A-Level Biology

Biodiversity

Question Paper

Time available: 75 minutes
Marks available: 54 marks

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1. A meadow is an area of grassland with a wide range of plant and animal species.

A student investigated whether cutting some of the plants in a meadow had any effect on the biodiversity of insects in that meadow.

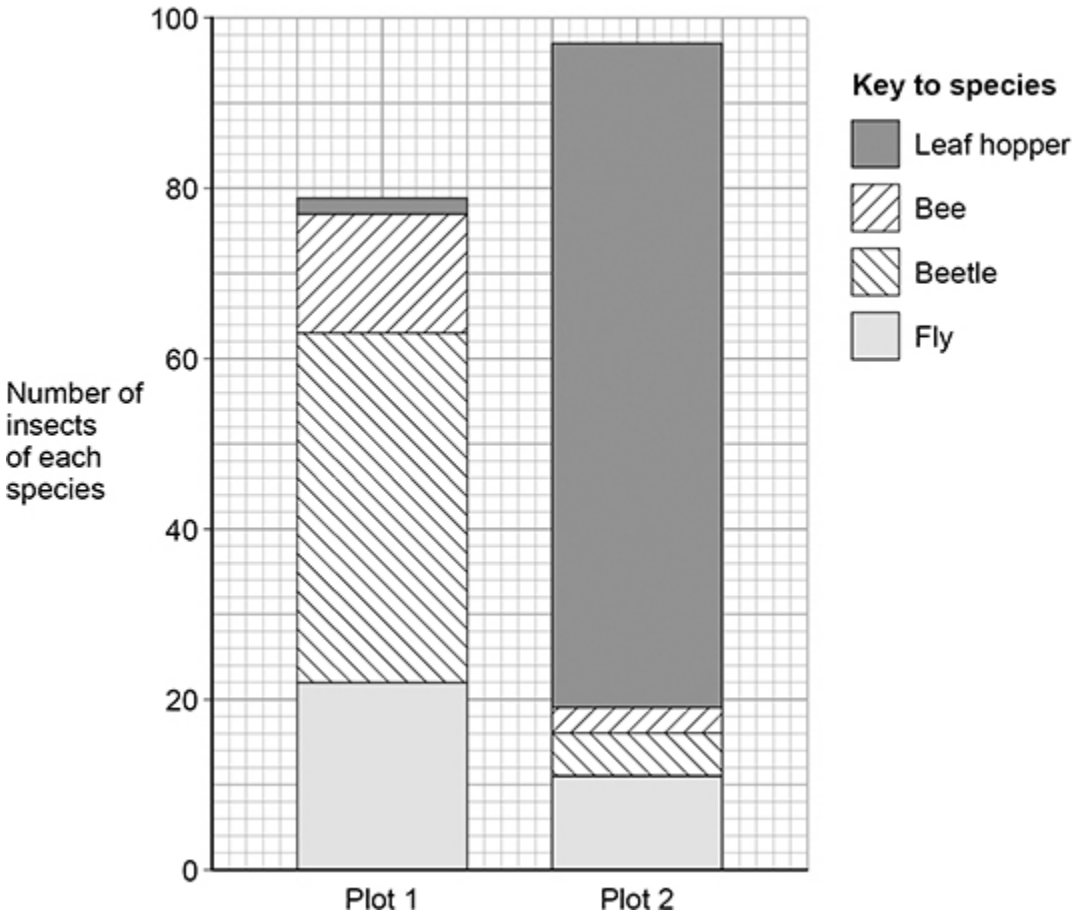
The student created two sample areas, called plots, in the meadow. Each plot measured 10 m × 5 m

The student:

- did not cut plants in **plot 1**
- cut the plants in **plot 2** with a lawn mower once a week.

After 10 weeks, the student captured all of the organisms of four insect species found in each of these plots.

The figure below shows the student's results.



(a) Use the information in the figure above to calculate the index of diversity for the insects captured in **plot 1**.

