

## Transformational Nature

### Unlocking the secrets of natural form, plant intelligence and the aging process

*Treework Environmental Practice seminar, Royal Botanic Gardens, Kew*

**Geoffrey March**, Arboricultural consultant (retired)

**Incredibly, this was the 21st seminar in the series 'Innovations in Arboriculture', and it was presented by Neville Fay and the whole team at Treework Environmental Practice, in conjunction with the AA. Such is the reliable calibre of the speakers and their subject matter at these seminars that nearly 100 delegates attended.**

We were welcomed by Tony Kirkham, Kew's Head of Arboretum, who reminded us of the dynamic state of the warming environment, it being almost impossible now to accurately predict when trees will leaf, flower, colour up or shed their leaves. However, Kew's research and collection of 55 species of *Fraxinus* places it in the forefront of assessing resistance to *Chalara*, for instance.

Neville then set the scene, stating that many philosophers today feel free to move into areas that refresh our inspiration (for him particularly this is ancient trees) before

quoting in typical crypto/optimistic style one of the speakers, Howard Thomas: 'The melody is defined by the notes that are excluded.' What were we in for?

**Francis Hallé** is a botanist but also the acknowledged expert on tree morphology who in a long career has worked up inspiring new ways of looking at trees. I was anticipating hearing much of what he covered at the 2007 seminar on the many morphological tree forms he has defined; however, we were treated to an original (and funny!) comparison of plant and animal life. And guess which life form can replicate itself from small fragments, has food come to it instead of vice versa, uses its own 'excrement' (lignin) to its advantage, borrows its mobility needs (e.g. for reproduction) from dumb animals and, having no vital organs, is not easy to kill (hint ... it's not animals)? Moreover, 'higher' attributes are not the sole preserve of animals: there are plant species out there with the ability to hear/move (the 'dancing plant' of Yunnan), smell (a parasite of the tomato plant), respond to touch by folding their leaves – and this without a nervous system or muscles – release a chemical in response to fire that inhibits further burning (cypress), and even show sensitivity to tides and earthquakes.

Back in Hallé's core subject of reiteration, the growth of a side shoot from a stem has a hidden root system in the cambium of the parent plant, thus acting semi-parasitically (unless these 'roots' finally reach the soil). When this is manifested as basal, sucker or layer growth, it allows the organism to perpetuate itself, potentially indefinitely. By this measure the oldest organism discovered on Earth is the King's holly (*Lomatia tasmanica*, New Zealand) at an astonishing 43,000 years. The oldest discovered so far, that is: there is speculation that the North American quaking aspen (*Populus tremuloides*) could far exceed that! And the best the animal kingdom can offer? The tortoise, at around 300 years. Note to Hallé fans: his

next book, due for release in September, will be *50 Years of Exploration of the Botanical Gardens of the World*.

Who better to continue this exploration of superpowers than **Stefano Mancuso**, plant neurobiologist and professor at the University of Florence. It may come as a bit of a shock but plants are in fact much more sensitive than animals and this is because ... they can't run away. As a consequence of the resulting liability to predation, they possess no animal-like organs. However, it is now established that, somewhere in nature, roots can respond to sound and produce sound, leaves of climbing plants can change to match their host, the leaf epidermis can act as a lens and the cortex as a retina, animal life can be actively induced to attack the plant's invaders, and – in direct comparison with animals – immunity-forming processes and even circadian rhythms are found. Slime moulds operate as a single cell with many nuclei and can exhibit extreme sophistication in spatial awareness. This was cleverly illustrated by an experiment replicating the interlocking transport 'nodes' of urban Japan, where the organism optimised the flow to a far greater degree than mere human brains could. A fascinating link was posited between roots and fungi, suggesting a possible vestigial reference to an early merging of fungi and algae as a precursor to the development of higher plants. This could help explain the origins of root/mycorrhizal interaction and even the successful development of land-based plants with their new ability, via the cuticle, to resist desiccation. And roots themselves, within the myriad of root apices, are considered to contain brain-like units of the nervous system, all interconnected by vascular strands (cv neurons) and auxins (cv neurotransmitter) to form a plant neuronal system capable of immense processing capability.



Plant gerontologist Howard Thomas, Emeritus Professor of Biology at Aberystwyth University (left) and Francis Hallé from the University of Montpellier – 'the acknowledged expert on tree morphology'.



Stefano Mancuso, plant neurobiologist and professor at the University of Florence.



