DOI: 10.53478/TUBA.2018.006

Chapter 5
The Importance of an Open Grown Tree – from Seed to Ancient

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A Tree is merely a unique dynamic individual support system for Fungi and other micro-organisms.

Abstract

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 growth forms of trees i.e. the open grown form versus the forest form shade tolerant tree of a similar age, especially because of the vast range of conditions affecting their growth to speculate on. However in preparing the article it became clear that there might be interesting to speculate on some of the comparisons to be drawn between the two forms at either end of the spectrum. In the exercise the challenge has been of setting out and describing some of the vast array of habitats provided on and within a single tree which are an integral part of the complex co-evolutionary relationships with other organisms.

Introduction

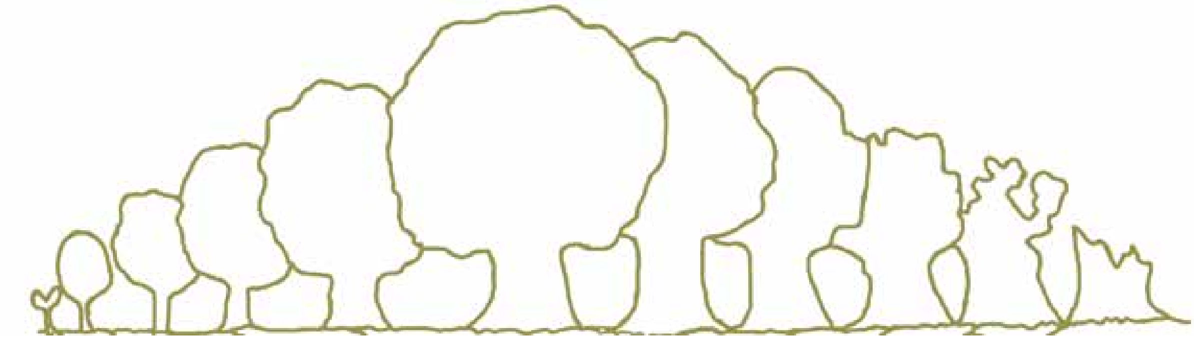
Old, open grown trees in open, park-like landscapes are an essential component of the Vera (2000) hypothesis and include any treed landscape that has light demanding and shade tolerant tree species. These open grown trees have provided biological continuity for visible and invisible, old growth biodiversity down the centuries and perhaps even millennia. As early as the 1960s the late distinguished ecologist in the UK Francis Rose, from his specialist knowledge of lichens, was expressing doubts (pers comm.) about the concept that prevailed at the time amongst European ecologists that dense, continuous, closed canopy forests extended across the whole of northern Europe. The importance and conservation of the open grown tree 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). Bergman (2006) emphasises the importance of open grown oaks in conservation of their biodiversity in Swedish archipelagos.

Across Temperate Eurasia, and the Mediterranean region, these open landscapes have been extensively replaced by arable farmland and man-made dense canopy commercial forests comprised of mainly shade tolerant species That open grown trees of all ages often in ageing parkland and including hedgerow trees remain in the UK in such numbers is therefore one of the most important contributions to the biodiversity of Europe.

Description and comparisons

An open grown tree is a tree that may have grown virtually all its life without competition from other trees. It usually has a short, squat, fat trunk with a very large diameter, often with large spreading limbs especially in the lower crown of which some grow out almost horizontally.

Sequential changes of the crown area/volume and trunk girth/volume of an individual open grown oak (*Quercus* spp.) **Figure 5.1**



Overall time span could be up to 500 years and might be up to 1000 years. Given ideal soils and conditions.

