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RHS Level 3 Certificate in Plant Growth, Garden Planning and Applied Propagation

Courses for RHS Qualifications

Topic 2: Plant Knowledge

Topic overview: from the RHS syllabus

The plants that are cultivated within both historic gardens and landscapes, and those used within wider green spaces, are the result of exploration and plant collecting. It is important that horticulturists understand the process of plant introductions. This includes historical contexts, along with the introduction of plant material that is being wild collected through current exploration.

The horticulturist who is engaged in the management of these living collections is often involved in researching various topics to inform plant husbandry. This research involves developing skills relating to the use of reliable information sources, along with a knowledge of international standards of plant nomenclature. Areas of research include; origin and natural habitat, folklore and use in medicine, biodiversity ratings and conservation status.
This information is applied in the selection of species, in the management of living collections and horticultural interpretation.

The management of living collections involves the management of data, and the use of plant records to collate data and inform future management decisions

The content for each topic in the qualification is set out in a series of Assessment Outcomes. An outcome is what you should know after studying a specific part of the syllabus.

There are four overarching qualification wide outcomes that need to be considered for all topics, these are:

- **Health and safety**
- **Sustainability**
- **Best practice**
- **Equality and diversity**

These will be signposted as appropriate throughout your course notes.

This topic consists of four Elements. There are three Assessment Outcomes within this element, A01, A02 and A03.

AO1 is the basic knowledge, AO2 how it is used and AO3 looks at how this element relates to other areas of horticulture and in particular to other areas of the syllabus These are what you should know once you have studied this element. They have been set out in the table on the next page, along with the RHS commentary.

AO3 will be examined at the end of the Unit as it brings together all the topics.

Element 1: The role of exploration on plant diversity		
AO1: Knowledge	**AO2: Application**	**AO3: Integration**
The process of plant introductions to British gardens from the 16th to the 21st Centuries. The impact of plant exploration and introductions on: • world populations of people • world populations of plants • gardens in Britain	The advantages of wild collected plant material with regard to resilience, genetic diversity and conservation. The regulation and ethical implications on the collection of plant material from the wild e.g. Convention on Biological Diversity, Convention on International Trade in Endangered Species (CITES). The impact of wild collection on biodiversity.	The impact and importance of exploration and plant introductions on horticultural heritage.

Commentary

AO1 allows the learner to study the process of plant introductions, along with their impact on the world and on gardens.

AO2 considers horticultural practices today including the regulation and ethical considerations of wild collection.

AO3 moves on to consider the impacts of exploration, and the introduction of new plant material on horticultural heritage. This includes the concept that new plant introductions contributed to the development of style within gardens. These gardens are now often considered to be heritage sites. The concept and the argument that when undergoing development work, the palette of plants should be based around plants of the period. Qualification- wide outcomes. For example sustainability and the changing climate can be applied to offer opposing concepts to determine plant selection strategies.

Introduction

Topic 1 explored the many influences on the development of gardens. One of these influences is the role of plant explorers and introductions which will be looked at in more detail here. The indigenous plants of Britain are wonderful and valuable, but relatively few in number. There were only a few hundred plant species a thousand years ago. The British temperate climate has been ideal for the introduction of many plants from all over the world. For the plant introductions that didn't suit the climate, great efforts were made to accommodate them in glasshouses, or rock gardens.

The general movement of plants around the world is also explored with its impact on world populations. These have sometimes been beneficial, bringing valuable new crops to a country. At other times it has resulted in exploitation.

The movement of plants via humans has also had major effects on the indigenous plants of different countries. There are regulations in place to protect biodiversity from both over collection of plants, and the introduction of plants that may cause problems.

A short history of plant introductions to British gardens

Most of the plants arriving in Britain up until the mid 16th century came from Europe, particularly from the Mediterranean.

Clematis viticella was introduced at the end of 1560s by Hugh Morgan (c.1540 -1613) who was apothecary to Queen Elizabeth I and had two botanic gardens in London.

Lavandula dentata and *L. stoechas* arrived in the 16th century from the Mediterranean.

Nigella damascena arrived in Britain from the Mediterranean in 1570.

Laburnum anagyroides arrived from Southern Europe and Asia around 1560.

John Gerard (1545 – 1612) the English herbalist, listed some of the plants that arrived in his *Catalogue* of 1596 and *Herball* of 1597.These include *Catanache caerulea* and a note that he received the seed from Padua. He received *Astrantia major* from Austria and *Eranthis hyemalis* from southern Europe.

Primula auricula is thought to have been brought over by the Huguenots at the end of the century, when they were fleeing persecution in France. *Tagetes patula* originated in Mexico, but is another plant that is thought to have found its way to England via the Huguenots. Some plants from Asia, Africa, India and the Americas were finding routes across to Britain.

John Tradescant the elder (c1570 – 1638) and his son John Tradescant the Younger (1608 – 1662) were both Royal gardeners. They travelled to Russia, Africa and N.America and introduced several important plants to Britain. These include *Liriodendron tulipifera, Tradescantia* x *andersoniana* and *Taxodium distichum.*

The history of plant introductions to British gardens is closely linked with general exploration of the world, trade, colonialisation and empire building. Earlier expeditions were part of famous historical voyages. Then they were associated with botanic gardens such as Kew, and the Horticultural Society (later to become the Royal Horticultural Society).

The Royal Botanic Gardens, Kew sent plant hunters all over the world and invested heavily in the study of new plant introductions. Kew also started transferring economically important plants between countries. This resulted in the establishment of plantations in British colonies of plants such as rubber, cinchona (quinine) and tea.

The era of sponsorship by wealthy country garden owners and nurseries followed. A few of the expeditions were also privately funded.

As you explore the stories of the plant hunters you can also follow the story of garden styles and fashions. Many of the plant introductions started different styles, and many were to supply an increasing demand for plants to suit the different styles. These include the Victorian shrubberies, rock gardens, bedding and conservatories displaying exotic plants. The woodland gardens filled with rhododendrons followed. A fashion for particular plants has fuelled plant movement, often resulting in a loss of species and biodiversity in its natural environment. These fashionable plants have included Tulips, rhododendrons, bulbs and ferns.

Plant hunting does continue today, but generally without any wealthy patrons and not on the same scale. It is controlled by legislation, although illegal plant hunting takes place.

It is important to remember when discussing plant 'discoveries' and 'new plants', that these plants were generally just new to the explorers. They were already very familiar to indigenous people.

The plant hunters often faced lengthy sea crossings and dangerous conditions when they arrived. They had huge adventures and amongst the danger, some amazing sights. The names of the plant hunters are often familiar as so many plants have been named after them.

There has also been widespread movement of cultivars with changing fashions. The bedding plants bred in Victorian times with their new knowledge of genetics quickly became fashionable. This movement is still taking place today. Flower shows fuel new fashions.

Francis Masson (1741 – 1806)

The expeditions of Masson were linked with famous voyages and Kew Gardens. Masson joined Captain Cook for his second circumnavigation to explore new territories.

Joseph Banks had met with King George III to try and persuade him to build up a collection of plants at Kew. Originally, it was Banks who was supposed to be travelling with Cook, but after a disagreement, the first official plant hunter for Kew was chosen as Masson.

Masson set off in 1772 on the HMS Resolution and spent three and a half months at sea before landing at Cape Town, S. Africa. He spent the next 34 years of his life plant collecting on various expeditions.

Cape Town was an emerging colony at the time, under the control of the Dutch East India Company. Masson collected seed of 'so many beautiful species of Erica which have succeeded so well in the Royal Gardens at Kew'. He found a rich flora in the area, particularly the Hottentot Holland Mountains.

The Swedish botanist Carl Per Thunberg heard that Masson was in S. Africa and persuaded him to join him on a trip to Blaauberg, Western Cape. Thunberg was known as an 'apostle' of Linnaeus. They ended up spending four and a half months on this trip and covered 1.000 miles on horseback. They arrived back at Cape Town with all sorts of treasures that Masson sorted and dispatched to Kew. These included *Strelitzia reginae, Protea grandiflora* and *Ixia viridis.*

On his next trip he collected *Quaqua incarnata (*syn*. Stapelia incarnata*), *Amaryllis belladonna* and *Lithops* spp.

