B7aD Ecosystems, Adaptation and Feeding Relationships: Exam Drill

Total Marks

AQA 8464 · Calculator allowed · about 95 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 This question checks three key terms used throughout ecology.

(a) Define the term 'niche'. **(1)**

(b) Define the term 'interspecific competition'. **(1)**

(c) Define the term 'intraspecific competition'. **(1)**

(Total for Question 1 is 3 marks)

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2 Yusuf is estimating the population of garden snails in a school allotment using the capture-mark-recapture method. He collects a first sample of snails, marks each one with a small dot of non-toxic paint on its shell, then releases them back into the allotment. A few days later he collects a second sample.

First sample: 40 snails caught, marked and released.

Second sample: 50 snails caught, of which 8 are marked.

(a) State the equation used to estimate population size from capture-mark-recapture data. **(1)**

(b) Use the equation to estimate the total population of snails in the allotment. Show your working and give your final answer to the nearest whole number. **(3)**

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(Total for Question 2 is 4 marks)

3 Required practical: Erin is investigating the population size of daisy plants growing across a school playing field, using 0.5 m by 0.5 m quadrats.

(a) State one way Erin could make sure the position of each quadrat is chosen randomly. **(1)**

(b) Erin instead places every quadrat in the parts of the field where daisies look most abundant, because this is quicker. Explain the effect this would have on her estimate of the total daisy population. **(2)**

(c) Suggest one way Erin could improve the reliability of her population estimate, other than sampling randomly. **(1)**

(Total for Question 3 is 4 marks)

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4 Amelia is comparing how body size affects heat loss in cold climates, using two cube-shaped models to represent two animals of different size. Model A has sides of length 2 cm. Model B has sides of length 6 cm.

(a) Calculate the surface area and the volume of model A (sides of 2 cm). **(2)**

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(b) Calculate the surface-area-to-volume ratio of model A, giving your answer in the form n : 1. **(1)**

.....

(c) Calculate the surface-area-to-volume ratio of model B (sides of 6 cm), giving your answer in the form n : 1. **(2)**

.....

(d) Using your answers to (b) and (c), explain which model represents an animal that is better adapted to surviving in a cold climate. **(1)**

(Total for Question 4 is 6 marks)

5 The diagram below shows the energy stored in the biomass at each stage of a pond food chain, in kJ per m^2 per year.

algae: 12000 kJ -> water fleas: 900 kJ -> minnows: 95 kJ -> pike: 9 kJ

(a) Calculate the percentage efficiency of energy transfer from algae to water fleas. **(2)**
Give your answer to 2 significant figures.

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(b) Calculate the percentage efficiency of energy transfer from minnows to pike. **(2)**
Give your answer to 2 significant figures.

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(Total for Question 5 is 4 marks)

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6 The table shows the relative abundance (arbitrary index units) of aphids and ladybirds recorded in the same rose garden over six consecutive years.

Year 1: aphids 20, ladybirds 4
Year 2: aphids 55, ladybirds 6
Year 3: aphids 30, ladybirds 14
Year 4: aphids 10, ladybirds 9
Year 5: aphids 25, ladybirds 3
Year 6: aphids 48, ladybirds 5

(a) Describe the relationship shown by the data between aphid numbers and ladybird numbers over the six years. **(2)**

(b) Suggest, in terms of predation, why aphid numbers fell between year 2 and year 3. **(2)**

(Total for Question 6 is 4 marks)

7 The capture-mark-recapture method described in Question 2 relies on several assumptions being true.

(a) State one assumption that must be true for the capture-mark-recapture method to give an accurate population estimate. **(1)**

(b) Suggest what would happen to the calculated population estimate if the paint marks made the snails more visible to predators, so that marked snails were more likely to be eaten before the second sample was collected. Explain your answer. **(2)**

(Total for Question 7 is 3 marks)

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8 Evaluate the use of random quadrat sampling, compared with placing quadrats only where a plant species looks abundant, for estimating the population size of that plant species across a large field.

(Total for Question 8 is 6 marks)

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9 The red squirrel population in a UK forest was 640 in 2015. By 2025, following the introduction of grey squirrels to the area, the red squirrel population had fallen to 224.

(a) Calculate the percentage decrease in the red squirrel population between 2015 and 2025. **(3)**

.....