They generally have a large dome-like crown compared with a forest form tree that is tall with a narrow trunk and a small crown. The forest form tree may often retain dead limbs below the crown (depending on species and growing conditions) which have died primarily through competition for light dependant on the extent and depth of it's own canopy and that of it's 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. This is especially relevant when comparing light-demanding trees such as oaks (*Quercus* spp.) and pines (*Pinus* spp.) with shade-tolerant trees such as beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) for a comparison of light requirements of tree species, the mass and diversity of canopy in woodland and crown might in many instances be very similar. However per tree, the production of leaves and roots will be far greater in the open grown form. Recent research (Kaetzel et al., 2012) comparing the biomass production an open grown oak with a forest form oak found. The vitality (crown structure), mortality rate and the ecological function (habitat structures of wood for insects and fungi) of those oaks were observed between 1992 and 1994 as well as between 2010 and 2012. The vitality of trees was found to be closely related to free range distance and existence of competing neighbouring trees. Likewise, the mortality rate was strongly determined by the pressure of competition exerted by younger adjacent trees. The observed survival rate confirms the considerable adaptability of these old oaks compared to younger, denser oak stands. The mass of leaves is ca. 20 times larger in solitary oaks compared to equally sized oaks from dense populations. Physiological biomarkers confirm the high adaptive potential of free-standing oaks.

The volume of wood in the trunk of a forest form tree might be greater than the trunk of an open grown tree of the same age but the open grown tree will have a greater volume of wood overall, with much of which is in its large spreading limbs giving a far greater and diverse surface area when compared to the single trunk with fewer and smaller limbs of a forest tree. Therefore one can assume equally that an open grown tree of other species of trees compared with a tree of similar age growing in confined woodland conditions will have a far greater diversity of organisms and a greater biomass production.

Figure 5.1 and Photograph 1 obviously there are situations and conditions where trees have to search for water and resources and will produce an extensive root system often extending substantial distances both vertically and horizontally.

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 is accepted to equate proportionately to the crown above ground. An open grown tree usually has little or no competition from other trees for resources including water, whereas woodland trees face constant stress from neighbours and consequently have shorter lives and if root grafting with neighbours has taken place then the transfer of minerals, nutrients and water from one tree to another through competition could accelerate the

Photograph 1: An open grown Oak (*Quercus robur*) over 400 years old with a full crown spread of over 35 meters. The large spreading lower limbs indicate the tree has grown it's whole life unrestricted in the open.

decline of any weaker individual trees. The former may therefore have a far greater life span and be productive also providing an ever changing habitat with age perhaps for as much as several centuries longer

Pollen

It is very clear today that our ancestors discovered the benefits of the open grown tree and the evidence is all around us today in the form of our tree fruit and nut orchards and fields full of shrub and 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 before fruit comes flowers and pollen and it therefore begs the question whether the analysis of pollen diagrams today has recognised the quantity and mobility of pollen production from an open grown tree with a large crown compared with the smaller, less productive crowns and reduced mobility of pollen from woodland and close grown trees? It begs the question on how we have arrived at presumably ‘the assumed tree and shrub cover of species’ when comparing 63 Eurasian species 46 species are either hermaphrodite or insect pollinated and only 17 wind pollinated!!!

The roots

Underground it is very difficult to assess the extent and volume of any individual root system. However there are some examples to be found. In the UK the Ancient Tree Forum traced roots from an ancient open grown oak in a recently cultivated and destroyed 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; beech trees (*Fagus sylvatica*) that are growing on steep banks along old sunken lanes or quarries; granny pines (*Pinus sylvestris*) on eroded river banks and hillsides; and in the case of ash (*Fraxinus excelsior*) it appears to regularly produce extremely large diameter roots several metres in length just on the surface often the volume and extent of the roots exceeds the crown area and spread. With the exception ash usually the extent of the root area is much greater than the area of the crown The majority of the roots can be found in the top 30cm of the soil, although there are examples in Spain of roots growing down to 9m and still with their mycorrhizal associations! (G. Pasola pers comm.). Even in the semi arid mountainous region of northern Portugal, with regular summer temperatures for 3 months of up to 40 c, there are substantial areas of beech (*Fagus*) woodland and broadleaved wood pasture with ancient open grown oaks (*Quercus* spp.) (said to have been retained as shade trees for shepherds). To survive in these apparently hostile growing conditions it’s reasonable to assume that from the time of the seed germination of these trees has responded to these conditions and have been able to put sufficient roots deep into the soil and rock crevices in search of a guaranteed supply of ground water. From the limited research undertaken roots are thought to extend out 1.5 to 2.5 times the radius of the canopy ie well beyond the drip line.

