The importance of open-grown trees

From acorn to ancient

Ted Green

An ancient open-grown oak at Silton, Dorset. Bob Gibbons

Old, open-grown trees in open, park-like landscapes are an essential component of the Vera (2000) hypothesis, and have provided biological continuity for an important suite of associated visible and invisible biodiversity down through the centuries (Green 2001). As early as the 1960s, the late distinguished ecologist Francis Rose, from his specialist knowledge of lichens, was expressing doubts (pers. comm.) about the concept that dense, continuous, closed-canopy forests once extended across the whole of northern Europe. The importance and conservation of open-grown trees as natural, cultural and literary icons (Spector *et al*. 2006) is now gaining recognition across the world. In Australia, for example, the best working definition of woodland is 'ecosystems that contain widely spaced trees with their crowns not touching' (Lindenmayer *et al*. 2005).

Across Europe, north of the Mediterranean region, these open landscapes have been largely replaced by dense-canopy forests. That open-grown and often ageing parkland and hedgerow trees remain in the UK in such numbers is therefore one of our most important contributions to the biodiversity of Europe.

This article is an attempt to illustrate the importance of open-grown trees for biodiversity. Initially, there was no intention to make comparisons between the two extreme forms of tree, i.e. the open-grown form versus the forest form, especially because of the vast range of conditions

affecting their growth. However, during preparation of the article it became clear that there may be some interesting comparisons to be drawn between these two forms. The challenge has been to set out and describe some of the vast array of habitats provided on and within a single tree, all of which are an integral part of the co-evolutionary relationships.

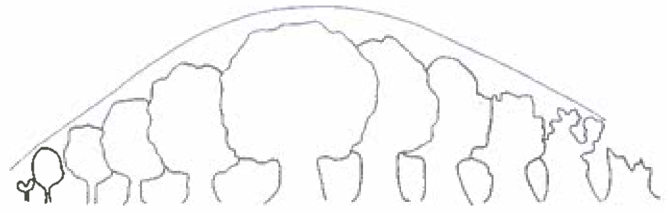

Figure 1 Sequential changes of the crown area/volume and trunk girth/volume of an individual open-grown oak. Overall timespan could be up to 500 years and may be up to 1,000 years.

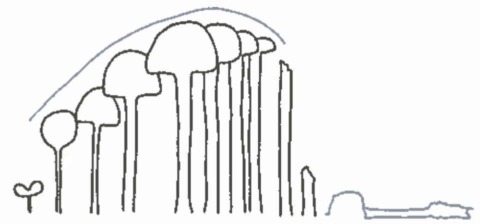

Figure 2 Sequential changes of the crown area and trunk girth of forest-form trees. Overall timespan in the case of oak could be less than 400 years and in the case of Beech 200-300 years.

Comparing forms

It is very clear that our ancestors discovered the benefits of the open-grown tree, and the evidence is all around us today in the form of our fruit and nut orchards, working trees (Green 1996) and fields full of shrubs yielding soft fruits. Even cabbages benefit from being individually spaced. This knowledge probably extended back to hunter-gatherers, when man would have found that open-grown trees and shrubs could produce vastly more fruit than their equivalent in a grove or shady woodland. Naturally, flowers and pollen precede fruit, and it therefore poses the question of whether the analysis by paleobotanists of pollen from soil profiles has recognised the quantity and mobility of pollen production from an open-grown tree compared with the smaller, less productive crowns and reduced mobility of pollen from woodland and close-grown trees?

An open-grown tree is a tree that has grown virtually all its life without competition from neighbours. It has a short, squat, fat trunk with a very large diameter and spreading limbs, of which some grow out almost horizontally. This is especially relevant when comparing light-demanding trees such as oaks *Quercus* and pines *Pinus* with shade-tolerant trees such as Beech *Fagus sylvatica* and Hornbeam *Carpinus betulus* (for a comparison of light requirements of common tree species, see Table 1). They generally have a large dome-like crown when compared with a tree from a dense forest, which typically is tall with a narrow trunk and a small crown. The forest-form tree may often retain dead limbs below the crown which have died through competition for light from the canopy of neighbouring trees. The degree to which the tree is a light-demanding or shade-tolerant species will also have some influence on its growth form, especially where it is influenced by surrounding trees. Per unit area, the mass and diversity of canopy in woodland and in the crown

Table 1 Comparison of light requirements of common tree species in the UK. The ranking by shade tolerance is derived from a desk study (Niinemets & Valladares 2006).

