

BOTANIC GARDENS, HERBARIA AND RESEARCH: THE UK EXPERIENCE

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ABSTRACT: The evolution of botanic gardens in the United Kingdom is outlined, with special regard to the Royal Botanic Gardens, Kew. The modern role of such gardens is discussed and particular attention is given to Kew's Breathing Planet Programme.

Key words/phrases: Botanic gardens, Breathing Planet Programme, Kew, United Kingdom.

Of all scientific institutions, botanic gardens have, perhaps, the longest history, some of them existing as entities for hundreds of years. In the UK, as in Ethiopia, they are still being established, most notably in recent years – in a spirit of devolution or nationalism – the National Botanic Garden of Wales. The oldest in the English-speaking world is that at the University of Oxford, England, founded in 1620 and there is a handful of even older ones in Continental Europe. Many such gardens, as in the case of Oxford, sit on prime real estate – and, despite the obvious economic pressures, have remained on their original sites. What does this longevity tell us about their roles in society over 400 or so years – and what does it tell us about society itself?

The United Kingdom, which is a small country with little altitudinal variation, low biodiversity and really no truly original vegetation left, but with over 60 M people, is said to have 116 botanic gardens – national ones include the Royal Botanic Gardens Kew, National Botanic Garden of Wales and the Royal Botanic Garden Edinburgh. Almost every nation and most principal cities in the developed world have botanic gardens; developing countries are establishing them, and those with surging economies, notably China, are putting literally billions of dollars into enormous new botanic gardens. Why is this? What is it that makes such institutions so important today?

Firstly we have to consider what botanic gardens, including arboreta, are not – they are not just parks or public gardens. The well-worn definition from the International Union for the Conservation of Nature (IUCN) is “a garden containing scientifically ordered and maintained collections of plants,

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usually documented and labelled, and open to the public for the purposes of recreation, education and research". The core of their *raison-d'être* is the fact that they exhibit scientific collections of plants – they are not merely there for display, though that is an important aspect of the work of many botanic gardens. They are there for education as well as recreation. It is this combination, I believe, that has kept them going for so long.

Nonetheless, through time the balance between these two functions has changed, has caused tensions, and indeed strife - when in essence it is the melding of these two functions that makes them, just as with other collections-based cultural organizations like art museums and natural history museums, extremely precious to society.

The early botanic gardens were entirely utilitarian in serving the very practical function of demonstrating medicinal plants and those early university ones were thus – that at Oxford was like this and the name of the Chelsea Physick Garden, founded in London in 1673 and still on the same site in London, recalls its origin and long association with the Worshipful Society of Apothecaries. At the same time 'cabinets of curiosities' were being amassed by rich people and this led to what has become in the UK the British Museum, with its Sloane Herbarium eventually to be united with Sir Joseph Banks's collections finally to become the Botany Department of the Natural History Museum.

Later with the discovery of more and more plants overseas, botanic gardens came to be rather self-conscious attempts at reproducing the Garden of Eden. So it was that Princess Augusta, dowager Princess of Wales, daughter-in-law of King George II of England, had the modest aim of having examples of all the world's plants in her garden at Kew, by then already rich in plant species as well as an extraordinary assembly of buildings or follies typical of the period, including a mosque, a Chinese aviary and House of Confucius, gothic cathedral, ruined arch, Alhambra, pagoda and sundry temples, lying alongside the purely landscape garden of the King himself.

The year 2009 saw the celebrations for the 250th anniversary of the founding of Kew as a botanical collection of plants, not a particularly long track record by comparison with certain other gardens I have mentioned. Nonetheless, the evolution of Kew from 1759 which heralded the end of the garden as a merely ornamental one, until today's modern scientific organisation has, I believe, some lessons for others. In 1759, then, Princess Augusta employed, effectively as the first Curator, the Scottish gardener,

William Aiton, the year when the British Museum was founded, two material representations of the inquiring Enlightenment in England. By 1768, Kew had over 3,400 plant species being grown under glass and in the open. Just 15 years before, Linnaeus had estimated that there were perhaps just 6,000 or so plant species in the wild (rather than the 300,000 or so suggested today), so Augusta seemed to be doing well, but by 1772, she was dead, of cancer, aged 52. By then the only other English university at the time, Cambridge, had its botanic garden and Ireland, then under British control, was to have its own in Dublin.