Monica Gagliano of the University of Western Australia is a plant cognitive ecologist.

Monica Gagliano of the University of Western Australia is a plant cognitive ecologist and she took us into the unexpected waters of ethical debate. More than anyone else, perhaps, scientists understand that nature – perhaps even the very act of 'being' – relies on variation and diversity. For organisms and ecosystems alike, this is constantly modified by natural selection to produce successful outcomes and overall stability. But here is the dilemma: modern plant biotechnology is leading us in the opposite direction, reducing options and diversity by promoting monocultures, leading to unstable ecosystems susceptible to epidemics of pathogen and weed. The relentless pursuit of perceived gains may well be hopelessly short term, producing less complex ecosystems ever-increasingly prone to collapse. While similar views have long been evident (Rachel Carson's *Silent Spring* being an obvious example), what made this speaker's viewpoint startlingly original was the idea that by de-objectifying plants and relating to them in their own right we will reconsider the way they are treated and delegitimise the reductive role of genetic modification.

Plant gerontologist Howard Thomas is Emeritus Professor of Biology at Aberystwyth University and he took us to some of the latest thinking on plant development and aging, refining it for us to the role of trees in particular. Unlike with previous speakers, this underlined fundamental differences between plant and animal life. If reproducing asexually, the latter undergoes 'deteriorative aging' that can only be rejuvenated (so providing indefinite propagation and growth) via sexual generations. Plants on the other hand can have an individual life

expectancy of over 2,000 years – and when clonal activity is taken into account this can extend much, much further, currently found to be in excess of 40,000 years as detailed by our first speaker. This may be partly explained by plants developing as open-ended repetitive units, acting more like a colonial organism (e.g. coral) than an individual, coupled with the apparent ability, unlike animals, to reset the biological clock (reboot juvenility) via mitosis in the meristem cells. If these apical meristems seem to be capable of immortality, what is happening with annual and other short-lived plants? If the apical meristem growth keeps one step ahead of the advancing wave of cell death coming up behind, then these extremities survive – creeping perennials being a case in point. With trees, the dead tissue is left behind to persist as a mummified corpse, namely wood.

I hadn't realised that most non-woody plants, with a 'live fast, die young' ability to colonise inhospitable and unstable habitats beyond the forest, arose secondarily from trees, with the primeval forest arriving first; and then grasses arrived tens of millions of years later. This newcomer had a special weapon in the evolutionary arms race in being able to withstand fire. It is thought that without fire, forest cover worldwide would potentially double. Soberingly, it is we humans who have acted – and continue to act – as the grasses' mercenaries in their war on forests. This slash and burn has been culturally sanctioned over the centuries by sources ranging from Augustine and Dante to fairy tales, novels and films, with the wildwood being seen as the embodiment of evil and the very 'heart of darkness'. Of course the Enlightenment ushered in notions of arcadia, and the romantic landscape movement allowed trees to take a special place at last: the noble tree, symbolising longevity, endurance and the ability to withstand change. This was given

a political spin: Howard cited Edmund Burke's appropriation of the doughty English oak tree to symbolise this country's innate opposition to those filthy revolutions occurring across the water ...

All Treework's speakers touched on the interconnectedness of all forms of life. The realisation that plants have much in common with animals was already in place by the end of the nineteenth century, with Huxley even stating in 1853 'The plant is, then, an animal confined in a wooden case.' This was positioned on an increasing understanding of physiological processes such as respiration, digestion, cell growth and reproduction.

By the end of this seminar any view of plants as passive objects solely designed to accumulate biomass was being rapidly demolished. In the words of Stefano Mancuso, 'plants ... accurately compute their circumstances, use sophisticated cost-benefit analysis and ... are capable of a refined recognition of self and non-self. Plants are as sophisticated in behaviour as animals but their potential has been masked because it operates on time scales many orders of magnitude longer than that operating in animals.'

Neville succeeded in his wish to 'open up the possibility for a more inclusive experience of the nature of Nature' and the seminar title of 'Transformational Nature' was well judged. The largest plant on earth is some 50 times the mass of the largest animal, and a conservative estimate has it that 97.5% of the Earth's biomass is provided by the plant kingdom. Despite the de-objectification of plant life being the common theme throughout the day, 'the most fascinating feature of plants is their otherness' – and we still don't know the half of it.



All images courtesy of Treework Environmental Practice.



The speakers and the Treework team.