Species	Approx. shade tolerance
Scots Pine *Pinus sylvestris*	33%
Hawthorn *Crataegus monogyna*	39%
Silver Birch *Betula pendula*	41%
Midland Hawthorn *Crataegus laevigata*	49%
Pedunculate Oak *Quercus robur*	49%
Ash *Fraxinus excelsior*	53%
Alder *Alnus glutinosa*	54%
Rowan *Sorbus aucuparia*	55%
Sessile Oak *Quercus petraea*	55%
Sweet Chestnut *Castanea sativa*	63%
Field Maple *Acer campestre*	64%
Sycamore *Acer pseudoplatanus*	75%
Holly *Ilex aquifolium*	77%
Hornbeam *Carpinus betulus*	79%
Small-leaved Lime *Tilia cordata*	84%
Yew *Taxus baccata*	89%
Beech *Fagus sylvatica*	91%

Statistical rigour was applied to the ranking but this does not necessarily mean that this holds true across the range of variation, e.g. in the UK Yew is generally regarded as more shade-tolerant than Beech.

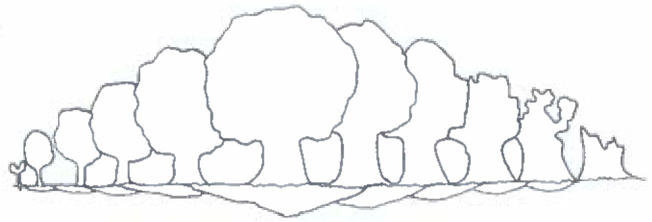

Figure 3 Sequential changes in the root area in relation to crown area of an individual open-grown oak.

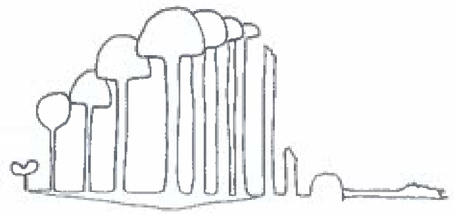

Figure 4 Sequential changes in the root area in relation to crown area of forest-form trees.

of an open-grown tree may in many instances be very similar. However, per tree, the production of leaves and roots will be far greater in the open-grown form. The volume of wood in the trunk of a forest tree may be greater than that in the trunk of an open-grown tree of the same age, but the open-grown tree will have a greater volume of wood overall, much of which is in its large spreading limbs. Therefore, an open-grown tree will have a far greater diversity of organisms and a greater biomass production compared with a tree of similar age growing in confined woodland conditions.

Roots and crowns

The dome of an open-grown tree is perhaps the most efficient shape for collecting energy, and the greater the leaf area, the greater the photosynthesis. The root system below ground must equate proportionately to the crown above ground. An open-grown tree has little or no competition, whereas woodland trees face constant stress from neighbours and consequently have shorter lives. The former may therefore provide habitat for as much as several centuries longer.

Under ground, it is very difficult to assess the extent and volume of any individual root system. However, there are some examples to be found. The Ancient Tree Forum traced roots from an ancient open-grown oak in a recently cultivated ancient grassland sward. The roots were still 2.5 cm in diameter over 50m from the trunk of the tree. There are also good examples showing the extent of exposed roots: Beeches that are growing on steep banks along old sunken lanes or quarries; 'granny pines' on eroded riverbanks and hillsides; and Ash *Fraxinus excelsior* appear regularly to produce extremely large-diameter roots several metres in length just on the surface. Usually the extent of the root area is much greater than the area of the crown, and sometimes the volume of the roots may be greater than that of the crown. The majority of the roots can be found in the top 30cm of the soil, although there are examples of the roots of a Downy Oak *Quercus pubescens* in Spain down to 9m (G Pasola pers. comm.). Even in the semi-arid mountainous region of northern Portugal, with regular summer temperatures for three months of up to 40°C, there are substantial areas of Beech woodland and broadleaved wood pasture with ancient open-grown Pedunculate Oaks *Quercus robur* (said to have been retained as shade for shepherds). To survive in these apparently hostile growing conditions it is reasonable to assume that these trees have put roots deep into the soil and rocks in search of a supply of ground water. Roots are thought to extend out 1.5 to 2.5 times the radius of the canopy, i.e. well beyond the drip line, from the limited research that has been undertaken.