The person who probably had more to do in turning the mission of botanic gardens in the United Kingdom – notably the gardens of the Royal family, to be combined in his lifetime as ‘Kew Gardens’, into a garden of economic plants was Sir Joseph Banks, who had the King George III’s ear on all matters concerning exploration, science and so on, being President of the Royal Society for 40 years. Although he published very little, he was a competent botanist, having been with Captain Cook on his 1768 voyage to the Pacific, but his great talent was picking the right people for the job, delegating and networking internationally. He had a vision of a great network for the expanding British sphere of influence, eventually to become the British Empire, with the royal garden at Kew as the centre for the discovery of plants – in particular those of economic use, his own experience in the Pacific leading to his promotion of the introduction to the Caribbean of the breadfruit, *Artocarpus altilis* (Moraceae). But at this time, though by 1789 with some 5,600 species, Kew was still effectively in part a vegetable garden for the royal household. Much of the grounds was grazed by sheep and cattle, cereals were sown and pheasants raised.

The economic importance of western botanic gardens came to an apogee in the imperial expansion of other European nations too. The gardens in the home countries became not merely the repository of the flood of new ornamental and medicinal but also of many other economic plants. And not merely the repositories – following the breadfruit example they and their satellites became the sorting-houses and trial grounds for what was to become the mass transportation of economic plants to other countries in the expanding empires. With increasingly sophisticated glass and heating technologies, these imperial centres assumed a crucial role in the economies of the colonizers and the colonized.

From the Jardin du Roi, later the Jardin des Plantes in Paris, to the Hortus in Amsterdam, but perhaps supremely to Kew, what have become the major plantation crops of much of the tropical world were introduced and propagated to be sent on to an increasing network of dependent new gardens in the colonies – to Mauritius, to Calcutta, to Singapore, to Java, to Sydney, the Caribbean. And so cork trees from the Mediterranean reached South Australia via Kew as did the better-known quinine from South America to India and rubber-trees from the Amazon reached what is now Singapore and Malaysia via Kew; coffee from Ethiopia was introduced to South America via Amsterdam, vanilla from Mexico to Madagascar via Paris.

Associated with this, began a huge world-wide project of documentation in the form of herbarium specimens. It is remarkably convenient for us then that the natural support tissues and defence compounds of land-plants allow them to be preserved in this way – lignin, cellulose and tannins make for long-lasting specimens, something that was noted 500 years ago in Italy, though the pressing of certain plants and inserting in books to keep out insects had been known long before in China for instance. And so they were needed for teaching in universities, notably in Europe to help train those going out to work in overseas territories, especially those concerned with forestry and agriculture, only latterly with conservation. Of the UK's 116 botanic gardens, 13 are now attached to universities, especially the oldest foundations. That there are about 115 universities in the UK, though, shows that this is no longer seen as a priority. Of the 459 listed herbaria in the UK, less than 10% are associated with universities and many of those are effectively mothballed. Only a handful of UK universities, surprisingly including some of the oldest and most prestigious, are actively using them for teaching and research.

Beginning as documenting, and then accumulating private herbaria put together by those interested in cabinets of curiosities, public herbarium collections in botanic gardens began to represent records of the flora of the world just as the grounds and greenhouses of botanic gardens were beginning to display increasingly plants for their own sakes. But beyond the private collection of Aiton, Kew had no herbarium, that of Sir Joseph Banks in central London being the repository for dried specimens.

