AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.4.6 BIODIVERSITY WITHIN A COMMUNITY

SCORE	PERCENTAGE
/252	%

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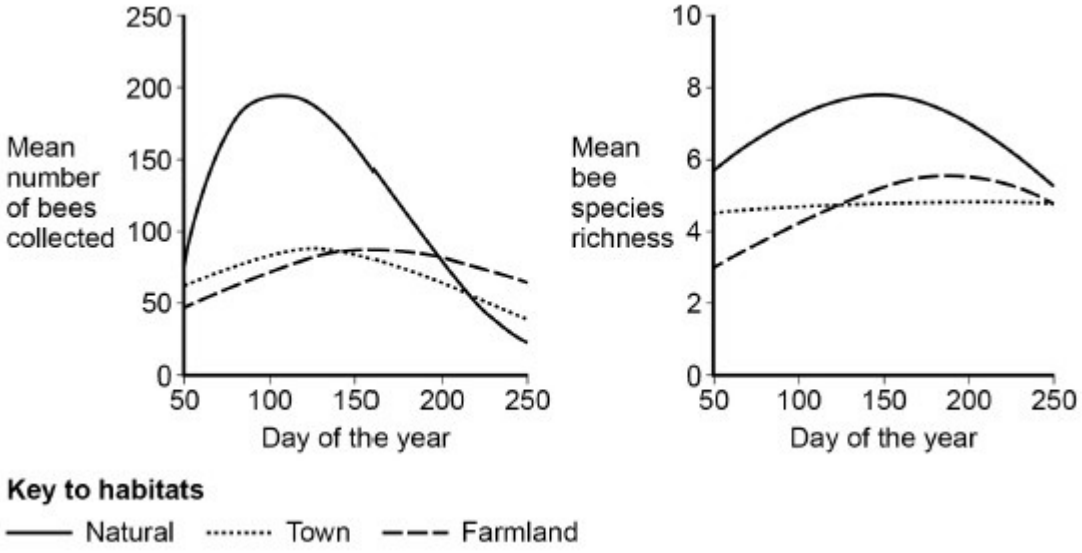
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Q1.

Bees are flying insects that feed on nectar made in flowers. There are many different species of bee.

Scientists investigated how biodiversity of bees varied in three different habitats during a year. They collected bees from eight sites of each habitat four times per year for three years.

The scientists' results are shown below in the graphs in the form they presented them.



(a) What is meant by 'species richness'?

_____

_____

_____

_____

_____

_____

_____

(1)

(b) From the data in the graphs, a student made the following conclusions.

1. The natural habitat is most favourable for bees.
2. The town is the least favourable for bees.

Do the data in the graphs support these conclusions? Explain your answer.

1. The natural habitat is most favourable for bees.

_____

2. The town is the least favourable for bees.

(4)

(c) The scientists collected bees using a method that was ethical and allowed them to identify accurately the species to which each belonged.

In each case, suggest **one** consideration the scientists had taken into account to make sure their method

1. was ethical.

2. allowed them to identify accurately the species to which each belonged.

(2)

(d) Suggest and explain **two** ways in which the scientists could have improved the method used for data collection in this investigation.

1.

2.

(2)

(e) Three of the bee species collected in the farmland areas were *Peponapis pruinosa*, *Andrena chlorogaster* and *Andrena piperi*.

What do these names suggest about the evolutionary relationships between these bee species? Explain your answer.

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(2)

(Total 11 marks)

Q2.

(a) Define each of the following terms.

Species _____

_____

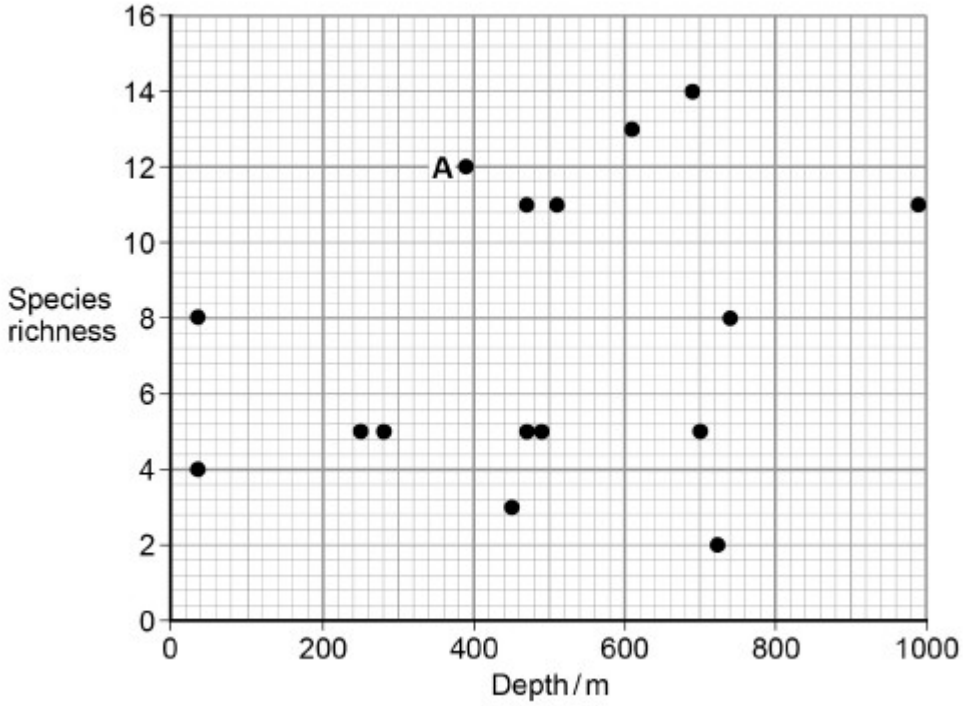
Species richness _____

_____

(2)

Scientists investigated the species richness of fish caught at various depths in the Pacific Ocean close to the western coast of Chile.

The graph shows the scientists' results. 68% of all the fish caught in this investigation came from sample **A**.



(b) What is the modal value of species richness?

_____

(1)

(c) 68% of all the fish caught in this investigation came from sample **A**.
A student thought this showed that sample **A** had a greater index of diversity than any of the other samples.

It is **not** possible to draw this conclusion from the given data. Give reasons why.

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(3)

(Total 6 marks)

Q3.

Ecologists investigated changes in grassland communities on large islands off the coast of Scotland between 1975 and 2010. On each island, they used data from a number of sites to determine the change in mean species richness and the change in mean index of diversity.

(a) **Table 1** shows plant species recorded at one site, on one island, in 1975.

Table 1

Species	Number of individuals
Hydrocotyle vulgaris	3
Plantago maritima	19
Ranunculus acris	3
Hieracium pilosella	3
Calliergon cuspidatum	10
Prunella vulgaris	16
Pseudoscleropodium purum	6

Calculate the index of diversity for this site using the formula:

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

d = _____

(2)

(b) Outline a method the ecologists could have used to determine the plant species richness at one site.

_____

_____

_____

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(3)

(c) Some of the ecologists' results are shown in **Table 2**. They carried out a statistical test to find out whether any differences between the 1975 and 2010 means were

significant. The values for P that they obtained are also shown in **Table 2**.

Table 2

Island	Change in mean species richness between 1975 and 2010	Value of P	Change in mean index of diversity between 1975 and 2010	Value of P
Islay	+8.89	≤0.001	+0.22	>0.05
Colonsay	+14.70	≤0.001	+2.68	≤0.01
Harris	−5.13	≤0.001	−2.44	≤0.01

Do these data show that there were any significant changes in the grassland communities on these islands? Give reasons for your answer.

_____

_____

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(3)

(Total 8 marks)

Q4.

A student investigated the species richness and index of diversity of insects in three different habitats, a barley field, a wheat field and a hedge.

Her results are shown in the table below.

	Number of individuals of each insect species in each habitat		
Insect species	**Barley field**	**Wheat field**	**Hedge**
a	32	4	34
b	78	0	12
c	0	126	22
d	0	5	12
e	0	0	8

f	0	0	42
g	0	25	13
h	0	10	12
i	0	0	12
j	42	41	0
Species richness			
Total number of insects (N)			

(a) Complete the table for species richness and the total number of insects of each habitat.

(2)

(b) Calculate the index of diversity of the wheat field.

