CHAPTER 2

BIODIVERSITY AND NATURE CONSERVATION

CHAPTER OUTLINE

2.1 WHAT IS BIODIVERSITY?

Biodiversity is a contraction of the term *biological diversity*, and refers to the **variety of life in all its forms, levels and combinations** (IUCN / UNEP / WWF, 1991) or to the **total variety of life on earth**. Although the word is quite new, the idea is not: to many people, there is little difference between biodiversity and wildlife. However, biodiversity refers to more than simply the total number of species of plants and animals, although this is how it is often used. Strictly speaking, biodiversity can be considered at three levels (figure 2.1).

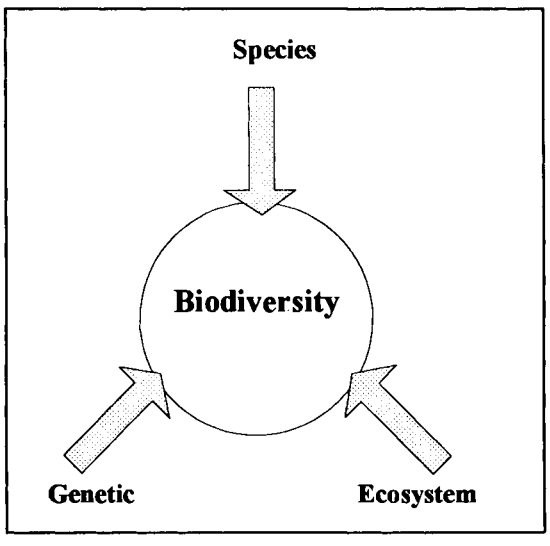

Figure 2.1. The three main levels or components of biodiversity.

Genetic diversity is a concept of the variability within a species, as measured by the variation in genes within a particular species, variety, subspecies or breed (McNeely, 1988). Each species of organism on the planet has, for instance, from 1000 to 400,000 or more genes, composed of deoxyribonucleic acid (DNA) and arranged in chromosomes in every single cell in the body of that organism. Genetic diversity is so great that no two individual organisms (apart from clones) have identical DNA, even if they are closely related. The DNA of distant relatives belonging to the same species is less similar than that of closer relatives of the same species, while different species have even less similar DNA. Some populations of a particular species have relatively uniform DNA, while others are more variable.

Species diversity is what most people think of when they think of biodiversity, and is the easiest level at which to appreciate the concept: the more species an area has, the higher its overall biodiversity (including genetic diversity) is likely to be. Strictly speaking, species diversity should not just measure species richness (i.e. how many species are present), but also evenness (i.e. how many of species X there are compared with species Y and Z). Conservationists seldom worry about evenness, and rely on species richness as one of the fundamental measures of how important an area is.

Ecosystem diversity relates to the diversity of the ecological complexes within which species occur. An area with several ecosystems is likely to be more species-diverse than an area with only one ecosystem.

2.2 GLOBAL SPECIES DIVERSITY

Since taxonomists first started describing and naming organisms scientifically about two hundred years ago, we have managed to name about 1.5 million species. Of these, about 250,000 are flowering plants, 750 are gymnosperms, 43,000 are vertebrates (mammals, birds, reptiles, amphibians and fish), 47,000 are fungi, 5,000 are bacteria, 27,000 are algae, 17,000 are bryophytes and the rest are invertebrates (WCMC, 1992).

This figure may sound impressive, but it probably only represents a very small proportion of the species that actually exist. Recent estimates (such as Erwin, 1982) suggest that there may be anything from 10 million to 100 million species, which means that we have only catalogued between 2% and 7% of all the world's species. Figure 2.2 gives a breakdown of the likely distribution of all these species amongst the major groups of plants and animals (WCMC, 1992). It helps explain why we have made such little progress in cataloguing species, because it reveals that most species are small and apparently insignificant. For example, the insects alone are thought to account for about two-thirds of all species (with one in every four species of organism being a beetle), whereas higher plants (including flowering plants and gymnosperms) account for only 2.4%, and all the vertebrates together only 0.4%.