In 1778 Masson travelled to Madeira, Tenerife and the Azores. Here he was imprisoned by the French and endured a hurricane. He did find *Jacobaea maritima* (*syn.Senecio cineraria*) there!

The next trip took him back to Cape Town. Britain and Holland were at war, so conditions were difficult for him in the Dutch colony. It didn't stop him plant hunting and he sent back seed of 176 species including *Zantedeschia aethiopica.*

A North American trip in 1797 involved a raid by French pirates, but seed of *Trillium grandiflorum* was collected to send back to Kew.

Sir Joseph Banks (1743 – 1820)

Sir Joseph Banks was an influential scientist. Rather than taking the Grand Tour around Europe, he decided to take a Grand Tour around the World. In 1766 he set off as the naturalist aboard the Fisheries Protection Vessel, HMS Niger. This was a seven month survey of Labrador and the Newfoundland coastland.

This trip formed the basis of his herbarium which can be seen today in the British Museum of Natural History. They are in the original mahogany boxes that he used. Although he was only bringing back pressed plant specimens, his travels set the scene for expeditions to come and increased the scientific knowledge of plants.

After the first trip, he then joined a ship under Captain Cook organised by the Admiralty and Royal Society. This voyage was for astronomical purposes – to observe the transit of Venus. It was also an opportunity for Britain to monitor its colonial rivals – Holland, Portugal and Spain. A secret mission was also added by King George III. They were to seek out the fabled land of *Terra Australis*.

Banks had to fund his own way, and paid £10,000 to join the expedition – a huge sum. In 1768 he set out on the Endeavour. On route he found several *Passiflora* spp. in Rio de Janeiro. Another find was *Gaultheria shallon,* in Tierra del Fuego.

Cook observed the transit of Venus and then it was time for the secret mission. After three months, land was finally spotted. This was North Island, New Zealand. Here a treasure that Banks found was *Phormium tenax.* In 1770 they finally sighted *Terra Australis*. They landed in a bay that had such rich flora, Banks called it Botany Bay.

The voyagers then returned via S. Africa. Banks recorded his disgust at the bad treatment of slaves there – not all colonial people agreed with the enslavement and often brutal conditions. Banks received a hero's welcome when he returned to England and then set about studying his collection.

The collection consists of dried plants. There were no seeds or plants to propagate from. The information and knowledge provided was immense though and provided an insight for other plant explorers.

Other important plants he found include *Leptospermum scoparium, Hebe elliptica, Veronica elliptica, Banksia integrifolia, Callistemon citrinus* and *Melaleuca citrina.*

David Douglas (1799 – 1834)

Douglas is credited with introducing over 200 new species, in particular many of the tall conifers which have had such an impact on British gardens and landscapes. Douglas explored some of the vast areas in North America in his expeditions where many of the conifers came from.

Britain only has three indigenous conifers – *Taxus baccata, Pinus sylvestris* and *Juniperus communis.* Parks, gardens and arboretums in Britain today have a huge array of conifers, many of which were introduced by Douglas. Themed gardens became popular in the 1830's, often including an American garden to display these new conifers.

In 1820 Douglas started a new job at the Botanic Gardens, Glasgow and William Hooker started there as a Professor of botany. William Hooker later became the first director of Kew.

In 1823 the secretary of The Horticultural Society of London (now the Royal Horticultural Society) asked Hooker to recommend a suitable botanical collector to work for the society. Hooker recommended Douglas for the role. These trips were paid for by subscriptions from wealthy members. The Horticultural Society at the time had its garden in Chiswick, which received seed from the expeditions.

The first expedition was supposed to be to China. This was abandoned due to political unrest. Instead, Douglas was sent to New England on the east coast of N. America. His travels were full of disasters but his plant collecting prolific. Douglas sent back seed of veronicas, liatris, solidago and asters. He collected *Saracenia* spp. from the swamps by the Hudson River.

The kitchen gardens of country houses in Britain benefitted from new varieties of plum, peach, apple, pear and grape.

The next trip took Douglas with the Hudson Bay Company Ship to the mouth of the Columbia River on the Oregon/Washington border. The indigenous Americans were wary to start with, but he developed a rapport with them.

Important finds here included *Gaultheria shallon, Ribes sanguineum, Pinus ponderosa, Erythronium grandiflorum* and *Mahonia aquifolium* (Oregon Grape).

The last expedition was to the west coast of America. Here Douglas found *Abies grandis, Pinus radiata, Sequoia sempervirens* and *Abies procera.* He unfortunately had an untimely end after falling into a pit.

Robert Fortune (1812 – 1880)

Robert Fortune, a Scottish plant hunter, spent nearly twenty years exploring the Orient. Trade between Britain and China was difficult and resulted in the Opium Wars, 1839 - 1842.

Opium and tea

The roots of the Opium War (or First China War) lay in a trade dispute between the British and the Chinese Qing Dynasty. By the start of the 19th century, the trade in Chinese goods such as tea, silks and porcelain was extremely lucrative for British merchants. The problem was that the Chinese would not buy British products in return. They would only sell their goods in exchange for silver, and as a result large amounts of silver were leaving Britain.

In order to stop this, the East India Company and other British merchants began to smuggle Indian opium into China illegally, for which they demanded payment in silver. This was then used to buy tea and other goods. By 1839, opium sales to China paid for the entire tea trade.

Chinese resistance

The Chinese wanted to stop the trade. Although opium was valued as a medicine that could ease pain, assist sleep and reduce stress, by 1840 there were millions of addicts in the country. Illegal opium imports were also eroding what had once been a favourable balance of trade.

Chinese efforts to end the trade were initially successful. In May 1839 they forced the British Chief Superintendent of Trade in China, Charles Elliott, to hand over the stocks of opium at Canton for destruction. This outraged the British, and was the incident that sparked conflict.

Free Trade

The war ended on 17 August 1842, with the Treaty of Nanking enabling the British to 'carry on their mercantile transactions with whatever persons they please'. The treaty committed the Chinese to free trade, including the trade in opium.

Hong Kong was ceded to Britain, and the Treaty Ports of Guangzhou, Amoy, Foochow, Shanghai and Ningpo were opened to all traders. The Chinese also paid reparations.

The ease with which the British had defeated the Chinese armies seriously affected the Qing dynasty's prestige.

This contributed to the Taiping Rebellion (1850-64). For the victors, the Opium War paved the way for the opening up of the Chinese market.

National Army Museum

Before this, some plants from China had been introduced, such as *Hydrangea macrophylla*, *Paeonia suffruticosa* and chrysanthemums. In 1804, William Kerr had been sent by Banks and returned with *Kerria japonica.* John Reeves had sent back seed to the Horticultural Society in 1816 and is credited for introducing *Wisteria sinensis.*

After the Opium Wars trade routes were opened and this made it easier for plant hunters to join trips and start collecting from a vast new resource. Fortune now started collecting on behalf of the Horticultural Society in Chiswick. As well as wild collecting, he also obtained plants from Chinese nurserymen.

The Horticultural Society wanted Fortune to look in particular for hardy plants, but also orchids, aquatics and several specific requirements such as blue peonies!

Fortune took with him Wardian cases – specially designed portable glasshouses to improve the chances of plants survival in the long crossings. Many precious cargoes of plants had been damaged or lost before.

Wardian cases were invented by Nathaniel Bagshaw Ward in the 1830's.

.Fortune had great respect for the Buddhist priests. He visited a temple outside Ningpo, but fell into one of the pits that were dug and camouflaged by the priests to protect the temple. Fortunately, he managed to get hold of a branch, and was then rescued.

Plants that were collected by Fortune in China include *Viburnum plicatum*, *Weigela florida, Jasminum nudiflorum* and *Lonicera fragrantissima.*

Fortune made further trips to China and then the USA. His fifth trip was privately funded and he set off for Japan. His introductions include *Cryptomeria japonica, Mahonia japonica* and *Anemone hupehensis* var, *japonica.*

One of his most important legacies was the transfer of tea plants from China to India. He brought back many plants useful for winter display and over 120 new species.

