# 18.2 Biodiversity

## Question Paper

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|---|---|
| Course | CIE A Level Biology |
| Section | 18. Classification, Biodiversity & Conservation |
| Topic | 18.2 Biodiversity |
| Difficulty | Hard |

**Time allowed:** 40

**Score:** /28

**Percentage:** /100

## Question 1a

A piece of UK grassland that was traditionally grazed by sheep has been left ungrazed for the past ten years.

Outline the steps to be followed in an investigation to estimate the population density of thistle plants that have colonised the area since grazing has been discontinued.

**[5 marks]**

## Question 1b

A biologist wanted to investigate the biodiversity of insects living in farmed fields in Somerset. The biologist used sweep-netting along transects through the middle of fields on four different farms and counted the number of different insect species present in the sweep-net samples from each farm. Table 1 below shows the results of this study.

**Table 1**

|  | Farm **A** | Farm **B** | Farm **C** | Farm **D** |
|---|---|---|---|---|
| Mean number of insect species per field (± standard deviation) | 32.6 (± 9.8) | 4.1 (± 1.9) | 23.6 (± 6.7) | 18.5 (± 7.4) |

The biologist used the data in Table 1 to report that the difference between the mean number of insect species present on Farm **B** and the number present on the other three farms differed significantly ($p < 0.05$).

Explain what the biologist meant by the term "*differed significantly ($p < 0.05$)*". Use the words *probability* and *chance* in your answer.

## Question 1c

The biologist in part (b) wanted to know many fields they should sample at each farm. They carried out a preliminary investigation and recorded the total number of different insect species present in an increasing number of fields. Fig. 1 shows the results.
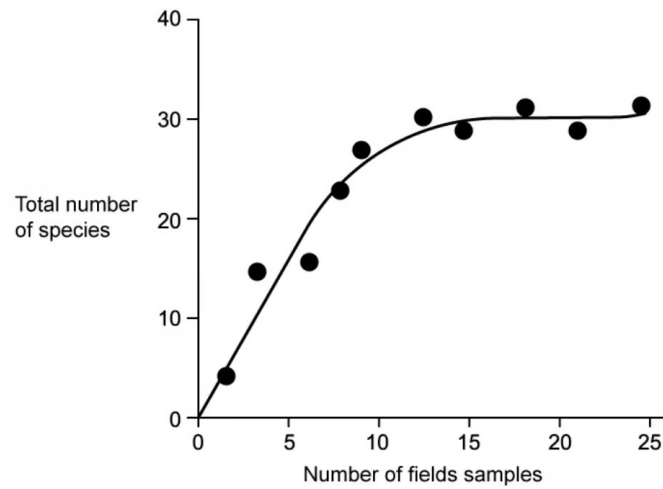


**Fig. 1**

Use the results in Fig.1 to explain why sampling 5 fields would not be an appropriate number **and** why 25 would also not be an appropriate number of fields to sample.

[2 marks]

## Question 2a

An ecologist had heard people say that stinging nettles (*Urtica dioica*) and the dock leaf plant (*Rumex obtusifolius*) often grow together. The ecologist decided to assess the abundance of these two species in a field. To do this, they recorded the percentage cover of each species in 11 randomly placed quadrats. Their results are shown in Table 1 below.

**Table 1**

| Quadrat | *U. dioica* percentage cover | *R. obtusifolius* percentage cover |
|---|---|---|
| 1 | 30 | 15 |
| 2 | 37 | 23 |
| 3 | 15 | 6 |
| 4 | 15 | 10 |
| 5 | 20 | 11 |
| 6 | 9 | 10 |
| 7 | 3 | 3 |
| 8 | 5 | 1 |
| 9 | 10 | 5 |
| 10 | 25 | 17 |
| 11 | 35 | 30 |

To determine the relationship between the percentage cover of these two species, the ecologist decided to calculate Spearman's rank correlation coefficient. They created a new table, which is represented in Table 2 below.

