Bio Factsheet

Number 34

Species Diversity

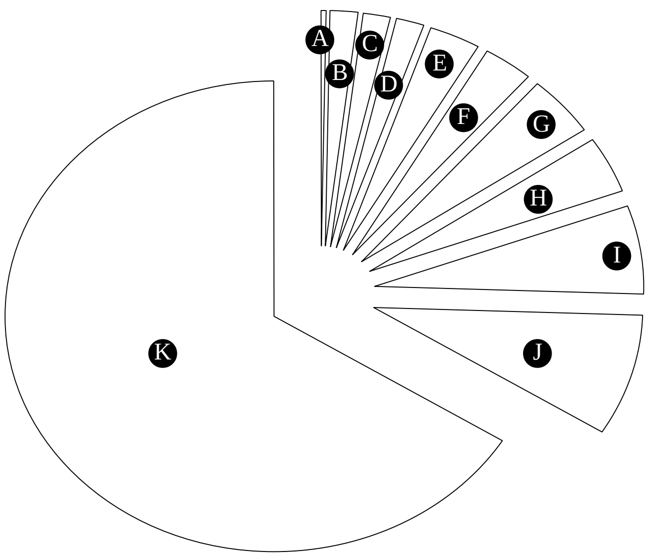
Species diversity is a very important ecological idea. It can be expressed mathematically and describes the number of individuals and the number of species in a community. It is estimated that there are 13-14 million different species on Earth. Humans have recorded about 2 million of these; in other words we simply know nothing about large parts of the animal and plant kingdom (Table 1). The ecosystems with greatest species diversity are tropical rainforests, coral reefs and large tropical lakes.

Table 1. Proportion of species discovered annually

Species	New species discovered annually (as a % of those already known)	Proportion of species described
Birds	0.8	High
Reptiles	1.17	High
Platyhelminthes	1.58	Moderate
Fungi	2.43	Very low

What seems more certain is that, in terms of number of species, insects rule the planet! (Fig 1).

Fig 1. Possible proportions of total species



KEY

A	Vertebrates 0.4%	F	Bacteria 3.0%
B	Algae 1.6%	G	Viruses 4.0%
C	Protozoans 1.6%	H	Nematodes 4.0%
D	Moluscs 1.6%	I	Arachnids 6.0%
E	Plants 3.0%	J	Fungi 8%
		K	Insects 65.0%

***Exam Hint** - As a general rule, the greater the species diversity in a particular ecosystem, the more stable it is.*

Measuring species diversity

The simplest way of measuring diversity is to count the number of different species. A garden on the outskirts of a small village might be visited by approximately thirty different species of birds; a city garden will probably have many fewer. So we can count the number of species present under standard conditions and produce a quantitative measure of diversity. There is a problem here, however. Look at the example in Table 1.

Table 1. Number of different species of plant found in two areas

Species	Total number of plants in	
	Quadrat **X**	Quadrat **Y**
A	95	18
B	2	23
C	1	27
D	3	14
E	1	20

This shows the plants found in two quadrats in some sand-dunes on the Welsh coast. There are five species in each but common sense suggests that the overall diversity is very different. Nearly all the plants in quadrat X belong to species A. In quadrat Y all five species are present in large numbers. Quadrat Y seems to have greater diversity than quadrat X. What we need is a way of calculating diversity which takes into consideration the number of individuals **as well** as the number of species. There are many different ways of doing this but one of the simplest is to calculate an index of diversity using the formula shown in Box 1 (overleaf).

Why is diversity important?

In order to interpret information about diversity we need to understand a very important principle. The distribution of living organisms is influenced by **abiotic** factors such as the amount of rainfall, soil pH, temperature and so on. The more extreme these abiotic conditions, the fewer the species that can survive and, therefore, the lower the diversity of organisms found there.

We will use this principle to compare the diversity of living organisms found in the Arctic with the diversity of those found in tropical rain forests. In the Arctic, over the long winter period, temperatures rarely rise above freezing and, as a consequence, water remains biologically unavailable, frozen solid as ice. The Arctic winter is not only cold but dark, for several months the sun barely shows above the horizon. These are clearly extremely harsh abiotic conditions. Not surprisingly, relatively few species are adapted to survive an arctic winter. Arctic ecosystems therefore tend to have low diversities.

However, within a tropical rain forest, there is water in abundance and temperatures are high throughout the year. Many organisms can survive in these conditions and the species diversity in such places can be very high.

Box 1. Calculating Diversity

Table 2 shows the number of plants of different species growing between the railway lines in a station.

Table 2.