William Lobb (1809 – 1864) & Thomas Lobb (1811 – 1894)

William and Thomas Lobb were employed by the Veitch nursery, first at Killerton, Devon and then at Exeter. They were the first plant collectors to be sent out by the nursery. In 1840 William Lobb boarded HM Packet Seagull at Plymouth bound for Rio de Janeiro. The packet ships were useful for plant collectors as they carried both packets (cargo) and people. These had more comfortable conditions than many of the other ships. Thomas Lobb was also given an annual allowance of £400 on his travels which lasted four years.

William Lobb was instructed by his employers to look for *Araucaria araucana* in Chile and send back seed to the nursery. He did so, but also sent back seed to a former employer – Sir Charles Lemon at Carclew.

A successful introduction from Chile was *Desfontainea spinosa.* Introductions from the Chiloe Islands, Chile included *Berberis darwinii, Embothrium coccineum, Crinodendron hookerianum, Tropaeoleum speciosum* and *Myrtus luma.* These plants all suited the mild Cornish climate and so prospered at the Veitch nursery and local country estates. They also brought some vivid colours to British gardens!

William's third trip was to San Francisco, where he found the impressive *Sequoiadendron giganteum.* This was coveted by Victorian garden makers. A further conifer find that proved popular was *Thuja plicata.*

Thomas Lobb set off from Portsmouth in 1843 to the East Indies in the search for tropical plants. Thomas collected many orchids and rhododendrons. Only a few of the *Vanda coerulea* that he transported back survived, but those that did fetched large sums of £300 each. A mania for orchids to display in the Victorian glasshouses and conservatories was developing.

Sir Joseph Dalton Hooker (1817 – 1911)

Joseph Hooker was an important botanist of the 19th century and a close friend of Charles Darwin. He became the second director of Kew.

Hooker joined Captain James Clark Ross on the HM Discovery ship - Erebus. This was a British Association expedition to the Antarctic. Ross had the task of pinpointing the magnitude of the South Pole. Hooker's role was that of assistant ship's doctor and botanist. There were two ships on the voyage, and they met with icebergs and collisions, but survived and the trip was a success.

On route they visited the Cape of Good Hope, Tasmania, New Zealand, the Falkland Islands and the southern tip of S. America. Hooker's notes provided vital information for Darwin's work on evolution.

The next trips began to fuel the British passion for rhododendrons. In 1847 he set off to Sikkim in the Himalayas. This was an expedition for Kew Gardens. Here he collected *Rhododendron argenteum* (syn, *R. Grande*), *R. thomsonii, R. cinnabarinum, R.dalhousiae* and *Magnolia campbellii*. Hooker spent six weeks sorting out his collection to send back to his father at Kew.

On his second trip out he found *Primula sikkimensis* and *P. capitata.* He also collected seed from a further 24 species of rhododendrons on the Chola Pass. Misfortune fell and he was

imprisoned for a while with an associate. However, they were freed and on his return to Darjeeling collected the orchid *Vanda coerulea.*

One of the nurseries that was successful in propagating the rhododendron seed from his later expeditions was Bagshot Nursery. The craze in rhododendrons suited late 19th century gardens with mixed planting of shrubberies and woodland. Introduced plants were grown amongst indigenous trees and shrubs.

Hooker was a key figure in the introduction of many Himalayan rhododendrons which can be seen as mature specimens today. He also aided the growth of the British Empire with the distribution of economically important crops around the colonies.

George Forrest (1873 – 1932)

George Forrest spent twenty eight years plant hunting in China. He was employed by the Royal Botanic Gardens Edinburgh in their herbarium.

In 1903, Arthur Kilpin Bulley asked the regius keeper (royal keeper), Professor Balfour, to recommend a plant hunter to travel to China. Bulley was a wealthy merchant who wanted a collection of plants at his garden at Mickwell Bow, Ness. This is now the Liverpool University Botanic Gardens. Forrest was recommended for the role.

In 1904 Forrest left to explore S.E. Tibet and N.W. Yunnan in Western China. This proved a good collecting area with varying habitats, from deep valleys to high spurs cut by rivers, grassland plateaus, hillsides and isolated areas keeping genetic differences in plants.

Forrest respected and befriended the local people. Rather than exploitation, he paid for thousands of Yunnan Chinese to be vaccinated against smallpox. He was, however, caught up in hostilities and political turmoil and civil war. In 1906 he returned home with many seeds, roots and plants, including *Primula bulleyana* and *P.viallii.*

Forrest made six more excursions. The last three were sponsored by the Rhododendron Society. This was the time of a mania for rhododendrons! Introductions include *Rhododendron sinogrande.* Another notable introduction was *Gentiana sino-ornata.*

Frank Kingdon-Ward (1885-1958)

Frank Kingdon-Ward made twenty two journeys to Burma, Tibet and Assam. He was the chair of botany at Cambridge University but gave this up when the American zoologist Malcolm P. Anderson asked him to join him on an expedition over central and western China to South Kansu. Anderson was to collect animal species and Kingdon-Ward was to collect plants which he later donated to the Botany School at Cambridge.

In 1911 he was asked by Bulley to plant hunt in the Yunnan. Forrest had been asked originally, but had moved to work for J.C. Williams at Caerhays in Cornwall. Although he was reported to feel lonely on his travels at first, he became entranced by the wild Chinese landscape which he called ‘The Land of the Blue Poppy’. This is the title of one of his many books about his plant hunting.

Kingdon-Ward sent back several *Meconopsis* spp. including *M. baileyi* although many didn’t thrive.

Other plants included *Rhododendron wardii, Lilium wardii,* and *Primula florindae*.

In 1926 Kingdon-Ward made further visits to N. Burma sponsored by a wealthy group of garden owners. This group included Lionel de Rothschild who was developing a famous collection of rhododendrons at Exbury, Hampshire.

Plants he collected here included *Cotoneaster conspicuous* and *Rhododendron macabeanum.*

Reginald Farrer (1880 – 1920) and the rock garden

Reginald Farrer had a long standing interest in alpine plants. He went on several plant hunting expeditions, to the Alps, Japan and Sri Lanka.In 1907 he wrote he first of several books on alpines and rock gardening – 'My Rock Garden'.

His next trip in 1914 -1916 was to China. He was accompanied by William Purdom (1880 – 1921).

The second trip to China was with Euan Cox (1893 – 1977) who was famous for collecting and breeding rhododendrons.

Farrer introduced several important alpine plants and fuelled the Victorian passion for creating rock gardens. Examples of the alpine plants he introduced include *Gentiana farreri* and *Geranium farreri.*

Farrer also introduced several other valuable garden plants, including *Potentilla fruticosa* and *Rodgersia aesculifolia.*

Case Study – Ernest H. Wilson (1876 – 1930), extract from research by Jenny Shukman

Ernest Wilson is often considered one of the greatest plant hunters, having huge influence in the shape of our gardens today. This is particularly related to his introduction of hardy plants. The following is an extract from a study into this significance:

The Plant Introductions of Ernest H. Wilson: Factors of Significance for Historic Garden Conservation

Introduction

Gardens have been shaped by many factors throughout history. These factors range from aspects such as politics, economics, peace and fashion to the role of influential people such as designers and architects. A basic influence which is often overlooked is simply the availability of different plants.

The importance of the conservation of historic gardens is gradually being recognised in its own right, rather than an afterthought to building conservation. The role of plants in the creation of these gardens often appears overlooked as a factor of significance for conservation. The main emphasis appears to focus on other factors, although also significant themselves, such as structures, influential designers and examples of garden styles.

Britain has a restricted, although important and beautiful range of native flora, due in the main to the last great ice age. The climate of Britain has, however, enabled a vast range of exotic introductions to thrive. The efforts of many plant hunters throughout history have resulted in a vast range of plant introductions which have significantly changed the character and substance of British gardens.

Whereas all of these plant hunters have played a role, some made more of a significant impact than others. Ernest H. Wilson, (1876-1930), was one of the most prolific and influential of all the plant hunters, introducing over a thousand plants to British cultivation. The majority of gardens today will have representatives or offspring from his introductions. There are many plants in important gardens today, both rare and popular, that can be directly linked to Wilson. A far greater number, also, are more than likely to be direct descendants of seed that he collected. For example, most of the plants of the popular *Sarcococca hookeriana* var. *digyna*, are represented by plants from seed that Wilson sent back from west Sichuan in 1901. Likewise, most of the more uncommon *S. ruscifolia* var. *chinensis* in the Western world, owe their existence to Wilson.

