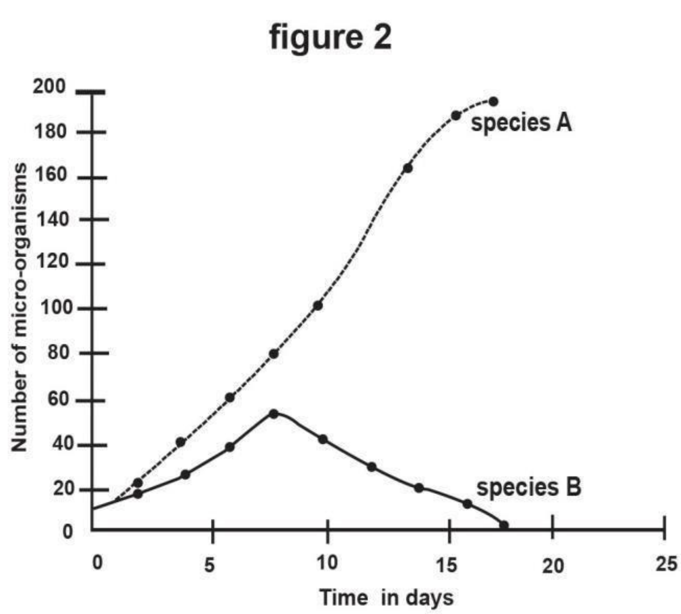
Tribolium continues to increase; as Oryzaephilus reduces gradually; eventually both species would go into/decrease to zero; due to exhaustion of food/accumulation of wastes;

- Oryzaephilus beetle was grown alone

Oryzaephilus would grow <u>much faster</u> than in mixed culture; attaining a higher maximum; stabilizes at carrying capacity; up to a point when food becomes exhausted; then decreases gradually;

18. The graphs below indicate the population growth of two related aquatic microorganisms of species **A** and **B** in two sets of culture media.
In figure **1** of the first set, both species were cultured in a long and cylindrical vessel while in figure **2** of the second set, both species were cultured in a shallow Petri dish.
Study the two graphs and answer the questions that follow.





(a)Describe the population growth patterns of the two organisms, **A** and **B** cultured in the shallow petri-dishes.

Species A.

From first day to 10th day, number of micro-organisms of species A increases rapidly;

From 10th day to 18th day, number of micro-organisms of species A increases gradually; to the highest;

Species B

From day 0 to 8th day, number of micro-organisms of species B increases rapidly; to a peak;

From 8th day to 18th day, number of micro-organisms of species B decreases rapidly; to zero;

(b) Give the differences in the population growth patterns of each of the species in both sets. (Shallow petri-dishes and long cylindrical vessels.

Differences in population growth pattern of species A

Long cylindrical vessel	Shallow petri - dish
Higher maximum population growth;	***Lower maximum population growth;***
Population grows faster	***Population growths slowly***
Population takes a shorter time to reach the carrying capacity/ Maximum population is attained earlier	***Population takes a longer time to reach the carrying capacity/maximum population is attained later;***

Differences in population growth pattern of species B

Long cylindrical vessel	Shallow petri-dish
Population grows faster	***Population grows slowly***
Higher maximum population growth attained	***Lower maximum population growth attained***
Maximum population growth is attained later	***Maximum population growth is attained earlier***
Population reached carrying capacity	***Population decreases to extinction***
Population remained constant/levels off after maximum	***Population decreases after maximum***

(c) Explain the differences in the population growth pattern observed in (b) above.

Both species A and B reproduced rapidly; reaching carrying capacity; when culture together in the long cylindrical vessel because the vessel provided a larger space; and there was vertical separation of species A and B; thus no interspecific competition;

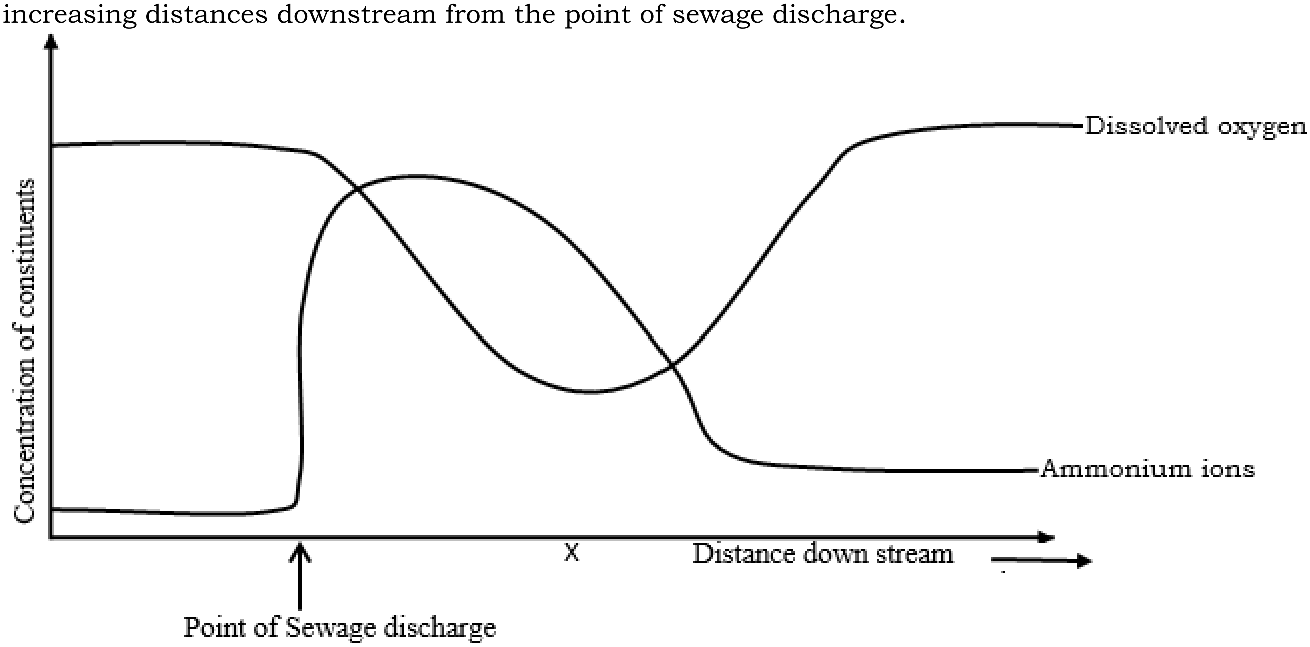
In the shallow petri-dishes, very small space is availed; species A and B co-existed in the same ecological niche; intense interspecific competition occurred; but with species A having better competitive advantage over species B; decreasing the population of species A to zero/extinction;

19. (a) What is meant by **eutrophication,** giving **two** main causes of it.

Nutrient enrichment of water bodies; caused by,

- ***Heavy use of nitrogen fertilizers on agricultural land;***
- ***Increased discharge of phosphates from sewage works***;

(b)Graph in the figure below shows the effect of sewage discharge on some chemical constituents of a river at increasing distances downstream from the point of sewage discharge.



Explain the variation in the concentration of ammonium ions and dissolved oxygen, downstream from point of sewage discharge.

- Ammonium ions.
  Increased rapidly; to a peak; a short distance from point of sewage discharge; because organic nitrogen containing compounds are broken down/decomposed forming ammonia; which dissolves in water forming ammonium ions;
  Further distance downstream, concentration of ammonium ions decreases rapidly; because ammonium ions are converted to nitrate ions; by nitrifying bacteria; and further by dilution with water;
- Dissolved oxygen
  Decreased rapidly at point of sewage discharge; to a minimum; because of decomposition of organic components of sewage; by aerobic bacteria;
  Further distance downstream, concentration of dissolved oxygen increases gradually; returning to the normal level; because of increased photosynthesis; and dissolution from the atmosphere;

(c) Suggest **two** ways in which the effects of sewage shown on the graph can be monitored.

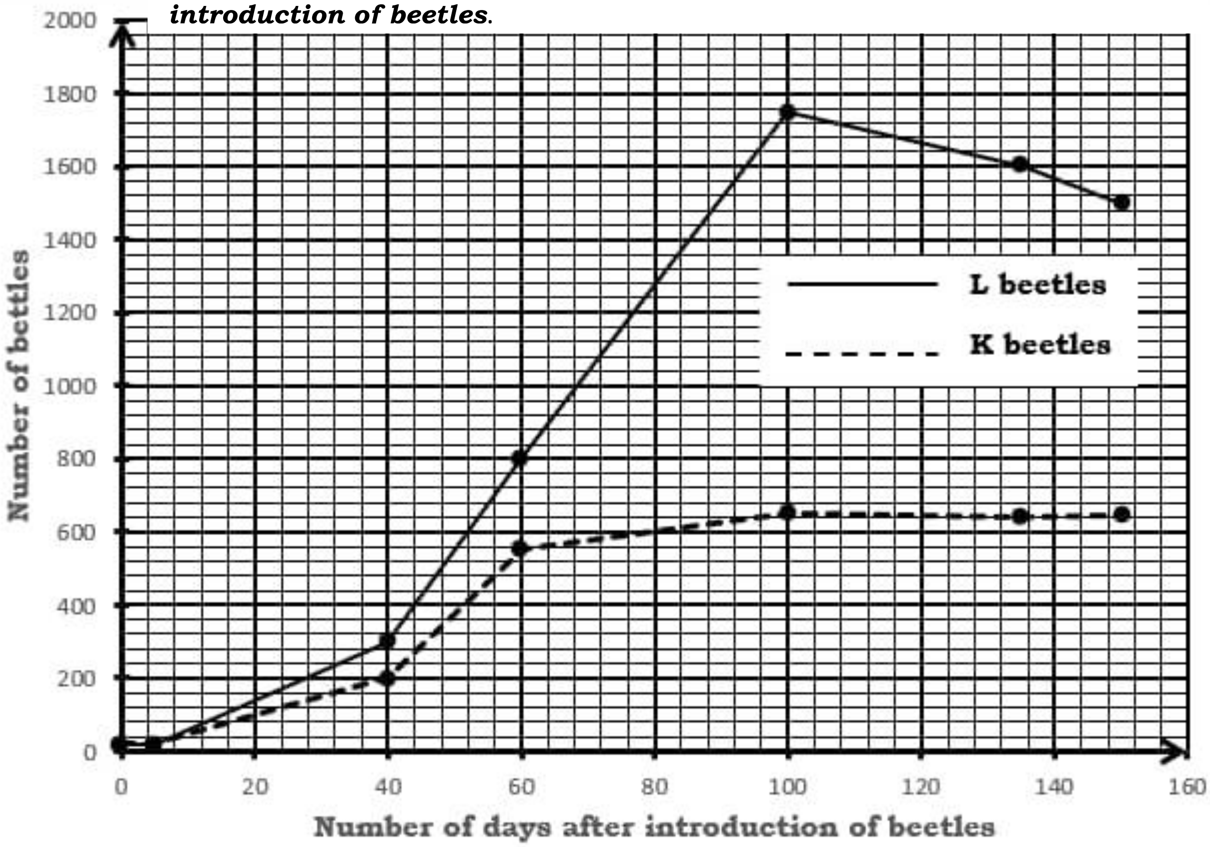
- ***Changes in the phytoplanktonic species present e.g. blue-green bacteria i.e. eutrophic waters characteristically show high abundance and low species diversity of phytoplanktons.***
- ***Biochemical/Biological Oxygen demand(BOD); with a high BOD indicating low availability of oxygen; characteristic of eutrophic waters;***