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 conditions, probably in direct correlation with the crown and probably brought about through stress for example from prolonged droughts outbreaks of disease or pest infestations which include root herbivores, nematodes and roots broken or damaged during periods of very strong winds. It appears that subterranean dead roots can have a distinct decay (recycling) ecosystem with the main drivers perhaps being fungi bacteria and invertebrates (Figure 5.2).

Forest form trees growing in close competition with small canopies still appear to be capable of gathering sufficient energy to produce often large volumes of wood in the trunk. However trees on the margin with a greater and more efficient leaf area may be able to provide extra energy and resources to their neighbours on the inside

Sequential changes in the root area in relation to crown area of an individual open grown oak

Figure 5.2

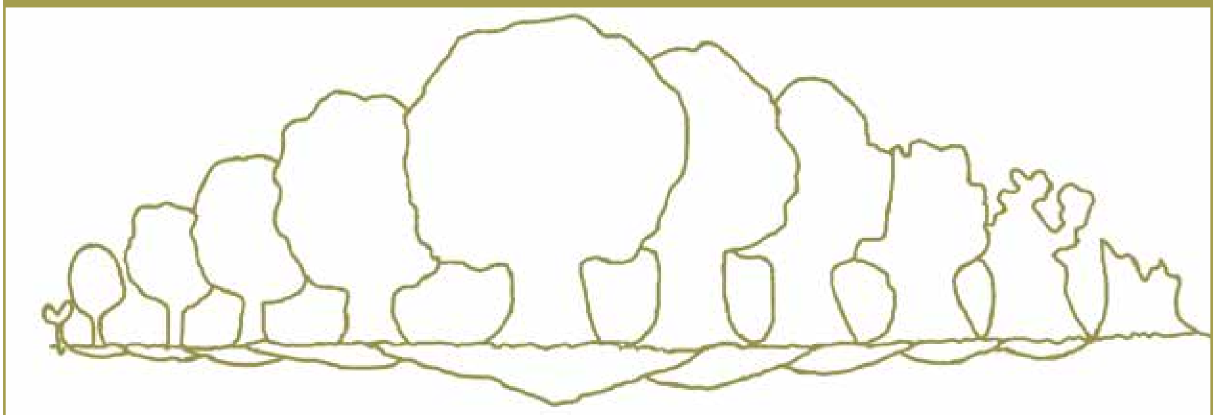


Figure 5.3 Sequential changes in the root area in relation to crown area of forest form trees

of the group via their network of grafted roots and their mycorrhizal partners in fact it may be they are actually be continually robbed of resources (Figure 5.3).

In dense beech (*Fagus* spp.) or other woodland of other shade tolerant species or groves of any or varied age, presumably the greater the number of trees, the greater density, the greater the competition, the greater the progressive self-thinning and subsequent death, the greater the production of non-living wood (deadwood), the greater the recycling of minerals and nutrients from the decaying wood. Therefore there is a constant supply of nutrients to the survivors through this recycling. Actually with non-intervention by man it is a natural structural; successional; sustainable; supply of decaying wood from seed to ancient. By having a very efficient, co-evolutionary, micro-organism support system it may be the trees only require a relatively small root area especially feeder roots. Individual trees do not require large spreading buttress roots for support 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 caused by wind exposure. However the situation is similar to that in the canopy and there is intense competition for any available space from other trees and plant roots to colonise in these far more restricted dense grove conditions.

It is generally accepted that open grown trees develop substantial buttress roots in response throughout its life to movement through the continual exposure to wind events. It will therefore have a greater number, diversity and mass of micro-organisms associated with the roots simply through the greater area available to individual species to colonise the roots.

