# 2.7 Classification and measuring biodiversity

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

**KEY WORDS** three-domain system • species richness • index of diversity • heterozygosity index • endemic

## Objective

Practise statements 4.14-4.18: the three-domain classification, species richness, the index of diversity D, the heterozygosity index and endemism – the calculation centre of WBI12.

## 1 Key knowledge and worked examples

### Classification and the three domains

Classification groups life by shared characteristics, tested ever more sharply by molecular evidence – ribosomal RNA sequencing split the old prokaryotes into **Bacteria** and **Archaea**, with everything else in **Eukarya**.

### The index of diversity

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

$N$ = total individuals of all species; $n$ = individuals of one species. Higher D = more diverse. Species richness alone ignores balance.

### Heterozygosity index

$H = \dfrac{\text{number of heterozygotes}}{\text{number of individuals sampled}}$ – genetic diversity within one species. Low H warns of inbreeding.

### Worked example: full D calculation

Four species with counts 60, 20, 15, 5; $N = 100$. Numerator $100 \times 99 = 9\,900$. Denominator $= 60 \times 59 + 20 \times 19 + 15 \times 14 + 5 \times 4 = 3540 + 380 + 210 + 20 = 4150$. $D = 9900/4150 = 2.39$. If one pesticide removed the last two species ($N$ stays 100 only in count – recompute with 80, 20: $D = 9900/(6320 + 380) = 1.48$): diversity collapses even though richness fell only by two.

## 2 Practice

**2.1** State the difference between species richness and the index of diversity. [2]

**2.2** Name the three domains of life. [1]

**2.3** A lake holds 200 fish: 120 of species A, 80 of species B. Calculate D. [2]

## 3 Exam-style questions

**3.1** The table gives the plants of two meadows.

| Species | Meadow 1 count | Meadow 2 count |
|---|---|---|
| Grass A | 70 | 20 |
| Grass B | 10 | 20 |
| Clover | 10 | 20 |
| Orchid | 10 | 20 |
| Total | 100 | 80 |

Calculate D for each meadow, state which is more diverse, and explain why the meadows can have the same species richness and still differ in diversity. [6]

**3.2** An island lizard population of 400 includes 60 heterozygotes at a coat-colour locus. Calculate the heterozygosity index, compare it with a mainland population where 200 of 400 are heterozygotes, and explain why a low index matters for the island population's future. [4]

**3.3** The tuatara lives only on small islands off New Zealand. Define the term describing this distribution, explain why such a species is unusually vulnerable to extinction, and describe one conservation method that directly increases its population size. [5]

## Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

**2.1** Richness counts the number of species present; the index of diversity also weighs how evenly individuals are spread among them.

**2.2** Bacteria, Archaea, Eukarya.

**2.3** $D = 200 \times 199/(120 \times 119 + 80 \times 79) = 39\,800/(14\,280 + 6\,320) = 1.93$.

**3.1** M1: $N_1 = 100$, numerator 9 900; denominator $= 70 \times 69 + 3 \times (10 \times 9) = 4830 + 270 = 5100$; $D_1 = 1.94$. $N_2 = 80$, numerator $80 \times 79 = 6320$; denominator $4 \times (20 \times 19) = 1520$; $D_2 = 4.16$. Meadow 2 is more diverse. Richness is equal (4 species each) but meadow 1's counts are dominated by one species, which D penalises and richness cannot see.

**3.2** Island $H = 60/400 = 0.15$; mainland $H = 200/400 = 0.50$ – three times higher. Low heterozygosity means few allele variants, so the island population copes badly with disease or environmental change – one pathogen could pass through a genetically similar population.

**3.3** Endemic. The whole species lives in one small area, so a single event – storm, fire, disease or introduced predators – can remove it entirely. Captive breeding with later release, or rat eradication to protect eggs, directly raises numbers.