The death of Banks and of George III in 1820 led to less patronage for the royal gardens, though through what has been seen as a somnolent time for Kew, good science was being done, in that Banks's legatee, Robert Brown, one of the first British botanists to study the Flora of Ethiopia, worked at

Kew with Franz Bauer, Banks's botanical artist in residence from 1790 (and with a pension from him until 1840), building on his own microscope work to disentangle the phenomena surrounding fertilization in plants, notably orchids - and this was to inspire Charles Darwin carrying this work forward after Brown's death in 1858. But in the 1820s, funds were reduced, and soon there were public criticisms of the management; eventually there was an inquiry to which John Lindley, then Professor of Botany in the new University of London raised the potential significance to the 'mother country', leading to the transformation from a private royal garden to a national botanic garden, the first the country had ever had, with William Hooker, Professor in the University of Glasgow, as its Director from 1841 - a post for which he had been angling for almost 20 years - and who was later to campaign and scheme to get a post for his son Joseph, eventually to become his successor as Director.

Also in 1848 came the first museum and by 1850 there were 180,000 visitors a year to the gardens, rising to 500,000 by 1865 (1.3 million today). There was still no public herbarium or library but William Hooker made his own, perhaps the largest and most comprehensive in private hands, available to visiting scientists. Then in 1852 a private herbarium and library came to Kew and, with its first curator, opened in 1853 in the oldest part of what is still the herbarium. In 1854 came George Bentham's herbarium and library; in 1865, William Hooker's library and herbarium was purchased.

But Kew had a wonderful garden too. With increasing leisure in western countries and the rise of both private and public ornamental horticulture, working men's flower-clubs, royal pleasure-gardens, and the importance of civic town-planning - especially the provision of public parks, as society became increasingly urbanized and disconnected from the countryside, botanic gardens moved into this new area too - but sometimes under duress.

So in 1851, within ten years of Kew's being put on a scientific footing, the First Commissioner of Works and Public Buildings, Kew's new master, insisted that Kew not buy items at the Aiton family's sale of precious things documenting the Gardens' early science and horticulture. This Commissioner's successors considered Kew to be a place primarily for public recreation, chastising Hooker for the lack of enough ornamental flower beds, leading to what Sir Joseph Paxton called a 'gaudy flower show' and the provision of plant material for other public parks. Display seemed to be tipping out science and the Kew Gardens Public Rights Defence

Association in 1877 forced morning opening against the Director's wishes.

Even before this, the future of Kew as a scientific organisation had been in serious jeopardy in 1868 when, as today, reduction in public expenditure was the policy of the government, though major scientific advances were being made. In 1872 Richard Owen, an opponent of Darwin in the evolution debate and Director of what was to become the Natural History Museum, proposed the move of the scientific collections to his departments. Only by pressure from the nation's scientists including Darwin, as well as public opinion in the newspapers, did the government relent.

The Hookers' retaliation came in the form of playing to the imperial ambitions of Great Britain with the writing of a whole series of colonial floras, effectively in aggregate a 'botanical survey of the Empire', beginning with the West Indies and Hong Kong (by Bentham), following on from Hooker senior's *Flora Boreali-Americana* (1829-40) and junior's work on New Zealand and Tasmania. Then came Australia (Bentham yet again) and India, right up to today the regional Floras of parts of Africa written in conjunction with scientific organisations in the countries themselves.

And as the colonies gained independence, they often established their own gardens like those in Britain and other colonial centres, so they were founded with a display, public education and to a lesser extent trial-ground functions right from the start, though the balance between public access and scientific work is still a big question – as it long continued to be at Kew.

The economic-scientific endeavour at Kew led to an enormous influx of material leading to the first expansion of the herbarium (there have been four more since), and the beginning of *Index Kewensis* which was nearly named *Index Darwinianus*, after Darwin whose legacy funded it to begin with. Then came the building of the first Jodrell Lab for physiological botany. The imperial projects under Assistant Director Thiselton-Dyer, to become Hooker's son-in-law and successor, led to the publication of the forerunner of the *Kew Bulletin* to channel information on economic plants to colonial administrators.