Fungi and other micro-organisums in the soil and decay

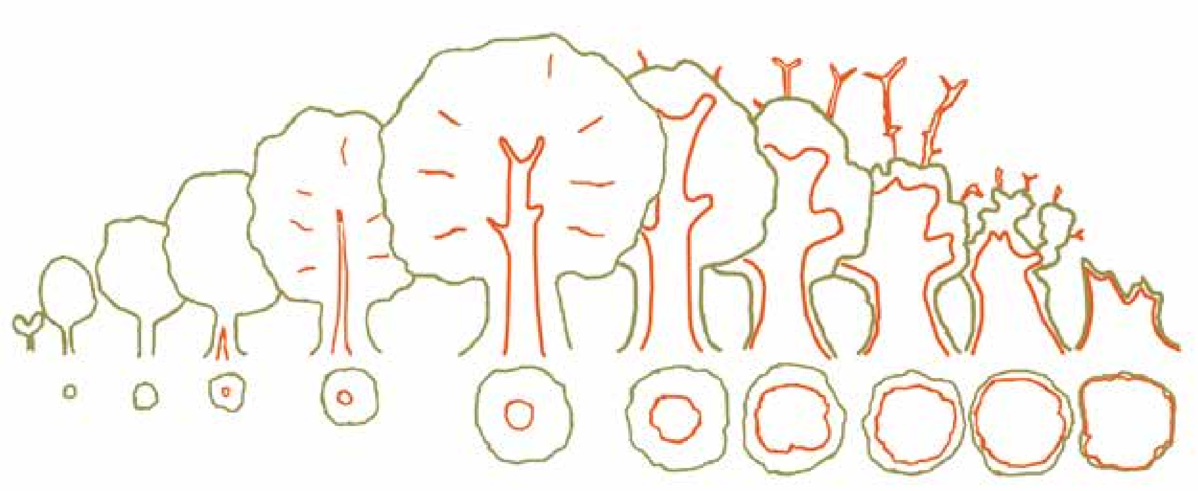
Decaying wood is the woodland soil of tomorrow'. One also needs to take account of essential mycorrhizal associations (Merryweather, 2001). They may extend over very large areas and can be interconnected with other trees of all ages and even different species of trees and other plants. It is assumed that many species are warmth loving and therefore can benefit from exposed areas under open grown trees. These complex relationships can be ever changing and are now increasingly being recognised for their fundamental importance in natural ecosystems.

The biodiversity of the decay (recycling) system is extremely complex and poorly understood. It's diversity of species both visible and invisible that carry out essential roles in the breakdown of all non living matter and comprise the major players - 'the bio-engine of recycling', can only be speculated on. We know it would include bacteria, fungi, 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 provide food for other organisms. Fungi are considred to be a major part of the essential bio-engine of all plant ecosytems and can be divided into the decayers (recyclers) of dead matter and Mycorrhizal fungi (the food gathers) which in a co-evolutionary complex symbiotic partnerships with trees perform a fundamental role by providing minerals, nutrients and trace elements which are often not available to the tree or other plants by ant other means. Also because of their longevity fungi and trees are an excellent example of providing biological continuity for future generations perhaps spanning centuries and even millennia. The fruit bodies produced by fungi in the ecto mycorrhizal group 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, slugs, several species of insects (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 can provide a succession of food especially for birds, bats and small rodents at a period when other insect food is declining. The endo-mycorrhizal group equaly fundamental and essential to their tree partners remain a mistery to scientists, infact as does most of the' world of the soil. Other fungal fruit bodies that have a woody texture are usually perennial and associated with decaying wood and do not necessarily produce adult insects in the autumn months. It must be mentioned that he wholesale picking of fruit bodies for commercial reasons is on the increase. The distructive impact of this continual removal on the tree and woodland ecosystems as a whole appears to be totally lost on society.

