Chapter 4 Vegetation types

The previous chapter considered vegetation structure and the processes which influence it in a general sense. However, grasslands and heathlands are primarily managed vegetation types, and need to be considered in the light of their management. The present chapter describes their history, distribution and their species' ecological attributes most likely to be influenced by climate change. In this chapter, forests are also mentioned briefly since they display some important and different relations between vegetation structure and climate.

4.1 Grasslands

4.1.1 Introduction

Prehistoric pollen and plant remains confirm that grassland was rare in the UK before civilisation. Neolithic and Bronze age men created much of the chalk downland, as well as grasslands at previously wooded altitudes. By Domesday (ca. 1086 A.D.), as well as downlands, pasture was scattered in greens, commons, and fields throughout the country (Rackham, 1986). However, in recent years the amount has declined. Fuller (1987) stated that the total area of lowland grassland in England and Wales had fallen from 7.8 M. ha. 50 years ago to just 4.8 M. ha. Of this, only 11% was semi-natural and rough grasslands as a result of drainage, ploughing and the use of inorganic fertilisers.

Three main types of grassland are distinguished according to soil type. 1) Calcareous grasslands (on soil of pH 5.5-8.4, high in available Ca^{2+} (300-1000 mg Ca/100 mg) and free $CaCO_3$ (30-75%), dry and porous) including those on Jurassic, Carboniferous, Magnesian and Devonian limestone as well as chalk. 2) Neutral grasslands (intermediate pH) which are further classified according to water regime, management, soil factors and geographical location. They include the washlands, alluvial meadows, flood-meadows, water meadows, ridge and furrow and dales hay meadows. 3) Acidic grasslands (on soil of pH 3.5-6 over hard rock or sandy geology) including a range of upland and lowland Festuca-Agrostis communities (Duffey et al., 1974; Wells, 1983). Calcareous grasslands are discussed in detail here.

4.1.2 Calcareous grasslands

a) Nature and extent

Originating on dry, basic soils in the hilly regions of north west Europe, calcareous grasslands were once widespread throughout this region. Primeval woodland clearance and arable cultivation was followed by centuries of grazing by domestic livestock which led to the establishment of very species-rich swards. However, with the advent of fertilisers they lost their agricultural significance and have now largely disappeared. A survey of chalk grassland by Blackwood and Tubbs (1971) revealed that only 3% (43,564 ha.) of the chalkland was covered by permanent grassland. Remaining areas were small and isolated from each other. Large areas of a habitat support more species and are less fragile and isolation lowers a site's potential for recovery. Fragmentation poses a serious threat to British calcareous grasslands (Keymer & Leach, 1990). The remaining areas include nature reserves and support ca. 750 plant species (including ca. 200 species of bryophytes and lichens) and a very species-rich invertebrate fauna.

b) Ecology

i) Flora

Rorison (1990) states that soil calcium carbonate affects pH and thereby nutrient availability and that this coupled with soil texture, topography, and regional or local climatic variations influences species composition. Floristic patterns relate to a general tendency for chalk soils in the South East to be warm and dry and those on the limestones of the north and west to be cool and wet (Rodwell, 1990). Due to chemical similarities between calcareous soils, certain species occur repeatedly in different grasslands with a constancy of over 80%, e.g. Briza media, Festuca ovina (sheep's fescue), F. rubra (red fescue), Carex flacca (glaucous sedge), Lotus corniculatus (bird's foot trefoil), Plantago lanceolata (ribwort plantain), Sanguisorba minor (salad burnet) and Thymus drucei (wild thyme) (Wells, 1983).

ii) Invertebrate fauna

The number of invertebrates resident in a calcareous grassland varies according to such factors as geographical location, management history, and vegetation structure. The nature of management (its timing and

intensity) whether grazing, cutting or burning changes the condition of the grassland and thereby influences the composition of the fauna (Morris, 1990; Jones-Walters, 1990).

Most species are relatively sedentary and have annual life cycles so the differing requirements of each stage of their life history must be satisfied each year if they are to persist at a site. Some plant species support a rich assemblage of phytophagous insects each of which may in turn be the target of predators and parasitoids. The condition and structure of the sward is of major importance for many invertebrates. For a good representation of the calcareous grassland insect fauna, it is necessary to maintain a range of turf heights. The reduction of sheep and cattle grazing and the effects of myxomatosis has led to greater decline of invertebrates dependent on short turf than of longer grassland specialists.