One also needs to take account of mycorrhizal associations. These may extend over very large areas and can be interconnected with other trees, and even with different species of tree and lower plant. These complex relationships can be ever changing and are now increasingly being recognised for their importance in natural ecosystems.

Perhaps a tree's roots can be likened to an inverted, much-flattened tree. The 'branches, twigs and leaves' of the root system expand and then contract with age and condition, probably in direct correlation with the crown. It appears that subterranean dead roots can have a distinct decay (recycling) ecosystem.

Forest trees growing in close competition, with small canopies, are still capable of gathering sufficient energy to produce often large volumes of

Figure 5 Sequential changes to the hollowing (horizontal and vertical cross-sections) of an individual open-grown oak providing a supply of successional, structural, sustainable decaying wood from acorn to ancient (Green 2001).

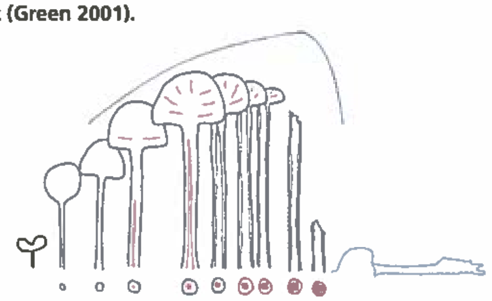

Figure 6 Sequential changes to the hollowing of forest-form trees.

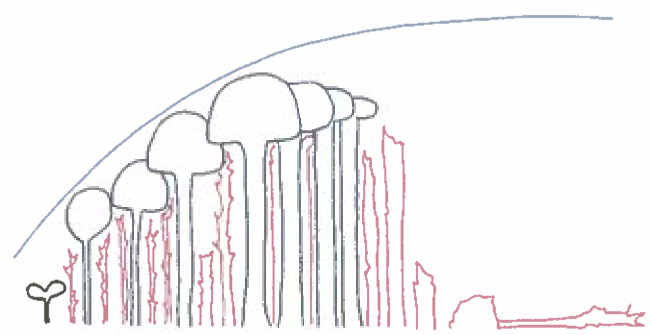

Figure 7 Sequential changes to deadwood from self-thinning, through competition, of dense forest trees.

wood in the trunk. However, trees on the margin and with a greater leaf area may be able to provide extra energy to their neighbours on the inside of the group via their network of grafted roots and mycorrhiza or, in fact, may actually be continually robbed.

In dense Beech woodland or groves, presumably the greater the number of trees, the greater the density, and the greater the competition, the greater the progressive self-thinning. Also, the greater the production of dead wood, the greater the recycling of minerals and nutrients from the decaying wood. There is a constant supply of nutrients to the survivors through this recycling. By having a very efficient, co-evolutionary, micro-organism support system, it may be that the trees require only a relatively small root area, especially feeder roots. Individual trees do not require large spreading buttress roots, as they are growing in dense, tight conditions. They give each other 'group support' against the elements, reducing the need for each tree to adapt individually to wind exposure. However, there is intense competition for space for other trees and plant roots to colonise in these far more restricted conditions.

It is generally accepted that open-grown trees develop substantial buttress roots in response to continual exposure to wind. They will therefore have a greater number, diversity and mass of micro-organisms associated with the roots, simply through the greater area open to colonisation.

Decay and hollowing

The length of the decay cycle will be far shorter in the more humid conditions found in woodlands and groves. A mature fallen Beech with a trunk diameter of 1m could well disappear back into the woodland soil within 30-40 years. However, a large fallen oak limb of about 60cm diameter in open conditions may still be present after 50-100 years. Regardless of whether it is ripewood or heartwood, the centre of the tree will decay more quickly in woodland.

