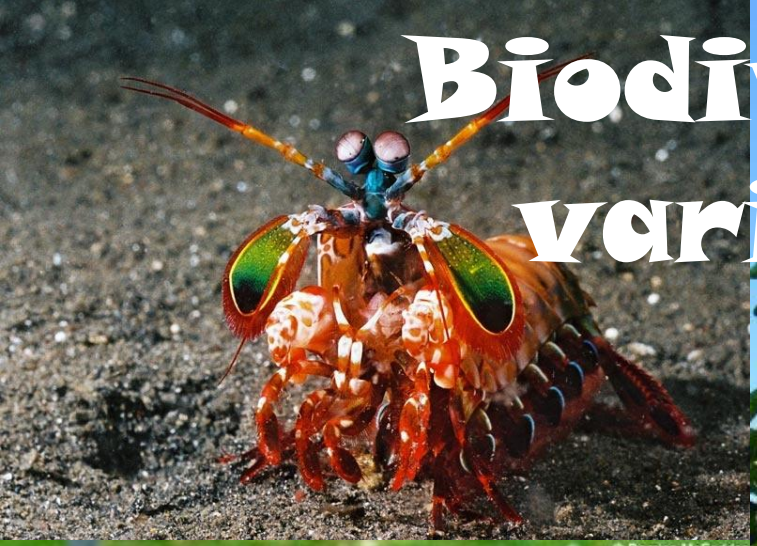
Biodiversity - the variety of life



Biodiversity definition:

Describes the variety of life and refers to the number and variety of organisms in an area. It has 3 components:

- Genetic diversity
- Species diversity
- Ecosystem (or habitat) diversity

The biochemical basis of life is similar for all organisms; they all contain the biochemicals:

- Carbohydrates
- Lipids
- Nucleic acids
- Proteins

*We see variation, or **biological diversity** among living organisms at all levels of biological organisation:*

1. Genetic diversity

The diversity of genes within a species (the genetic variability). This refers to the variety of alleles between members of the same species. E.g. in isolated populations, genetic variability will be low due to breeding of closely related individuals, which can lead to accumulation of dangerous recessive alleles e.g. genetic fingerprinting has shown this is the case with cheetah populations

- ***A lack of genetic variability can indicate that the species lacks sufficient adaptability and may not be able to survive an environmental hazard/change***

- The Irish potato blight of 1846, which caused a famine that killed one million people and forced another million to emigrate, occurred because only 2 potato varities had been cultivated (low genetic variability) and both were susceptible to the potato blight fungus *Phytophthora infestans*

- Genetic diversity is measured directly by genetic fingerprinting or indirectly be observation of phenotypic (physical) features e.g. banding and colour patterns in the land snail *Cepea nemoralis*

2. Ecosystem (habitat) diversity

The diversity of ecosystems or habitats within an area.

A wide range of habitats within an ecosystem/area will allow for greater species diversity e.g. countryside with ponds, rivers, woodlands, hedgerows, wet meadowland, set aside grassland will be more species rich and diverse than countryside with ploughed fields, drained land, and with no woods, hedgerows or wet areas

3. Species diversity

The diversity among species in an ecosystem.

Is a measure of both the number of individuals and the number of species in a community. We use objective measures to assess this:

Example a) **Species richness** is the number of different species present in an area. More species = a "richer" area

BUT this doesn't take into account how many of each species there are (i.e. the number of individuals of each species)

Therefore it is not a complete measure of species

This meadow may have ~10 species (high richness) but could be dominated by say just one (with many individuals) e.g. lots of daisies, and is thus not very diverse

Example b) We can measure the species diversity using the **Simpson's index:** It takes into account both species richness AND the evenness of abundance among the species present (i.e. How many individuals for each species)

It measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species e.g. community/Family/Genus etc) i.e. A low value/probability = very diverse area

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

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- The value of D (diversity) ranges between 0 to 1
- N is the total number of organisms (or percentage cover) of all species
- n_i is the number of organisms (or percentage cover) of one particular species
- Σ is the sum (total) of the individual calculations

If D=0 then there is infinite diversity
If D=1 then there is no diversity
i.e. the **larger** the value of D, the **lower** the diversity

Example:

Species	Number (n)	n(n-1)
Woodrush	2	2
Holly (seedlings)	8	56
Bramble	1	0
Yorkshire Fog	1	0
Sedge	3	6
Total (N)	**15**	**64**

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

$$D = \frac{64}{15(14)}$$

$$D = \frac{64}{210}$$

D = 0.3 (Simpson's Index)

PRACTICAL ECOLOGY – USING BIODIVERSITY MEASURES

- Species biodiversity can indicate the “biological health” of a habitat, and can be used to compare ecosystems/areas
- The Simpsons Index can be related to the abiotic harshness of an environment or to pollution in an ecosystem
- Generally the species diversity is greater in habitat in which abiotic conditions are less demanding or in which pollution levels are lower

However...

- Care must be taken when interpreting biodiversity measures in order to place importance on habitats
- Some habitats are harsh/stressful in terms of the ecological factors affecting the organisms present, and so few are adapted to survive there
- These few adapted species may well be very unique and/or rare and therefore the habitat is important, even though it has a low biodiversity measure

Nevertheless...

- A drop in biodiversity is usually a good indicator to ecologists that a detrimental event has occurred e.g. pollution
- Conversely, an increase in a biodiversity measure can indicate that corrective measures in an area e.g. conservation strategies, have been effective

Compare the Simpsons Index and species diversity of a garden in central Belfast to one in Ballynahinch:

The Simpson's Index will be lower in Ballynahinch than in Belfast. There will be more types of species and they will be more abundant because the environmental conditions will be less harsh - less pollution

How would the Simpsons Index differ for The Amazon Rain Forest and The Gobi Desert?

The Simpson's Index will be larger in the Desert than in the Rain Forest. There will be fewer types of species and they will be less abundant, because the environmental conditions will be harsher – few organisms are adapted to survive the lack of water and extreme temperature changes

Are these Gobi desert organisms less worthy of conservation?

Tip In the exam you could be asked to calculate Simpson's index. If so, the formula for Simpson's index, as presented above, will be provided within the question. (Note that some texts use derivations of the index above — as $1/D$ or $1 - D$. The index used here is the original equation as devised by Edward H. Simpson in 1949.) Worked examples of the use of Simpson's index to measure species diversity are provided on the biology microsite at www.ccea.org.uk.

To calculate Simpson's index for a particular area, the area must be sampled and the number of individuals of each species noted. For example, the diversity of the ground flora in a woodland might be determined by sampling with random quadrats. The number of plant species in each quadrat and the number of individuals of each species should be noted. There is no necessity to be able to identify all the species, provided that they can be distinguished from each other. Percentage cover could be used to determine plant abundance but there must be consistency, i.e. either all by 'number of individuals' or all by 'percentage cover'.