20. An investigator placed 500g of maize flour in a rectangular box with a perforated top and introduced equal numbers of the flour beetles *Tribolium confusum* (**K**) and *Tribolium castenum*(**L**) in the same box at the same time. The box was kept under similar environmental conditions in the school laboratory. The beetles were counted at certain intervals and the results are as shown in the Table below.

Number of days after introduction of beetles	Number of K beetles	Number of L beetles
0	20	20
5	20	20
40	200	300
60	550	800
100	650	1750
135	640	1600
150	645	1500

(a) Represent the information on a suitable graph.

A graph of number of K and L beetles varying with number of days after introduction of beetles.



(b) State the biological principle being represented by the graph in (a) above, with a reason.

<u>Gause's (competitive) exclusion principle</u>; two species of beetles, Tribolium confusum and Tribolium castenum <u>co-existed in the same ecological niche</u>; with Tribolium castenum <u>outcompeting</u> the Tribolium confusum/with Tribolium castenum having a <u>better competitive advantage</u> over Tribolium confusum for nutrients in maize flour;

(c) Compare the variation in the number of the two species of flour beetles over the experimental period.

<u>Similarities</u>.

Number of both *Tribolium confusum* and *Tribolium castenum*,

- ***Remain constant from day 0 to the 5th day;***
- ***Increase gradually from 5th day to 40th day;***
- ***Increase rapidly from 40th day to 60th day;***
- ***Attain a maximum;***
- ***Attain maximum at the same time (100th day);***

Differences

Number of *Tribolium confusum*(K beetles)	Number of *Tribolium castenum* (L beetles)
Lower from 5th day to 150th day;	***Higher from 5th day to 150th day;***
Increases gradually from 60th day to 100th day	***Increases rapidly from 60th day to 100th day***
Remains almost constant from 100th day to 150th day	***Decreases rapidly from 100th day to 150th day***
Lower maximum attained	***Higher maximum attained***
No peak attained	***Peak attained***

(d) Explain the relationship in the number of both species of flour beetles throughout the experimental period.

From day 0 to 5th day, number of K and L beetles remain constant and low; because sexually mature beetles were few; reproducing at a lower rate; and the beetles were getting adapted to the available food nutrients in their culture medium;

From 5th day to 40th day, number of K and L beetles increases gradually; because of slower reproductive rate by the two species;

From 40th day to 150th day, number of Tribolium castenum is higher than Tribolium confusum; because Tribolium castenum is a better competitor for nutrients in maize flour than Tribolium confusum;

From 40th day to 60th day, number of K beetles increases rapidly; while from number of beetles increases rapidly from 40th day to 100th day owing to a rapid reproductive rate of both species; on maximum utilization of available food/flour; allowing for faster metabolism; to generate energy for growth; and reproduction;

From the 100th day to 150th day, number K beetles remain almost constant because its population had reached a carrying capacity earlier; some of the K beetles were dying due to interspecific competition for food; and pollution form accumulation of metabolic wastes;

Number of L beetles decreases rapidly in the same period, owing to exhaustion of maize flour nutrients; pollution form accumulation of metabolic wastes; thus a higher death/mortality rate than birth/natality rate;

(e) (i) Briefly describe a suitable method you could use to determine the population of the flour beetles used in this investigation.

Capture mark Release recapture method/Lincoln index;

- ***Light traps are set up randomly in the rectangular box in which the flour beetles were being cultured;***
- ***Number of beetles of a given species caught are counted and recorded as N_1;***
- ***These beetles are then marked with a small paint/dye mark; released back into the box where they were being cultured; allowed to mix randomly with other members of the same species;***
- ***After five days (any sufficient time), light traps are set again, number of all beetles of a species counted and recorded as N_2;***
- ***Number of flour beetles in the second capture having paint/dye mark is counted; and recorded as N_3; giving number of beetles of a given species recaptured;***
- ***Total population , P*** $= \frac{N1XN2}{N3}$;

(ii) Suggest any precautions taken to ensure accuracy of the results in e (i) above.

- ***Mark used should not hinder the movement of the beetles; and make them conscupicous to predators;***
- ***Suffient time must elapse between the first capture and recapture of beetles;***
- ***Emigration and immigration of the flour beetles should not occur;***
- ***Marked beetles should mix randomly with other beetles of the same species;***

(f) Predict with reasons what could happen to the population of the flour beetles if the experiment were cultured in separate boxes in an open habitat outside laboratory.

Higher carrying capacity than that obtained under laboratory conditions would be attained by both K and L beetles; because of more food; breeding space; and thus reduced interspecific competition;

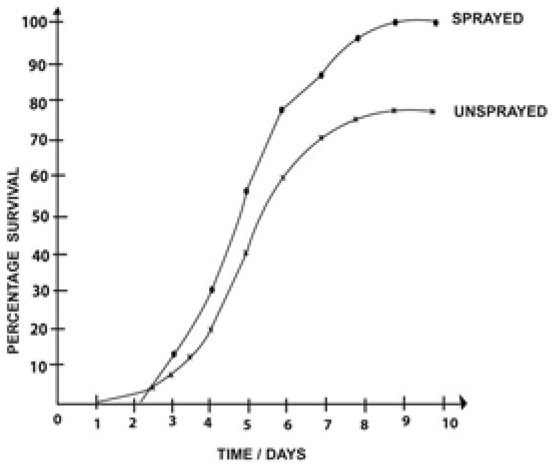
Population of Tribolium castenum would be higher than Tribolium confusum; because Tribolium castenum is a better competitor than Tribolium confusum.

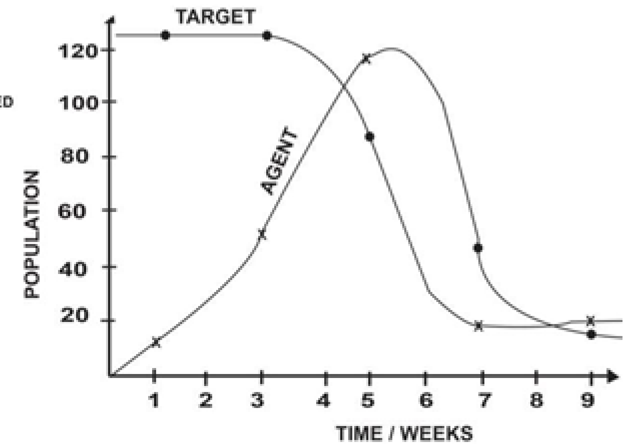
Populations of K and L would decrease after attaining maximum/ reaching carrying capacity; because of environmental resistance factors; that would cause death of more organisms;

Population growth rates of K and L would be more rapid than that of organisms grown under laboratory conditions; owing to abundant food supply;

21. In an experiment to study the effectiveness of DDT towards the cabbage white butterfly, *Pieris rapae* which feeds on cabbage leaves, two adjacent farm yards where prepared and *Pieris was* introduced in each farm and left for some time. After spraying one farm yard with DDT for three consecutive times, the number of eggs that survived and hatched into larvae at the sprayed and non-sprayed farm yards was determined as shown by Graph **A**.
In another set of experiment, *Pieris rapae* was exposed to birds as its control agents and the changes in the population of both, with time was determined as indicated by Graph **B**.
Study the graphs and answer the questions that follow. (**BS page 335)**

Graph **A** Graph **B**





(a) Account for the changes in the population of the control agent.

From 0week to 3 weeks, the population of the control agent increased gradually; since the reproducing individuals are still very few; and the control agent is not yet well adapted to the environment mainly in terms of obtaining enough food in form of Pieris;

From 3weeks to 5.5 weeks, the population of the control agent increased rapidly; to a peak; due to more reproducing members of the control agent; well adapted to the environment in obtaining sufficient food in form of Pieris without much competition hence their high reproductive rate.

From 5.5weeks to 7 weeks, the population of the control agent decreased rapidly; because of the rapid decrease in the population of Pieris; resulting into food scarcity; and intraspecific competition for food among the birds.