The formula to calculate the index of diversity (d) is

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

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

Give the answer to **2** significant figures and show your working.

d = _____

(2)

(b) The student concluded that cutting plants with a lawn mower increased the species richness of insects in that meadow.

Use information in the diagram above to explain why the student's conclusion is incorrect.

_____

_____

_____

(1)

(c) The student wanted to use the data from **plot 1** to estimate the total number of the beetle species in the meadow.

Suggest how the student should use the data from **plot 1** and other information provided to estimate the total number of the beetle species in the meadow.

(4)

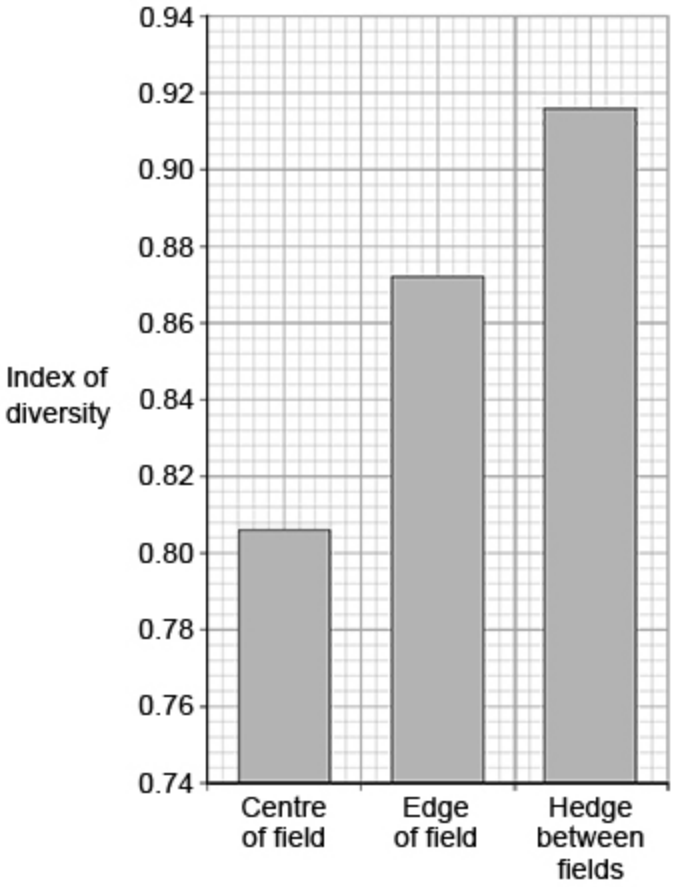
(Total 7 marks)

2. A group of students investigated biodiversity of different areas of farmland.

They collected data in each of these habitats:

- the centre of a field
- the edge of a field
- a hedge between fields.

Their results are shown in the graph.



(a) What data would the students need to collect to calculate their index of diversity in each habitat?

Do **not** include apparatus used for species sampling in your answer.

_____

_____

_____

_____

_____

(1)

(b) Give **two** ways the students would have ensured their index of diversity was representative of each habitat.

1 _____

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2 _____

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(2)

(c) Modern farming techniques have led to larger fields and the removal of hedges between fields.

Use the graph above to suggest why biodiversity decreases when farmers use larger fields.

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(1)

(d) Farmers are now being encouraged to replant hedges on their land.

Suggest and explain **one** advantage and **one** disadvantage to a farmer of replanting hedges on her farmland.