The economic side of Kew has never disappeared, during World War II for example, the herbarium worked on practical matters such as the taxonomy of roses so as to ensure correct identification of species with the highest levels of vitamin C when *Citrus* was unavailable through the Nazi blockade. Investigation of rubber from *Taraxacum* spp. was carried out in the Jodrell, which today covers all investigations of a lab basis from palynology and

wood anatomy to molecular phylogenetics besides the biochemistry of economically significant plants, research in conjunction with pharmaceutical and other companies worldwide.

Today Kew has the largest mycological herbarium in the world, housed in the Jodrell, and two botanical art galleries. It occupies two sites, the older in the organisation being the 132 ha in south-west London, the newer managed on behalf of the National Trust, Wakehurst Place of 200 ha in the countryside in the Sussex countryside south of London. The organisation currently employs getting on for 1000 people and has hundreds of volunteers. It has a budget of £52 M a year, half of which comes from the state. The 1.3 M annual visitors to Kew provide an essential source of self-generated income.

It has now become an organisation focused on conservation and restoration, still with a worldwide reach, whilst also being a World Heritage site since 1998 – the balance between its conservation mission and the burden of maintenance of heritage buildings often a difficult one. The Millennium Seedbank set up ten years ago at our country site, Wakehurst, is a tangible example of progress being made in providing tools for both conservation and restoration worldwide. Notable are Kew's efforts in the UK Overseas Territories, many of which are islands with fragile ecosystems, but also at home and working with over 100 countries worldwide in a collaborative basis.

Kew's work is now embraced by its Breathing Planet Programme where the fundamental work is driving discovery and global access to information on plants and fungi and the gardens are being transformed into vehicles to inform and inspire, to explain the importance of plants in all aspects of our lives. In a recent survey in another botanic garden 21% of visitors were seeking relaxation, 18% peace and tranquility – such results are typical of surveys conducted around the world. As St Thomas Aquinas wrote, 'You change people by delight; you change people by pleasure', so relaxed visitors are more receptive to overt or subtle messages. There is a huge market for these issues: the challenge therefore is to make the 'green wallpaper' created by the living collections tell a story.

Long-lived institutions like university gardens are more readily able to deal with long-term projects than, say, some research groups – and some plants, notably trees, are long-lived organisms. Botanic gardens and arboreta can take a long view. However, I remember a particular head of a Botany Department in England bragging that for him a plant was so much green

extract in a bottle. Such clever remarks seem like Neronian fiddling when we consider the plight of the world's plants and indeed ecosystems in general. Botanic gardens, rather than science departments in the narrow sense, have therefore found themselves increasingly concerned with not merely educating people about conservation but now actively practising it, in all kinds of ways.

Breathing Planet Programme

1. Driving discovery and global access to information on plants and fungi.
2. Identifying species and regions at high risk.
3. Helping global conservation programmes on the ground.
4. Growing locally appropriate species for a changing world.
5. Safeguarding 25% of species through the Millennium Seed Bank Project.
6. Building a global science network to restore damaged habitats.
7. Using botanic gardens to inform and inspire.

But no one garden can or should pretend to be able do this alone – and Kew is no exception. From the megalomania of Princess Augusta, the empire-building of Sir Joseph Banks, and the caché of Imperial Kew before 1914, has come an organisation dedicated to using what we have in terms of expertise and collections to help build capacity and bring practical outcomes to peoples in many parts of the world.

At the pure science end, we have Mark Chase heading up the Angiosperm Phylogeny Group, and the coming together of many of Europe's major herbaria to build on that to agree a successor to Bentham and Hooker's classification for use in herbarium, library and garden (Fig. 1). Working with Missouri Botanical Garden and others, we have The Plant List as a tangible effort within the aims of the Convention on Biological Diversity in The Year of International Biodiversity and the announcement of a Sampled Red List for Plants as a barometer of conservation success in the future.