From 7 weeks to 9.4 weeks, the population of the control agents decreased gradually, because of the decrease in the level of competition among the few remaining members of the control agents; the less adapted birds were out competed by the well adapted ones; resulting into their death, emigration, low growth and reproductive rates; few well adapted ones thus continued to reproduce but at a slower rate;

(b) Account for the

(i) decrease in the population of *Pieris rapae.*

From 3weeks to 4 weeks, the population of the pieris decreased gradually; due to less production of the Pieris by a small population of birds which had not yet become adapted to their environment.

From 4weeks to 6.0 weeks, the population of Pieris decreased rapidly; since they were highly fed upon by the large population of the well adapted control agent.

From 6.0weeks to 7.0 weeks, the population of the target then decreased gradually; because of the low rate of production by the small population of well adapted birds;

(ii) population of *Pieris* and that of the control agent from 8½ to the 9th week.

From 8.5weeks to 9 weeks, the population of the control agent decreased gradually and then remained below that of the prey(Pieris) which slightly increased and then remained constant, because the great decrease in the population of the control agent caused less feeding on the Pieris;

The population of Pieris was maintained above that of the predators; because being at the lower trophic level than their predators; thus obtained a larger amount of energy than their predators; causing their higher rate of growth; and reproduction than their predators;

The population of both maintained constant because of the dynamic equilibrium, between the two which got established

(c) Compare the number of eggs of *Pieris* between the sprayed and non-sprayed farm yards.

Similarities

In both the sprayed and non-sprayed farm yard, percentage survival of the eggs,

- ***Are equal at 2.5 days.***
- ***Remain constant from 9days to 10 days.***
- ***Increased rapidly from 4days to 6 days.***
- ***Increased gradually from 6days to 9days;***
- ***Increased from 2.1days to 9days;***
- ***Is zero at the start of the investigation;***
- ***Attain a maximum;***
- ***Attain maximum at same time(9days);***

Differences

Percentage survival eggs in sprayed farm land	Percentage survival eggs in unsprayed farm land
Higher from 2.5days to 10days	***Lower from 2.5days to 10days***
Lower from day 1 to 2.5days	***Higher from day 1 to 2.5days***
Remained constant at 0 from 1day to 2.1days	***Increases gradually from 1day to 2.1days***
Increased rapidly from 2.1days to 3.5days	***Increased gradually from 2.1days to 3.5days***

(d) Explain the differences in the number of eggs of *Pieris* that survived and hatched into larvae at the sprayed and non-sprayed farm yard.

From day 1 to 2.1 days, there were no surviving eggs in the sprayed farm while in unsprayed farm percentage survival of eggs increased gradually because the sprayed DDT is toxic; thus killed the Pieris and the ones in the unsprayed farm yard survived;

From 2.1 to 3.5 days, percentage survival of eggs increased rapidly in the sprayed farm yard but gradually in the unsprayed farm yard; because spraying with broad- spectrum DDT; larval predators e.g. soil-dwelling ground beetles were killed; larval predation is thus significantly reduced; resulting in new resurgence;

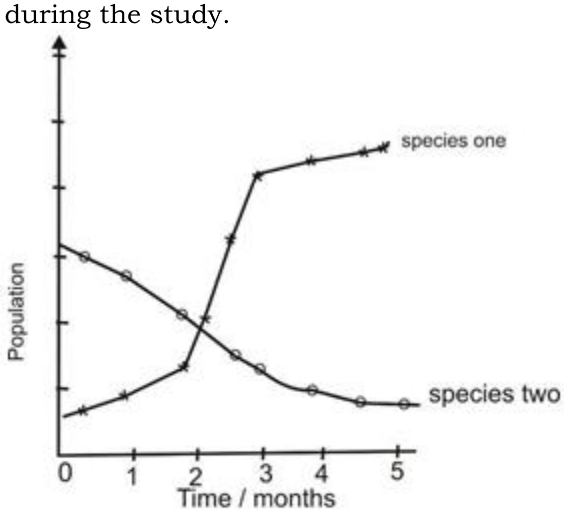
From 2.5days to 10days, percentage survival of eggs was higher in the sprayed farm yard than in the unsprayed farm yard; because the larval predators' population is smaller in size than the Pieris(prey); and are at a higher tropic level; are thus more vulnerable and recover more slowly than the Pieris hence a slower rate of growth and reproduction;

From I day to 2.5 days, percentage survival of eggs was lower in the sprayed farm yard than in the unsprayed farm; due to the toxic DDT killing the pieris; and the ones in the unsprayed farm, were not killed; thus survived and reproduced.

(e) Outline any **three** advantages of the method used in Graph **B** to that used in Graph **A**.

- ***Environmental pollution is less since it is not toxic, associated with lower pest resistance compared to pesticide use.***
- ***The biological control, there is no pest resistance to the predator unlike the pesticide use.***
- ***There is no pest insurgence, in biological pest control unlike the pesticide use.***
- ***Persistence of the control chemicals is not evident of biological pest control.***
- ***The predators are very specific to the target hence non target biota not affected.***
- ***Biological pest control is not associated with bio magnification unlike pesticide use.***
- ***Bio accumulation is also not evident in biological pest control unlike the pesticide use.***

22. Parasitic wasps can be used for biological control of white flies. Wasps were released into a glasshouse at the same time to find out which one was more effective. Graph shows how the population of both species varied during the study.



(a)What is meant by **biological pest control**?

Use of an organism (natural predator, parasite or pathogen) to reduce population of another organism (pest species or weeds); perceived to be potentially harmful by feeding on it; to a level at which it is economically unharmful;

(b) Give the difference between the population of the two species of the wasps during the study period.

- ***Population of species two is higher than that of species one from 0months to 2months;***
- ***Population of species one is higher than that of species two from 2months to 5months***
- ***Population of species two decreases while population of species one increases from 0months to 5months;***

(c) Explain the changes in the population size of species one

Initially the population of species one was too low; since few of them were introduced in the glasshouse;

From 0months to 1.8months population of species one increased gradually; because of interspecific competition between the two species; and species one being a better competitor than species two;

From 1.8months to 3 months the population of species one increased rapidly; because reducing population of species two, cause little interspecific competition between the two species;

From 3months to 5 months, population of species one increased gradually, owing to intense intraspecific competition amongst the species one;

(d) Outline the advantages and disadvantages of biological control as a method of regulation of pest population.

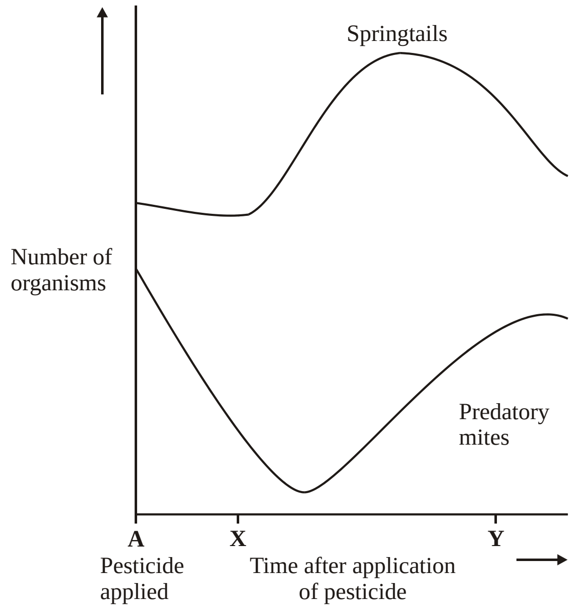
Advantages.

- ***If well-screened, a biological control agent only attacks the pest;***
- ***Forms self-perpetuating population (only one application required);***
- ***Cheaper e.g. saves cost of repeatedly using chemicals;***
- ***Safer because does not leave chemical residue;***
- ***No pest resistance to the control agents;***

Disadvantages

- ***Doesn't completely eradicate pest;***
- ***cost of researching / setting up a biological control system;***
- ***biological control agent may become a nuisance itself/must be well screened;***
- ***slower to get rid of pest than chemicals;***
- ***more subject to environmental factors;***

23. The graph in the figure below shows the effect of a single application of a biodegradable pesticide on the numbers of predatory soil mites and their principal prey, springtails. Study it and answer the questions that follow.



(a) Explain the change in the number of predatory soil mites and spring tails during the period,

(i) **A** to **X**.

Number of springtails remains almost constant; because springtails are not affected by the pesticide;
Number of predatory soil mites decreases rapidly; because some mites were killed by the pesticide;

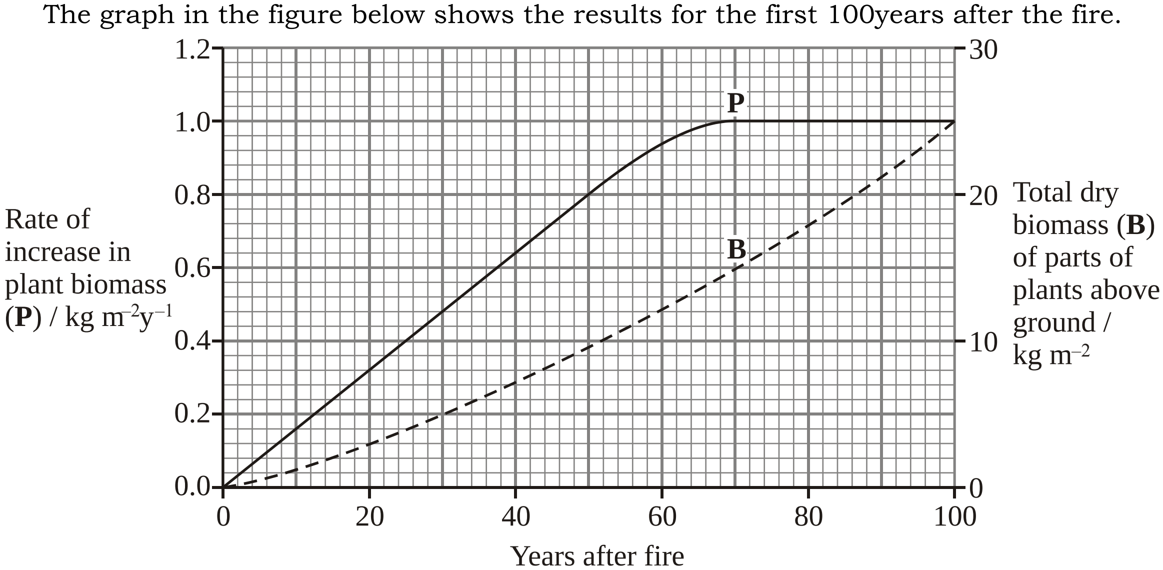
(ii) **X** to **Y**

Number of springtails increases; to a peak; because of decreased numbers of their predator, mites; that could feed on them;
Number of mites increases rapidly; owing to decreasing concentration of pesticide in the soil; after long period from its time of application;

(b) Describe what might be expected to happen to the numbers of mites and springtails over a long time period if pesticide was no longer used.