Advantage _____

_____

_____

_____

_____

Disadvantage _____

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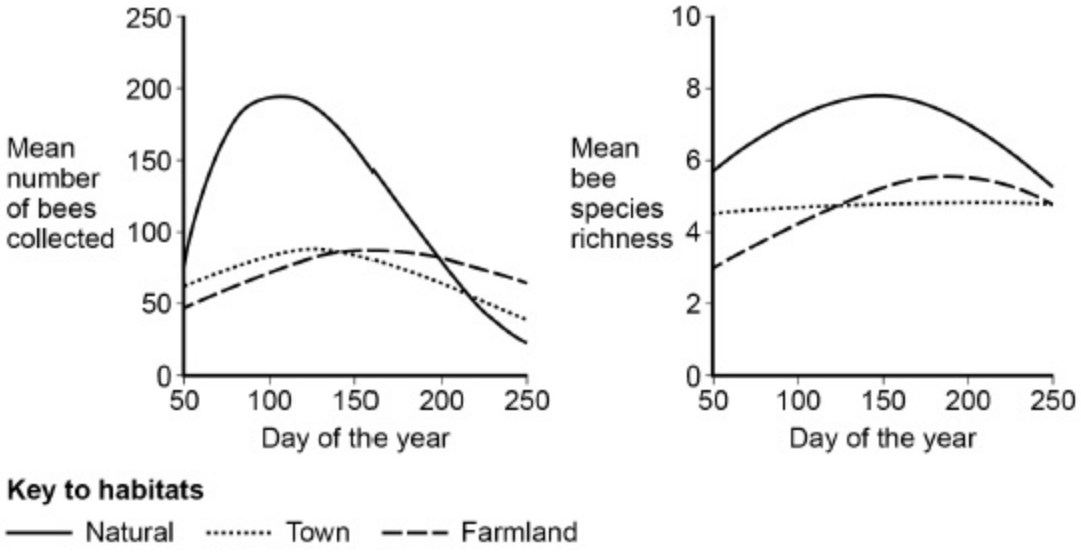
(2)

(Total 6 marks)

3. 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’?

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_____

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_____

_____

_____

(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.

_____

_____

_____

_____

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_____

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

_____

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(2)

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

1. _____

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2. _____

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_____

(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.

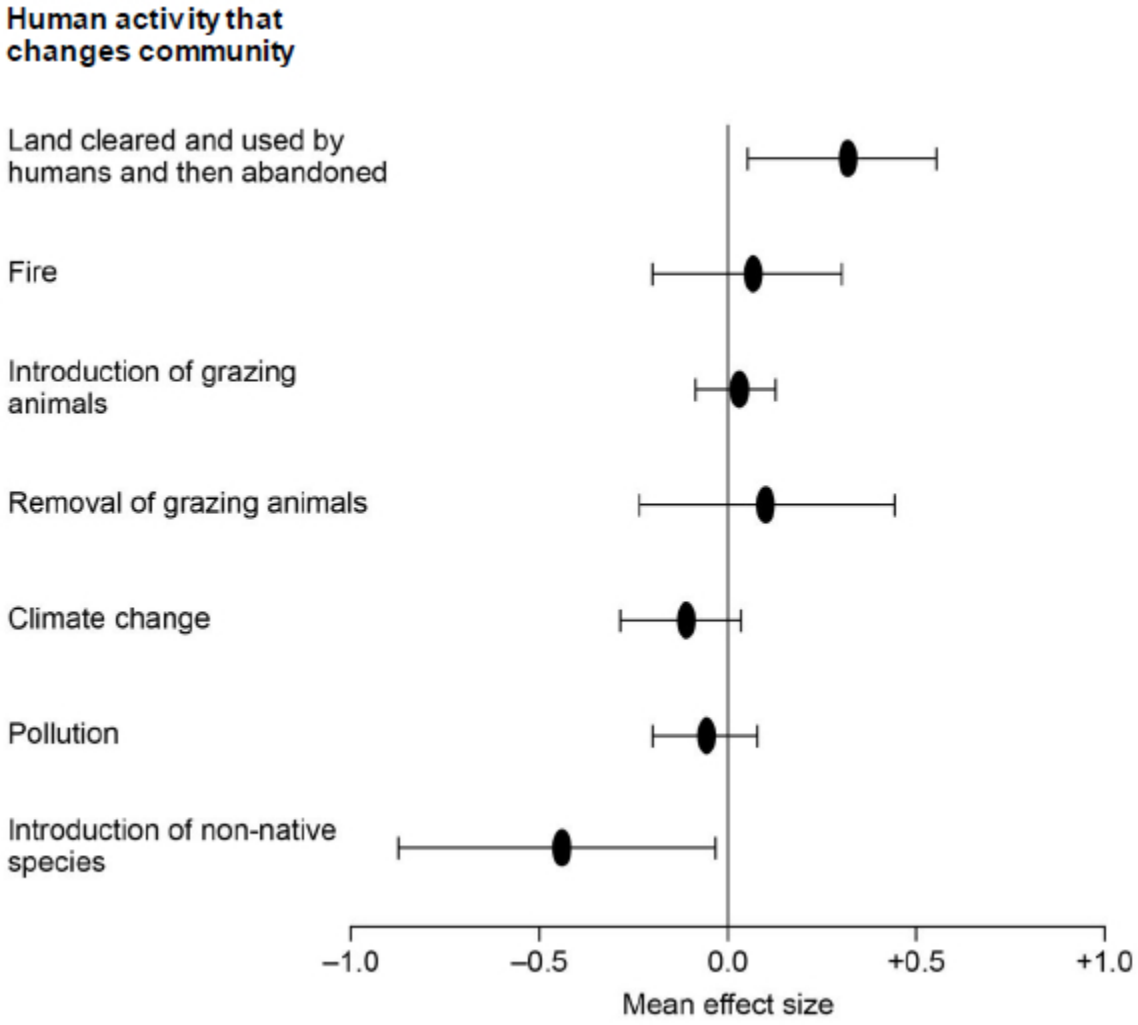
(2)

