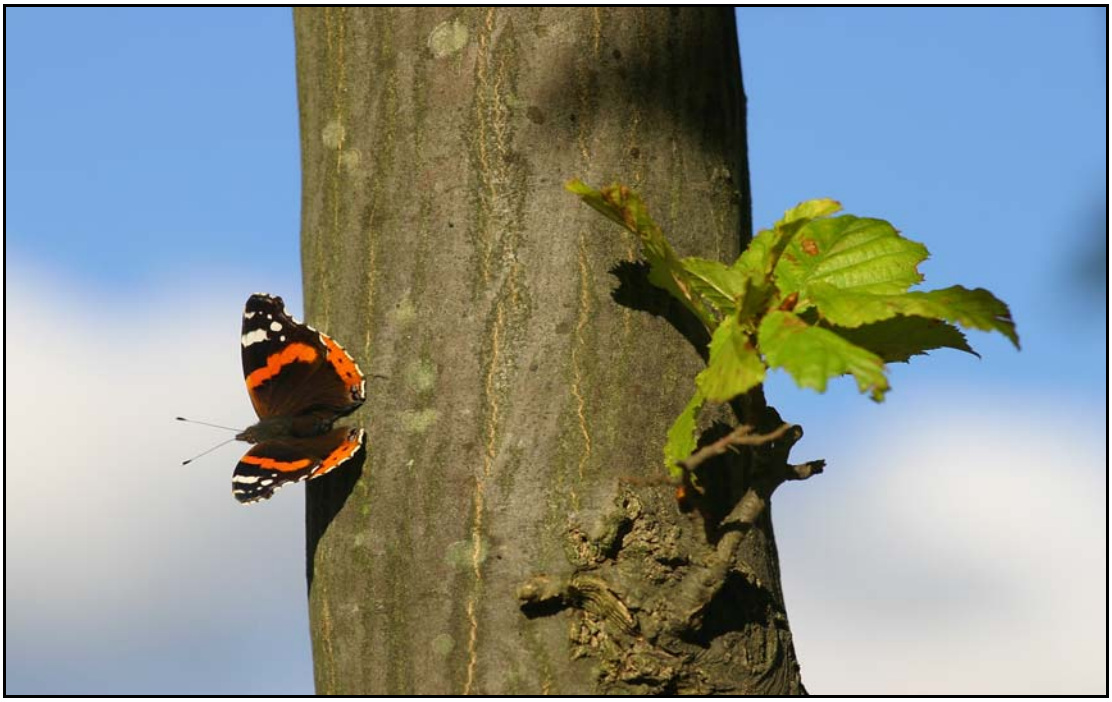
Plants and climate change: which future?

Chapter 4: Plant community interactions

Chapter summary

It is clear that different plant species will respond differently to climate change. Some species will stay in place but adapt to new climatic conditions through selection or plasticity. Other species will move to higher latitudes or altitudes. Some species may become extinct. Because of this, plant community composition will be reorganised, new communities will emerge and others will be lost. One of the biggest concerns of this community reshuffling is the disruption of food webs and co-evolved mutualisms, such as the relationships between a plant and its pollinator or seed disperser. If species that rely on each other no longer co-occur in the same time or space, both may be driven to extinction. Diseases, pests, and invasive species may spread into new ranges putting more pressure on fragile communities. Maintaining biodiverse communities will become an even greater conservation priority.



Key points of this chapter:

- Plant species are reacting differently to changing environmental conditions. We can therefore expect climate change to induce a reassortment of species within plant communities. The consequences of these changes are largely unknown, but are likely to be significant.

- Disruption in the synchrony between plants and pollinators is already affecting food security, nutrition and agriculture, as well resulting in a decline of the numbers of pollinators themselves.

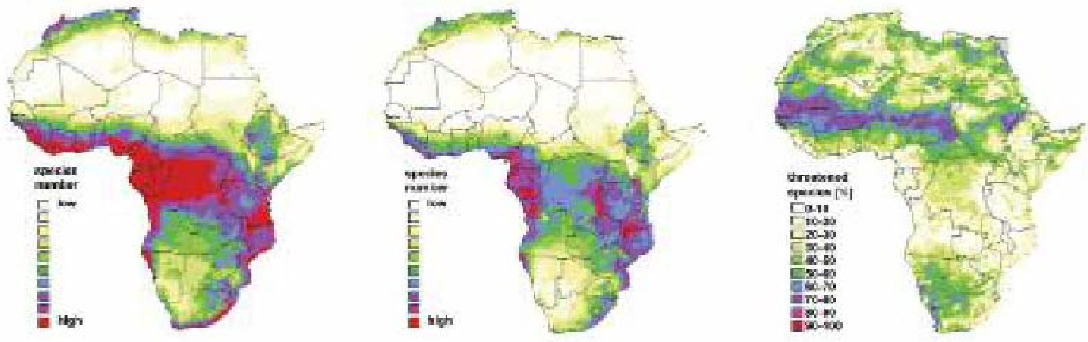
- Bluebells, an emblematic spring flower in the UK, are facing increasing competition from other common wild plants, as warmer springs encourage the earlier growth of these species.

- Globally, the cost of damage caused by invasive species has been estimated to be US$1 trillion per year; close to 5% of global GDP. Climate change is likely to exacerbate the problem as ‘weedy’ species increase and threaten the survival of native species.

- Many food chains are dependant on synchrony between species along the chain. Early bud burst for example can deprive caterpillars of their preferred food and lack of caterpillars will have a consequent impact on the food supply for bird species.

