1.9 A-Level Biology: Required Practicals and Data Analysis: 30-minute Pack

AQA 7402 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student used a choice chamber with four quadrants (damp/dark, damp/light, dry/dark, dry/light) to investigate the effect of humidity and light on the distribution of woodlice (Porcellio scaber). After 10 minutes, 40 woodlice were distributed as follows: Damp/dark: 16, Damp/light: 9, Dry/dark: 8, Dry/light: 7

(a) Explain why a choice chamber is a suitable piece of apparatus to investigate the effect of humidity and light on the distribution of woodlice. **(2)**

(b) State the null hypothesis for this investigation. **(1)**

(c) If there is no preference, an even distribution of woodlice among the four quadrants would be expected. Calculate the expected number per quadrant and the value of chi-squared for this data, using chi-squared = sum($(O - E)^2 / E$), and state the number of degrees of freedom. **(3)**

(d) The critical value of chi-squared at p = 0.05 for 3 degrees of freedom is 7.82. Interpret the result of this test, referring to both values. **(2)**

(Total for Question 1 is 8 marks)

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2 A student at Oakfield Academy near Nottingham used a systematic belt transect across a 20 m gradient from the edge of a small woodland into open meadow, recording light intensity and the percentage cover of white clover (Trifolium repens) using 0.25 m^2 quadrats every 4 m.
Distance from woodland edge (m): 0, 4, 8, 12, 16, 20
Light intensity, mean of 3 readings (klux): 2.1, 5.4, 9.0, 13.8, 17.6, 20.9
Percentage cover of clover (%): 4, 11, 28, 69, 54, 82

(a) Identify the sampling technique used and explain why it is suitable for investigating a change along an environmental gradient such as this. **(2)**

(b) State a suitable null hypothesis for this investigation. **(2)**

(c) A Spearman's rank correlation coefficient calculated for this data gives rs = +0.94. The critical value at p = 0.05 for n = 6 is 0.886. Explain what the value of rs indicates about the relationship between light intensity and clover cover, and comment on its statistical significance. **(3)**

(d) Calculate the standard error of the mean for the light intensity readings, given a mean of 11.5 klux and a standard deviation of 7.3 klux (n = 6). Use SE = SD / $\sqrt{n}$. Give your answer to 3 significant figures. **(2)**

(e) Evaluate the reliability of using percentage cover as a measure of clover abundance in this investigation, and suggest two improvements to the method. **(6)**

(Total for Question 2 is 15 marks)

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Mark scheme · 1.9 A-Level Biology: Required Practicals and Data Analysis: 30-minute Pack

Question 1

(a) it allows the animal to move freely and choose between different conditions (e.g. damp/dry, light/dark) simultaneously **B1**

(a) allowing the experimenter to observe which conditions the woodlice show a preference for/aggregate in **B1**

(a) Answer: Woodlice can move freely between conditions, allowing their preference to be observed

(b) there is no significant difference between the observed and expected (even) distribution of woodlice among the four quadrants (woodlice show no preference) **B1**

(b) Answer: There is no significant difference between the observed and expected (even) distribution of woodlice

(c) expected number per quadrant = 40/4 = 10, and at least three correct $(O-E)^2/E$ terms (3.6, 0.1, 0.4, 0.9) **M1**

(c) chi-squared = 5.0 cao **A1**

(c) degrees of freedom = 3 **B1**

(c) Answer: Expected = 10 per quadrant; chi-squared = 5.0; degrees of freedom = 3

(d) 5.0 is less than the critical value (7.82), so the null hypothesis is accepted **B1**

(d) there is no statistically significant difference between the observed and expected distribution; the woodlice show no significant preference for a particular combination of humidity and light (any apparent clustering is due to chance) **B1**

(d) Answer: Accept the null hypothesis, since 5.0 < 7.82; no significant preference shown

Question 2

(a) systematic sampling along a belt transect **B1**

(a) allows the change in a variable (here, % cover / community) to be recorded at set intervals along a gradient, showing how the two factors are related, rather than sampling randomly (oe) **B1**

(a) Answer: Systematic sampling using a belt transect; it records data at set intervals along the gradient so the relationship between distance/light and clover cover can be seen

(b) there is no correlation / no significant relationship (oe) **B1**

(b) between light intensity and percentage cover of clover (both variables correctly named) **B1**

(b) Answer: There is no correlation between light intensity and the percentage cover of clover.

(c) a strong, positive correlation (close to +1) **B1**

(c) as light intensity increases, percentage cover of clover increases (oe) **B1**

(c) rs (0.94) exceeds the critical value (0.886), so the correlation is statistically significant at p = 0.05 / unlikely to be due to chance **B1**

(c) Answer: Strong positive correlation; statistically significant since 0.94 > 0.886

(d) $\sqrt{6}$ = 2.45 (or equivalent correct substitution) **M1**

(d) 2.98 klux (awrt 2.98) cao **A1**

(d) Answer: 2.98 klux

(e) **L3** A detailed evaluation identifying at least two clear limitations of the method with linked, appropriate improvements, using scientific reasoning throughout. Coherent and well structured. **5-6**

(e) **L2** Some relevant limitations and/or improvements identified, with some scientific reasoning, though development is limited or the response is only partly linked. **3-4**

(e) **L1** Basic or isolated statements about the method with little scientific reasoning or linkage between limitation and improvement. **1-2**

(e) **L0** No relevant content. **0**

(e) Indicative content:

- Percentage cover is an estimate and is subjective, so different observers may record different values for the same quadrat (observer bias)
- Overlapping vegetation/layered canopy can make cover appear greater than 100%, or make it difficult to judge accurately
- Improvement: use a point quadrat / pin frame, recording the number of pin hits on clover, giving a more objective and quantitative measure of abundance
- Only one transect line was used, so the data may not be representative of the whole field/site if there is local variation in the vegetation
- Improvement: repeat the transect at several random locations across the site and calculate a mean, to increase sample size and reliability
- The fixed 4 m sampling interval may miss finer-scale variation, particularly where change is more rapid (e.g. close to the woodland edge)
- Improvement: use a smaller sampling interval, or a greater number of quadrats overall, to increase resolution/detect variation more precisely

(e) Answer: Level 3 response linking at least two limitations (e.g. subjectivity of % cover, single transect line) to specific improvements (e.g. point quadrats, repeated random transects)

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