A-LEVEL BIOLOGY • EXERCISE SHEET

18.2 Biodiversity

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS biodiversity 生物多样性 • mark-release-recapture 标志重捕法 • ecosystem 生态系统 • niche 生态位 • quadrat 样方

Objective

Build the skills to answer exam questions on **biodiversity** — **ecosystem** 生态系统 and **niche** 生态位, the levels of biodiversity, **random sampling** 随机取样 methods, and **Simpson's index** 辛普森指数.

You must be able to:

- define ecosystem and niche and explain the levels of biodiversity
- describe sampling methods (quadrats, transects, mark-release-recapture)
- use the Lincoln index and Simpson's index of diversity

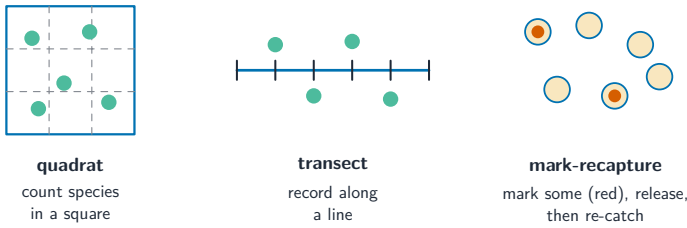
1 Worked examples

■ Levels of biodiversity

Biodiversity = the range of ecosystems, the number of species (and abundance), and genetic variation within a species

An **ecosystem** is the living things in an area plus their non-living surroundings; a **niche** is a species' role and place within it.

■ Sampling methods



Quadrats and transects sample fixed organisms; mark-release-recapture estimates mobile animals

Random sampling avoids bias. The **Lincoln index** estimates a population: $N = \frac{n_1 \times n_2}{m}$ (first catch × second catch ÷ marked recaught).

■ Simpson's index of diversity

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

where n = number of one species and N = total of all species. A higher D means more diverse and usually more stable.

2 Practice

2.1 Define the term **niche**. [1]

2.2 Name a sampling method suitable for (a) plants in a field and (b) mobile beetles. [2]

3 Exam-style questions

3.1 Why is random sampling important when measuring biodiversity? [1]

- **A** it counts every organism
- **B** it avoids bias and gives a fair, representative sample
- **C** it is faster than other methods
- **D** it only samples the rarest species

3.2 A higher value of Simpson's index of diversity (D) indicates: [1]

- **A** fewer species
- **B** a more diverse, usually more stable, community
- **C** a smaller area
- **D** more abiotic factors

3.3 In a mark-release-recapture study, 60 snails are caught, marked and released. Later, 80 are caught, of which 24 are marked.

(a) Use the Lincoln index to estimate the population size. [2]

(b) State **one** assumption of this method. [1]

3.4 A pond contains 3 species with 5, 3 and 2 individuals (N = 10). Calculate Simpson's index of diversity, D. [3]

3.5 A student used ten randomly placed quadrats, each 0.25 m^2, to sample a grassland. Species **A** was present in 7 quadrats, with a total of 84 individuals across all ten.

(a) Explain what is meant by *ecosystem* and by *niche*. [2]

(b) Calculate the percentage frequency and the density per square metre of species **A**, showing your working. [4]

(c) Describe how the student should have positioned the quadrats, and explain why random positioning matters. [3]

(d) Name the three levels at which biodiversity is measured, and explain why counting species alone can be misleading. [3]

Solutions

2.1 the role and position of a species within its ecosystem.

2.2 (a) quadrats / transects; (b) mark-release-recapture.

3.1 B. Random sampling avoids bias, giving a representative result.

3.2 B. A higher D means greater diversity and usually greater stability.

3.3 (a) $N = \dfrac{60 \times 80}{24} = 200$ snails.
(b) any one: no births/deaths/migration; marks do not affect survival; marked animals mix randomly.

3.4 $\sum(n/N)^2 = (5/10)^2 + (3/10)^2 + (2/10)^2 = 0.25 + 0.09 + 0.04 = 0.38$; $D = 1 - 0.38 = 0.62$.

3.5 (a) An ecosystem is all the organisms in an area together with the non-living components of their environment, and the interactions between them. A niche is the role an organism plays — where it lives, what it feeds on, what feeds on it, and the conditions it tolerates.
(b) Percentage frequency $= \dfrac{7}{10} \times 100 = 70\%$; total area sampled $= 10 \times 0.25 = 2.5$ m^2; density $= \dfrac{84}{2.5} = 33.6$ individuals per m^2.
(c) Lay two tapes at right angles as axes and use random numbers to generate each pair of coordinates; random placement removes the observer's unconscious bias towards interesting or easy patches; only then is the sample representative, so the results can be applied to the whole area.
(d) Habitat (or ecosystem) diversity, species diversity, and genetic diversity within a species. A species count treats a species represented by one individual the same as one represented by thousands, so an index such as Simpson's, which uses the abundance of each species as well, gives a truer picture of the community.