Fluctuation in the population occurs;
i.e. ***increase in number of springtails supporting a subsequent increase in number of mites; also causing a crash on the springtail number; followed by an inevitable decrease in number of mites;***
Number of the springtails(preys) remains higher than the number of predatory soil mites;
Variation in numbers reduced;

24. A fire destroyed a large area of a forest. The process of succession was studied until the forest was re-established. The rate of increase in plant biomass, **P** was determined at regular intervals. Also, the total of biomass of the parts of plants above the ground, **B** was measured in sample areas.
The graph in the figure below shows the results for the first 100years after the fire.



(a) Ten years after the fire most of the area was covered with herbaceous plants.

(i) Describe how you could measure the dry biomass of the parts of the herbaceous plants above the ground in a sample area of $1m^2$.

- ***Collect all plant material above the ground;***
- ***Heat in an oven at or just below 100℃; to drive off all the water;***
- ***Cool in a desiccator; and weigh using a weighing scale;***
- ***Repeat and a constant mass is obtained;***

(ii) How could the researchers make sure that they obtained reliable data for the total biomass of the parts of the plant above the ground?

- ***Large number of sample area/repeats;***
- ***Randomly selected;***

(iii) Suggest **two** limitations involved in measuring the rate of increase in plant biomass, **P** which would affect the accuracy of the data.

- ***Drying destroys plants, so different samples needed;***
- ***Large area, so difficult to get representative samples;***
- ***Difficult to measure biomass of trees;***
- ***Variability in growing conditions;***
- ***Variability of abiotic conditions in different areas of forest;***

(b) Calculate the ratio **P** to **B** at the following times after fire.

(i) 10years

P= $0.16Kgm^{-2}y^{-1}$***;*** ***B=*** $1Kgm^{-2}$***;***

P:B= $\frac{0.16}{1}$***;*** ***<u>1:6.25;</u>***

(ii) 100years

P= $1.0Kgm^{-2}y^{-1}$***;*** ***B=*** $25Kgm^{-2}$***;***

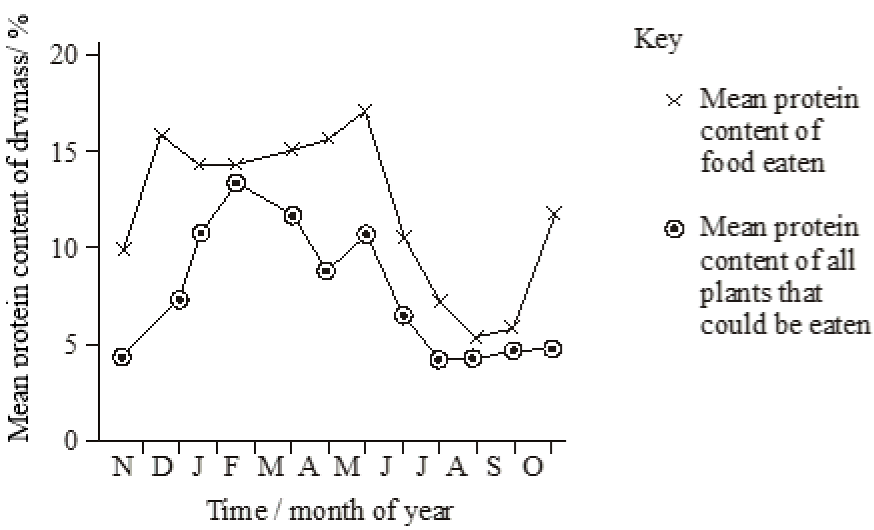
P:B= $\frac{1.0}{25}$***;*** ***<u>1:25;</u>***

(c) Explain the change in the ratio at 10years and 100years.

Ratio at 10years is <u>lower</u> than at 100years; because

- ***most of the plants are trees/large;***
- ***high proportion of dead / non-photosynthesizing biomass;***
- ***herbs grow rapidly/small so large percentage increase;***
- ***herbs have higher productivity;***

25. The graph in the figure below shows the changes in the mean protein content of all the plants in a grassland in Africa that could be eaten by the wildebeest at different times of the year. It also shows the mean protein content of the food the wildebeest actually eats.
Study it carefully and answer the questions that follow.



(a) Compare the changes in the mean protein content of food eaten and mean protein of all plants that could be eaten by the wildebeests.

<u>Similarities</u>.

Both protein content of food eaten and mean protein of all plants that could be eaten,

- ***Attain peaks;***
- ***Attain <u>two</u> peaks;***
- ***Increase from November to December;***
- ***Decrease from May to September***;
- ***Increases rapidly from April to May;***
- ***Attain second peak at same time/in late May***;

<u>Differences</u>

Mean protein content of food eaten	Mean protein of all plants that could be eaten
Higher throughout the year	***Lower throughout the year***
Decreases from December to February	***Increases from December to February***
Increases gradually from February to April	***Decreases rapidly from February to April***
Increases rapidly from late September to late October	***Remain almost constant from late September to late October***
Higher peaks attained	***Lower peaks attained***
Minimum attained	***No minimum attained***
First peak attained earlier;	***First peak attained later***
Increases rapidly from November to December	***Increases gradually from November to December***

(b) Suggest an explanation for the difference in the mean protein content of all the plants which could be eaten and the mean protein content of the food actually eaten.

Throughout the year, mean protein of the food actually eaten is <u>higher</u> than mean protein content of all plants that could be eaten; because wildebeest are <u>selective feeders</u>; only eating <u>some species/parts</u> of plants with a <u>higher protein content</u>;

(c) Account for the change in the plant content of the plants between July and September.

Plant content decreases; because of little/no rain during this period; thus <u>less nitrates are absorbed</u> by plants; affecting protein synthesis; and <u>parts of higher plants die</u>; leaving a higher proportion of cellulose/non-protein content in the diet;

(d) When wildebeest eat food containing less than 6% protein, they start to lose protein from their body tissues. Suggest and explain how a deficiency of **one** named protein makes the wildebeest more susceptible to being caught by predators.

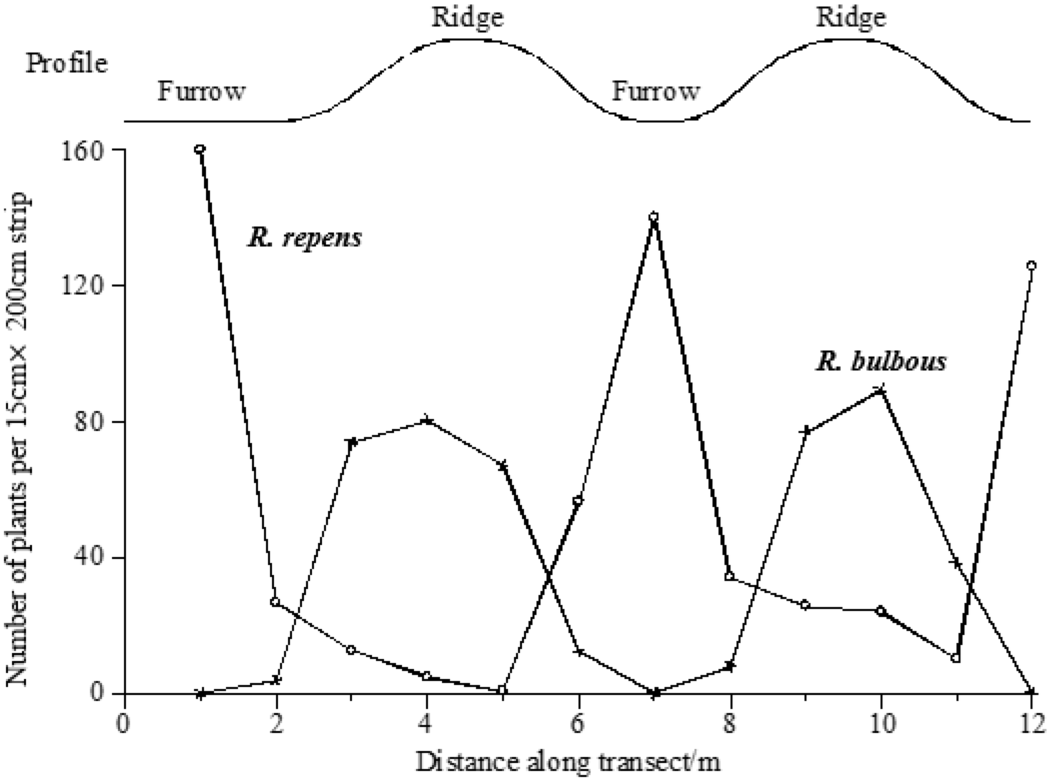
<u>Myosin/actin</u>; skeletal muscles weaken; slowing movement of the wildebeest during escape from its predators;

<u>Haemoglobin</u>; insufficient oxygen; for ATP synthesis during respiration; thus little energy is availed for muscle contraction;

26. In an investigation on the distribution of two species of buttercup, *Ranunculus bulbosus* and *Ranunculus repens* in a field crossed by small ridges and furrows, a transect across the ridges and furrows was used.