Most species, therefore, hardly even enter our consciousness when we think of the plants and animals around us: even scientists and conservationists have tended to focus on higher plants and vertebrates and neglect the rest, if only because it has proved difficult to get funding for studies of less "glamorous" groups.

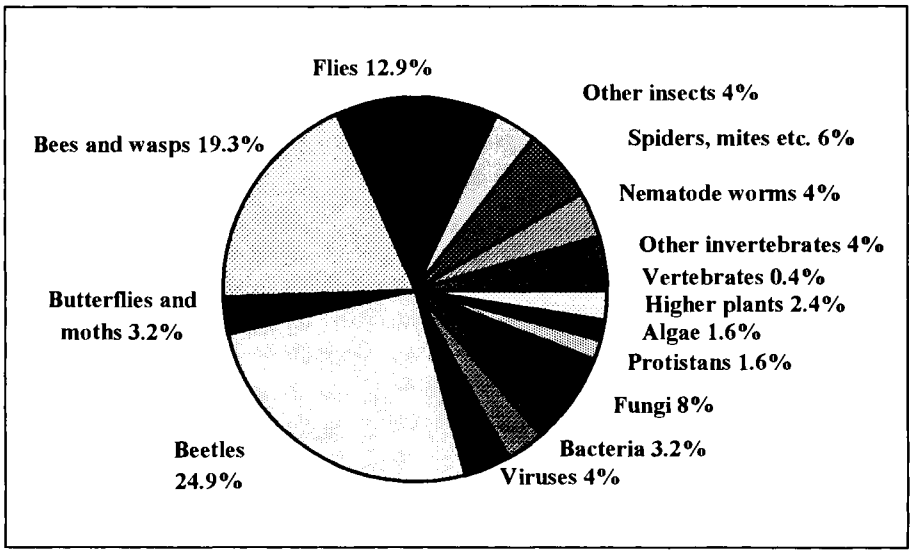

Figure 2.2. Global species diversity: probable breakdown by major groups. After WCMC (1992).

2.3 WHICH AREAS ARE MOST IMPORTANT FOR BIODIVERSITY CONSERVATION?

Species richness is not uniform across the planet: some areas are richer than others. Because conservationists are interested in conserving as many species as possible, some areas will be more important for conservation than others. Three main gradients of species richness exist (figure 2.3). Areas that, because of their location, are rich in species, are likely to be more important for conservation than areas that are poorer in species, although we should remember that even species-poor areas can support rare or unusual species.

2.3.1 Latitude

There is a very strong and clear gradient in species richness with latitude, which means that areas of the planet nearest to the equator are generally much more species-rich than areas towards the poles. This applies to nearly all groups of plants and animals, and is true of aquatic as well as terrestrial environments. The gradient is probably due to differences in the amount of the sun's energy reaching the earth's surface at different latitudes: fewer species can tolerate the increasingly cold or fluctuating climatic

conditions that are found as one moves away from the equator. Figures 2.4 and 2.5 illustrate this gradient for swallowtail butterflies and termites. Some further comparisons follow:

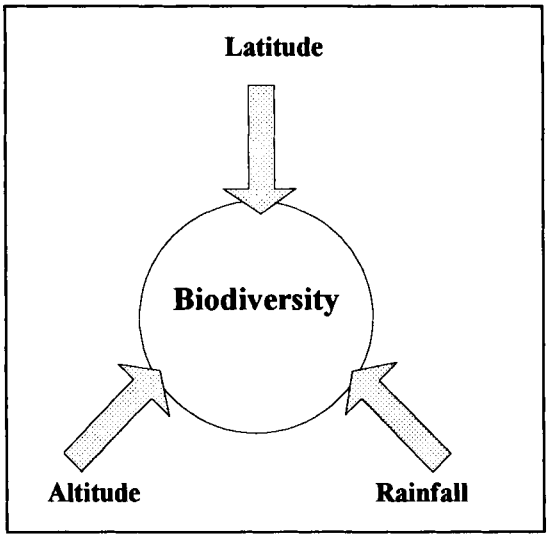

Figure 2.3. The three main factors contributing to geographical variation in the diversity of life.