(b) Higher tier only. Explain, in terms of interspecific competition, how the presence of grey squirrels could cause the red squirrel population to decline. **(2)**

(Total for Question 9 is 5 marks)

10 The simplified marine food web below shows some feeding relationships off the UK coast.
phytoplankton -> zooplankton -> herring -> seal -> orca
herring is also eaten by cod

(a) Predict what would happen to the herring population if the seal population increased greatly. **(1)**

(b) Explain the likely effect on the cod population of the same increase in the seal population. **(2)**

(c) State one reason why a real food web is likely to be more complex, and predictions like this less certain, than this simplified diagram suggests. **(1)**

(Total for Question 10 is 4 marks)

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11 Callum records the number of dandelion plants in ten 0.5 m by 0.5 m quadrats placed randomly across a school field with a total area of 2400 m^2. The total number of dandelions counted across all ten quadrats is 65.

(a) Calculate the mean number of dandelions per quadrat. **(1)**

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(b) Each quadrat has an area of 0.25 m^2. Use your answer to (a) to estimate the total number of dandelions growing across the whole 2400 m^2 field. Show your working. **(3)**

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(Total for Question 11 is 4 marks)

Mark scheme · B7aD Ecosystems, Adaptation and Feeding Relationships: Exam Drill

Question 1

- (a) **B1** the role or way of life of an organism within its habitat, including what it eats, where it lives and how it interacts with other organisms, oe
- **(a) Answer: The role or way of life of an organism within its habitat.**
- (b) **B1** competition between organisms of different species for the same resource, e.g. food, water, light, space or mates, oe
- **(b) Answer: Competition between organisms of different species for the same resource.**
- (c) **B1** competition between organisms of the same species for the same resource, oe
- **(c) Answer: Competition between organisms of the same species for the same resource.**

Question 2

- (a) **B1** population estimate = (number in first sample x number in second sample) / number in second sample that are marked, oe
- **(a) Answer: Population estimate = (number in first sample x number in second sample) / number in second sample that are marked.**
- (b) **M1** substitutes correctly: population estimate = (40 x 50) / 8
- (b) **M1** calculates the numerator: 40 x 50 = 2000
- (b) **A1** 250 (snails) cao
- **(b) Answer: 250 snails**

Question 3

- (a) **B1** lay two tape measures at right angles along two sides of the field and use a random number generator (or random number table) to generate a pair of coordinates for each quadrat, oe
- **(a) Answer: Use two tape measures as axes across the field and a random number generator to pick coordinates for each quadrat.**
- (b) **M1** identifies that the sample is no longer representative of the whole field, because it is biased towards areas with more daisies, oe
- (b) **A1** explains this would make the mean density calculated too high, so the estimate of the total population would be an overestimate, oe
- **(b) Answer: The sample would be biased towards daisy-rich areas and so not representative of the whole field; the calculated mean density, and therefore the estimated total population, would be too high (an overestimate).**
- (c) **B1** increase the number of quadrats sampled (a larger sample size gives a more reliable mean), oe; accept using a larger quadrat, or repeating on different days
- **(c) Answer: Increase the number of quadrats sampled, so the mean density is based on a larger, more reliable sample.**

Question 4

- (a) **M1** surface area = 6 x (2 x 2) = 24 cm^2
- (a) **A1** volume = 2 x 2 x 2 = 8 cm^3
- **(a) Answer: Surface area = 24 cm^2; volume = 8 cm^3**
- (b) **B1** 3 : 1 (24 / 8 = 3), ecf from part (a)
- **(b) Answer: 3 : 1**
- (c) **M1** surface area = 6 x (6 x 6) = 216 cm^2 and volume = 6 x 6 x 6 = 216 cm^3
- (c) **A1** 1 : 1 (216 / 216 = 1) cao
- **(c) Answer: 1 : 1**
- (d) **B1** model B (the larger animal), because it has a smaller surface-area-to-volume ratio, so it loses proportionally less heat energy from its body surface relative to the heat it generates/stores in its volume, so it can maintain its body temperature more easily in the cold, oe
- **(d) Answer: Model B, because its lower surface-area-to-volume ratio (1:1, compared with 3:1) means it loses relatively less heat through its surface, so it retains body heat more easily in a cold climate.**

Question 5

- (a) **M1** substitutes: (900 / 12000) x 100
- (a) **A1** 7.5% cao
- **(a) Answer: 7.5%**
- (b) **M1** substitutes: (9 / 95) x 100
- (b) **A1** 9.5% cao (accept 9.47% to 9.5%)
- **(b) Answer: 9.5%**