Species	Number of plants of this species in study area
Dandelion	7
Oxford ragwort	28
Common sowthistle	1
Buddleia	2
Mugwort	5

The index of diversity (d) is calculated from the following formula

$$d = \frac{N(N-1)}{\Sigma n(n-1)}$$

where N = total number of organisms of all species & n = Total number of organisms of a particular species

$$d = \frac{43 \times 42}{(7 \times 6) + (28 \times 27) + (1 \times 0) + (2 \times 1) + (5 \times 4)}$$

$$d = \frac{1806}{42 + 756 + 0 + 2 + 20}$$

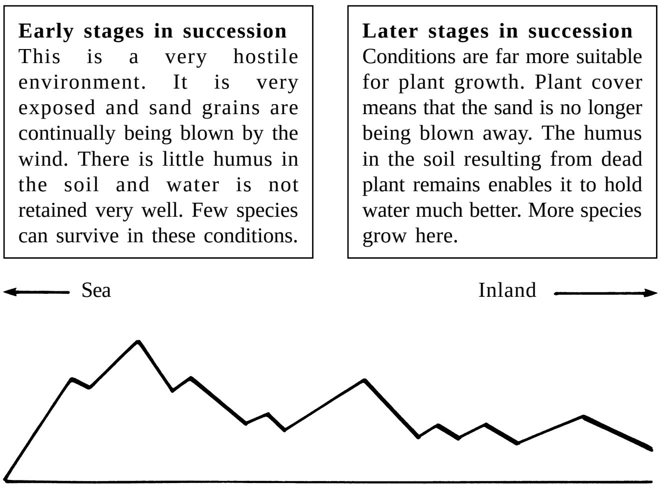
$$d = \frac{1806}{820} = 2.2$$

On its own, this figure of 2.2 tells you very little. It does, however allow you to compare the diversity of plants growing between the railway lines with the diversity of plants growing in other areas. In this particular case, the diversity was much lower than on a disused piece of rail track nearby.

Diversity and Succession

Succession is the ecological process in which the different species of organisms in a community are gradually replaced by others over a period of **time**. Sand dunes are found in many areas around the coast. Near the sea, abiotic conditions are harsh. The sand is blown by the wind and is unstable. It contains little humus and therefore dries out very rapidly. There are also low levels of soil nutrients such as nitrates. One of the few plants able to survive in these conditions is marram grass. In time, the roots of the marram grass bind the sand particles together, Plants die and decompose, increasing the humus in the soil. Marram grass can no longer survive and it is replaced by other species of plant. It is the basic principle that we applied earlier. As succession takes place, abiotic conditions become less severe. More species occur and there is a higher diversity. This is summarised in Fig 2.

Fig 2. Sand dune succession

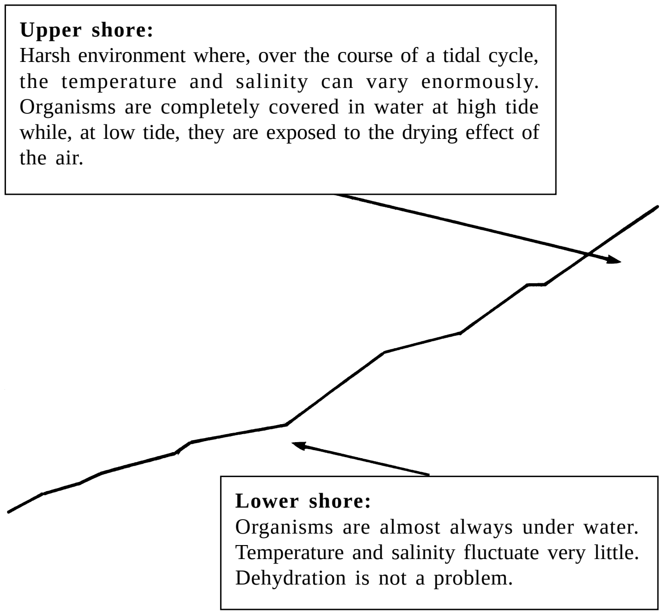


Result: Increasing diversity as succession progresses

Diversity and zonation

Abiotic conditions often vary within an ecosystem. Around the high tide level on a rocky seashore, for example, abiotic conditions are extreme. Organisms that live there must be able to withstand considerable fluctuations in temperature and salinity. On the lower shore, abiotic conditions show much less variation. Organisms are covered by sea water for much of the day. Temperature and salinity will vary little. Applying our general principle again, as we go down the shore, abiotic conditions become much less severe (Fig 3).

Fig 3. A rocky sea shore



Result: Many more species of marine organisms can live on the lower shore. Therefore diversity increases down the shore.

Diversity and Pollution

Human activity frequently leads to pollution of the environment. Pollution results in harsher environmental conditions, so the more pollution, the lower the diversity of organisms.

Biologists can make use of this idea to monitor pollution levels. A number of different indices of diversity have been designed to assess water quality. They take into account the fact that some groups of animals are much more sensitive to pollution than others. Each group that is present at a particular site is given a value, the values are added together and a figure is obtained which provides an idea of the amount of organic pollution at the site.

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