Many important gardens were shaped by particular plants introduced by Wilson, and a particular garden style evolved from the plants introduced in the era of which Wilson was a key player.

Sarcococca hookeriana var. *digyna* – a key plant in many winter gardens today

Wilson introduced numerous plants from China and Japan to the Western world. Although plant introductions from other parts of the world have played important roles in many English gardens, it is those from Asia that can be argued to have played the most significant role. English gardens found that the Asiatic species of genera already known to them, such as *Cornus, Magnolia, Prunus, Betula, Spiraea* and *Viburnum*, were all more successful than their American counterparts, familiar since the middle of the eighteenth century.

The opening up of China to the Western world allowed a huge and exciting influx of plants. This relates in part to the vast diversity of plants in the area. A particular area that Wilson collected in was Emei Shan (Mount Omei), in the Sichuan province. Described as 'calculated to set a plantsman's pulse racing', the mountain has in excess of three thousand different indigenous plants. This may be compared with a total of approximately two thousand native plants for the whole of the British Isles. Plants introduced from China in the early 20th century were described by contemporary garden owners as being very different from those cultivated in western gardens.

The role that Wilson played in the development of a range of gardens is immense. At the time of his introductions many garden owners were keen to display as many new plants as possible. The manner in which these plants were subsequently displayed varied enormously, some being planted without a great deal of thought to style or design. However, a particular style of woodland gardening, using exotic introductions amongst native woodland can be seen to have evolved directly as a result of the introductions. The development of a naturalistic style which incorporated exotic planting can be seen to run side by side with the ever increasing range of plants being introduced. Links with significant designers of the time become apparent, and a whole social network emerges. The era of major planting of exotics in such a manner was unique.

To celebrate and commemorate his influence as a plant hunter, a garden has been created in Chipping Camden planted exclusively with Wilson introductions.

Historical background

Wilson's plant hunting expeditions were set in an era of discovery fuelled by a desire of wealthy Victorians to display and show off as many treasures as possible from foreign countries.

Ernest H. Wilson was born in Chipping Campden, Gloucestershire in 1876. On leaving school at the age of thirteen, he took an apprenticeship at the nurseries of Messrs. Hewitt of Solihull. In 1892 he was employed by Birmingham Botanical Gardens as a gardener, also studying botany in the technical school. His next step was to the Royal Botanic Gardens, Kew, in 1897, combining this with studying for the Royal Horticultural Society Higher Grade Examination in Horticulture, and subsequently, botany at the Royal College of Science.

James Veitch & Sons, Chelsea, were interested in Chinese plant introductions and contacted Sir William Thiselton-Dyer, the Director of the Royal Botanic Gardens, Kew, to recommend a suitable candidate for a plant hunting expedition. Wilson was suggested for the role.

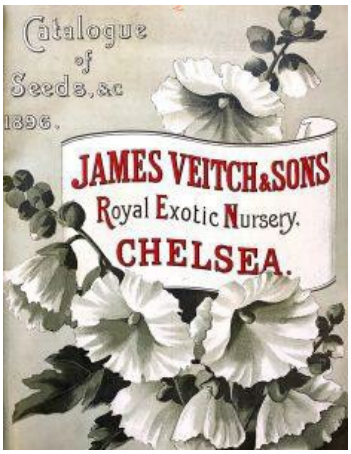
Veitch's nursery

Veitch's nurseries had their beginnings in Exeter in the late 1700's, started by John Veitch

(1752-1839). Sir James Veitch, (1815-1869), has been described as the originator of the Golden Age of gardening, creating a new enthusiasm for gardening and encouraging sponsors for expeditions to new and exciting areas. The Veitch Nursery played a significant part in the development of ornamental horticulture. Veitch's are acclaimed as the first nurserymen to send out commercial plant collectors, the first to collect in Japan, and the first to recognise the potential of China.

Sir Harry James Veitch, (1840-1924), was the 'fourth generation of the famous nursery dynasty'. By the 1850's the nursery at Exeter needed to expand and a site on the King's

Road, Chelsea, to be called the Royal Exotic Nurseries, was acquired. Sir Harry James Veitch moved to London to run this branch.



Sir Harry James Veitch searched for larger grounds to cultivate nursery stock, and leased 35 acres at Coombe Wood Nurseries, Kington Hill from the Duke of Cambridge. This land proved particularly valuable as different aspects and soil conditions existed, enabling a wide range of plants to be cultivated. The extensive grounds at Coombe Wood enabled customers to walk around and view a huge selection of hardy trees, herbaceous plants and roses. As satellite sites developed the Veitch family became responsible for several nurseries supplying Victorian Britain with an ever expanding palette of plants.

The main Chelsea nursery and its satellites at Coombe Wood and Feltham became enormously successful. The new introductions, the plant houses and the orchids became part of the social calendar and royalty, heads of state, eminent scientists, including Darwin, and high society all paid homage to the collections at Chelsea.

The Coombe Wood Nursery propagated and housed the majority of Wilson's early introductions. The lease for Coombe Wood expired in 1914, at the end of the great horticultural dynasty. The nursery stock at Coombe Wood was auctioned just as many of Wilson's original introductions were coming into the flowering stage.

'To my mind *Davidia involucrata* is at once the most interesting and beautiful of all trees of the north-temperate flora'.

Ernest H. Wilson

Wilson's expeditions

Wilson was initially engaged by Veitch's Nursery of Coombe Wood and Chelsea, undertaking two expeditions to China, from 1899-1902 and1903-1905, in search of hardy ornamental plants for British gardens. Two further expeditions were made to China under the employment of the Arnold Arboretum, from 1906-1908 and 1909-1911. Following this, Wilson collected in Japan from 1914-1915, and Japan and Korea from 1917-1918.

The destinations of Wilson's plant introductions

From the first expeditions of Wilson, seeds, cuttings and some living plants were sent back to the Coombe Wood Nursery for subsequent propagation and sale. Many also were sent to the botanic gardens such as Kew, along with herbarium specimens. There are many more destinations from the Arnold Arboretum expeditions and plants also reached Chenault's Nursery in France.

Although most gardens in Britain are likely to have some of Wilson's plants, and are therefore likely to have been influenced in some way in their development, there are clusters of gardens with stronger links. These have similar climates and edaphic conditions, or social networks encouraging the exchange or purchase of plants.

Many of the plants that Wilson introduced are particularly suited to woodland gardens, with a vast range of hardy trees and shrubs. An important group of gardens in the High Weald of Sussex all developed as a result of plant introductions of this era, with many particular associations with Wilson. These include Borde Hill, High Beeches, Nymans, Leonardslee and Wakehurst Place. Cornwall, with its mild climate also proved suitable for many of Wilson's plants, in particular rhododendrons, magnolias and camellias. Several woodland gardens therefore exist in Cornwall, such as Caerhays, which were highly influenced by Wilson's introductions. Irish gardens include Rowallane Garden and Glasnevin, with similar climates to Cornwall. A range of other gardens were found to be significant in Gloucestershire and Herefordshire, and to the south east, in Kent.

Coombe Wood Nursery sale

Although many gardens gradually developed as a result of acquiring plants as they were introduced, the sale of the Coombe Wood Nursery stock had a dramatic effect. There are many records of cartloads of plants being transported to gardens across the country.

Veitch's sale catalogue details thousands of Wilson's plants.

These include: *Clematis montana* var. *rubens*

''A new and lovely form of the much prized and well known *Clematis montana* introduced through our collector from the mountainous regions of Central China. It is perfectly hardy and flowered for the first time in the open ground at our Coombe Wood Nursery during the summer of 1903. In foliage and habit closely resembles the typical species, except in the leaf stalks and stems being purplish, but differs remarkably in the colour of its flowers which is a pleasing shade of soft rosy red. Price 10s 6d each'.