Case studies from this chapter:

Case study 4.1 - Climate change: predicted decrease in plants species diversity in Africa by the year 2100



recent plant diversity | **predicted plant diversity by the year 2100** | **proportion of threatened species per area**

Conclusions

- the geographic ranges of 90% of all species may decrease in average to about 50% of their recent range;
- some areas may lose up to 80% of all species, in particular in the Sahel region;
- up to 25% of all species may go extinct by the effects of climate change (Sommer *et al*., 2006).

Case study 4.2 – Competition and the bluebell (*Hyacinthoides non-scripta*)

The bluebell is a bulbous spring flowering plant that is popularly thought of as Britain's national flower. Its fragrant bell-shaped flowers stand upright when they are in bud, but hang downwards when fully open.

When growing en masse in woodlands they create a beautiful haze of blue colour. Although the bluebell is widespread in Britain, it is globally threatened, and British populations represent 25-49% of the world's total.

During periods of cold weather, spring flowers such as bluebells have already started the process of growth by preparing leaves and flowers in underground bulbs in summer and autumn. They are then able to grow in the cold of winter or early spring by using these resources stored in their bulb. Other species - such as cow parsley (*Anthriscus sylvestris)* or dandelions (*Taraxacum officinale*) are more temperature dependent, and require warm weather before they are able to germinate and grow. With the warmer springs induced by climate change, bluebells will lose their 'early start' advantage, and be outcompeted by temperature sensitive plants that start growing earlier than in the past (Botanic Gardens Consaervation International (BGCI, no date).

To exacerbate the problem for *Hyacinthoides non-scripta,* the Spanish bluebell *Hyacinthoides hispanica* is more vigorous than the native species and proving able to outcompete the native species. *H.hispanica* also readily crosses with *H.non-scripta,* producing a fully fertile hybrid; *H.hispanica x non-scripta,* further threatening the genetic integrity of the indigenous species (Pilgrim & Hutchinson, 2004).

Case study 4.3 – Proteaceae and sugarbirds

Two Sugarbird species in South Africa are highly dependent on Proteaceae flowers, and leave their territories only during the dry season when flowers are absent. Their entire life cycles are adapted to those of the plants. Species within the Proteaceae family however, are predicted to face range contradictions and extinctions and be especially vulnerable to aspects of climate change such as increased fire frequency. In turn, sugarbirds are important pollinators of proteoids. If the birds' own temperature tolerances force them away from the flowers the plant-pollinator link may be broken. In this way, both sugarbird populations are detrimentally affected but plant populations will also likely reduce (Simmons *et al.,* 2004).

Case study 4.4 – Pests and pathogens

This is an area of uncertainties, reliant on several limiting factors (Garret *et al.*, 2006).

For aphids, one of the most important natural controls is raindrops, which dislodge the aphids or damage their feeding parts. It is not known whether lower summer rainfall will reduce this control mechanism or whether less frequent but heavier rainfalls will increase it (Bisgrove &Hadley, 2002).

One experimental study on the long-term effects of elevated CO_2 on the evolution of the pathogen fungus *Colletotrichum gloeosporioides* on *Stylosanthes* spp. demonstrated that host resistance under elevated CO_2 was linked to pathogen aggressiveness (Chakraborty *et al.*, 2002).

Outside of the laboratory, the effects of climate change on crop pests are already being felt in some areas. Reduced incidence of frosts led to an increase in the tropical grass webworm in New Zealand causing severe damage to pasture grasses. Citrus canker, a highly contagious bacterial disease favouring heat and heavy rain has spread by hurricane to citrus crops throughout Florida in the USA and bean leaf beetle, which affects soybean crops by spreading bean pod mottle virus have migrated from the southern USA to the central and northern Midwest (UNEP, 2006).

Case study 4.5 – Invasive species

The water hyacinth (*Eichhornia crassipes*) originates from the Amazon but now threatens native biodiversity globally. Its growth rate is among the highest of any plant known; the species is able to double its mass in 12 days and can grow faster than it can be cleared. These species form dense mats that cover thousands of hectares, preventing sunlight and water from getting into the water and choking out other species. This results in a loss of livelihood (fishing), decrease in available water and even a threat to power generation. The Akosombo Dam in Ghana is under serious threat from the water hyacinth (Sarpong, 2004).

The water fern *Azolla* spp. is an invasive plant species, widely introduced globally via ship's ballasts, for example in the Caspian sea (Global Invasive Species Database, 2005). The species provides a haven for mosquito larvae in Africa.

Acacia nilotica has been declared a weed of national significance in Australia. Though introduced to provide shade for sheep it causes significant damage to cattle production by reducing pasture production. In terms of the environment, the species increases soil erosion and water loss through transpiration. *A.nilotica* has vast potential distribution and actively expands its range. Climate change will likely increase areas at risk of invasion (Kriticos *et al*., 2003).

Case study 4.6 – Disturbance in Africa

Africa, like other continents though perhaps to a greater degree, is characterised by ecosystem control through disturbance, such as fire and grazing regimes. Changing disturbance regimes will interact with climate change in important ways to control biodiversity, for instance through rapid, discontinuous ecosystem ‘switches.’

For example, changes in the grazing and fire regime during the past century are thought to have increased woody-plant density over large parts of southern Africa. Fire-maintained ecosystems, often C4 grasslands, regenerate from fire quickly. After a fire, there are high levels of light, nutrients and water – it is CO_2 that is the limiting factor for woody plant growth. Under elevated CO_2 tree density may increase in savannas – and yet, in South Africa savannah ecosystems host the most species richness and endemic species (Bond *et al.,* 2003).

Ecosystem switches are accompanied by species shifts and even species extinction. Even subtle changes in species composition of rich ecosystems such as forests will impact biodiversity resources. Although much larger scale ecosystem switches, such as forest to savannah or shrubland to grassland, clearly occurred in the past, the geographical range shifts required to preserve biodiversity into the future will be strongly constrained by habitat fragmentation (IPCC, 2001b).