4.2 Heathlands

Heathland vegetation is composed of ericoid plants, i.e. dwarf woody plants which are many branched, evergreen and sclerophyllous (i.e. adapted to dry conditions). The presence of resins and oils renders the vegetation highly inflammable at certain times of year. These plants require cool temperatures and fairly high humidity and grow on free-draining, nutrient-poor and acidic soils (pH 3.5-6.7). Frequently, they represent a stage of vegetation succession and therefore some factor, whether climatic, edaphic, biotic or anthropogenic, must be present to restrict the invasion of scrub and trees (Beijerinck, 1940).

4.2.1 Nature

In Britain, the distinction is made between moorland and heathland reflecting the division between the uplands and lowlands, between north and south and between the wetter, organic, peaty soils and the drier, sandy, acidic soils. Heathlands are clearly the product of human activities (as shown by pollen records, Godwin, 1944a, b) and need to be managed since if neglected they turn to woodland. Moorland is not so evidently an artefact and is more stable (Rackham, 1986). Here, discussion is mainly confined to the 'lowland heathlands', areas of ericaceous dwarf-shrubs growing at low altitudes below 250 m (800 ft.) in acidic, nutrient-poor, mineral soils.

4.2.2 Extent

Not only has there been an overall decrease in the area of heathlands, but considerable fragmentation has occurred through reclamation for farming, forestry, urban development, mineral extraction, military training and public recreation (Moore, 1962). In the mid-18th century, the Dorset heathlands were formed from eight large blocks separated only by the river valleys (Webb & Haskins, 1980). Moore (1962) showed that by 1960 these heathlands had become fragmented into over 100 pieces. In 1978, Webb and Haskins estimated there to be almost 800 separate pieces of heathland in Dorset.

4.2.3 The flora

The composition of heathlands varies across Britain according to altitude, climate and soil. Local variation depends mainly on the soil moisture conditions and therefore topography. Where soils are free-draining and the water table remains well below the surface at all times, dry heath vegetation develops. Where drainage is impeded, and the water table is near the surface, wet or mesophilous heath develops. Humid heath is an intermediate form.

a) Dominant plant species

Calluna vulgaris is the most widespread member of the Ericaceae and its growth in a variety of locations from sea-level to an altitude of 1040 m (Gimingham, 1960) is associated with ecotypic differentiation (Grant & Hunter, 1962). Calluna sheds very large numbers of seeds in the autumn mainly dispersed by wind (Gimingham, 1960). Their germination rate is best when subjected to fluctuating temperatures in the range 17-25 ^{o}C and is greater on wet soil and peat than on either dry soil or humus (Bannister, 1964). Ungerminated seed forms a seed-bank which may persist for up to 40 years (Gimingham, 1972). Erica cinerea (Bell heather) is generally confined to the driest parts of the heathland because germination and establishment of seedlings is poor in waterlogged or peaty soils. Erica tetralix (Cross-leaved heath) has a higher germination rate than bell heather, but on dry soils germination and establishment are poor. Hence, cross-leaved heath is confined to the wetter soils, where it competes successfully against Calluna.

b) Dry heath

Heathlands have a very species poor flora. Dry heath is the poorest, but as we pass along the gradient of increasing soil wetness, through humid and wet heath to valley mire, botanical richness increases. Besides Calluna and bell heather, bracken and a species of dwarf gorse, the only plants to occur commonly on dry heath are Potentilla erecta (tormentil), Polygala serpyllifolia (heath milkwort), Galium saxatile (heath bedstraw), Hypericum pulchrum (slender St. John's-wort) and Rumex acetosella (sheep's sorrel). The most abundant grasses are Festuca ovina (sheep's fescue), Deschampsia flexuosa (wavy hair grass) and Agrostis curtisii (bristle bent).

c) Wet heath

The humid and wet heaths are much richer in plants than dry heath. In these areas, cross-leaved heath grows with Calluna. Molinia caerulea (purple moor grass) is characteristic of the humid and wet heaths, as are Drosera spp. (sundews) and Narthecium ossifragum (bog asphodel). These areas have many more species of rushes, sedges and similar species, such as Juncus acutiflorus, J. squarrosus and J. bulbosus, Scirpus cespitosum (deer grass) and Eriophorum augustifolium (cotton grass).

4.2.4 Vegetation dynamics

There is a process of natural change which occurs in heathland vegetation and this is checked or modified by factors such as grazing or burning. Plants grow from seedlings, become larger and more woody, occupy more space and show changes in aerial structure. Throughout their life-cycles, they vary in the amount of green matter and litter they produce, and the quantity of nutrients they take up and release. Changes in the spaces between plants as they grow and die determine which other species colonize these patches. Vegetational changes are of two types. Successional changes occur as one vegetation type is gradually replaced by another and proceeds towards a stable climax, whereas cyclical changes are a repeating pattern which occurs in the vegetation.