Clematis montana var. *rubens* and *C.tangutica* – seen covering many pergolas, walls and fences in gardens today.

'Clematis orientalis var. *tangutica* - a new species, recently introduced by us from China where it inhabits hedges and copses at considerable elevation in the province of Yunnan. Resisted 16 degrees of frost at Coombe Wood. Received First Class Certificate from the RHS March 10th 1903'.

The kiwi fruit, *Actinidia chinensis*, is listed under 'Choice and New Climbers'.

. . . it has not yet flowered in England, but in its native country it produces handsome yellow flowers 1½ inches in diameter, borne in clusters on dwarf shoots. These are succeeded by edible fruits having the size of walnuts, and the flavour of ripe gooseberries. Apart from its flowering and fruiting qualities it is a remarkably handsome plant and will be of great value on a pillar or pergola in the open garden. Price 5s and 7s 6d each.

The descriptions provide a valuable insight into the excitement of this vast range of new plants arriving, and help to explain the competition between garden owners that developed. The prices included, which garden owners appeared happy to pay, reflect the novelty and rarity of the plants, many of which are easily obtained today.

Chenault's Nursery

Wilson's plant introductions also found their way to France, to Chenault's Nursery at Orléans. Nursery catalogues from the era record many of Wilson's plants, tracing their introduction through the era.

From the 1913-14 catalogue:

'Clematis armandii. Large evergreen leaves, panicles of numerous pure white flowers, in April. 3s. 0d.

Berberis wilsonae. Of dwarf habit, with much branched stems, covered with glossy green leaves, rich golden flowers; fruits of a beautiful crimson autumn coloration. Highly decorative. Each 1/0 dozen 10/0'.

The 1924-25 catalogue:

'New Shrubs. Azalea De Kurume (*Rhododendron* Kurume) A new species recently introduced from Japan. Very hardy in the open, and very floriferous. The leaves are evergreen, small, round, deep green. The plants we offer raised from seed from the native country . . . may vary in colour from lilaceous mauve to carmine pink. Each 3/6; per 12 £2.00

Forsythia ovata. A new and distinct species native of Corea. Vigorous shrub with cylindrical boughs, oval green leaves. Numerous and early flowers, brilliant canary yellow, appearing in the first fine days of February. They open before others of the same species. Each 3/6; per 12 £2.00'

'Lilium regale (Wilson) Royal Lily. Beautiful Chinese species, easy to grow; the natives where it grows plant it on their roofs. Very large flowers, fragrant, the sepals are shaded with lilaceous pink on the outside, while the inside is nacreous pure white with a vivid canary yellow throat; orange yellow stamens. June. Each 1/6 per 12 16/-

The Sussex Gardens

Borde Hill

Borde Hill is a grade II* listed garden situated near Cuckfield, West Sussex, within the High Weald Area of Outstanding Natural Beauty (AONB).

The main gardens consist of a series of garden rooms, with a different atmosphere and style for each. At a greater distance from the entrance, unmade paths lead through slightly overgrown woodland. These areas of woodland are home to many important Wilson introductions, as well as other eminent plant hunters. The style of planting exotics amongst a backdrop of native trees is well illustrated here, with the exotics in many cases having reached maturity.

Champion specimen of *Liriodendron chinense*, Borde Hill grown from seed collected by Wilson in 1913, and the Wilson introduction – *Acer griseum.*.

The High Beeches

High Beeches is a grade II* registered garden situated near Handcross in West Sussex, within the High Weald AONB.

Plants bought at Veitch's sale, including some of Wilson's introductions, such as *Davidia involucrata*, *Berberis wilsonae* and *Viburnum rhytidophyllum*.

Important Wilson introductions in the garden include *Ilex yunnanensis*, accession number 15032. This particular plant has had cuttings taken by Kew for propagation. The rare *Lonicera henryana* is also to be found here.

A report by A.F. Mitchell provides interesting links with Robinson:

'It is based on the woodland garden ideas of William Robinson, a three layer structure of tall trees with high canopy, pruned of low branches, as light cover, above carefully chosen shrubs and small trees, and a rich ground flora of plants natural to the site, together with some added bulbs and herbs'.

Nymans

Nymans garden is situated near Cuckfield in West Sussex within the High Weald AONB, and is a grade II* registered garden.

A guidebook of 1976 illustrates the herbaceous border, stating that it was laid out with the help of Gertrude Jekyll and William Robinson. A description is given of the development of the garden through plant introductions by hunters such as Wilson, including American azaleas sent by Wilson via the Arnold Arboretum.

Davidia involucrata var. *vilmoriniensi* & *Liriodendron chinense*

Wakehurst Place

Wakehurst Place is a grade II* registered garden situated at Ardingly, West Sussex, within the High Weald AONB.

It is currently managed by the Royal Botanic Gardens, Kew, creating the opportunity to grow and conserve plant material in a rural setting with different soil and climatic conditions from Kew. The gardens were under the care of a modern day plant collector, Tony Schilling, from 1967 to 1991.

Plants introduced by Wilson include *Emmenopterys henryi, Stewartia sinensis, Davidia involucrata* and *Persea ichangensis,* syn. *Machilus ichangensis*.

Stewartia sinensis, Persea ichangensis, syn. *Machilus ichangensis*

Leonardslee

Leonardslee is situated in Lower Beeding, Horsham, West Sussex, within the High Weald AONB, and is a Grade I registered garden.

A list of trees and shrubs planted at Leonardslee was published in 1913. It lists some 91 Chinese rhododendrons collected by Wilson, and other Wilson's introductions, such as *Tetracentron sinense* and *Davidia involucrata*.

Highdown Gardens

Highdown Gardens is a registered grade II* garden, consisting of a square shaped site on the south facing slopes of Highdown Hill, Worthing West Sussex. Highdown Gardens were created by Sir Frederick and Lady Stern from 1909 to 1967 on a site of pure chalk. Part of the site had previously been quarried for chalk. This provides a contrast to the more acidic soils of the other Sussex gardens of the High Weald. A wealth of information about Highdown Gardens is to be found in the book Stern wrote about its creation, 'A Chalk Garden'.

Wilson's introductions played a prominent role in the development of the gardens as it was found that the Chinese introductions tended to fare better on the chalk than many of their American counterparts. Stern found it difficult to obtain information on what would succeed in the chalky soil they had decided to create a garden in. Advice was provided by Sir Arthur Hill, later a Director of Kew Gardens, but the garden was largely started as an experiment. In a forward thinking manner, similar to current thinking on ecological planting, Stern studied geological maps of temperate areas to try and discover plants which would tolerate the alkaline soil conditions.

The garden was created during a period when many expeditions were going out to China and the Himalayan regions collecting rare and beautiful plants. Many of these plants can still be seen in the gardens today, particularly plants collected by Reginald Farrer and Ernest Henry Wilson.

These plants include *Acer griseum* and *Prunus serrula*, bought at the Coombe Wood Nursery sale in 1912.

Lilium regale was recorded as having grown happily in the chalky garden for years, described as 'one of the finest garden lilies ever introduced and as near perfection any lily could be'. *Hydrangea villosa* is described as 'the finest flowering autumn shrub in this garden'.

Social network

The history of plant introductions parallels the social networking of the times. Plants were swapped between those belonging to certain networks, and competition to display the newest and best encouraged sponsorship of expeditions and subsequent purchases of plants, often at very high prices.

The connection between the owners of the group of Sussex gardens has been described as the 'Sussex Clique'. These include Ludwig Messel of Nymans, Wilfred Loder of High Beeches, Edmund Loder of Leonardslee, Frederick Godman of South Lodge and Stephenson Clark of Borde Hill. All were landowners who had made their money in the city, and all described as passionate and knowledgeable.

The skilled gardener, Ellen Willmott was a particular patron of Wilson. She is commonly remembered for scattering seed of *Eryngium giganteum* in gardens that she visited, but had much wider horticultural influence, gaining the Victoria Medal of Honour along with Jekyll in 1897. Many plants are named after her, such as *Rosa willmottiae*, collected by Wilson in China in 1904. Willmott was involved in the supply of roses for Nyman's rose garden.