Use the following formula:

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

where N = total number of organisms

and n = total number of organisms of each species.

_____

_____

(2)

(c) The index of diversity of the insects was higher in the hedge than in the barley field. Suggest why.

_____

_____

_____

_____

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(3)

(Total 7 marks)

Q5.

The UK government pays farmers to leave grassy strips around the edges of fields of crops. These grassy strips contain a variety of plant species. Leaving the strips is an attempt to encourage biodiversity of animals.

(a) Give **two** reasons why the grassy strips increase the biodiversity of animals.

1. _____

2. _____

(2)

A group of scientists investigated the effect of grassy strips on the biodiversity of soil animals.

- They divided a field into plots measuring 25 m × 5 m, with a 5-metre-wide grassy strip of land between each plot.
- Each year, they planted wheat in each of the plots.
- In the fifth year, they removed samples of soil from each plot where wheat was growing and from the grassy strips around them.
- They sorted each soil sample by hand for 40 minutes to collect the soil animals within the sample.

(b) The scientists decided to collect animals from the soil samples for 40 minutes.

Suggest how the scientists decided that 40 minutes was an appropriate time.

_____

_____

_____

_____

_____

(2)

(c) The table below shows how the scientists published their results. They calculated mean values and two times the standard deviation (SD) of the mean.

Two standard deviations above and below the mean includes 95.4% of the data.

Group of animals	**Mean number of animals per m^2 (± 2 × SD)**		**Mean number of species per m^2 (± 2 × SD)**	
	Soil under wheat crop	**Soil under grassy strips**	**Soil under wheat crop**	**Soil under grassy strips**
Beetles	41.2 (± 6.4)	80.1 (± 10.1)	10.0 (± 1.6)	17.3 (± 1.0)
Centipedes	18.4 (± 3.6)	13.5 (± 1.0)	1.8 (± 0.3)	2.1 (± 0.2)
Earthworms	244.5 (± 27.1)	281.2 (± 39.4)	3.8 (± 0.3)	5.1 (± 0.2)

Millipedes	38.4 (± 12.2)	36.2 (± 2.9)	3.5 (± 0.3)	3.2 (± 0.2)
Woodlice	0.0	73.9 (± 8.5)	0.0	2.8 (± 0.2)

It would **not** be possible to calculate an index of diversity from the results in the table.

Explain why.

_____

_____

_____

(1)

A summary of this research was published in a farming magazine. The journalist concluded that creating grassy strips around fields had little effect on the diversity of soil animals.

Do you agree with this conclusion?

Use evidence from the table to justify your answer.

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(4)

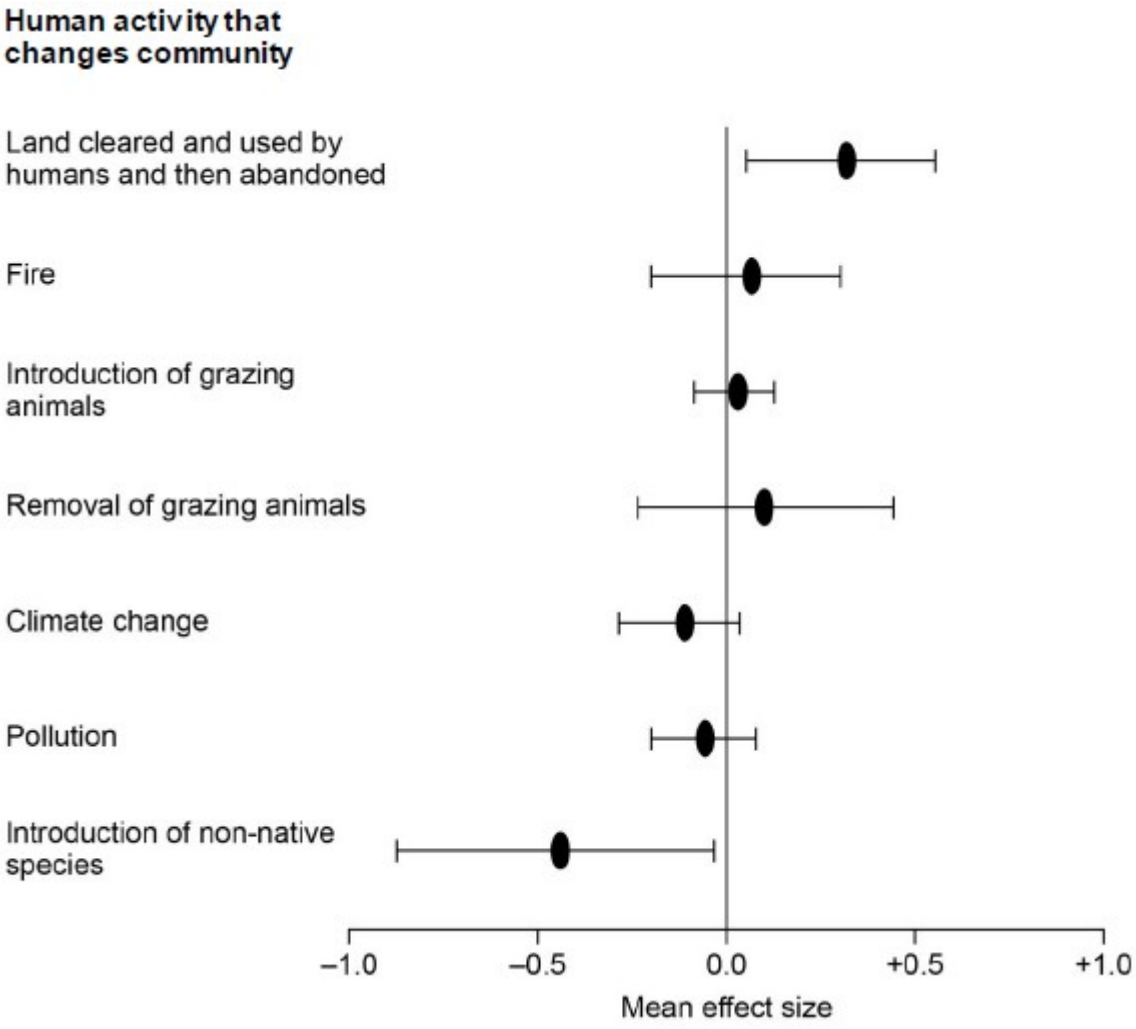
(Total 9 marks)

Q6.

Scientists investigated changes in plant biodiversity in different communities after changes caused by humans. They collected data from many published investigations that recorded changes in species richness of plants over a large number of years.

The scientists used data from each investigation to calculate the effect size.
The effect size is a measure of change in species diversity with time. A positive value shows an increase in species richness with time.

The graph below shows the scientists results in the form in which they were published. The horizontal bars represent ±2 standard deviations, which includes 95.4% of the data.



(a) What can you conclude from these data about the effects of human activities on biodiversity?

_____

_____

_____

_____

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_____

(3)

(b) Suggest an explanation for the effect size when non-native species were introduced to communities.

_____

_____

_____

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_____

(2)

(c) Describe how you would investigate the effect of an invasion by a non-native species of plant (a biotic environmental factor) over many years on the abundance of a native species of plant in a community.

_____

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(3)

(d) Effect size is calculated in the following way.

1. Divide the species richness in the last year of an investigation (SR2) by species richness in the first year of the investigation (SR1).
2. Find the natural log ($\log_e$) of the result.
3. Divide this by the time (T) between the first and last year in decades (1 decade = 10 years).

In one community:

- species richness in year 2 (SR2) was 15.3
- species richness in year 1 (SR1) was 18.2
- and the investigation lasted for 29 years.

Use $\log_e$, SR2, SR1 and T to write an equation for 'effect size' and calculate its value for this investigation. On a calculator, the key for $\log_e$ is shown as ln, or $\log_e$.

Effect size = _____

(2)

(Total 10 marks)

Q7.

A student investigated the distribution of plants in a heathland.

The table below shows the number of plants he found in a sample area of 1 m^2.

Species of plant	Number counted in

	1 m²
Common heather	2
Red fescue	14
Vetch	2
White clover	8

(a) What is the species richness of this sample?

(1)

(b) Calculate the index of diversity of this sample. Show your working.

Use the following formula to calculate the index of diversity.