(Total 11 marks)

4. 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?

(3)

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

(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.

(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)

5. 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 m^2**
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.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

6. 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?

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_____

(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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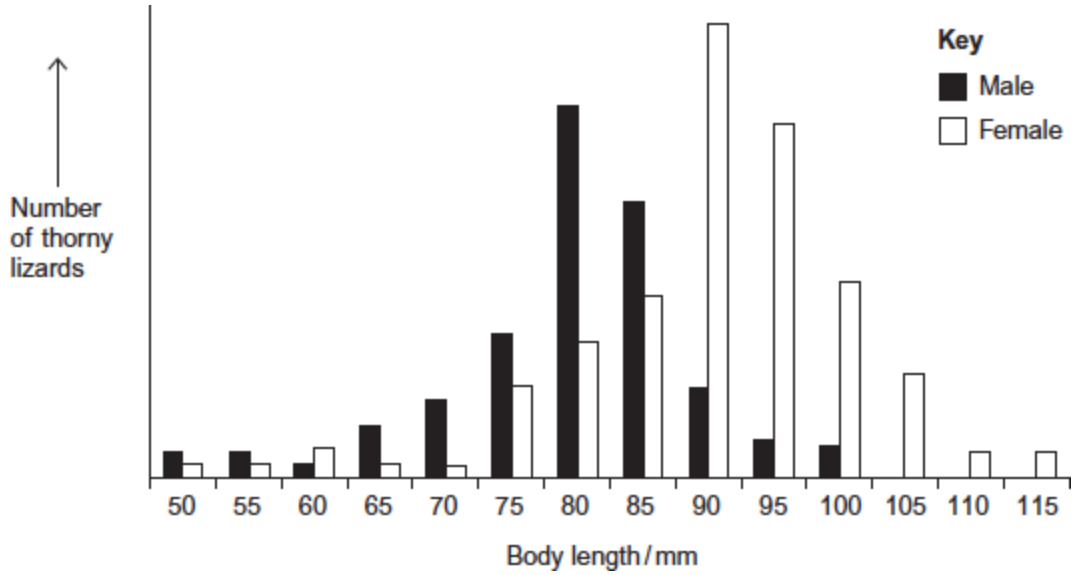
(3)

(Total 8 marks)

7. (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)