Development of the 'Woodland and Plantsman's Garden'

The significance of Wilson's plant introductions is apparent when viewed in the context of the development of particular garden styles. The individual plants are important in more general conservation terms, but the introduction of a vast new range of exotic hardy plants can be seen to have resulted in the evolution of a major design style, that of the 'woodland and plantsman's garden'. This style can also be seen to have emerged in parallel with Robinson's ideas of naturalistic gardening.

A collection of Wilson's fifty azaleas in the 'Azalea Bowl', Exbury, Hampshire

The development of Robinson's style, using exotic species within an informal, naturalistic setting would not have been possible without the plant introductions of the era. Wilson played a crucial role introducing a vast number of plants from China, which were particularly suited to the British climate. The evolution of a major design style of naturalistic planting can be seen to be carried on today, taken in a slightly different direction, by designers such as Piet Oudulf.

The style of naturalistic woodland planting, with widespread use of exotics was enabled and brought to a pinnacle through the efforts of the intrepid plant hunters, of which Wilson was a key figure. The interest in this style has been overshadowed in current times by an overriding interest, sometimes bordering on obsession, with the English country garden style epitomised by Jekyll. It has been argued that no new styles have developed since the era of the woodland style. It is undoubtedly highly worthy of recognition in historic garden conservation.

The evolution of a parallel style today would not be possible with increasing concerns and legislation concerning plant introductions and invasive aliens. Modern day plant hunters, such as Roy Lancaster, agree that plant collecting in 'the old sense' will never be repeated, describing Wilson's removal of basket loads of bulbs from China, which would now be illegal.

The great excitement of the era becomes apparent when reading accounts of the gardens, such as that of Stern in the creation of Highdown Gardens. This epitomises an era not to be repeated on the same scale. The detail included in books such as Stern's, on the new introductions and their origins, brings to life the atmosphere of the time. Some of the plants that were new and exciting at the time have, perhaps, now become so familiar that they are taken for granted. Many have been overplanted in landscape schemes, as ubiquitous 'groundcover', resulting in their individual beauty and characteristics being overlooked.

Every prestigious garden of the era appears to have acquired a specimen of *Davidia involucrata.* These early 20th century woodland gardens were largely created around particular plants. Many of these gardens developed through the wealth, passions and rivalry of a generation of landowners. The majority of these gardens are now being opened to the wider public, thus enabling the plant introductions of hunters such as Wilson, to be appreciated by a wider cross section of society.

The plants introduced by Veitch's Nursery were once the domain of the wealthy, but are now available to the majority of people who wish to plant them.

Exercise

Select five of your favourite plants and see if you can find out:

- when they were introduced
- where they originated
- who introduced them

Modern day plant hunters

Plant hunting isn't carried out in the same way now, as there is legislation to protect both indigenous plants and the country that they are introduced to.

Bleddyn and Sue Wynn-Jones are modern day plant hunters and have a nursery in Wales:

> **Declaration of Intent**
> At Crûg Farm Plants our primary goal in collecting and growing wild plants from seed, is the ex-situ conservation of the diversity within the plants that we are capable of growing.
>
> We aim to and have introduced hitherto new genera, species, varieties and forms that are not to our knowledge in cultivation.
>
> Our aim is to introduce plants to cultivation that are correctly identified and legally collected. Working with authorities within our chosen target countries, to share and enhance the knowledge of plants.
>
> We aim to distribute the product of our labours initially to safe facilities, such as Botanic Gardens and public gardens with the expertise to grow these collections. While selling the remaining plants to retrieve our considerable costs.

Crûg Farm Plants

This highlights the importance of conserving plants that may be in danger in the wild, and keeping them growing ex-situ. This allows the re-introduction to areas where they may be threatened with extinction.

The movement of plant crops around the world

As well as the history of ornamental plant introductions, many important plant crops have been transported around the world. Population growth is based on the availability of resources. These resources include basic food crops such as maize and potatoes, and plant based resources such as jute, cotton and rubber. They have been introduced into different countries and often changed substantially through successive plant breeding.

The movement of these crops have had a mixture of benefits and huge impacts on indigenous populations and the environment. The following is an article from the World Rainforest Movement :

> From the 15th century onwards, technological progress enabled Europe to take an enormous lead in charting the whole world through the invasion of the American continent, the almost total annihilation of the native population, and the unrestricted take-over of political and economic power.
>
> America's economy was restructured and oriented according to European requirements. A diverse agriculture was replaced by a system of large plantations to grow sugar, cotton and tobacco for the European market, under a monoculture system which was usually harmful to the soils after repeated use and left the countries vulnerable to plant diseases sweeping through the entire crop. Local biodiversity was degraded or lost and forests were cleared.
>
> The American plantations were based on the exploitation of enslaved African people which made of Africa an annex to America, with the function of providing the continent's slave labour. Some hundred million African people were savagely chased for that purpose.
>
> In the 19th century, the large scale single-crop farming that had been introduced in America was also imposed in Africa by the Europeans, along the same basis: to provide goods inexpensively to the European markets.
>
> Sugar cane, tobacco, cotton, tea, rice and coffee were some of the main products grown in the colonies, which paradoxically had to begin importing food since cash crops generally took a majority of the available farmland, sometimes up to 80%.
>
> Sugar cane required a heavy input of labour (originally slaves). Grown in monocropping, it depleted the soil quickly. By 1700, Brazil was the main sugar producing area in the world, and most of the West Indies became largely sugar cane plantations.
>
> Tobacco was originally grown on small farms, later on in large plantations with slaves. Also cotton was a key raw material for the Industrial Revolution, which was originally

focused on the textile industry, particularly cotton goods. Most cotton was grown on plantations. Like sugar and tobacco, it depleted the soil quickly.

Tea as a cash crop came to dominate the economies of south-east Asia. In India, tea plantations were established on the hills of Assam province by clearing the forests.

Rice had been grown by peasants in south-east Asia for their own use or for trade in local markets, for centuries before European control was established. Britain annexed Burma in 1852 and established extensive rice paddies to produce rice for export to Britain (the area under rice cultivation there increased 20 times between 1855 and 1920). Also the opening of the Suez Canal in 1869 meant that crops from Asia were easier to transport. France occupied Indo-China in 1861 and brought about similar transformations. In both Burma and Indo China, large plantations drove out the small landowners and left the sharecroppers permanently in debt.

Coffee is indigenous to Africa, but it was first grown as a cash crop in Ceylon in the late 17th century, and later in Java. After a coffee blight broke out in the 1870s, production in south-east Asia fell. Brazil stepped in and became the main supplier in the world. As large coffee plantations exhausted quickly the soils, new fields were opened up as the railways penetrated deeper in the forest in the 19th century.

The independence of American and later African states did not mean a change in the economic and social structure. Agricultural, trading, and land-ownership patterns set during the colonial period persisted. Diversification proved very difficult, so newly independent colonies simply tried to produce more of the cash crops they had already been producing. This resulted in even greater dependence on the same commodities and a general response of finding even more products to export for cash. Newly born local elites also helped to maintain commercial dependence which was in general reinforced by economic and financial treaties with the former colonial powers and/or following successors.

In the early phases of Western imperialism, Asia wanted nothing that Europe offered. European powers could interpose themselves only as brokers of the common items of Asian trade. However, European colonialism transformed the landscape of Southeast Asia and the lives and livelihoods of its peoples, as it regularized, fenced and atomized the region in entirely new and foreign ways diminishing its shared identity. Between about 1870 and the early years of the twentieth century, European colonialism created a whole new state system in Southeast Asia.

The coffee production and trade of the Dutch East Indies company from the early eighteenth century on thronged the hills of West Java with imported coffee trees and carried off the produce for sale in Europe. Similarly, the Spanish in the Philippines sought to establish a monopoly over the production and marketing of tobacco in specified parts of Luzon for nearly a hundred years from the late eighteenth century on. From the

1830s, the Dutch forced Javanese peasants in their millions to grow huge quantities of coffee, sugar, indigo and other tropical products for export and sale in Europe.

The export-oriented monoculture productive pattern imposed by the colonial system –in the past as in the present-- has been at the expense of the people and the ecosystems, mainly the forests. Those cultures who had lived in close contact with nature had

developed quite a balanced relationship with their environment, which could be a referent to follow. But old and later new colonization put a wedge that made the global world enter into the present blind alley.