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

where N is the total number of organisms of all species
and n is the total number of organisms of each species

Index of diversity = _____

(2)

(c) Suggest how this student would obtain data to give a more precise value for the index of diversity of this habitat.

_____

_____

_____

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_____

(2)

(Total 5 marks)

Q8.

Species richness and an index of diversity can be used to measure biodiversity within a community.

(a) What is the difference between these two measures of biodiversity?

_____

_____

(1)

Scientists investigated the biodiversity of butterflies in a rainforest. Their investigation lasted several months.

The scientists set one canopy trap and one understorey trap at five sites.

- The canopy traps were set among the leaves of the trees 16–27 m above ground level.
- The understorey traps were set under trees at 1.0–1.5 m above ground level.

The scientists recorded the number of each species of butterfly caught in the traps. The table below summarises their results.

Species of butterfly	Mean number of butterflies		P value
	In canopy	In understorey	
Prepona laertes	15	0	< 0.001
Archaeoprepona demophon	14	37	< 0.001
Zaretis itys	25	11	> 0.05
Memphis arachne	89	23	< 0.001
Memphis offa	21	3	< 0.001
Memphis xenocles	32	8	< 0.001

(b) The traps in the canopy were set at 16–27 m above ground level. Suggest why there was such great variation in the height of the traps.

_____

_____

(1)

(c) By how many times is the species diversity in the canopy greater than in the understorey? Show your working.

Use the following formula to calculate species diversity.

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

where N *is the total number of organisms of all species and* n *is the total number of organisms of each species.*

Answer = _____

(3)

(d) The scientists carried out a statistical test to see if the difference in the distribution of each species between the canopy and understorey was due to chance. The P values obtained are shown in the table.

Explain what the results of these statistical tests show.

_____

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(3)

(Total 8 marks)

Q9.

Ecologists investigated the size of an insect population on a small island. They used a mark-release-recapture method. To mark the insects they used a fluorescent powder. This powder glows bright red when exposed to ultraviolet (UV) light.

(a) The ecologists captured insects from a number of sites on the island. Suggest how they decided where to take their samples.

_____

_____

_____

_____

(2)

(b) Give **two** assumptions made when using the mark-release-recapture method.

1. _____

_____

2. _____

_____

(2)

(c) Suggest the advantage of using the fluorescent powder in this experiment.

_____

_____

_____

_____

(2)

The ecologists did **not** release any of the insects they captured 1–5 days after release of the marked insects.

The table below shows the ecologists' results.

Days after release	Number of marked insects remaining in population	Number of insects captured	Number of captured insects that were marked
1	1508	524	78
2	1430	421	30
3	1400	418	18
4	1382	284	2
5	1380	232	9

(d) Calculate the number of insects on this island 1 day after release of the marked insects.

Show your working.

Answer = _____

(2)

(e) The ecologists expected to obtain the same result from their calculations of the number of insects on this island on each day during the period 1–5 days after release. In fact, their estimated number increased after day 1.

During the same period, the number of insects they caught decreased.

The method used by the ecologists might have caused these changes.

Use the information provided to suggest **one** way in which the method used by the ecologists might have caused the increase in their estimates of the size of the insect population.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q10.

Scientists investigated the effect of different types of animal farming on the diversity and number of dung beetles. They determined the number of dung beetle species and their total number on intensive (**I**), rough grazing (**R**) and organic (**O**) farms.

Figure 1 and **Figure 2** show some of their results.

Figure 1

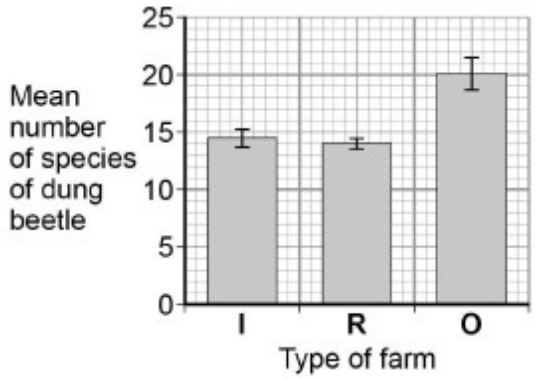
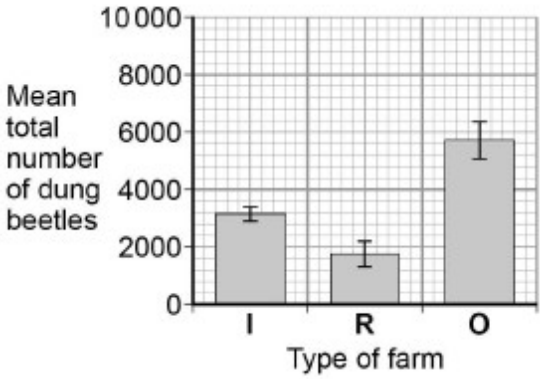


Figure 2



Key: I Standard deviation

(a) What is the mean species richness for dung beetles on the rough grazing farms?

_____

(1)

(b) In addition to the information provided in **Figures 1** and **2**, what other measurement is required to calculate an index of diversity for dung beetles?

_____

_____

(1)

(c) Explain what the standard deviations suggest about the difference in mean total number of dung beetles between the different types of farm.

_____

_____

_____

_____

_____

(2)

(d) The scientists placed traps to collect the dung beetles at sites chosen at random.

Explain the importance of the sites being chosen at random.

_____

_____

(1)

(e) On the intensive farms, the farmers had removed hedges to increase land for grazing. This resulted in a decrease in the diversity of birds on these farms.

Explain why the removal of hedges caused a decrease in the diversity of birds.

_____

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_____

_____

(3)

(Total 8 marks)

Q11.

(a) What is meant by species diversity?

_____

_____

_____

(1)

(b) Give **two** pieces of information needed to calculate an index of diversity for a community.

1. _____

2. _____

(2)

(c) A scientist investigated the effect sewage entering a river had on the distribution of organisms living in the river. Where sewage entered the river, he found a high density of organisms but a low index of diversity.

Suggest how sewage entering the river could explain the scientist's findings.

_____

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(2)

(d) A second scientist repeated the investigation of the first scientist at the same place. The second scientist obtained a high index of diversity.

(i) Explain how the second set of results affects the ability of the scientists to make any conclusions about the effect of sewage on the index of diversity.

_____

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(2)

(ii) Suggest the additional steps that should be taken by the scientists before they are able to make any conclusions about the effect of sewage entering this river.

_____

_____

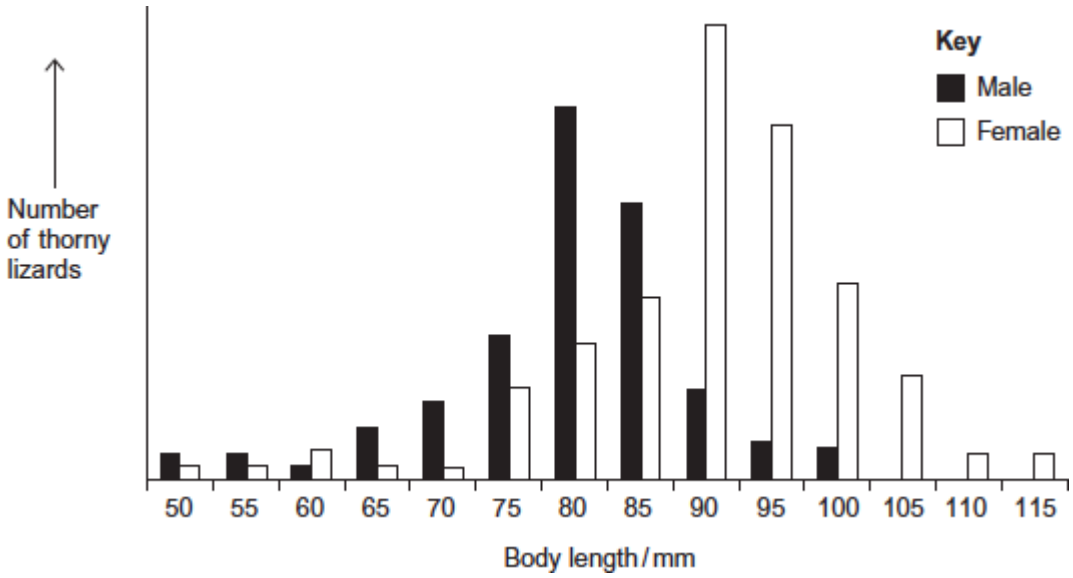
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(1)

(Total 8 marks)

Q12.