Cyclical changes

Four distinct growth phases were described by Barclay-Estrup and Gimingham (1969). Calluna vulgaris was dominant in all the age classes represented but changes in biomass and shoot production occur (Barclay-Estrup, 1970) : in the 'pioneer' phase, its cover was 4%, in the 'building'

phase 22%, in the 'mature' phase 42% and in the 'degenerate' phase 3%. Litter production by Calluna was 0.5 g per plant in the pioneer phase, 0.6 g in the building phase, 12.1 g in the mature phase and 8.4 g in the degenerate phase (Cormack & Gimingham, 1964).

In the pioneer phase, lasting for about 3 to 6 years, Calluna cover is small and other species of vascular plants reach their greatest abundance. In the building phase, from 7 to 13 years of age, Calluna growth is at a maximum and it excludes all other species. By the mature phase, from 12 to 28 years, bryophytes colonise the soil surface, but Calluna remains dominant and reaches its maximum biomass. Bryophytes reach their maximum abundance in the degenerate phase, from 16 to 29 or more years, and as the canopy becomes more open, other species of vascular plants and Calluna seedlings are able to establish. In old, unmanaged heathland, where succession is checked, a mixed age structure develops, and plants representing all phases are distributed throughout the vegetation. By contrast, fire creates large, homogeneous areas of vegetation, where all the plants belong to one of the phases and have the same age and structure.

4.2.5 The fauna

a) Invertebrates

About 40 insect species depend on Calluna for food but the diversity of the herbivore fauna in a heathland plant community varies with the age, nutrient content and structural diversity of the plants. There are two groups of invertebrates associated with heathland. First, there are the phytophagous species that feed on Calluna, Erica spp., gorse, broom, bracken, and other characteristic heathland plants whose distribution is determined by the distribution of their food plants. Secondly, there are species whose distribution is determined by their requirement for particular physical conditions which are only available on heathland, such as sandy soil for burrowing, hot open spaces or the structural diversity of the much-branched canopy of dwarf-shrubs.

Webb and Hopkins (Webb, 1983; Webb & Hopkins, 1984; Hopkins & Webb, 1984), surveyed the invertebrate fauna of 22 of the Dorset heathlands ranging in area from 0.1 to 500 ha and different distances from each other. They found, surprisingly, that the smallest and most isolated species of heathland had the largest number of species largely because many of the species did not originate from heathlands but from surrounding habitats (Webb et al., 1984). Several other surveys have been conducted on heathland arthropods (e.g. Barclay-Estrup, 1974) with

detailed studies of ants (Brian, 1964), spiders (Merrett, 1976) and the soil fauna (Chapman & Webb, 1978). Two points emerge. First, although there are species which can be considered as heathland-dwelling, many can also be found elsewhere or are associated with plants not necessarily confined to heathland. Secondly, the succession in the plant communities influences the distribution of many invertebrate species largely through changes in vegetation structure, which in turn affects the microclimate near the ground and in the vegetation canopy.

b) Vertebrates

The small mammals (McLean, 1990) and birds (Morris & Duffey, 1974) of calcareous grasslands are ubiquitous species in Britain, and none are confined to these habitats. By contrast, four of the rarest vertebrates in Britain, two reptiles (sand lizard, Lacerta agilis and smooth snake, Coronella austriaca) one amphibian (natterjack toad, Bufo calamita) and one bird species (Dartford warbler, Sylvia undata), are more or less dependent on heathland. Because they are at the forefront of conservation issues concerning this community detailed description of the sand lizard, the smooth snake and the Dartford warbler is reserved until the last chapter. In fact, the publicity that tends to surround them tends to eclipse the fact that vertebrates in general are not particularly common, and few are dependent upon heathland.

4.3 Forests

Prehistoric and early historic forest clearance in Britain was probably much more extensive than was once thought, and by Norman times perhaps only 15% of the land was under trees (Rackham, 1986). Since native forest once covered nearly all of Britain, a very large proportion of our flora and fauna are woodland species. Many of the larger species of mammals and birds of prey have long disappeared with the fragmentation of the forest. Those species that remain are now threatened by the conversion of the native tree cover to exotic conifers, which develop quite different habitats unable to support the same species (Green, 1985).

4.3.1 Trees

Trees vary greatly in shape, size and many attributes, but all are large woody plants with a comparatively long life-span. Their woody nature enables them to grow far higher than herbaceous forms, allowing

their leaves to receive more light than the shorter plants beneath them, effectively displaying flowers to pollinating animals or the wind, and increasing the distance over which the seeds can be shed. As it grows older, the form and physiology of a tree must allow it to grow under the changing conditions of life associated first with the ground layer, then the shrub layer, and finally the tree canopy. The size, form and longevity of a tree all influence the development of the community to which it belongs, as do the shade which it casts, the plant litter which it produces, and its ability to resist disease, water loss and fire (Packham & Harding, 1982).