The number of buttercup plants in each of a series of long narrow strips (15cm × 200cm) at right angles to the transect was counted.

The results are shown on the graph in the figure below.



(a) Explain what is meant by a **transect**.

Is a line /belt across a habitat/field/environment; along which a survey or observations are made;

(b) Suggest why the counting was done in long narrow strips instead of in square quadrats.

So that samples were confined to a ridge or furrow;

(c) Give the differences in the distribution of the two species of buttercup plants in the furrow and ridges.

Profile	Number of buttercup plant species	
	R. repens	R. bulbosus
Ridge	***Lower from 2.3m to 5.5m; and 8.3m to 11.5m***	***Higher from 2.3m to 5.5m; and from 8.3m to 11.5m***
Furrow	***Higher from 1m to 2.3m; and 5.5m to 8.3m***	***Lower from 1m to 2.3m; and 5.5m to 8.3m***

(d) In a follow-up experiment, 50 seeds of each species were sown in pots. In half of the pots the soil was able to drain freely. The other pots had no drainage, so the soil was waterlogged. The results are shown in the table below.

Pot	Mean number of seedlings per pot	
	R. bulbosus	*R. repens*
Free-draining soil	32	12
Water logged soil	2	12

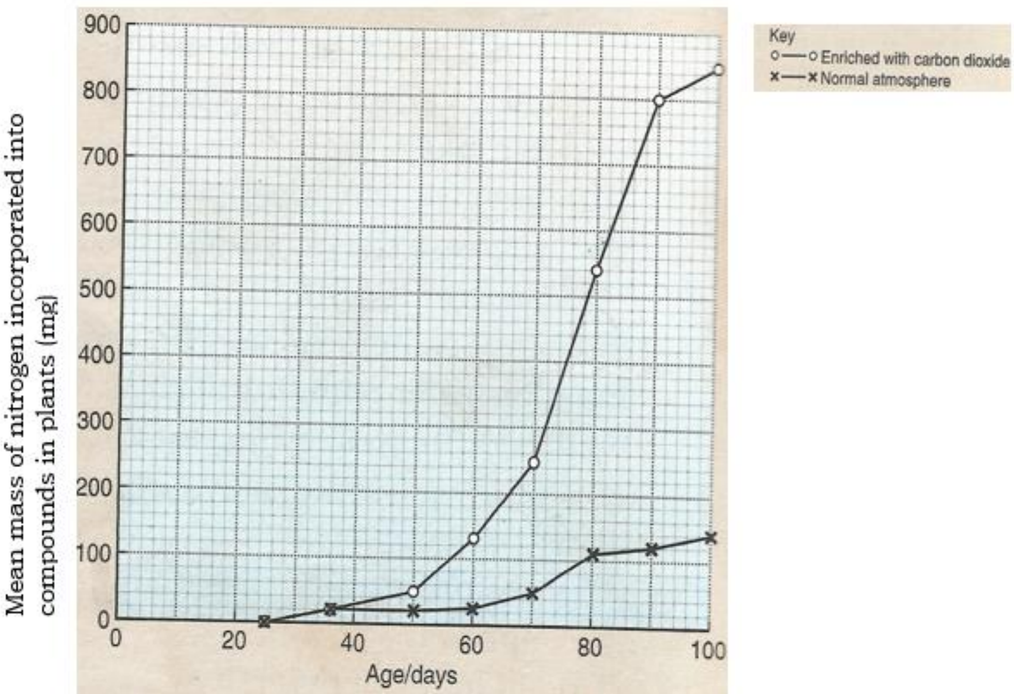
(i) Using these results, suggest an explanation for the different distribution of *R. bulbosus* and *R. repens* in the field.

Number of R. bulbosus is <u>higher</u> in free-draining soil than in water logged soil; because R. bulbosus germinate / grow more readily on drier ridges; thus <u>compete</u> more successfully;

(ii) Explain how waterlogging of the soil might affect the rate of growth of a seedling.

<u>Reduced oxygen concentration</u> in the soil; <u>reducing ATP synthesis</u> during respiration; thus <u>active uptake</u> of ions from soil for growth decreases ;/ root development is inhibited;
More denitrification occurs, so less nitrate for protein synthesis;

27. An experiment was carried to investigate the uptake of nitrogen in soya bean seedlings grown in an atmosphere enriched with carbon dioxide and seedlings grown in a normal atmosphere (control plants).
The experimental results are shown in the graph below. Use it to answer the questions that follow.



(a) (i)Describe how the mean mass of nitrogen incorporated into compounds in soya bean seedlings vary with the age of the plants in an atmosphere enriched with carbon dioxide.
From 25days to 50days, mean mass of nitrogen incorporated into compounds in soya bean seedlings increases gradually; From 50days to 90days, mean mass of nitrogen incorporated into compounds in soya bean seedlings increases rapidly; From 90days to 100days, mean mass of nitrogen incorporated into compounds in soya bean seedlings increases gradually; to the highest;

(ii) Compare the effect of the atmosphere enriched with carbon dioxide and the normal atmosphere on the mass of nitrogen incorporated into the soya bean seedlings.
<u>Similarities</u>.
In both the atmosphere enriched with carbon dioxide and the normal atmosphere, mass of nitrogen incorporated into the bean seedlings,

- ***Are equal at day 36;***
- ***Gradually increases from 90days to 100days; and from 25days to 36days;***
- ***Attains a maximum***
- ***Attains maximum at the same time/100days***;
- ***Rapidly increases from 70days to 80days***;

<u>Differences</u>

Mean mass incorporated into the seedlings in an atmosphere enriched with carbon dioxide.	Mean mass incorporated into the seedlings in a normal atmosphere.
<u>Higher from 36days to 100days</u>	***<u>Lower from 36days to 100days</u>***
Gradually increases first, then rapidly increases from 36days to 60days.	***Remains constant from 36days to 60days***
<u>Higher maximum</u>	***<u>Lower maximum</u>***
Rapidly increases from 80days to 90days	***Gradually increases from 80days to 90days***

(b) Suggest explanations for differences observed in the graph
From 36days to 100days, mean mass of nitrogen incorporated into the seedlings in the atmosphere enriched with carbon dioxide is higher than that in normal atmosphere; because <u>sufficient</u> carbon dioxide was availed; for photosynthesis; forming hexose sugar; converted to protein, a source of nitrogen in the seedlings;

(c)How is the nitrogen absorbed by soya bean seedlings utilized
Form part of chlorophyll;
Fixed into ammonium ions by nitrifying bacteria; that react with organic acids forming amino acids; required for protein synthesis;

(d) Explain how different plants have overcome the problem of nitrogen deficiencies in the soils they grow in.
<u>Carnivorous plants</u>; have traps on their leaves with which they trap insects/small animals; digested by protein digesting enzymes secreted from the glands on their leaf surfaces;
<u>Symbiotic relationship</u>; e.g. leguminous plants and nitrogen fixing bacteria in their root nodules;

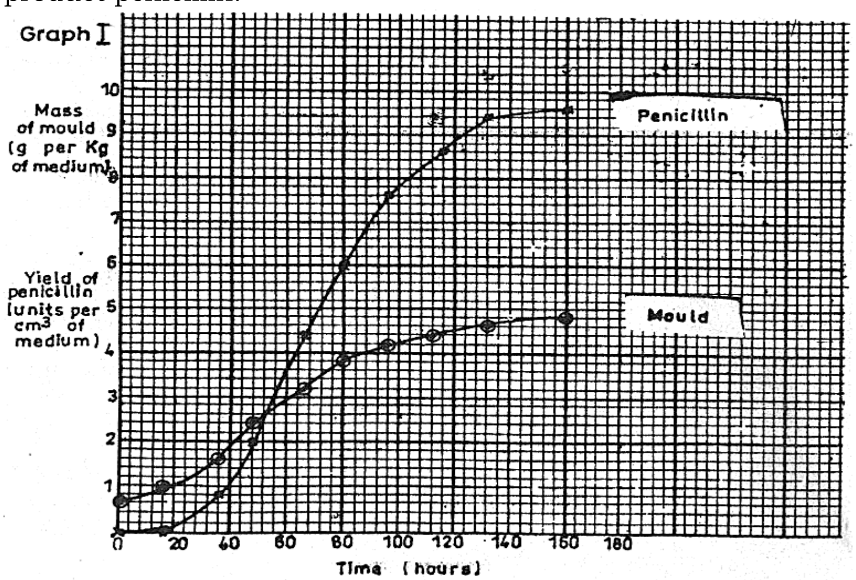
***Development of deep root system* by plants to absorb nitrates from the deeper layers of the soil and transported to shoot;**

***Parasitism*; by plants like vanilla, striga weed develop haustoric attachments on other plants deriving the nitrogen from the host plant;**

28. The table below shows the growth of the yeast *Saccharomyces* in a culture medium and the yield of its product, ethanol. (**UNEB 2001(P2) Modified**)