(a) Ecologists measured the body lengths of male and female thorny lizards living in the same habitat. The ecologists measured the body lengths to the nearest 5 mm. The graph shows how they presented their results.



Give **two** differences in the variation in body length of male and female thorny lizards.

1. _____

_____

2. _____

_____

(2)

(b) Another group of ecologists investigated biodiversity of lizards in a woodland area.

Their results are shown in the table.

Lizard species	**Number of individuals**
Dominican giant anole	5
Hispaniolan green anole	11
Hispaniolan stout anole	22
Bark anole	91
Hispaniolan grass anole	13
Cope's galliwasp	5
Cochran's least gecko	8
Peninsula least gecko	1

The index of diversity can be calculated using the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

(i) Use the formula to calculate the index of diversity of lizards in the woodland area.
Show your working.

Answer = _____

(2)

(ii) The ecologists also determined the index of diversity of lizards in an oil palm plantation next to the woodland area. They found fewer species of plant in the oil palm plantation. Lizards feed on plants and insects.

Explain why fewer species of plant would lead to fewer species of lizard in the oil palm plantation.

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(3)

(Total 7 marks)

Q13.

(a) What **two** measurements are needed to calculate an index of diversity?

1. _____

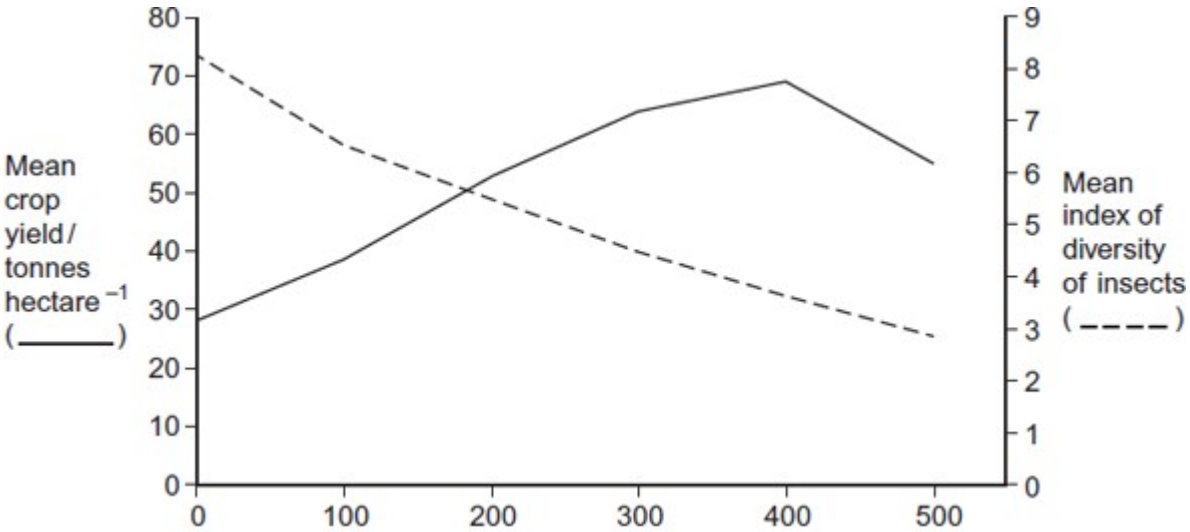
2. _____

(2)

(b) A herbicide is a chemical used to kill weeds. Ecologists investigated the effect of a

herbicide on crop yield and the diversity of insects. They sprayed different fields with the same volume of different concentrations of the herbicide. At harvest, the ecologists determined the mean crop yield and the mean index of diversity of insects for fields that had received the same concentration of the herbicide.

The figure below shows their results.



(i) Some fields acted as controls. They were sprayed with a solution that did not contain the herbicide. Explain the purpose of these control fields.

_____

_____

_____

(1)

(ii) Suggest an explanation for the relationship between the concentration of herbicide and the mean crop yield.

_____

_____

_____

_____

(2)

(iii) Explain the relationship between the concentration of herbicide and the mean index of diversity of insects.

_____

_____

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_____

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(3)

(Total 8 marks)

Q14.

Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

(a) Name the process that resulted in the development of woodland from farmland.

_____

(1)

(b) Explain the increase in the diversity of birds as the woodland developed.

_____

_____

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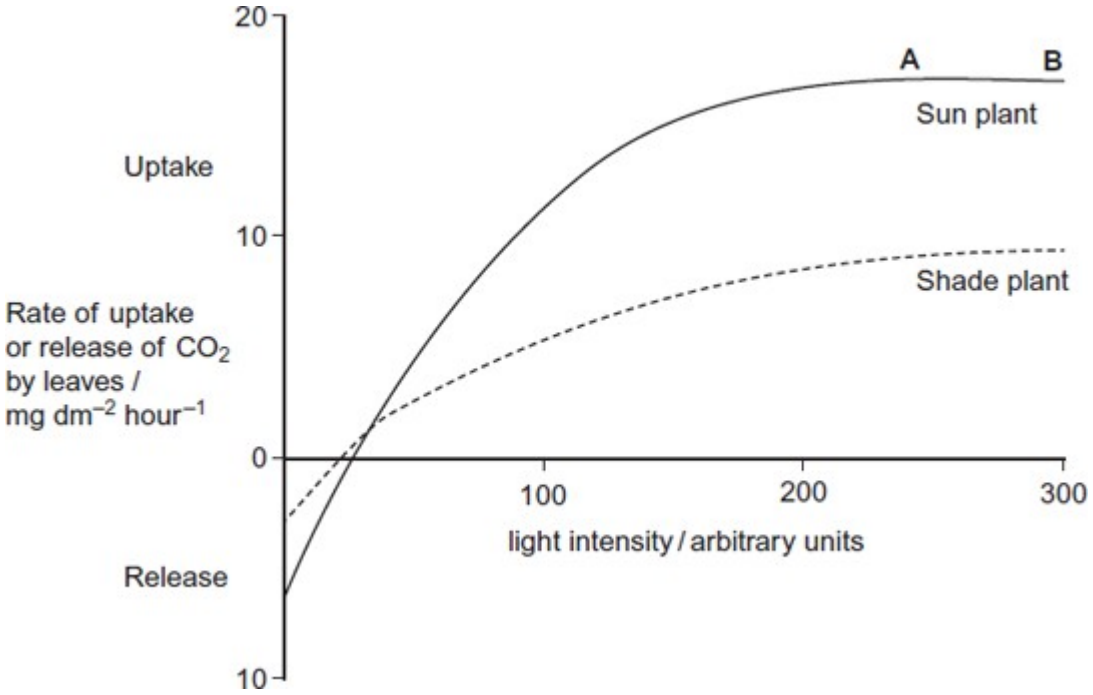
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(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

1. _____

2. _____

(1)

(ii) Explain why CO_2 uptake is a measure of net productivity.

_____

_____

(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

_____

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(2)

(Total 8 marks)

Q15.

(a) What is a *species?*

_____

_____

_____

(2)

(b) Scientists investigated the diversity of plants in a small area within a forest. The table shows their results.

Plant species	Number of individuals
Himalayan raspberry	20
Heartwing sorrel	15
Shala tree	9
Tussock grass	10
Red cedar	4
Asan tree	6
Spanish needle	8
Feverfew	8

The index of diversity can be calculated by the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

(i) Use the formula to calculate the index of diversity of plants in the forest. Show your working.

Answer = _____

(2)

(ii) The forest was cleared to make more land available for agriculture.

After the forest was cleared the species diversity of insects in the area decreased. Explain why.

_____

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(3)

(Total 7 marks)

Q16.

The Amazonian forest today contains a very high diversity of bird species.

- Over the last 2 000 000 years, long periods of dry climate caused this forest to separate into a number of smaller forests.
- Different plant communities developed in each of these smaller forests.
- Each time the climate became wetter again, the smaller forests grew in size and merged to reform the Amazonian forest.

(a) Use the information provided to explain how a very high diversity of bird species has developed in the Amazonian forest.