4.3.2 Evergreen and deciduous forests

Almost all conifers and some angiosperm trees are 'evergreen', their leaves lasting for several seasons so that the tree canopy casts a heavy shade throughout the year. Beneath 'deciduous' trees, however, a far higher proportion of the available light reaches the forest floor in winter than in summer. The structure and chemical nature of leaves influence woodland processes. The needles of conifer trees, which often take several years to decay, form a thick litter which impedes the growth of herbs and the development of tree seedlings. In contrast, the litter of broad-leaved trees is incorporated into the soil within a few weeks.

4.3.3 The flora

The aerial parts of trees tower above the shrubs, herbs and bryophytes which form the other three layers or strata commonly present in temperate woodlands. The development of the understorey is greatly influenced by the species, size and spacing of the trees present. There is normally a mosaic on the forest floor reflecting variations in humus and nutrient contents, pH, soil moisture, soil aeration, and available light (Packham & Harding, 1982). The litter on the forest floor affects the humus type and mineral nutrient status of the soil, while its physical presence often influences species differentially. It is often distributed very unevenly accumulating in hollows and being trapped by robust ground-flora species.

4.3.4 The fauna

a) Vertebrates

Since most of Britain was formerly covered with woodland, many of the indigenous animals are species of woodland habitats. Certain mammals can cause serious damage to woodland herbs, shrubs and trees, by eating

foliage, severing roots, stripping bark, and trampling or even felling whole plants. They also play a role in woodland regeneration, as feeders on fruits, seeds and seedlings. Many kinds of deer and other large herbivores rely on woody browse during the winter and may seriously damage preferred tree species. Red deer (Cervus elaphus) and roe deer (Capreolus capreolus) still occur in some well wooded areas and fallow deer (Dama dama), probably introduced in Roman times, and the more recently introduced Sika deer (Cervus nippon) and Muntjac (Muntiacus reevsii) are also widespread, but locally, distributed in woods (Green, 1985).

b) Invertebrates

Many insects and other invertebrates are woodland species and some are confined to them, e.g. the purple emperor butterfly (Apatura iris) whose caterpillars feed on sallow. Herbivorous species include foliage-feeders, gall-formers and sap-suckers and some are serious pests to commercial forestry. Invertebrates are largely responsible with the fungi for the breakdown of leaves, wood and other organic matter in woods and the recycling of its nutrients. In woodland soils, earthworm species are enormously abundant and form a staple item in the diet of many animals including badgers (Meles meles) and moles (Talpa europaea) (Green, 1985).

4.3.5 Coppiced woodlands

Coppicing formerly produced a regular supply of small wood for firewood, charcoal, hurdles, fencing etc. but ceased in most British woodlands after the Second World War. Trees such as hazel and sweet chestnut will send out a mass of shoots from the stump (or 'stool') if first cut when young, and will continue to do so for many hundreds of years on rotations of 10-25 years. Unlike most woodland management practices, coppicing actively encourages variety and has been revived in many woodland nature reserves. Different stages of a coppicing cycle provide a wide variety of structural and climatic condition and an old coppiced woodland may contain more than 300 herb species and a rich insect and bird fauna (Packham & Harding, 1982).

a) The flora

Increases in the amount of light reaching the ground layer after cutting the coppice enables many established herbs to grow more vigorously and other species to establish. Coppicing encourages the exuberant spring flowering of vernal species such as primrose (Primula

vulgaris) and wood anenome (Anenome nemorosa), while later in the year violets (Viola riviniana), red campion (Silene dioica), yellow archangel (Lamiastrum galeobdolon), foxglove (Digitalis purpurea) and rose-bay willow herb (Epilobium hirsutum) may flourish.

b) The fauna

Sunny glades and woodland edges are frequented by numerous species of butterfly, including the rare heath fritillary (Melitaea athalia) which now occurs in less than a dozen sites in Britain. Its larval food plant, common cow-wheat (Melampryum pratense), tends to die out as the canopy closes. Other insects are attracted to small, sheltered clearings, and in general the habitat diversity associated with coppicing supports a corresponding diversity of insects. Clearings with insects in turn attract certain birds such as grasshopper warblers (Locustella naevia), nightjars (Caprimulgus europaeus) and tree pipits (Anthus trivialis), while other species may be favoured by cover for nesting or feeding.