**Table 2**

| Quadrat | *U. dioica* percentage cover | *R. obtusifolius* percentage cover | *U. dioica* rank | *R. obtusifolius* rank | $D$ | $D^2$ |
|---|---|---|---|---|---|---|
| 1 | 30 | 15 | | | | |
| 2 | 37 | 23 | | | | |
| 3 | 15 | 6 | | | | |
| 4 | 15 | 10 | | | | |
| 5 | 20 | 11 | | | | |
| 6 | 9 | 10 | | | | |
| 7 | 3 | 3 | | | | |
| 8 | 5 | 1 | | | | |
| 9 | 10 | 5 | | | | |
| 10 | 25 | 17 | | | | |
| 11 | 35 | 30 | | | | |

Complete Table 2.

**[2 marks]**

## Question 2b

Using the formula provided below, calculate Spearman's rank correlation coefficient ($r_s$) for the data from part (a).

$$r_s = 1 - \left( \frac{6 \times \Sigma D^2}{n^3 - n} \right)$$

**Key to symbols:**

$D$ = difference in rank between each pair of measurements

$n$ = number of pairs of items in the sample

Show your working.

[2 marks]

## Question 2c

Before they started collecting data for the investigation described in part (a), the ecologist made a null hypothesis.

(i)
State the null hypothesis of this investigation.

[1]

(ii)
Using Table 5.3 below, state whether or not the ecologist was able to reject the null hypothesis and explain why.

[2]

Table 3

| Number of pairs of data | Critical value at $p$ = 0.05 (5%) |
|---|---|
| 5 | 1.00 |
| 6 | 0.89 |
| 7 | 0.79 |
| 8 | 0.74 |
| 9 | 0.70 |
| 10 | 0.65 |
| 11 | 0.62 |
| 12 | 0.59 |
| 13 | 0.56 |
| 14 | 0.54 |
| 15 | 0.52 |

**[3 marks]**

## Question 2d

Give a full conclusion that the ecologist can make from this investigation.

**[3 marks]**

## Question 3a

The diversity of dung beetle species was investigated at two grassland sites in North America.

Dung beetles feed on animal faeces (dung).

The first grassland site was grazed by cattle and the second grassland site was **not** grazed by cattle. The areas of the two grassland sites were the same.

At each grassland site, dung beetles were collected, identified and counted.

The results are shown in Table 1.

Table 1

| dung beetle species | number of dung beetles on grassland grazed by cattle | number of dung beetles on grassland not grazed by cattle |
|---|---|---|
| A | 4267 | 6641 |
| B | 2005 | 774 |
| C | 353 | 108 |
| D | 218 | 85 |
| total | 6843 | 7608 |

(i)
Simpson's index of diversity (D) for the dung beetles on the grassland site grazed by cattle was calculated as 0.522, using the formula:

$$D = 1 - \left( \Sigma \left( \frac{n}{N} \right)^2 \right)$$

Key to symbols:
n = number of individuals of each species present in the sample
N = the total number of all individuals of all species present in the sample

Calculate Simpson's index of diversity (D) for the dung beetles on the grassland site that was **not** grazed by cattle.

Complete Table 2 to show your working.

Write your final answer to **three** decimal places.

Table 2

| dung beetle species | number of dung beetles on grassland not grazed by cattle | $\dfrac{n}{N}$ | $\left( \dfrac{n}{N} \right)^2$ |
|---|---|---|---|
| A | 6641 | | |
| B | 774 | | |
| C | 108 | | |
| D | 85 | | |
| total | 7608 | | |

[3]

(ii)
Describe what the results in Table 1 and both figures for Simpson's index of diversity show about the effect of grazing by cattle on the diversity of dung beetles.

[2]

**[5 marks]**

## Question 3b

Other species of beetle that do not feed on animal dung are found on the grassland sites.

Name **and** describe **one** method for estimating the population size of a species of beetle that does **not** feed on dung in each of the two areas of grassland.

**[4 marks]**