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(5)

(b) Speciation is far less frequent in the reformed Amazonian forest. Suggest one reason for this.

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(1)

(Total 6 marks)

Q17.

(a) There are ethical and economic arguments for maintaining biodiversity.

(i) Suggest **one** ethical argument for maintaining biodiversity.

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_____

(1)

(ii) Suggest **one** economic argument for maintaining biodiversity.

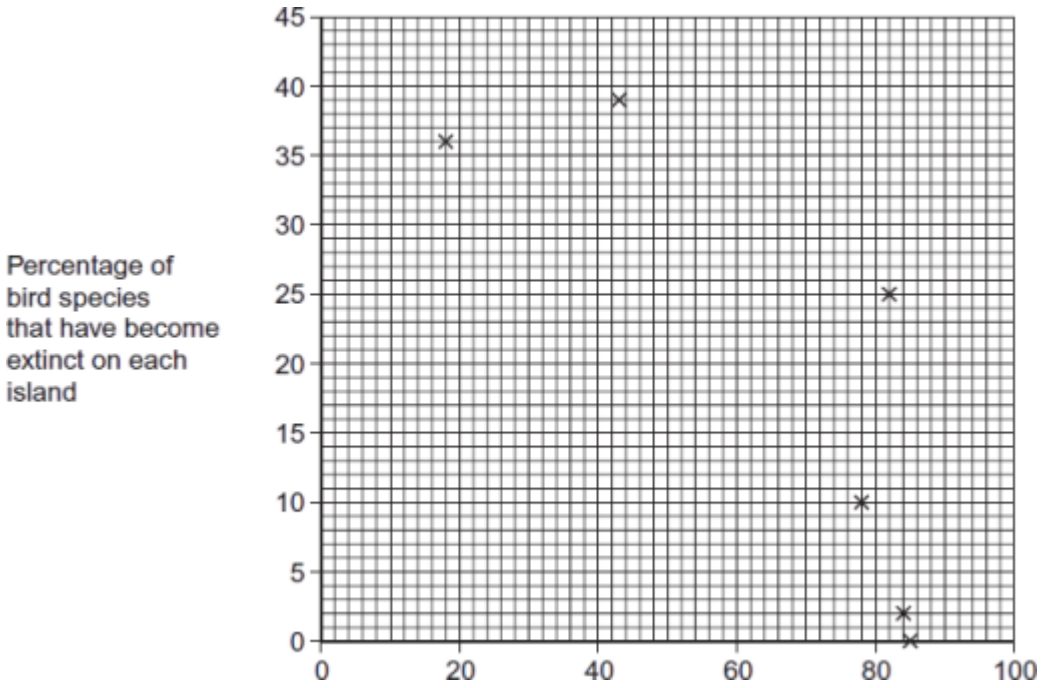
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(1)

Ecologists calculated the percentage of bird species that have become extinct on six islands in the last one hundred years. They also calculated the percentage of original forest area remaining on each island after the same time period. The graph shows their results.



(b) Explain the relationship between the percentage of original forest area remaining and the percentage of bird species that have become extinct.

_____

_____

_____

_____

_____

(2)

(c) What **two** measurements would the ecologists have needed to obtain to calculate the index of diversity of birds on each island?

1. _____

2. _____

(2)

(d) The ecologists noted that the species of birds surviving on the coldest islands had a larger body size than those surviving on warmer islands.

Explain how a larger body size is an adaptation to a colder climate

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q18.

Scientists investigated the species of insects found in a wood and in a nearby wheat field. The scientists collected insects by placing traps at sites chosen at random both in the wood and in the wheat field.

The table shows the data collected in the wood and in the wheat field.

Species of insect	Number of organisms of each species	
	Wood	Wheat field
Bird-cherry oat aphid	0	216
Beech aphid	563	0
Large white butterfly	20	0
Lacewing	12	3

7-spot ladybird	36	0
2-spot ladybird	9	1
Total number of organisms of all species	640	220

(a) The scientists collected insects at sites chosen at random. Explain the importance of the sites being chosen at random.

_____

_____

_____

(1)

(b) (i) Use the formula

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

to calculate the index of diversity for the insects caught in the wood, where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

Show your working.

Answer _____

(2)

(ii) Without carrying out any further calculations, estimate whether the index of diversity for the wheat field would be higher or lower than the index of diversity for the wood.

Explain how you arrived at your answer.

_____

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_____

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(2)

(c) A journalist concluded that this investigation showed that farming reduces species diversity.
Evaluate this conclusion.

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(2)

(d) Farmers were offered grants by the government to plant hedges around their fields. Explain the effect planting hedges could have on the index of diversity for animals.

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(2)

(Total 9 marks)

Q19.

(a) A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

(i) Explain the importance of taking a large number of samples at each site.

_____

_____

_____

(1)

(ii) Explain the importance of taking samples at random.

_____

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_____

(1)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

Species	Number of plants per m^2
Sheep's fescue	11
Creeping buttercup	6
Clover	5
Dandelion	2
Sheep's sorrel	1
Lady's bedstraw	7
Stemless thistle	4

The index of diversity can be calculated from the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

(b) Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer _____

(2)

(c) The golf course was surrounded by undeveloped grassland from which it had been produced.
The golf course had

- some areas of very short grass which was cut frequently
- some areas of longer grass which was cut less frequently
- some areas of long grass and shrubs which were never cut.

The index of diversity for the insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

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(3)

(Total 7 marks)

Q20.

Costa Rica is a Central American country. It has a high level of species diversity.

(a) There are over 12 000 species of plants in Costa Rica. Explain how this has resulted in a high species diversity of animals.

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(2)

(b) The number of species present is one way to measure biodiversity. Explain why an index of diversity may be a more useful measure of biodiversity.

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(2)

(c) Crops grown in Costa Rica are sprayed with pesticides. Pesticides are substances that kill pests. Scientists think that pollution of water by pesticides has reduced the number of species of frog.

(i) Frogs lay their eggs in pools of water. These eggs are small. Use this information to explain why frogs' eggs are very likely to be affected by pesticides in the water.

_____

_____

_____

_____

_____

(2)

(ii) An increase in temperature leads to evaporation of water. Suggest how evaporation may increase the effect of pesticides on frogs' eggs.

_____

_____

(1)

(Total 7 marks)

Q21.

(a) What information is required to calculate an index of diversity for a particular community?

_____

_____

_____

(1)

(b) Farmers clear tropical forest and grow crops instead. Explain how this causes the diversity of insects in the area to decrease.

_____

_____

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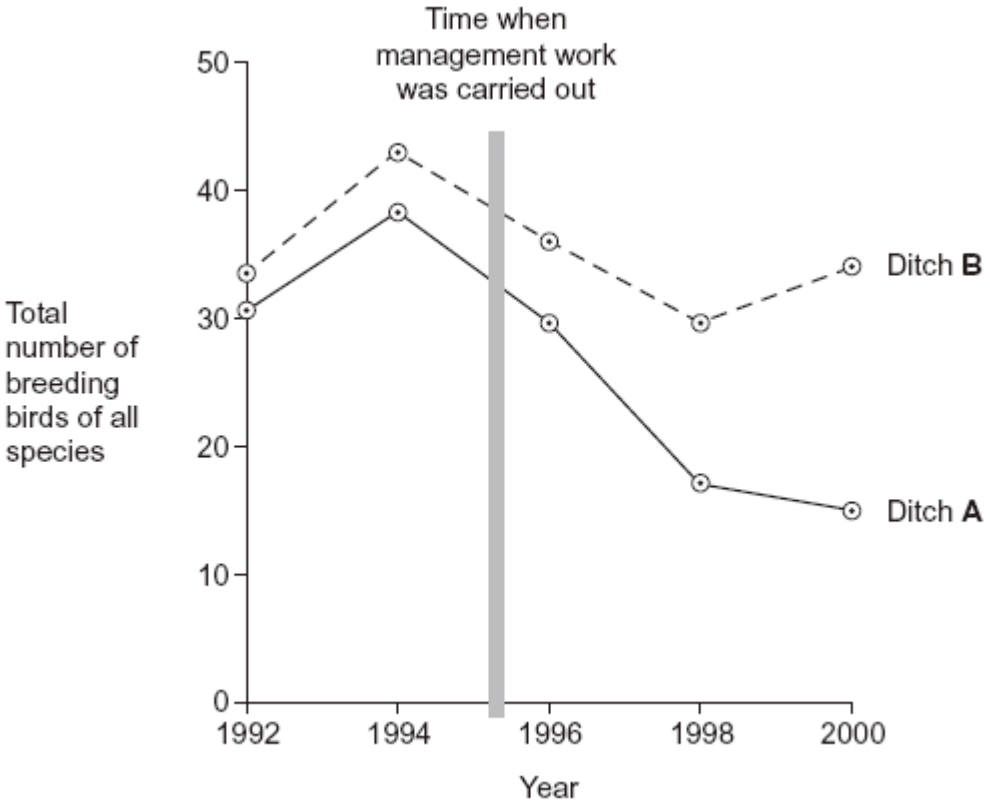
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(3)

Farmers manage the ditches that drain water from their fields. If they do not, the ditches will become blocked by plants. Biologists investigated the effects of two different ways of managing ditches on farmland birds.