Hollowing of trees, including palms, is now widely accepted as a perfectly natural function. It is usually associated with the ageing process. In deciduous trees the non-living wood is either heartwood or ripewood, which can be broken down by many species of fungi that may be associated with other micro-organisms in the decay process. There are circumstances where some species of saproxylic beetle and other insects, including tree ants, may also have important roles. The decay of non-living wood in the centre of trees can have the added benefit to the tree of releasing nutrients locked up in the heart- or ripewood. In rainforest systems, minerals and nutrients such as mould and droppings, trapped in the contents of hollow trees, are very important as a source of nutrients that in other locations would be leached away through high rainfall (L Boddy pers. comm.). A succession of different organisms will benefit from different-sized cavities created by the progress of hollowing.

The decay process of the heartwood can begin when the tap root begins to die. However, the hollowing process may start in other parts of the tree. Depending on the fungi and other associated micro-organisms of the decay process present, in any tree population a proportion of the trees will be either in the process of hollowing or decaying throughout. This is considered perfectly natural.

In most situations, the smaller the volume of wood, whether standing, dead or fallen, the more rapid the decay process. This is especially relevant in species such as Beech that have ripewood, and not heartwood as in oaks. True heartwood which has been air-dried in the crown or trunk of a tree through exposure can be sound or in the process of hollowing. In the latter case, the outer shell can take centuries to decay.

Fungi and recycling

The biodiversity of a tree's decay and recycling system (Rayner 1993) is extremely complex and poorly understood. The diversity of species both visible and invisible that carry out essential roles and comprise the major players – 'the bio-engine of recycling' – can only be speculated upon. We know that it will include bacteria, fungi and invertebrates (of which nematodes must be singled out for their importance), and presumably any single organism could be the primary coloniser which might then facilitate an ever-changing succession of other micro-organisms. All these organisms will in turn provide food for others.

The fruit bodies produced by fungi are an interesting example. The soft, fleshy annual mushrooms usually appear from the end of summer through the autumn and into early winter. Not only are they a source of food for animals, including man, but also slugs, several species of insect (beetles and flies) and nematodes. The insects, often flies, are emerging from the fruit bodies at the time when the bulk of other insects are finished for the year. Therefore they provide a succession of food, especially for birds, bats and small rodents, at a period when other insect food is declining. Other fungal fruit bodies, those having a woody texture, are usually perennial and associated with decaying wood and do not necessarily produce adult insects in the autumn months. The wholesale picking of fruit bodies, not only for commercial reasons but also by eastern Europeans for the pot, is on the increase. The impact of this continual removal on the woodland ecosystem appears to be totally lost on so-called ecologists.

It has been a very thought-provoking exercise to try to encapsulate the differences between open-grown and forest-form trees over time. It has thrown up more questions than answers. However, one important question is answered, and that is that our old open-grown trees hold one of the keys to the past. It is hoped that the debate will continue.

Acknowledgements

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Ted Green MBE is founder member of the Ancient Tree Forum and a campaigner for the conservation of ancient trees and the recognition of the importance of fungi in ecology.

Bringing in the cattle, part of the daily pendulation of livestock in the Saxon village of Viscri in Transylvania.
Bob Gibbons

Lessons from abroad – a look at management of grasslands in Transylvania

Andrew Jones

Conservation of our British species-rich grassland has been failing despite tremendous efforts on the part of the Government agencies and the NGO sector. The fragmentation and disappearance of our semi-natural grasslands is reasonably well known (Blackstock *et al.* 1999), and loss of sites is still continuing under agricultural intensification, with the increasing isolation of our best grassland sites. Land acquisition surrounding remaining high-value grasslands, such as in nature reserves, to provide corridors for colonisation and buffering has been a recent policy of conservation bodies, especially the Wildlife Trusts, but at times this resembles some last-ditch defensive military operation. Despite all our efforts, we know from the work of the county flora mapping project that some of our quintessential grassland species, such as the Green-winged Orchid *Orchis morio*, are continuing to disappear (Preston *et al.* 2002; Jacquemyn *et al.* 2009; Walker 2007).

Our grassland habitats and flora have developed their specific character over thousands of years of use, mainly under our varying regimes for grazing