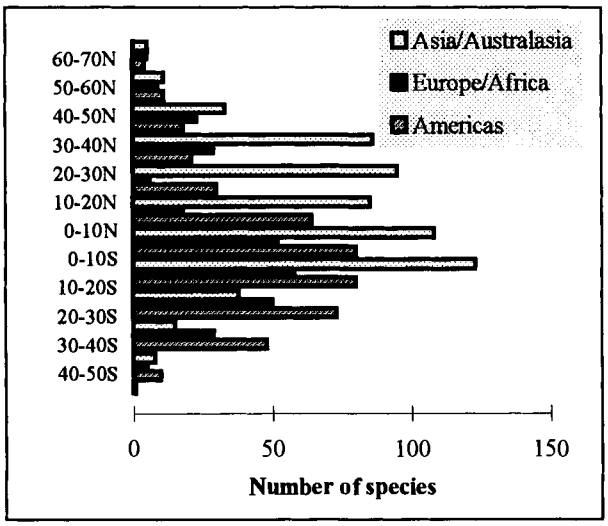

Figure 2.4. Variation in number of species of swallowtail butterflies with latitude. After Collins and Morris (1985).

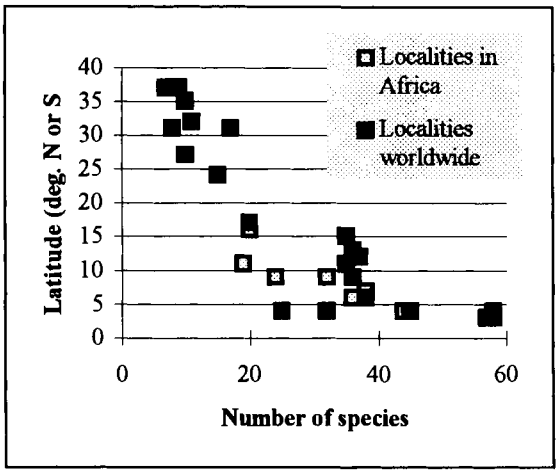

Figure 2.5. Variation in number of species of termites with latitude, from selected localities. After Lepage (1983) and Collins (1983).

- There can be as many or more tree species in a single hectare of tropical moist forest in Uganda (11 to 70 according to Howard, 1991) as there are in the whole of Britain.
- Budongo Forest alone supports about half as many plant species (866 according to Synnott, 1985) as the whole of Britain.
- Uganda has at least ten times as many butterfly species as the whole of Britain.
- Over 1000 bird species have been recorded from Uganda, almost twice as many as have been recorded from Britain, and nearly three times as many as have been recorded from Sweden.
- Lake Victoria contains almost as many species of fish (at least 177) as all the freshwater systems of Europe (192) (WCMC, 1992).

2.3.2 Altitude

Within any one region, there tend to be more species at low altitudes than at higher ones. This is probably a reflection of increasing cold or climatic extremes with altitude, to which relatively few species have managed to adapt. Figures 2.6 to 2.8 illustrate this relationship with data for trees and birds. Figure 2.7 is especially revealing in the context of Uganda, since it shows that, whereas over 70% of Uganda's trees can be found in forests at about 1000 m altitude, only about 10% of them can be found in forests at 3000 m altitude, and even fewer above this.

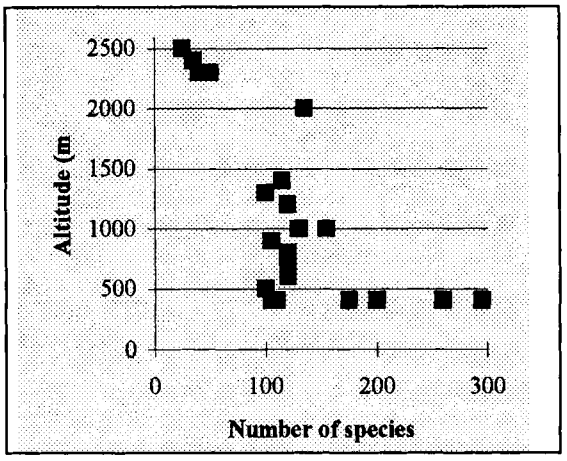

Figure 2.6. Variation in tree species richness with altitude from forest plots in central Africa, based on trees >20 cm dbh. After Pierlot (1966).