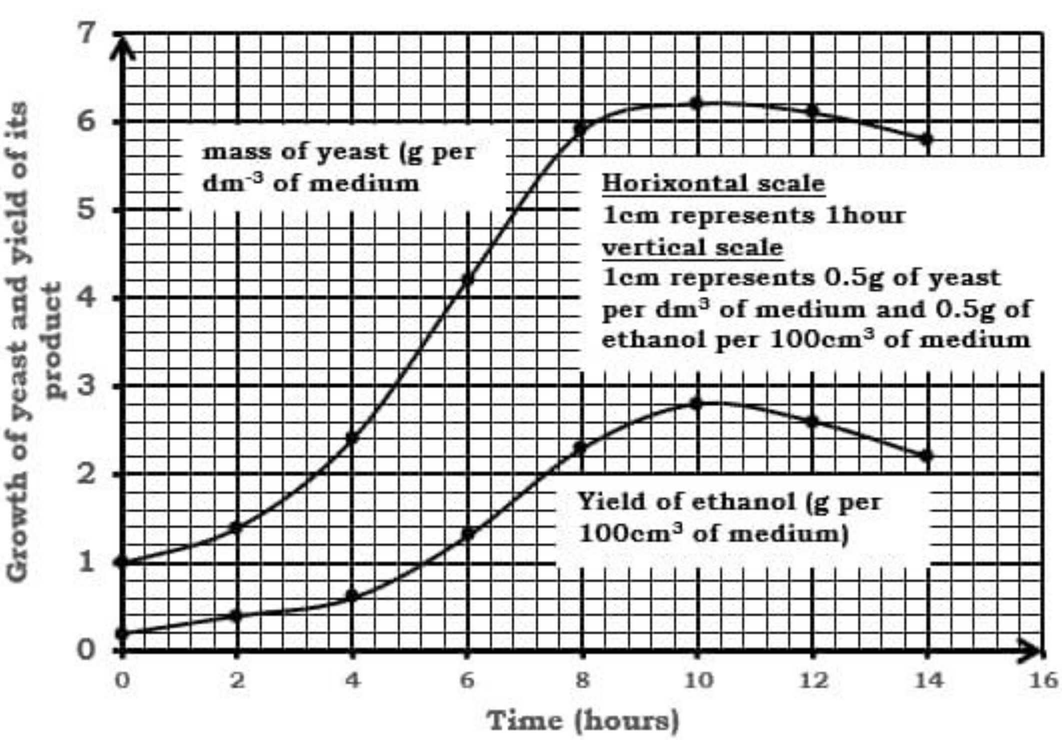
Time(hours)	Mass of yeast (gdm^{-3} of medium)	Yield of ethanol (g per 100cm^{3} of medium)
0	1	0.2
2	1.4	0.4
4	2.4	0.6
6	4.2	1.3
8	5.9	2.5
10	6.2	2.8
12	6.1	2.6
14	5.8	2.2

Graph in the figure below shows the growth of the ascomycete mould, *Penicillium notatum* and the yield of its product penicillin.



Study the data given above to answer the following questions.

(a) Represent the information in the table on a suitable graph.



(b) Give **two** differences in the growth pattern of the mould and the yeast.

Yeast grows <u>faster</u> than mould; i.e. noticeable increase in mass of yeast within less than 2hours; while in the mould, the increase is noticeable after about 10hours;

Growth of the yeast begins to decrease after 10hours; while growth in the mould continues throughout the experimental period.

(c)Explain the growth pattern of yeast population during the following experimental periods.

(i) 0-2hours.

<u>Little</u> growth occurs/growth increases slowly; because yeasts are <u>adjusting/adapting to their new environment</u>; e.g. synthesis of new enzymes to breakdown a wide range of nutrients available in the culture medium;

(ii) 4-8hours.

Growth increases rapidly; because <u>no limiting factors</u> (there is plenty of nutrients and breeding space); yeast cells <u>reproduce at their maximum rate</u>;

(iii) 8-10hours

Grows increases <u>slowly</u>; because one or more <u>nutrients are getting depleted</u>; and <u>accumulation of toxic wastes, ethanol</u>;

(iv) 10-14hours

Growth decreases slowly; because of <u>exhaustion of nutrients</u>; and <u>cell death number outweighing number of new cells produced</u>; owing to toxicity of ethanol;

(d) Describe the relationship between the

(i) growth of the mould and the yield of penicillin

As mass of mould increases between 0hours and 16hours, no penicillin is produced;

As mass of mould increases between 16hours and 160hours, yield of penicillin also increases; with increase in yield of penicillin more rapid than increase in mass of mould between 48hours and 132hours;

(ii) growth of the yeast and production of ethanol.

As mass of yeast increases between 0hours and 10hours, yield of ethanol also increases;

As mass of yeast decreases between 10hours and 14hours, yield of ethanol also decreases;

(e) State **three** ways in which the pattern of accumulation of penicillin in graph **I** differs from the pattern of accumulation of ethanol on your graph.

- ***Penicillin is not produced until 16hours while production of ethanol starts instantly;***
- ***No peak attained in penicillin production while peak is attained in ethanol production;***
- ***Penicillin production proceeds for a longer time than ethanol;***

(f) Ethanol is a direct product of metabolic processes essential for the life of the organism. Penicillin is a product of metabolic processes which are not essential to keep the organism alive. Suggest how the differences in the patterns of accumulation of these two products may be related to their differing roles in the metabolism of the producer organisms.

Ethanol is a by -product of <u>anaerobic respiration</u>; and its production rate directly affects the rate of growth of yeast;

Penicillin is a <u>secondary metabolite</u>; thus its production does not directly affect the metabolic rate of mould;

(g) Outline **four** ways in which antibiotics work.

Interfere with some essential metabolic functions of microorganisms such as

- ***Cell wall synthesis;***
- ***Protein synthesis;***
- ***Nucleic acid synthesis;***
- ***Cell membrane function;***

(h) Other than the production of penicillin, mention other economic importance of mould.

- ***Spoilage/ poisoning of food e.g. bread by secretion of the digestive enzymes on the substrate; by Rhizopus nigricans/ common bread mould;***
- ***Some species e.g Rhizopus stolonifer/ black bread mould; decompose organic material in the soil; thus recycling nutrients back to the soil; for utilization by plants;***
- ***Some species e.g. Rhizopus stolonifer; produce steroids within their cells; that can be used as birth control pills;***
- ***Fermentation of food e.g. by Rhizopus microsporus;***
- ***Production of alcoholic beverages e.g. Rhizopus oryzae;***
- ***Destruction of fabrics;***
- ***Cause nosocomial infection and necrosis to infected areas in infants;***
- ***Manufacture of anaesthetics;***
- ***Manufacture of meat tenderisers;***

29 (a) Describe what is meant by the following terms.

(i) Community

Localized group of several populations of different species interacting with one another and the physical/chemical factors of the environment;

(ii) Ecosystem

Localized group of communities and their physical environment; OR

Definable area containing a relatively self-sustained community of organisms interacting with their non-living surroundings e.g. a pond.

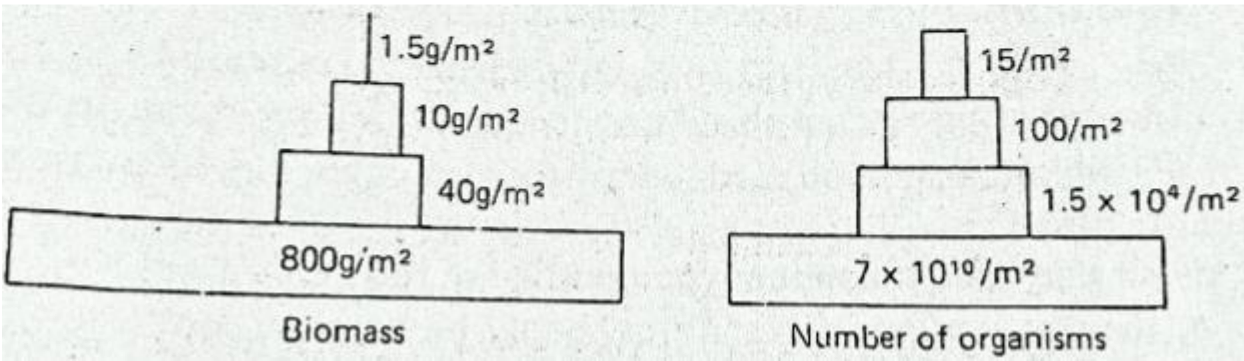
(iii) Food chain

Sequence of organisms usually starting with producer and ending with a top consumer; in which each organism is the food of the next in the chain;

(b) Evaluate the use of studying food webs rather than food chains in ecology.

- ***Food webs give more accurate picture of the natural feeding relationships****;*
- ***Linear food chains are rare****;* ***because few animals confine themselves to a single type of food; and few plants serve as the only food for one type of herbivore***;

(c) The figures below represent pyramids of biomass and number of organisms in the same ecosystem, each of which is not drawn to scale.



(i) Explain why the relationships between the various trophic levels are different when comparing the two figures.

Trophic levels of the pyramid of biomass give no indication of numbers of individuals i.e. a single plant could be the producer and a few thousand insects could be feeding on them as primary consumers;

Pyramid of numbers also give no indication of biomass at each level;

(ii) What further kind of pyramid could be constructed to give additional information about the four trophic levels?

Pyramid of energy; giving an idea of energy flow at each trophic level;

(iii) Why are there seldom more than four trophic levels in each pyramid?

At each trophic level, <u>less energy is available</u> than in the previous one; owing to so much of <u>loss of energy</u>; thus <u>little energy left to support large number of top consumers</u>; limiting the number of trophic levels.

30. (a) What is meant by the following terms.

(i) Biological diversity.

Existence of wide variety of life on earth.