- Ditch **A** was cleared of plants on both banks
- Ditch **B** was cleared of plants on one bank.

The graph shows the number of breeding birds of all species along the two ditches, before and after management.



(c) (i) The points on the graph have been joined with straight lines rather than with a smooth curve. Explain why they have been joined with straight lines.

_____

_____

_____

(1)

(ii) It would have been useful to have had a control ditch in this investigation. Explain why.

_____

_____

_____

(1)

(d) A farmer who wanted to increase the diversity of birds on his land read about this investigation.

He concluded that clearing the plants from one bank would not decrease diversity as much as clearing the plants from both banks. Evaluate this conclusion.

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_____

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_____

(3)

(Total 9 marks)

Q22.

(a) Heath is a community of plants and animals. A student investigated the species diversity of plants in this community. The table shows her results.

Plant species	Number of plants per m^2
Heath rush	1
Bilberry	1
Sheep's sorrel	5
Ling	2
Bell heather	1
Heath bedstraw	8
Mat-grass	11

(i) The index of diversity can be calculated from the formula

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

where

d = index of diversity

N = total number of organisms of all species

n = total number of organisms of each species.

Use this formula to calculate the index of diversity for the plants on the heath.

Show your working.

Answer _____

(2)

(ii) Explain why it may be more useful to calculate the index of diversity than to record only the number of species present.

_____

_____

_____

_____

(2)

(b) The demand for increased food production has led to areas of heath being used to grow wheat. Explain the effect of this on

(i) the species diversity of plants

_____

_____

_____

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_____

_____

(2)

(ii) the species diversity of animals.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q23.

Biologists studied the process of succession in an area of wasteland over a period of ten years. They calculated the index of diversity of the area every year. After three years, the index of diversity was 1.6. After ten years, it had risen to 4.3.

(a) What information concerning the organisms present in the area is suggested by the increase in the index of diversity?

_____

_____

_____

_____

(2)

(b) The increase in the index of diversity is one indication that a biological succession is taking place in the area. Describe those features of a succession that would bring about an increase in the index of diversity.

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(3)

(Total 5 marks)

Q24.

Deforestation often involves clearing large areas of forest for use as agricultural land.

(a) Deforestation reduces the diversity index of an area cleared in this way. Explain why.

_____

_____

_____

_____

(2)

(b) Because the forest soil is often nutrient-poor, nitrogen-containing fertilisers may be applied to ensure good crop yields. Use your knowledge of the nitrogen cycle to explain the potential benefit of applying a fertiliser containing ammonium nitrate rather than one containing potassium nitrate.

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(3)

(Total 5 marks)

Q25.

Mayflies are insects which lay their eggs in streams and rivers. The nymphs which hatch from the eggs live in the water for several years.

Mayfly nymphs were collected by disturbing the gravel of a stream bed. A net placed immediately downstream caught any animals which were washed out of the gravel. Eight samples were collected from shallow, fast-flowing parts of the stream and eight from deeper, slow-flowing parts. Nymphs from two different families of mayfly were found. The results are given in the table.

	Family Caenidae		**Family Baetidae**	
	Shallow water	**Deep water**	**Shallow water**	**Deep water**
Mean number of nymphs	2.38	12.88	24.50	6.00
Standard deviation	1.51	7.92	6.72	1.51

(a) Describe how you would have collected the samples in order to ensure they were representative of the habitats being investigated and could be compared with each other.

_____

_____

_____

_____

_____

_____

(3)

(b) Which **one** of the four samples showed the greatest variation within the sample? Give evidence from the table for your answer.

_____

_____

(1)

(c) The two families of mayfly nymph occupy different ecological niches.

(i) What is meant by the term *ecological niche*?

_____

_____

(1)

(ii) Describe the evidence in the table which suggests that the two families of mayflies occupy different ecological niches.

_____

_____

(1)

(iii) Explain the advantage to these two families of mayflies of occupying different ecological niches.

_____

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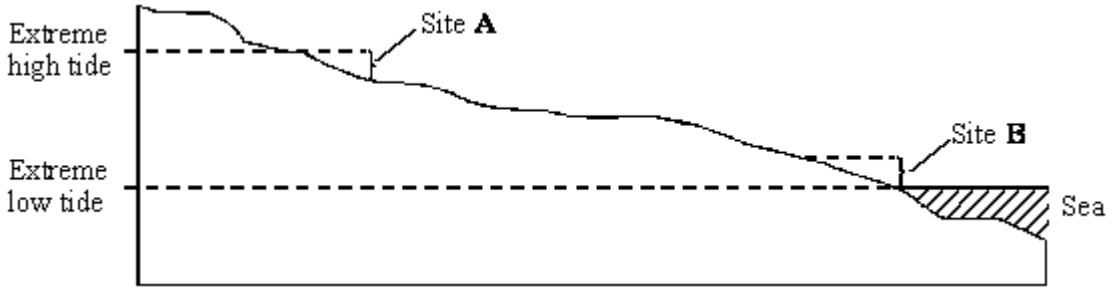
(2)

(Total 8 marks)

Q26.

Parts of the sea shore form a very hostile environment for living organisms. Twice each day the incoming and outgoing tides alternately cover the organisms on the sea shore with water and then leave them exposed. The force of the waves could also dislodge any organisms that were not firmly attached.

The diagram shows a section through a rocky shore. Two sites were studied: site **A** was on the upper shore and site **B** on the lower shore.



The table shows the seaweeds that were found growing at sites **A** and **B**.

Site A: upper shore	Mean number per m^2	Site B: lower shore	Mean number per m^2
Ascophyllum nodosum	2	*Corallina officinalis*	31
Fucus spiralis	10	*Fucus serratus*	8
Fucus vesiculosus	4	*Laminaria digitata*	15
Pelvetia canaliculata	6	*Laminaria hyperborea*	3
		Laminaria saccharina	6

		Laurencia pinnatifida *Palmaria palmata*	18 6
Index of diversity		Index of diversity	4.77

(a) (i) Use the formula $d = \frac{N(N-1)}{\Sigma n(n-1)}$

where **d** = index of diversity
N = total number of organisms of all species
n = total number of organisms of a particular species

to calculate the index of diversity for the seaweeds growing at site **A**.
Show your working.

Index of diversity at site **A** = _____

(2)

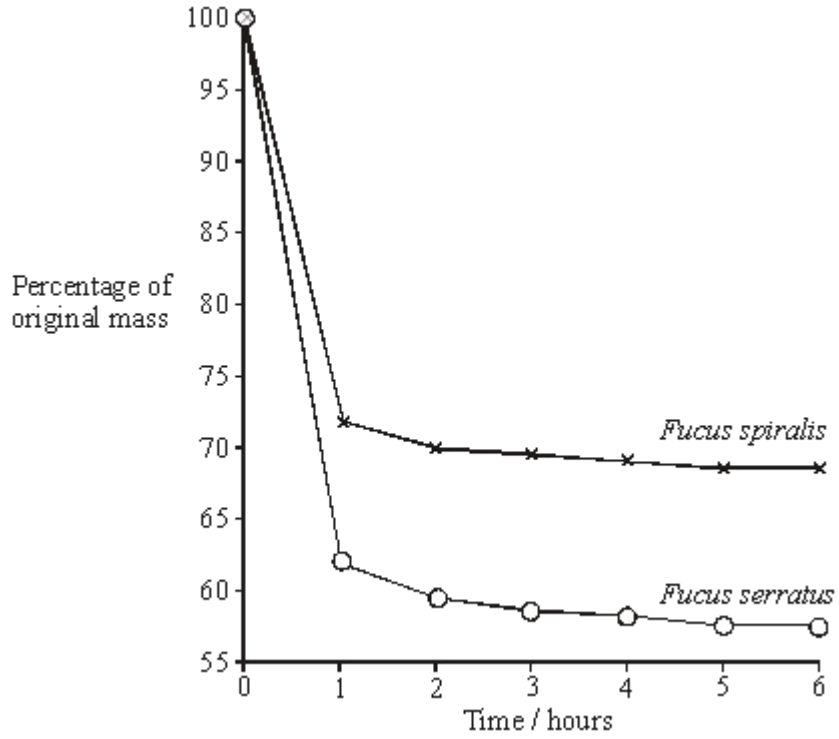
(ii) Give **one** advantage of calculating the index of diversity rather than just recording the number of species present.