Vascular Plant Classification Committee (2009)

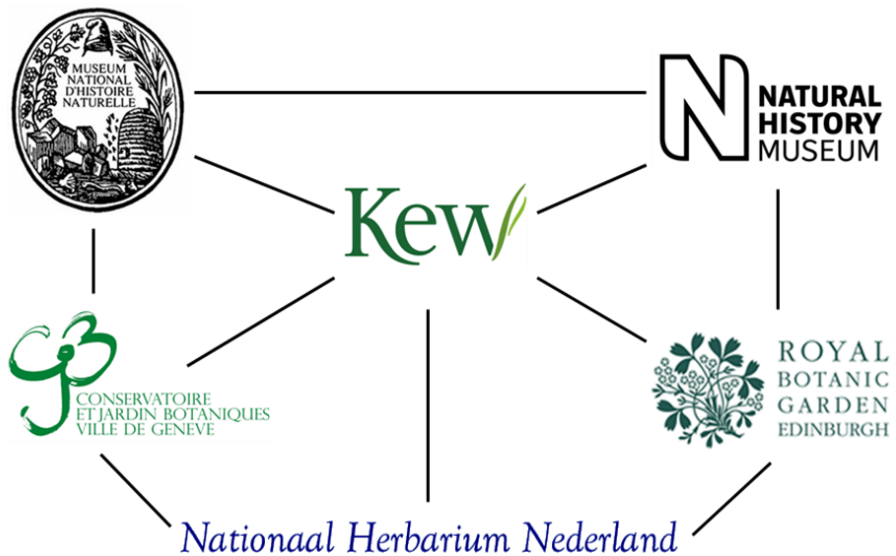


Fig. 1. Member organisations of the international Vascular Plant Classification Committee, formed in 2009 in order to reach a widely accepted consensus on collection arrangement. Image © Royal Botanic Gardens Kew.

We have streamlined our research structures and increased collaboration in line with the Breathing Planet Programme and continue to work with organisations throughout the world but are focusing our effort on those with limited capacity at the moment, though we are thrilled to be part of international projects initiated by others, such as the Flora of Ethiopia Project, and with other London museums are working with overseas organisations as part of the World Collections Programme.

The importance of public education about plants in the West is increasing as school and university curricula become apparently inexorably depleted of plant content. University departments of botany become amalgamated with others so that in some universities the plant 'voice' has become lost altogether. With human fascination with technology and its applications in biological science, there has inevitably become a crowding in of studies at the molecular end of the subject, part of this perhaps appeasing the 'physics envy' felt by the so-called soft(ish) sciences. Basic training in plant science seems old-fashioned by comparison; and there is only a certain amount of

time for a student to absorb information and techniques - though all this could be said of learning to add up or subtract – plant scientists need the basic building blocks. Kew is extremely concerned that with increasing affluence and urbanisation there is an increasing plant illiteracy, not just in the West where we have set up The Great Plant Hunt (Fig. 2), now being rolled out overseas too.



Fig. 2. The Great Plant Hunt is a Kew-led initiative to raise awareness among school children of the importance of plants. Image © Royal Botanic Gardens Kew.

Kew has come a long way since Princess Augusta or indeed 1913 when the Suffragettes looking to raise their profile in campaigning for votes for women descended on what was seen as an elitist organisation entirely funded by government, smashed the greenhouses, destroyed orchids and even burned down the Refreshments Pavilion. Indeed we increasingly rely less and less on government funding (now around 50%) so that fund-raising becomes everyone's business. No doubt this will lead to compromises on the science versus recreation front, but we believe that the Breathing Planet Programme allows us to deal with our local issues in that regard without jeopardizing our international obligations as a major botanic garden organization in the twenty-first century.

We are at your service.

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