(ii) Biological conservation

Sustainable use of resources;

(iii) Extinct species

Species of organisms that are no longer present in their unique range nor in other likely habitats; ***e.g. the Dinosaur,***

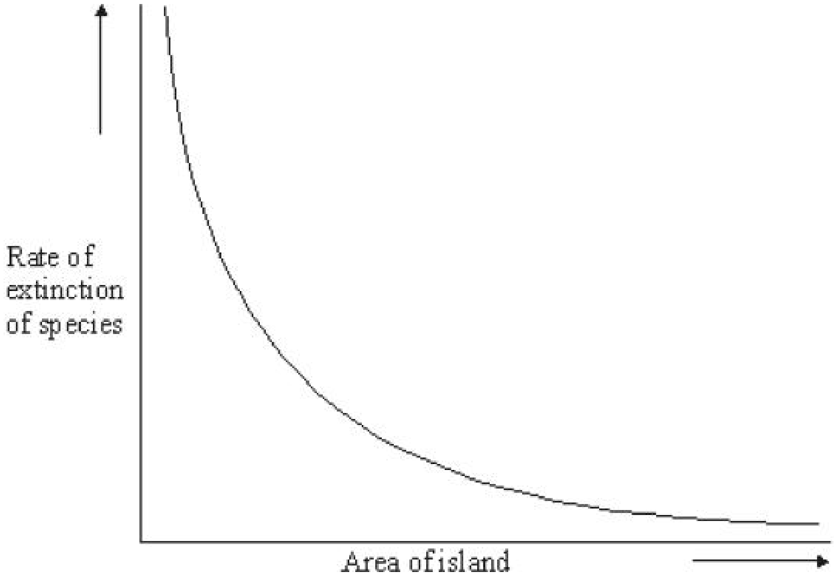
(iv) Keystone species.

Is a species with disproportionately large effect on its natural environment relative to its abundance; e.g. **. a medium-density herd of <u>elephants</u> generates a wide diversity of habitats and promote a varied community of associated grazing and browsing animals**;

(b) Justify the need for biological conservation.

- ***Survival of many species/ prevent extinction;***
- ***Education and resource;***
- ***Production of enough natural products such as food, timber and minerals for human needs;***
- ***Recreation;***
- ***Aesthetic value;***
- ***Ethical reasons; as all living species have a right to co-exist with humans on earth;***

(c) The graph in the figure below shows the rate of extinction of species of birds on islands of different size.



(i)Describe the relationship between the rate of extinction of species and the area of the island.

As the area of the island increases, rate of extinction decreases;

(ii) Account for the relationship in a(i) above.

As the area of island increases, rate of extinction decreases; because <u>more diverse habitats</u> and <u>more resources</u> available for colonizing species;

(iii) Describe how other factors may affect the rate of extinction of species on an island.

<u>Diseases</u>- increased cases increase extinction rate; predators- <u>High predation</u> increases extinction rate;

<u>Distance of island</u>- the nearer the island the higher the extinction rate due to high population and high competition that results thereafter;

<u>Seasons</u>; <u>toxins</u>; <u>temperature</u>; <u>natural calamities</u>/catastrophes; <u>number of species on the island</u> etc.

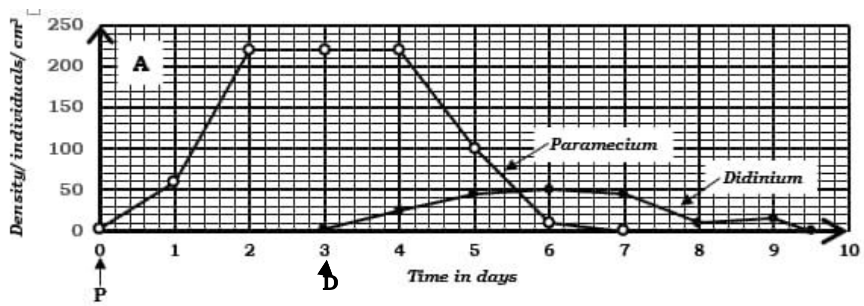
31. Graphs **A**, **B** and **C** show results of three experiments that were carried out to study the relationship between a predator, *Didinium* and a prey *Paramecium*, under three sets of conditions.

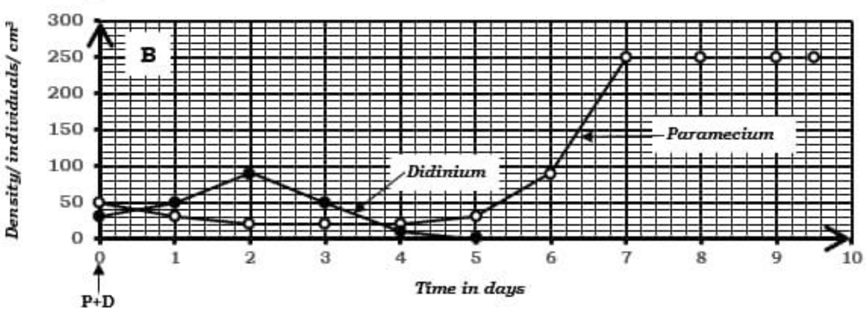
In the first experiment, *Paramecium* was introduced into a culture at point **P** and *Didinium* at point **D** as shown in graph **A** in figure **1**.

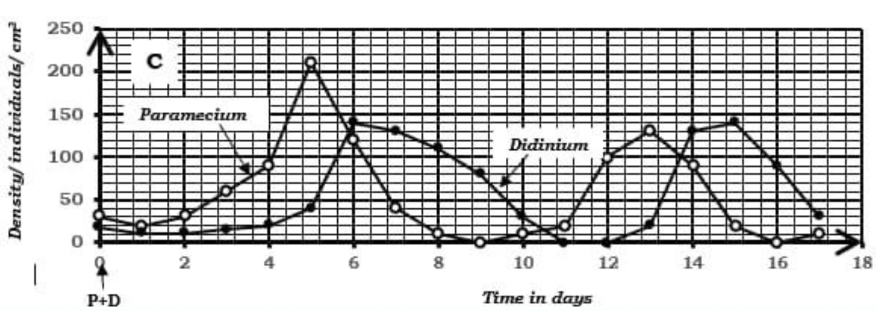
In the second experiment, the *Paramecium* and *Didinium* were introduced together at point **P+D** at different population densities. This is shown in graph **B** in the figure **2**.

In the third experiment, *Paramecium* and *Didinium* were introduced together at point **P+D** at different densities, and after three days as shown by the arrows in graph **C** in the figure **3**. **UNEB 2004(P2)**

Study the graphs and answer the questions that follow.







(a) Describe the trend of a population growth of *Paramecium* and *Didinium* in graph.

(i) **A**

<u>Paramecium</u>

From day 0 to first day, population increases gradually;

From 1st day to 2nd day, population increases rapidly; to a maximum;

From 2nd day to 4th day, population remains constant;

From 4th day to 6th day, population decreases rapidly; then decreases gradually to zero from 6th day to 7th day;

<u>Didinium</u>

From 1st day of its introduction to 2nd day, population increases gradually; to a maximum;

From 2nd day to 4th day, population remains constant;

From 4th day to 5th day, population decreases gradually;

From 5th day to 6th day, population remains constant;

From 6th day to 6.5th day, population decreases slowly; to zero;

(ii) **B**

<u>Paramecium</u>

From day 0 to 2nd day, population decreases gradually;

From 2nd day to 4th day, population remains constant;

From 4th day to 5th day, population increases gradually;
From 5th day to 7th day, population increases rapidly; to a maximum;
From 7th day to 9.5th day, population remains constant;

Didinium.

From day 0 to 2nd day, population increases gradually; to a peak;
From 2nd day to 4th day, population decreases rapidly;
From 4th day to 5th day, population decreases gradually; to zero;

(iii) C.

Paramecium

From day 0 to 1st day, population decreases very slowly;
From 1st day to 4th day, population increases gradually;
From 4th day to 5th day, population increases rapidly; to a peak;
From 5th day to 7th day, population decreases rapidly;
From 7th day to 9th day, population decreases gradually;
From 9th day to 11th day, population increases gradually;
From 11th day to 13th day, population increases rapidly; to a peak;
From 13th day to 15th day, population decreases rapidly;
From 15th day to 16th day, population decreases gradually; then increases slightly from 16th day to 17th day;

Didinium

From day 0 to 1st day, population decreases slightly;
From 1st day to 3rd day population remains constant;
From 3rd day to 5th day, population increases gradually;
From 5th day to 6th day, population increases rapidly; to a peak;
From 6th day to 9th day, population decreases gradually;
From 9th day to 11th day population decreases rapidly; to zero;
From 11th day to 12th day, population remains constant at zero;
From 12th day to 13th day, population increases gradually;
From 13th day to 15th day, population increases first rapidly, then gradually; to a peak;
From 15th day to 17th day, population decreases rapidly;

(b) Explain the interaction of the two species of organisms in graph

(i) A

From 4th day to 7th day, population of Paramecium decreases; to extinction; because it was being preyed upon by the introduced Didinium
From 1st day of Didinium introduction to 2nd day, its population increases gradually to a maximum; because of presence of food(Paramecium); which on depletion, decreases population of Didinium from the 7th day to 9.5th day to zero;

(ii) B

From day 0 to 2nd day, population of Paramecium decreases gradually because all of it that was in the clear-fluid medium was preyed upon by Didinium; which gradually increases and later starves to death;
From 4th to 7th day, Paramecium population increases because of its emergency from the sediment;

(c) Compare the trend of the population growth of the two species in graph B and C.

Similarities.