_____

_____

(1)

(b) Availability of water is one abiotic factor which determines the distribution of seaweeds. The graph shows loss in mass due to water evaporation for two of the seaweed species. The two seaweeds belong to the same genus but one was found only on the upper shore and the other only on the lower shore.



Explain how the results shown in the graph relate to the distribution of these two seaweeds on the sea shore.

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(3)

(Total 6 marks)

Q27.

When coal is mined by open-cast mining, the top layer of soil is first scraped off and stored in a large heap. Once mining has finished, the area can be reclaimed. Soil from this store is then spread back over the surface.

Some of the bacteria living in the soil store respire aerobically and some respire anaerobically. **Table 1** shows the numbers of aerobic and anaerobic bacteria found at different depths in a soil store.

Depth / cm	**Mean number of bacteria per gram of soil (× 10^7)**			
	Aerobic bacteria		Anaerobic bacteria	
	after 1 month	after 6 months	after 1 month	after 6 months
0	12.0	12.1	0.6	0.8

50	10.4	8.6	0.8	1.3
100	10.1	6.1	0.7	4.1
150	10.0	3.2	0.7	7.9
200	11.6	0.8	0.7	8.4
250	11.9	0.7	0.8	8.8
300	11.0	0.8	0.6	9.1

Table 1

(a) Some of the soil used to determine bacterial numbers was collected from the surface of the soil store. Describe how you would ensure that this soil was collected at random.

_____

_____

_____

_____

(2)

(b) (i) Describe how the numbers of aerobic bacteria after 6 months change with depth.

_____

_____

_____

_____

(2)

(ii) Explain the difference in the numbers of aerobic bacteria at a depth of 300 cm between 1 and 6 months.

_____

_____

_____

_____

(2)

(c) Explain how the changes in bacterial numbers which take place at 150 cm illustrate the process of succession.

_____

_____

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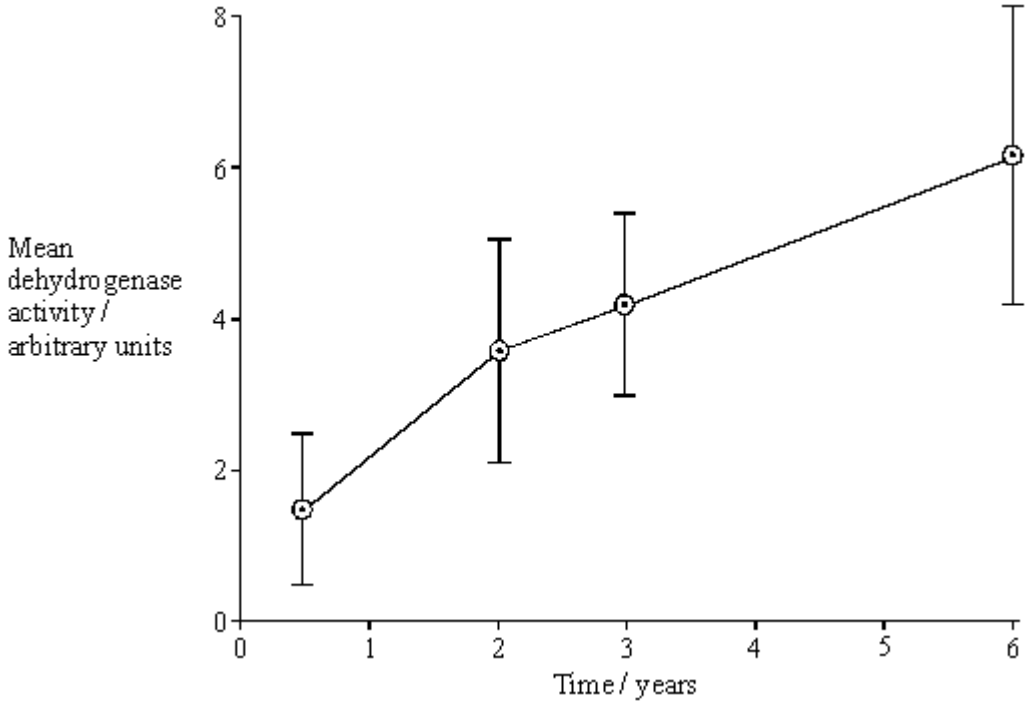
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(3)

Dehydrogenase is an enzyme involved in aerobic respiration. Dehydrogenase activity in a soil sample can be used as a measure of the activity of aerobic bacteria. The graph shows the mean dehydrogenase activity of soil samples taken from the same depth in a soil store at different times. The bars on the graph represent two standard errors above and below the mean.



(d) (i) From what depth in the soil store would you expect these soil samples to have been taken? Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

(2)

(ii) How would you expect dehydrogenase activity to vary with depth after 6 months?

Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(e) What do the error bars tell you about the difference between the mean dehydrogenase activity at 6 months and 3 years? Explain your answer in terms of probability and chance.

_____

_____

_____

_____

_____

_____

(3)

(f) **Table 2** shows the dehydrogenase activity and the number of aerobic bacteria present in some soil samples.

Dehydrogenase activity / arbitrary units	Number of aerobic bacteria per gram of soil ($\times 10^7$)
13.1	12.0
9.2	8.7
5.5	6.5
3.0	4.6
2.2	2.7
0.4	0.6

Table 2

A sample of soil was found to have dehydrogenase activity of 8.7 arbitrary units. Explain how you would use the data in **Table 2** to predict the likely number of aerobic bacteria in 1 g of this soil sample.

_____

_____

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_____

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_____

(3)

(Total 20 marks)

Q28.

The table shows the numbers of adult butterflies in two areas of the same tropical forest. In the logged area some trees had been cut down for timber. In the virgin forest no trees had been cut down. The two areas were the same size.

	Logged forest		Virgin forest	
Butterfly species	**Number**	$n(n-1)$	**Number**	$n(n-1)$
Eurema tiluba	72	5112	19	342
Cirrochroa emalea	43	1806	132	17292
Partenos sylvia	58	3306	14	182
Neopithecops zalmora	6	30	79	6162
Jamides para	37	1332	38	1406
Total	216	11586	282	25384

(a) Describe a method for finding the number of one of the species of butterfly in the virgin forest.

_____

_____

_____

_____

(2)

(b) The index of diversity of a forest can be calculated using the equation

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

Calculate the index of diversity for the virgin forest. Show your working.

Answer _____

(2)

(c) What does the table show about the effects of logging on the butterfly populations?