Article based on information from: “The Third World”, http://www.yorku.ca/bwall/nats1840/lecturesx4/4x11thirdworld.pdf ; “Reinventing a Region: Southeast Asia and the Colonial Experience”, Robert Elson, http://www.palgrave.com/pdfs/1403934762.pdf

World Rainforest Movement

Case study – the potato, *Solanum tuberosum*

The potato is consumed across the world and is a valuable food crop due to its high nutritional value. It has been travelling for five centuries!

The Andes and the Incas

Domestication of the potato began in the Andes. There is archaeological evidence that the wild potato was gathered there some 13,000 years ago. Eight domesticated types developed in the Andes and amongst them, *Solanum tuberosum* subsp. *andigena.* This is the ancestor

of the European potato. It is genetically very similar to the modern potato but physically very different – a similar genotype but different phenotype.

The 16th century was an important time of the Inca civilisation. This was a very sophisticated civilisation with great feats of engineering. The hard working population was fed on potatoes. The Incas had constructed irrigation systems from the mountains, using aqueducts to bring water to the fields on drier plains. It had built a network of paved carriageways linking the four corners of their empire. This was to transport guano to the lands that were infertile.

The Inca farms grew two main crops – maize and potatoes. Maize was cultivated between 1,500 and 3,500m whereas the potato could grow up to an altitude of 4,200m. This was all controlled by the empire. The maize went to the elite of society and potatoes were available to all.

The Spanish Conquest

The Inca Empire was built on military conquest, but then came the Spanish Conquest. The Incas were taken by surprise with the invasion when the Spanish landed in Peru in 1532. The Spanish were astounded by the Inca Empire. The Spanish were looking for gold and to spread the Catholic faith. 16th century Europe was a time of great religious conflict with Catholics against Protestants. Catholic Spain was very powerful at the time and was on a mission to repress the Protestants. The Spanish invaders were using Peruvian silver to fund their wars but needed a good food supply for their troops. They realised the value of the potato as a highly nutritious food crop for feeding their troops. They kept this find a secret.

There is evidence of potatoes growing in the Spanish Canaries in 1567. The Canary Islands were being used as a base for acclimatising plants from different areas they had discovered. They acclimatised plants grown in sub-tropical zones in the ‘Old World’ that were bound for plantations in the ‘New World’, and for plants going the opposite way as well.

English botanists knew less about the potato at the time. John Gerard, (1545 – 1612) published a work in 1597 and confused the sweet potato with the potato that came from Peru, so the Spanish had kept this a good secret!

Spread across Europe

In 1601 the first publication about the potato in Spanish lands appeared. From 1573 – 1620 it was gradually moving across Europe to Poland, Austria, France, Italy, England, Switzerland and Germany. Gaspard Bauhin (1560 – 1624) in Basel, wrote a detailed description and named the potato *Solanum tuberosum.* He recognised the similarities of other plants in the *Solanaceae* family, such as tomato and aubergine.

Some of the first introductions in Europe were unsuccessful as the potato was from equatorial regions with the same length of day and night constantly. Once the photoperiodic response was understood, potatoes were gradually selected to grow in different regions.

The Spanish influence declined in Europe during the Golden Age with the defeat of the Armada in 1588. The potato was a great success though!

During the 17th and 18th centuries it was widely grown in vegetable gardens in Europe. In late 18th century England most cottagers grew potatoes in their vegetable gardens. There were also market gardens developing for selling in the cities. These often used Irish

labourers. The potato became so popular in France in the middle of the 18th century that it was taxed.

The potato started to replace bread, although the wealthy favoured white bread as a staple food.

Ireland and the Great Famine

In Europe, the potato progressed most quickly in Ireland, with its ideal climate. The survival of the Irish population that remained after Cromwell's armies crushed the Irish resistance in 1653 depended on potatoes. The population increased rapidly in later years showing the value of the potato for rural workers, where they mainly subsisted on potatoes and milk. Between 1750 and 1845 the population increased by 4 million, and then there was an outbreak of *Phytophthora infestans.*

The disease began in the summer of 1845 and fields of potatoes were affected in Poland, Germany, Belgium and France. With a wet summer in Ireland it struck particularly badly. The potatoes that were grown for the rural workers to eat were all the Lumper variety. Being clones, they were all affected and spoiled. This started the Great Famine years 1845 -1852, during which it is estimated 1 million died. Many more emigrated to escape the famine.

In the 1880's Bordeaux mixture was developed to control the disease. This is no longer approved in the UK, but a range of cultural methods and fungicides are used for its control. There are no chemicals approved for the home grower in the UK.

Due to the problem of disease, there are tight controls on the movement of potatoes now.

Beyond Europe

Today, the largest producer of potatoes is China, producing over 94 million metric tonnes in 2021. India follows with over 54 million metric tonnes.

Back to Peru - The International Potato Centre (CIP) Lima

The International Potato Centre, or *Centro Internacional de la Papa* was founded in 1971 in Lima. Through scientific research it aims to:

- reduce poverty
- ensure food safety
- improve the management of the natural resources in the Andes

Andean farmers currently grow 74,000 species of indigenous potatoes – the extreme opposite in genetic diversity of the one clone in Ireland. Research is carried out to enable potatoes to be grown in varied climates and soils for growing in developing countries. It looks at methods of achieving this without the unacceptable inputs of pesticides and fungicides, which would add both costs and dependency on the large agrochemical companies.

Further information from the CIP:

Cultivated Potato Germplasm Collection

The genebank at the International Potato Center (CIP) began with a donation from the Peruvian National Potato Program of approximately 1,800 potato accessions comprising traditional cultivars. The collection was placed in the CIP Huancayo Experimental Station of Santa Ana-INIA Huancayo. The initial focus on the germplasm collection was to eliminate mixtures, atypical plants and plants with virus symptoms. Among the 45 years of existence of the potato genebank the number of cultivated potato accessions peaked at 17,347 accessions. After extensive research involving the identification and removal of duplicates, the active cultivated potato collection now total 4,870 accessions including 4,467 traditional landrace cultivars from 17 countries (mainly from the Andean region) and improved varieties. The entire clonal collection is conserved *in vitro* and distributed internationally as tissue cultured materials. The improved varieties comprise released varieties mainly by Latin-American countries and genetic stocks used to identify resistance to diseases (late blight, bacterial wild). This Global collection is maintained In Trust and is distributed with the Standard Material Transfer Agreement (SMTA) under the terms of the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA). All accessions in the collection are maintained and available for use in research, breeding and training by humanity now, and into the future.

Genebanks conserve living plant samples of the world's important crops and their wild relatives. They ensure that the genetic resources that underpin our food supply are both secure in the long term for future generations and available in the short term for use by farmers, plant breeders, and researchers. These collections are important to ensure that crop plants which may contain genes to resist disease, provide enhanced nutrition, or survive in changing or harsh environments do not become endangered or extinct over time.

The genebank at the International Potato Center (CIP) in Lima, Peru maintains clonal and seed collections of potato, sweetpotato, and Andean roots and tubers (ARTC's). The genebank is maintained as a global public good under the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). CIP's germplasm is available for requestors for research, education, and breeding purposes. This germplasm has been used in breeding programs in over 100 countries. CIP is the custodian of the world's largest in vitro genebank. Further, it houses one of the world's leading herbarium collections and cryopreservation program.

Repatriation/Reintroduction

The return of traditional cultivars to the farmer's communities whose ancestors developed and conserved these landraces for millennium and which are still located in the micro-centers of potato diversity, is termed repatriation. This activity has a very important impact for CIP's germplasm use including:

- The restoration of diversity and variability of cultivated potatoes in the Andean biodiversity micro-centers;
- The restoration of local productivity by replacing seed stocks with pathogen-free accessions contributing to increased food security, productivity and poverty alleviation;
- Mitigating the challenges and impacts of climate change by the introduction of traditional cultivars tolerant/resistant to biotic and abiotic stresses.

Since 1997, 89 communities have received over 6000 samples of cultivated potato from the CIP genebanks, comprising >1,250 accessions or almost 30% of the CIP collection of native landraces.