In most situations especially in woodland the smaller the volume of wood, either 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 oak. However non-living wood in open exposed areas generally decomposes much slower including true heartwood which has been air dried and very desiccated in the crown or trunk of a tree through exposure can be sound or only just in the process of

Figure 5.4

Sequential changes to the deadwood and hollowing of an individual open grown oak (*Quercus* spp.)



slowly hollowing. In the latter case the outer shell can take centuries to decay.

Depending on tree species the length of the decay cycle can be far shorter in the more humid conditions found in woodlands and groves. A mature fallen beech or other tree species forming ripe wood with a trunk diameter of 1m could well disappear back into the woodland soil within 30-40 years. However a large fallen oak limb mainly comprised of heart wood of about 60cm diameter in open exposed conditions might still be present after 50-100 years. Therefore the time-lapse of decomposition of live wood to dead wood ratio is far shorter in woodland shade compared with open grown trees. Regardless of whether the centre of the tree is ripewood or heartwood it will decay more quickly in woodland.

The diverse, often dynamic and ever changing species of fungi and other associated micro-organisms of the decay process present in any tree population, a proportion of the trees will be in the process of hollowing is considered perfectly natural. There is evidence that the greater the volume of decaying non-living wood (the heartwood or ageing ripewood) the increasing importance to biodiversity such as fungi and invertebrates especially in old open grown trees with short fat trunks.

Hollowing of living trees is now widely accepted as a perfectly natural co-evolutionary function in the non-living wood of most plants including palms. It is usually associated with the aging process of the annual growth rings. In deciduous trees the non–living wood is either heartwood or ripewood which can be decayed by many species of fungi that may be associated with other micro-organisms during the decay process. There are circumstances where some species of saproxylic beetle and other insects including tree ants - behaving in a similar fashion to termites, which may also play important roles. The decay of non-living wood in the centre of trees can be an added benefit to the tree by releasing nutrients locked up in the non-living heart- or ripewood. In rainforest systems, minerals and nutrients trapped in the contents of hollow trees eg mould, bat and bird droppings, are very important as a source of nutrients that in other locations would be leached away through high rainfall (L. Boddy, pers comm.). Also a succession of different organisms will benefit from different size cavities created by the progress of hollowing. Not forgetting what must be a rare and tenuous mini ecosystem that has evolved to live solely in 'rot pools' that is water filled cavities found in the mainly in the main stem, larger limbs and hollows created between large buttress roots (Figure 5.4).

"*A supply of succession, structural, sustainable decaying wood from acorn to ancient*".

The decay process of the heartwood can begin when the tap root begins to die, however the hollowing process may also begin in other areas of the tree by totally different species of fungi and other micro-organisms (Figure 5.5 and Figure 5.6).