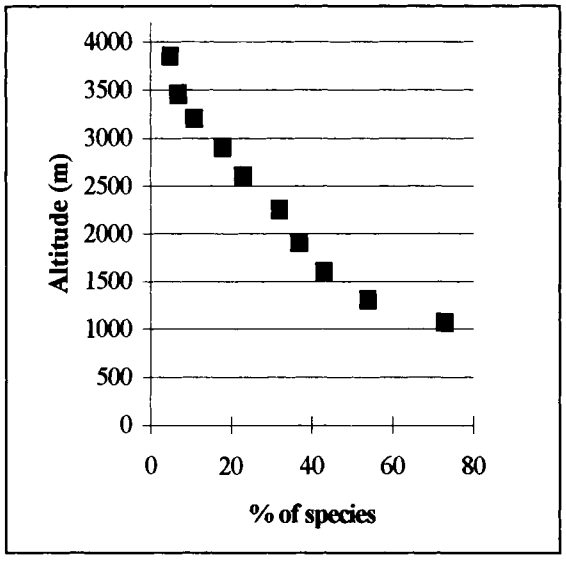

Figure 2.7. Proportion of forest tree species that occur at various altitudes in Uganda (based on a 35% sample of all known species). After Hamilton (1975).

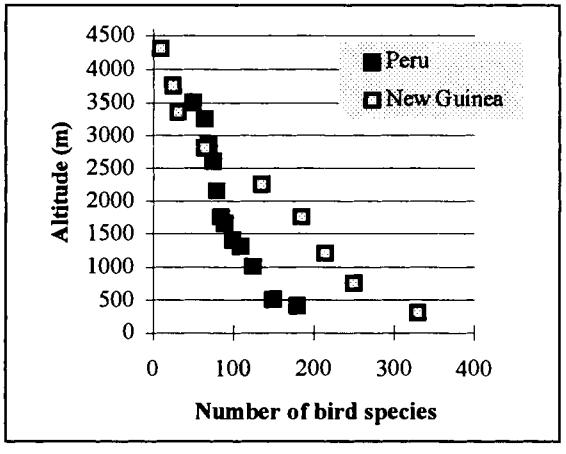

Figure 2.8. Variation in number of bird species with altitude. After Myers and Giller (1988).

2.3.3 Rainfall

For terrestrial environments, variation in rainfall produces a third gradient of species diversity: wetter areas tend to be more species-rich than drier areas. All organisms need water to survive, even if they do not have to actually drink water, and it seems that the wetter the climate, the more species can survive. This effect is illustrated for trees in Figure 2.9. A similar trend exists for birds in Africa, as shown by Pomeroy and Lewis (1987). They found that, for tropical Africa, moist areas or countries tend to support more bird species than dry areas or countries of a similar size; this effect was noticeable whatever size of area that was investigated. Thus Uganda, a moist country, has nearly twice as many bird species as the much drier countries of Senegal and Gambia have when considered together, even though they have almost the same surface area. Similarly, Uganda has very nearly as many bird species as its relatively dry neighbour, Kenya, even though Kenya's surface area is several times that of Uganda's.

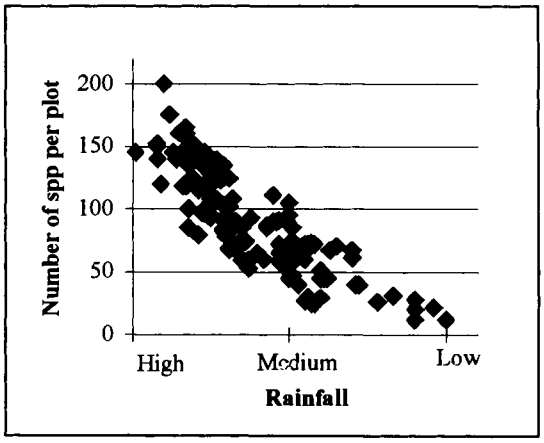

Figure 2.9. Variation in tree species richness with rainfall in Ghanaian forests. After Hall and Swaine (1976).