Question 6

- (a) **B1** as aphid (prey) numbers rise, ladybird (predator) numbers rise shortly afterwards, e.g. aphids peak in year 2 (55) and ladybirds peak in year 3 (14), oe
- (a) **B1** as ladybird numbers rise, aphid numbers then fall, e.g. after ladybirds peak in year 3, aphids fall to their lowest in year 4 (10), oe
- **(a) Answer: Ladybird numbers rise shortly after aphid numbers rise (e.g. aphids peak at 55 in year 2, ladybirds peak at 14 in year 3), and aphid numbers then fall once ladybird numbers are high (aphids fall to 10 in year 4).**
- (b) **M1** ladybird numbers were rising over this period (from 6 to 14), oe
- (b) **A1** so more aphids were being eaten (predated) by the larger number of ladybirds, reducing the aphid population, oe
- **(b) Answer: Ladybird numbers were increasing over this period, so more aphids were being eaten by the growing number of predators, reducing the aphid population.**

Question 7

- (a) **B1** one valid assumption: the marked individuals redistribute (mix) evenly/randomly throughout the population before the second sample; or there is no significant immigration, emigration, births or deaths between the two samples; or the marking does not affect the survival or behaviour of the marked individuals, oe
- **(a) Answer: Example: the marked snails mix randomly back into the whole population before the second sample is taken.**
- (b) **M1** fewer marked snails would survive to be recaught in the second sample than expected, oe
- (b) **A1** this reduces the number of marked individuals in the second sample, so the population estimate calculated would be too high (an overestimate), because that number is a denominator in the calculation, oe
- **(b) Answer: Fewer marked snails would survive to be caught in the second sample, so the estimated population would be an overestimate, because the number of marked individuals recaptured is used as a denominator in the calculation.**

Question 8

- **Level 3** (5-6): A balanced evaluation that compares both methods, explains the effect of bias on the estimate, and reaches a justified conclusion about which method is more valid, with reference to reliability and/or accuracy.
- **Level 2** (3-4): Some comparison of the two methods with at least one clear explanation of why non-random sampling introduces bias, but the evaluation is not fully balanced or the conclusion is not fully justified.
- **Level 1** (1-2): Simple statements about one method only, or a comparison with little or no explanation.
- **Indicative content:**
  - Random quadrat placement gives every part of the field an equal chance of being sampled, so the sample is representative of the whole field, including areas of low and high density
  - Placing quadrats only where the plant looks abundant introduces sampling bias, because it deliberately excludes areas of low abundance
  - This bias would make the mean density calculated from the sample higher than the true mean density across the whole field, so the estimated total population would be an overestimate
  - Random sampling can still be affected by chance (sampling error), especially if the number of quadrats used is small, so a large sample size is also needed for a reliable estimate
  - Random sampling takes longer and requires more effort (generating coordinates, moving across the whole field) than simply sampling an obviously abundant area
  - Overall conclusion: random sampling is more valid because it avoids systematic bias, even though it takes more time and a large sample is still needed for good reliability

Question 9

- (a) **M1** calculates the decrease: 640 - 224 = 416
- (a) **M1** substitutes: (416 / 640) x 100
- (a) **A1** 65% cao
- **(a) Answer: 65% decrease**
- (b) **M1** grey squirrels compete with red squirrels for the same resources, such as food (e.g. acorns, seeds) and nesting/breeding sites, oe
- (b) **A1** grey squirrels are more successful competitors (e.g. larger body size, can digest acorns more efficiently, tolerate higher population densities), so red squirrels obtain fewer resources, reducing their survival and/or reproduction and so their population size, oe
- **(b) Answer: Grey squirrels compete with red squirrels for the same food and nesting sites, but are more successful competitors, so red squirrels obtain fewer resources, reducing their survival and reproduction and causing the population to fall.**

Question 10

- (a) **B1** herring population would decrease, because more seals means more herring are predated (eaten), oe
- **(a) Answer: The herring population would decrease.**
- (b) **M1** cod population would be likely to decrease, oe
- (b) **A1** because cod also feeds on herring, so cod is now competing with a larger seal population for a smaller (falling) herring population, meaning less food is available per cod, oe
- **(b) Answer: The cod population would be likely to decrease, because cod compete with seals for herring, and with more seals eating more herring, there is less food available for cod.**
- (c) **B1** one valid reason: cod (and other predators) may have alternative food sources to switch to; other factors such as disease, fishing or temperature also affect population sizes; there may be many more species and feeding links in a real food web, oe
- **(c) Answer: Example: cod may be able to switch to eating other prey species if herring become scarce, so the effect may be smaller than predicted.**

Question 11

- (a) **B1** 6.5 (65 / 10) cao
- **(a) Answer: 6.5 dandelions per quadrat**
- (b) **M1** calculates mean density: 6.5 / 0.25 = 26 dandelions per m^2
- (b) **M1** substitutes: 26 x 2400
- (b) **A1** 62400 dandelions cao
- **(b) Answer: 62400 dandelions**