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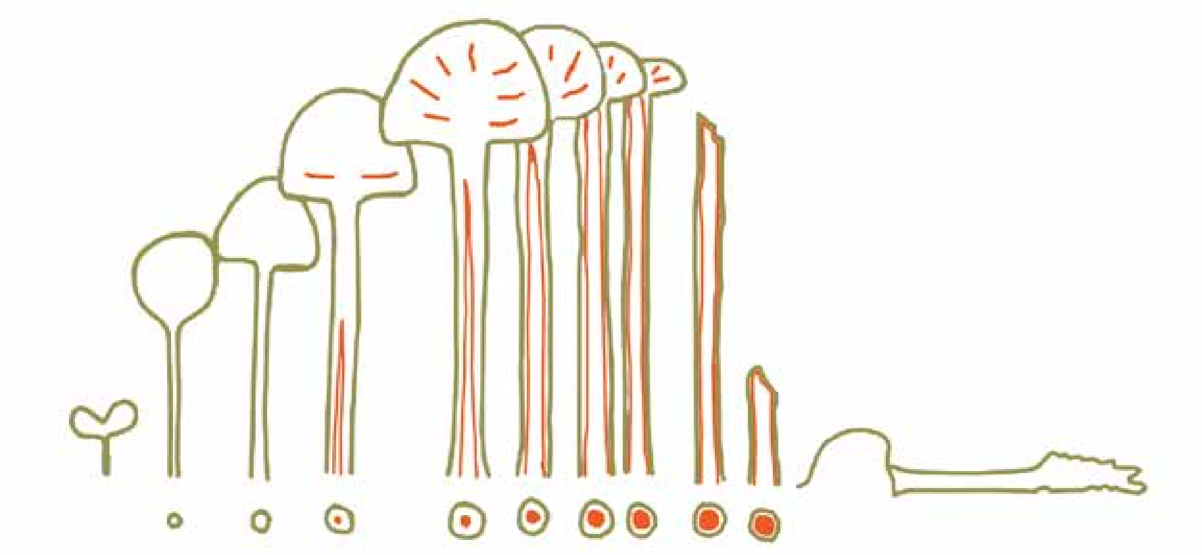
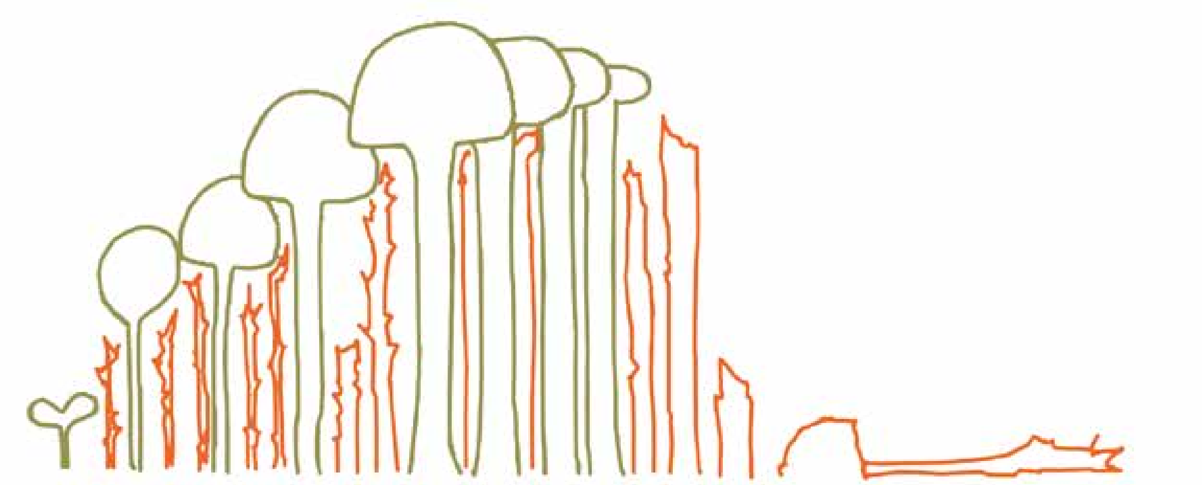
Conclusions

It has been a very thought provoking exercise to try and encapsulate the differences between open grown and forest form trees over time. It has thrown up more questions than answers. In fact no attempt has been made to explore comparisons between under crown and canopy ground cover or understory trees and shrubs in relation

Sequential changes to the hollowing of forest form trees **Figure 5.5**



Sequential changes to deadwood from self-thinning through competition from neighbours in dense woodland **Figure 5.6**



to light demanding or shade tolerant species However, one important question is answered and that is that our old open grown trees of open treed landscapes and wood pasture hold the key to the past. And it is hoped the debate will continue.

Acknowledgments

I would like to thank the late Francis Rose for his encouragement to think 'outside the box' to Keith Alexander, Jill Butler, Mick Crawley and other members of the Ancient Tree Forum for sharing their knowledge and experiences. Special thanks to Frans Vera for his inspiration and as the late Francis Rose said 'His work is Landmark'. This paper is a revised version of The Importance of Open Grown Trees from Acorn to Ancient-British Wildlife June 2010.

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