_____

_____

_____

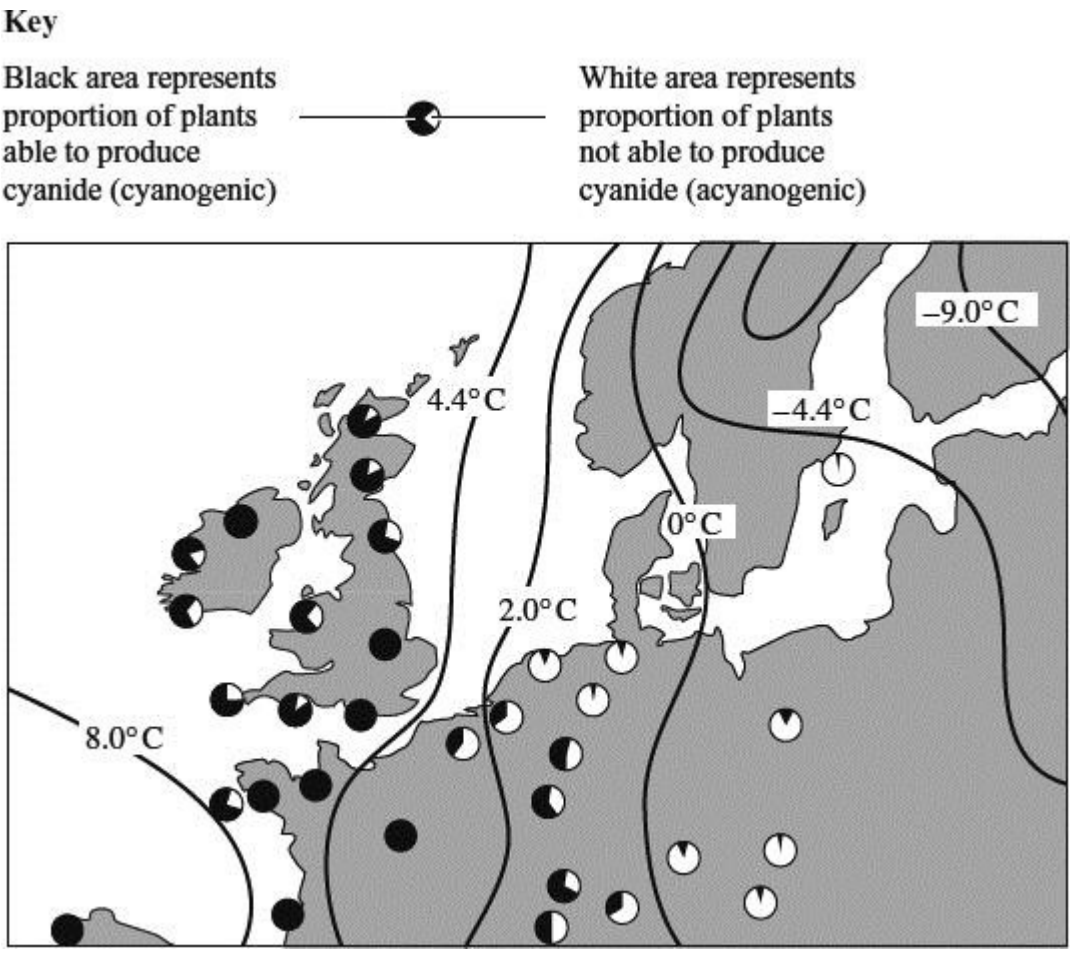
(2)

(Total 6 marks)

Q29.

Clover plants have leaves all through the year. Some clover plants have leaves that produce poisonous hydrogen cyanide gas when damaged. These cyanogenic plants are less likely to be eaten by snails. However, the leaves of these plants can be damaged by frost, resulting in the production of enough hydrogen cyanide to kill the plants. Acyanogenic plants do not produce hydrogen cyanide. This characteristic is genetically controlled.

The map shows the proportions of the two types of plant in populations of clover from different areas in Europe. It also shows isotherms, lines joining places with the same mean January temperature.



(a) Explain how different proportions of cyanogenic plants may have evolved in populations in different parts of Europe.

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_____

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_____

(4)

(b) Differences in cyanide production may affect the total number of clover plants growing in different areas. Describe how you would use quadrats in an investigation to determine whether or not there is a difference in the number of clover plants in two large areas of equal size.

_____

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_____

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_____

(4)

(Total 8 marks)

Q30.

A hedgerow is a line of shrubs and trees bordering a field, together with the herbaceous plants at their base. In the last 50 years farmers have removed many hedgerows.

(a) Explain **two** advantages for a farmer of removing hedgerows.

1. _____

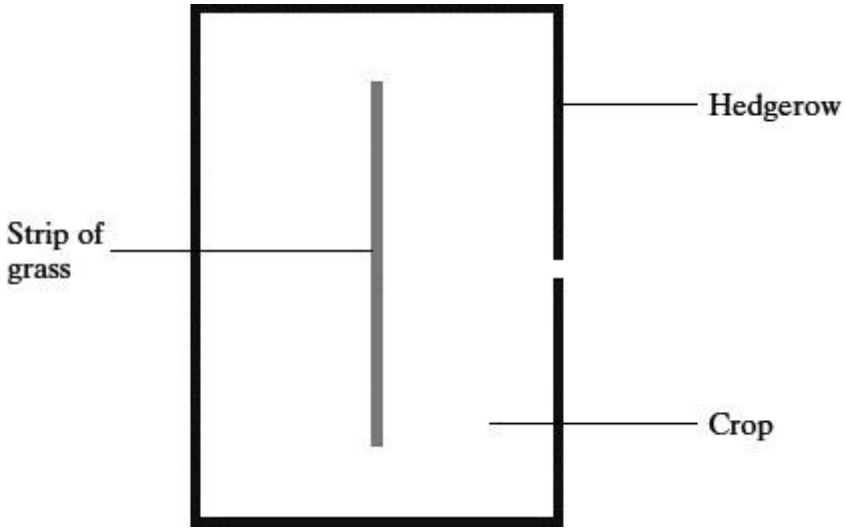
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2. _____

_____

(2)

(b) In recent years some hedgerows have been replanted. Ground beetles, which are unable to fly, are predators of crop pests. The beetles overwinter in the shelter of grasses at the base of the hedgerow. In some large fields, a permanent strip of grass is left as shown in the diagram.



Suggest and explain the advantage of leaving the strip of grass in the middle of the field.

_____

_____

_____

_____

(2)

(c) Apart from providing a habitat for predators of crop pests, give **two** biological benefits of replanting hedgerows.

1. _____

_____

2. _____

_____

(2)

(Total 6 marks)

Q31.

Lacewings are insects that feed on aphids and mites, which are crop pests. The numbers of six species of lacewings, **A** to **F**, were counted on samples of apple and strawberry crops. The results are shown in the table.

Crop	Number of adults of each species of lacewing	Diversity

	A	B	C	D	E	F	index
Strawberry	31	0	3	29	17	1	3.2
Apple	10	1	1	7	0	1	

The diversity index (d) is calculated from the formula

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

where N is the total number of organisms of all species
and n is the total number of organisms of each species.

(i) Calculate the diversity index for lacewing species in the apple crop and write the figure in the table. Show your working.

(2)

(ii) Suggest a reason why the diversity index for the lacewings is different between the two crops.

_____

_____

(1)

(Total 3 marks)

Q32.

The vegetation on a large heap of waste from an old mine was investigated. The table shows the results of the measurements of certain factors in 1m^2 frame quadrats placed on the south-facing slope.

Quadrat	Angle of slope / °	Vegetation cover / %	Moisture content of soil / %	pH of soil
1	45	60	17.2	5.6
2	30	70	14.6	4.2
3	25	68	20.3	5.2
4	12	100	23.5	7.1

5	7	85	21.0	5.4
6	1	100	21.2	6.8

(a) Which of the factors measured are abiotic?

_____

(1)

(b) Describe how the investigators could obtain the value for vegetation cover in each quadrat.

_____

_____

_____

_____

(2)

(c) The correlation between vegetation cover and soil moisture content was tested statistically. These two factors were found to be positively correlated, and $p < 0.05$. Explain what this result means.

_____

_____

_____

_____

(2)

(d) At first the waste heap had no plants growing on it. Some of the first plants to colonise it were small herbaceous plants. Explain **one** way in which colonisation by herbaceous plants could change the physical environment.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q33.

The Solomon Islands are situated in the Pacific Ocean. The nearest large land mass is Australia, which is about 1500 km away. The biggest islands are mountainous, with large areas of tropical forest and a wide range of habitats. Some islands have a very high species diversity, and many species are endemic, that is they occur only in the Solomon Islands.

The table shows the total number of species on the islands in four vertebrate classes and the percentage which are endemic.

Vertebrate class	Total number of species	Endemic species / %
Mammals	53	36
Birds	223	20
Reptiles	61	16
Amphibians	17	53

(a) How many reptile species are endemic?

_____

(1)

(b) Suggest an explanation for the high proportion of endemic species on the Solomon Islands.

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)