2.3.4 The most species-rich areas

Putting these three gradients together, we can see that the richest terrestrial ecosystems should be:

- in the lowlands
- near the equator
- in high rainfall areas

The ecosystem that dominates such areas is lowland equatorial rainforest, and numerous studies from Africa, Asia and Latin America confirm the richness of this ecosystem. For instance, the mostly forested South American country of Ecuador has only 3% the land area of

Europe, but may support 50% more plant species (Repetto and Gillis, 1988), and a study in Amazonian Peru produced 1200 species of beetle from the canopy of just nineteen trees of the same species (Erwin, 1982).

For reasons which are not entirely clear, and are anyway beyond the scope of this book, the equatorial and tropical rainforests of Latin America seem to be more species-rich than those of Asia, which are in turn richer than those of Africa, but even so, Africa's lowland equatorial and tropical rainforests are probably richer in species than any other ecosystems on the African continent. For each country in sub-Saharan Africa, Pomeroy (1993) has examined the data that exists on species richness amongst mammals, bird, fish, butterflies and flowering plants. On the basis of his analysis, he concludes that the most species-rich countries are Cameroon and Tanzania, closely followed by Uganda and Zaire, and then Kenya and Rwanda (Figure 2.10). He suggests that the main reason for this is that each of these countries is equatorial and contains at least some (in fact over 3000 km^2) tropical moist forest.

But we should remember that biodiversity also includes ecosystem diversity, and the more ecosystems there are in an area, the more species may be present there overall. Within Uganda's borders there is a wide range of ecosystems, ranging from moist forests at 600 m altitude, through medium-altitude moist and dry forests, swamps, woodlands, savannahs and semi-deserts, to high-altitude rainforests and moorland. This is one of the reasons why Uganda is thought to have one of the highest densities of species of any country in Africa. A further analysis reported by Pomeroy (1993), this time restricted to terrestrial birds, suggests that in Africa the area of maximum diversity is centred on central East Africa, and in particular in south-west Uganda (Figure 2.11). This is probably a reflection of the diversity of ecosystems that exist in this part of Africa, as well as the presence of tropical forest and many endemic species (see Chapter 4).

Some further examples of Uganda's relative species richness follow (from Stuart and Adams (1990) and McNeely et al. (1990)). Uganda is:

- The most species-rich country in Africa for mammals given its area, and the second-most species-rich regardless of area (only Zaire has more).
- The most species-rich country in Africa for birds given its area, and the third-most species-rich regardless of area (after Zaire and Kenya).
- The fifth-most species-rich country in Africa for swallowtail butterflies regardless of area (after Zaire, Cameroon, Congo and Tanzania).
- The tenth-most species-rich country in Africa for reptiles regardless of area.
- The tenth-most species-rich country in Africa for flowering plants regardless of area.
- The thirteenth-most species-rich country in the world for primates regardless of area.

So it is clear that, for its area, Uganda is particularly rich in species. This is one of the main reasons why international attention is being focused on conservation in Uganda, and why the conservation of Uganda's tropical forests in particular is seen as such a high global priority.