_In both graph B and C,

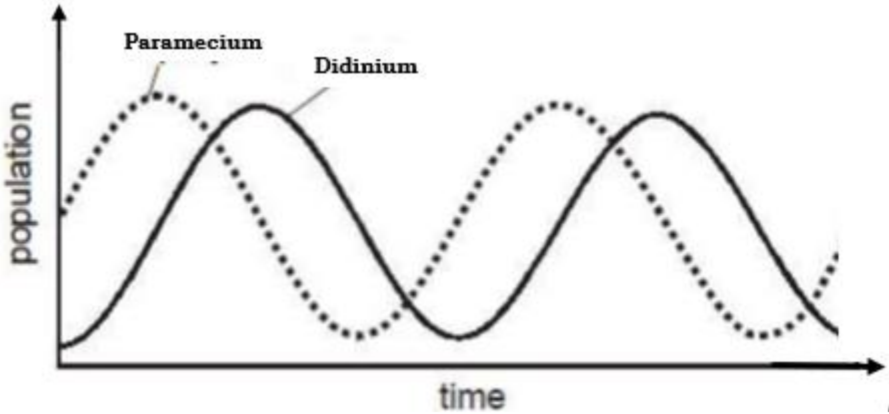
- ***Didinium population attains peak;***
- ***Didinium population decreases after the peak;***
- ***Extinction of Didinium occurs/ Population decreases to zero;***
- ***Paramecium population decreases gradually from day 0 to 1st day;***

Differences

Species	Graph B	_Graph C
Paramecium	• ***No cyclic fluctuation in population*** • ***Population attain a maximum*** • ***Population does not decrease to zero/no extinction***	• ***Cyclic fluctuation in population*** • ***Population attain peak*** • ***Population decrease to zero/extinction occurs***
Didinium	• ***Lower peak attained*** • ***Peaks once*** • ***Peaks earlier*** • ***No cyclic fluctuation in population***	• ***Higher peaks attained*** • ***Peaks twice*** • ***Peaks later*** • ***Cyclic fluctuation in population occurs***

(d) Sketch a graph to show the expected trend of the population with time if *Paramecium* and *Didinium* were introduced at the same time under natural environmental conditions.

<u>A graph showing the variation in the population of Paramecium and Didinium under natural environmental conditions with time.</u>



(e) Explain the trends of the population curves of paramecium and Didinium you have sketched.

At the beginning, population of Paramecium is higher than Didinium; so as to provide food to the Didinium(predator);

With low Didinium population initially, enough food is available; thus few Paramecium are preyed upon; increasing both their number;

Large number of Paramecium provides enough food to Didinium; thus reproduce fast, rapidly increasing their number;

With increased Didinium population, many Paramecium are eaten; decreasing Paramecium population; subsequently intraspecific competition for few remaining Paramecium sets in; Didinium population then decreases as some individuals are unable to obtain enough food to sustain them;

Finally, a very low number of Didinium, allows Paramecium population to recover; cycle starts again;

32. In an investigation, a nutrient broth containing glucose, amino acids and vitamins was inoculated with a small number of *Escherichia coli* in a conical flask. The culture was sampled at intervals and the living cell concentration for the culture was determined at this sampling times for 2days.

The results of the measurements of the growth of an *Escherichia coli* population is shown in the Table below. Study it carefully and answer the questions that follow.

Time (hours)	0	2	4	6	8	10	12	15	20	30	35	40	45
Population/cell number X $10^{-6}cm^{-3}$	0	0	0	1	30	420	512	513	511	513	164	9	1

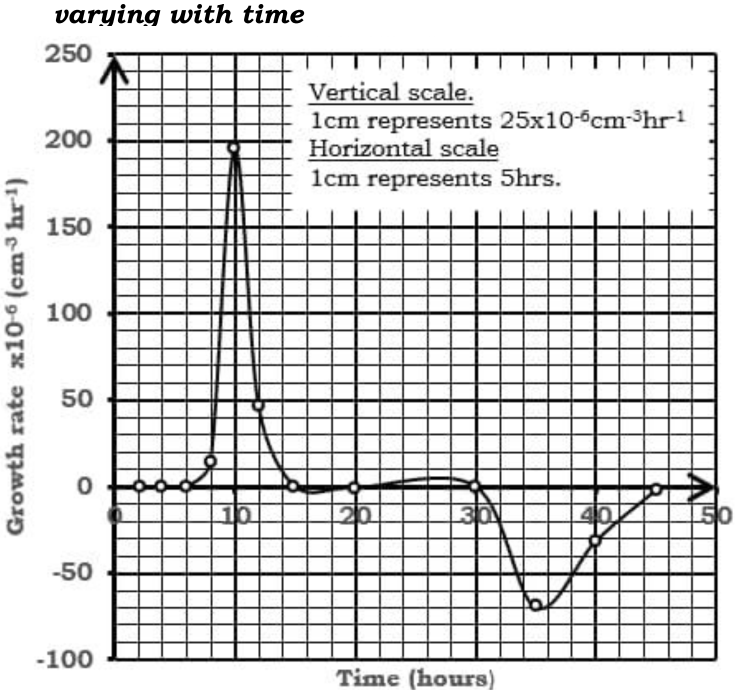
(a) Calculate the growth rate of the bacteria population over the experimental period.

Time (hours)	0	2	4	6	8	10	12	15	20	30	35	40	45
Increase in population/cell number X $10^{-6}cm^{-3}$		***0***	***0***	***1***	***29***	***390***	***92***	***1***	***-2***	***2***	***-349***	***-155***	***-8***

Time (hours)	0	2	4	6	8	10	12	15	20	30	35	40	45
Growth rate/increase in cell number X $10^{-6}cm^{-3}$ hr^{-1}		***0***	***0***	***0.5***	***14.5***	***195***	***46***	***0.3***	***-0.4***	***0.2***	***-69.8***	***-31***	***-1.6***

(b) Use the information in (a) above to plot a growth rate curve of a culture of *Escherichia coli.*

<u>Graph of growth rate of Escherichia coli varying with time</u>



(c) Describe the shape of the graph plotted in (b).

From 2hours to 6hours, growth rate remains constant; at zero;

From 6hours to 8hours, growth rate increases gradually;

From 8hours to 10hours, growth rate increases rapidly; to a peak;

From 10hours to 12hours, growth rate decreases rapidly;

From 12hours to 15hours, growth rate decreases gradually; to zero;

From 15hours to 30hours, growth rate remains constant at zero;

From 30hours to 35hours, growth rate decreases gradually; to a minimum;

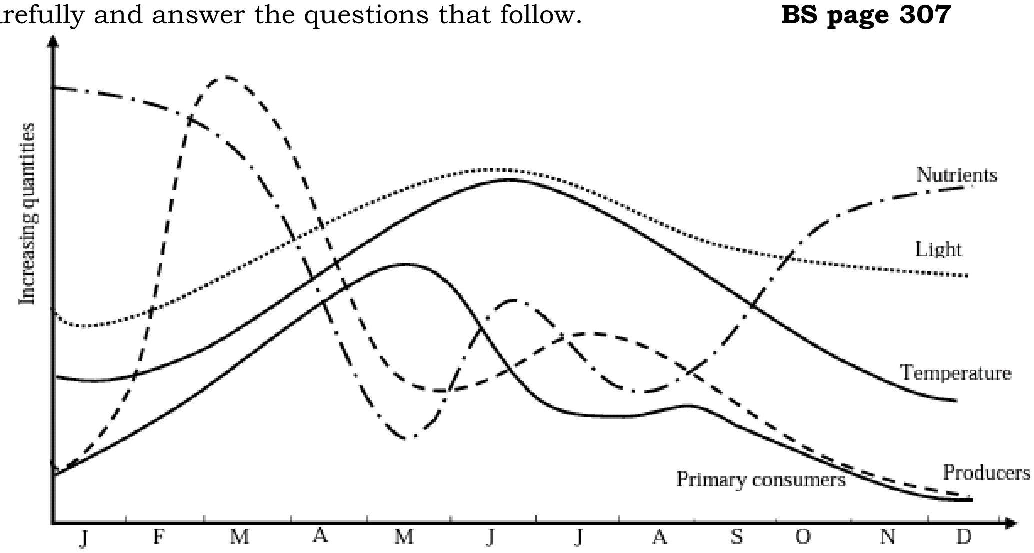
From 35hours to 45hours, growth rate increases gradually;

(d)Account for shape of the graph in the following periods.

(i) 2-6hours

Growth rate remains constant at zero because

bacteria are adjusting to their new environment; e.g. by synthesizing new enzymes to break down a wide range of nutrients available in the culture medium;
(ii) 8-10hours
Growth rate increases rapidly to a peak because with plenty of nutrients; and breeding space; bacteria reproduce at their maximum rate;
(iii) 10-15hours.
Growth rate decreases; because one or more nutrients are getting depleted; and accumulation of toxic wastes;
(iv) 15-30hrs
Growth rate remains constant at zero; because cell death is equivalent to new cells formed;
(v) 30-35hours
Growth rate decreases gradually to a minimum because of exhaustion of nutrients; and accumulation of wastes; cell death number outweighing number of new cells produced;
(e) (i) Using the information, given above state the method used by the experimenter to measure the population growth of E. coli.
Viable counting; in which only living bacteria cells in the culture are counted using either spread plates or pour plates;
(ii) Apart from the method given above, briefly describe one other method could have used to measure population growth of E. coli.
Turbidimetry;/measuring cloudiness or turbidity of a solution(suspension); in which the more cells there are in the solution(suspension), the greater the turbidity;
33. The graph in the figure below shows changes in standing crop biomass of producers, primary consumers and some environmental variables in a lake during one year.
Study it carefully and answer the questions that follow. **BS page 307**



(a) In what months could an inverted pyramid be obtained?
May and June
(b) Using on the data given, account for the changes in the phytoplankton production in the following months.
(i) February to Early April.
Increases rapidly; to a peak; because of increase in light intensity and duration; increase in temperature; and availability of nutrients; all of which increases photosynthetic rate; increasing energy production for reproduction and growth;
Also few primary consumers/zooplankton; that would feed on the phytoplankton;
(ii) Early April to late May
Decreases rapidly; below the primary consumers/zooplanktons; because of rapid decrease nutrients concentration of the lake; photosynthetic rate/production thus decreases; and grazing by the primary consumer/zooplankton;
(iii) June to late July.
Increases gradually; to a peak; because of decrease in the numbers of primary consumers/zooplankton; increase in nutrient concentration of Lake (caused by surface layers of water cool and mix more freely with the colder, deeper layers); and increase in temperature and light intensity; photosynthesis and growth thus favoured;
(iv) August to December
Decreases gradually; because of decrease in temperature; and light intensity; thus not favourable for photosynthesis; and growth;