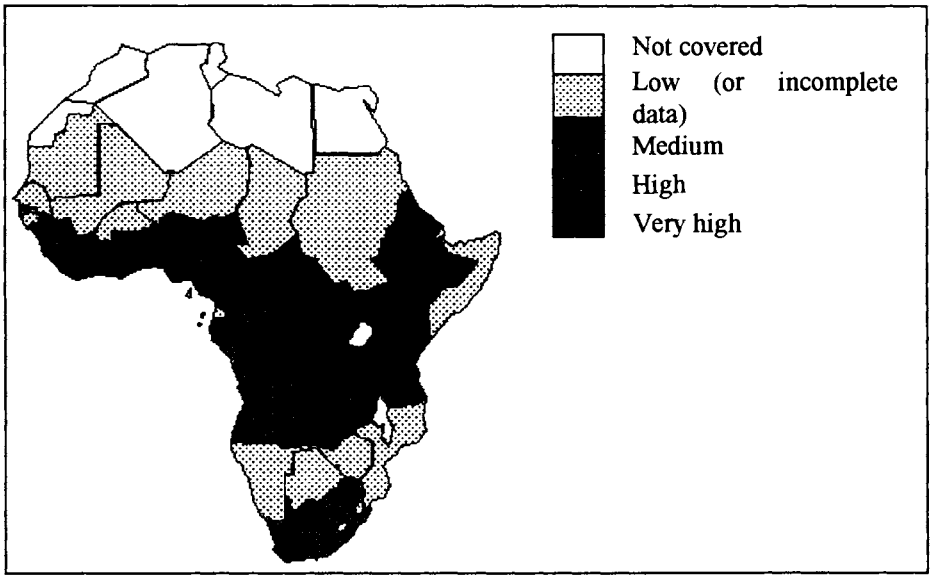

Figure 2.10. Relative species richness for mainland countries in the Afrotropical region. Countries are ranked based on numbers of mammals, birds, fish, butterflies and flowering plants recorded from each. Redrawn from Pomeroy (1993).

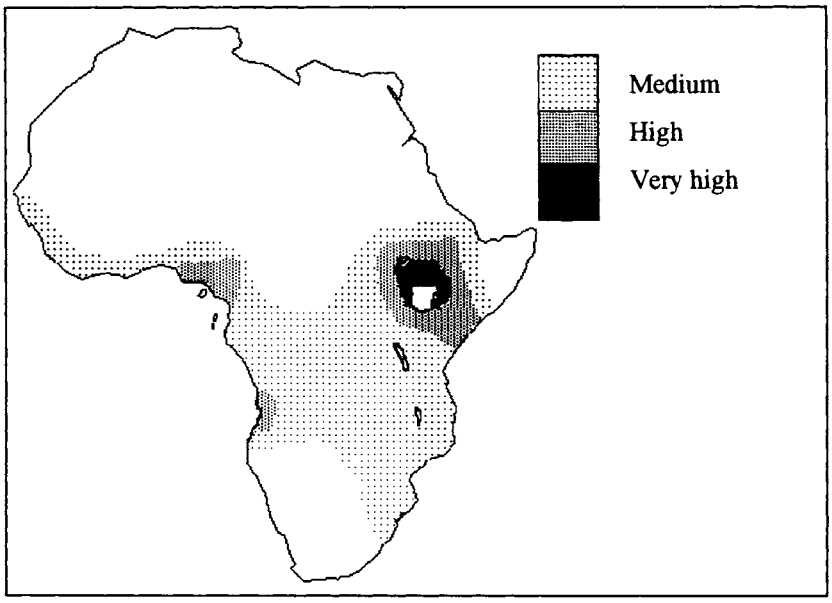

Figure 2.11. Geographical variation in African land-bird species-richness (adapted from Pomeroy (1993)).

2.4 SUMMARY

- The term "biodiversity" embraces the degree of nature's variety.
- Biodiversity levels vary from place to place.
- The wet, equatorial lowlands are the most species-rich, supporting tropical rainforest.
- Biodiversity levels in Uganda are probably the highest in Africa, bearing in mind the size of the country, because it has a wide range of climates from wet to dry, of altitudes from low to high, and yet it straddles the equator where biodiversity levels are naturally highest.

2.5 FURTHER READING

Pomeroy, D.E. 1993. Centers of high biodiversity in Africa. *Conservation Biology*, Vol. 7(4). 901-907.

Stuart, S.N. and Adams, R.J. 1990. *Biodiversity in sub-Saharan Africa and its Islands.* IUCN, Gland.

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Wilson, E.O. 1988. *Biodiversity.* National Academy Press, Washington D.C.