Wild Relatives of Potato

Potato is one of the main crops for world food security and as essential part of the culture and the familiar economies for Andean farmers. Since many of the wild potato relatives grow and survive in extreme climatic conditions and under constant attack by pests and diseases, their genetic material keep a high potential for abiotic resistance and frost and drought tolerance. The use of wild relatives in potato breeding could provide countless genes for novel traits, tolerant and resistances not found in commercial cultivars. Our main goal as genebank is to conserve, characterized and screen the accessions to increase the accessibility of wild species to the scientific community to expand their potential use of the traits maintained in the wild potatoes.

The CIP genebank maintain one of the biggest collections of wild potato species populations under long term storage as botanic seed. The collection consists of more than 2500 accessions and represent 140 species classified within the Solanum genus Petota section Solanaceae family, based on Hawkes,1990 and Spooner et al., 2004. The geographical range of wild potato species is highly varied and are natural distributed around 16 countries of America: Mexico, United States from North America; Costa Rica, Guatemala, Honduras, Panama from Central America; and Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela from South America. The centers of origin and diversity of the potato are located in the Andes Mountains of South America, considering the Collao plateau,

the watershed basin of Titicaca Lake, corresponding to the territories of Peru and Bolivia as the primary center of origin and diversity. Other secondary centers of diversity are between southern Bolivia and northern Argentina; to the north we consider the knot of Pasco in Peru; the knot of Loja in Ecuador and Peru; volcanic complex of Chimborazo, Tungurahua and Cotopaxi in Ecuador and the Pasto knot in Colombia.

The scope of these geographical areas implies the relationship of the potato with the prehistoric human groups and the cultures that based their development on potato cultivation, remaining until the present in the populations of the Andean World.

Other crops have taken different journeys around the world, often involving exploitation and enslavement.

Exercise:

Select a different crop, for example rubber, tea, coffee, sugar cane or jute.

- Find out where it is grown now.
- Find out how it has travelled around the world.
- Find out whether this journey has been a result of colonialism.

Movement of invasive plants

Some plants that have been introduced as ornamentals have subsequently become invasive causing severe problems, so not all plant introductions are a welcome addition! Examples include *Reynoutria japonica* (syn. *Fallopia japonica*) introduced into Victorian Britain by Phillip von Siebold in 1850.

The RHS has useful information:

What are non-native invasive plants?

Non-native plants are those that occur outside their natural range due to direct or indirect introduction by humans. If the introduced plants persist in natural or unmanaged habitats, they are termed 'naturalised'.

Many naturalised species do not present a problem but some that spread and outcompete native species can threaten ecosystems, habitats or native species. Only where this occurs are the plants termed invasive non-native species. These are considered to be invasive either due to lack of natural control mechanisms (such as herbivores); rapid rate of spread (by seed or vegetatively) or suppression of other species (such as allelopathy or competition for resources).

Non-native invasive plants can:

- Change ecosystems and habitats and have non-biotic effects, such as reducing or impeding water flow leading to flooding, or changing the
- Outcompete native plants either by habitat change or by spreading so rapidly as to crowd out slower growing species, threatening the long-term survival of species
- Take a long time to become invasive. Many of the plants now considered invasive have been growing in the UK for over 100 years and for much of that time showed no sign of becoming a problem
- Be expensive to eradicate. It is also very costly to restore degraded habitat, if it can be done at all

Invasive plants covered by legislation

There are a number of different regulations at both national and European level in place to help protect our environment from invasive non-native plants.

In Scotland the **Wildlife and Natural Environment Act (Scotland) 2011** is now in force making it illegal to plant any non-native plant in the wild in Scotland.

Elsewhere in the UK it is an offence to plant or cause to grow in the wild plants listed on Schedule 9 of the **Wildlife and Countryside Act (1981)**. In April 2014 a **ban on sale of five of the worst invasive water plants in the UK** came into force.

EU Regulation on Invasive Alien Species lists 36 plants. This legislation still applies in the UK. These plants should not be planted or caused to grow in the wild but in addition are banned from sale and gardeners possessing them should undertake measures to control them.

The collection of wild plants

Wild plants have many benefits over highly cultivated ones. The breeding of new cultivars can have huge benefits as well, such as bringing increased new disease resistance and the ornamental value to gardens. The wild plants have a huge pool of genetic diversity which is important to conserve. Plants have evolved to adapt to many different environmental conditions. This is important for biodiversity, and is also important for future plant breeding. Plants are often back crossed with wild species to reintroduce valuable traits.

Plant collecting will never be carried out on the scale and in the manner of the plant hunters described. There are regulations now for the movement of plant material.

Plant collecting both in the past and in present times has had both positive and negative effects. In some cases over collection has depleted natural populations of plants.

Examples include the Victorian fashion for ferns. Between 1840 and 1890 a fern fever or Pteridomania developed. Ferns were promoted as being good for the constitution and fern collecting a sign of intelligence. Using the new network of railways, many Victorians set out with a newly published guide book on ferns to collect all over Britain. In the process, many were over collected and species lost in different areas. There was also a black market for their sale. It was the era of the amateur naturalist and the collector, but with different ideas of how to collect. Ferns were simply uprooted and removed from their wild habitats.

Other plants that have been over collected include many bulbs, such as *Galanthus* spp., *Cyclamen* spp., and *Sternbergia* spp. There is still illegal collection which threatens the survival of species across the world. Plants particularly affected include orchids, bulbs, cacti, tree ferns and cycads, carnivorous plants and N. American trilliums.

Turkey has been much exploited for cyclamen. In the late 1960's *Cyclamen mirabile* had been wiped out from one of two known sites completely by plant collectors. This spurred the formation of The Convention on International Trade in Endangered Species (CITES). Turkey exports many bulbs today, but this is carried out in a different way. They are cultivated ex-situ and not wild collected.

Greece is an example of a country affected by over collecting. The island of Crete, for example, is a biodiversity hotspot. The rich and unique flora has attracted and continues to attract tourists, botanists, scientists, collectors, legal and illegal traders and nursery holders from around the world.

Over collections harms biodiversity and also affects the options available for plant breeding in the future, by depleting the gene pool available. Plant breeding is used for developing disease resistance plants, and if the original species are no longer there, the chances of success are severely depleted.

The protection in place now includes:

Convention on International Trade in Endangered Species of Wild Fauna & Flora (CITES)

CITES was drafted as a result of a resolution in 1963 at a meeting of members of the IUCN (the World Conservation Union). In 1973 the text of the convention was agreed by 80 countries and it entered into force.

The aim is to monitor and control international trade in threatened animals and plants. It operates through a system of export and import licences relating to three lists of endangered species. These lists are the CITES appendices I, II and III. Appendix I has the strictest regulations for the most threatened species – those in danger of extinction.

Appendix-I specimens

1. An import permit issued by the Management Authority of the State of import is required. This may be issued only if the specimen is not to be used for primarily commercial purposes and if the import will be for purposes that are not detrimental to the survival of the species. In the case of a live animal or plant, the Scientific Authority must be satisfied that the proposed recipient is suitably equipped to house and care for it.

2. An export permit or re-export certificate issued by the Management Authority of the State of export or re-export is also required.

   An export permit may be issued only if the specimen was legally obtained; the trade will not be detrimental to the survival of the species; and an import permit has already been issued.

   A re-export certificate may be issued only if the specimen was imported in accordance with the provisions of the Convention and, in the case of a live animal or plant, if an import permit has been issued.

   In the case of a live animal or plant, it must be prepared and shipped to minimize any risk of injury, damage to health or cruel treatment.

Appendix-II specimens

1. An export permit or re-export certificate issued by the Management Authority of the State of export or re-export is required.

An export permit may be issued only if the specimen was legally obtained and if the export will not be detrimental to the survival of the species.
A re-export certificate may be issued only if the specimen was imported in accordance with the Convention.

2. In the case of a live animal or plant, it must be prepared and shipped to minimize any risk of injury, damage to health or cruel treatment.

3. No import permit is needed unless required by national law.

Appendix-III specimens

2. In the case of export from any other State, a certificate of origin issued by its Management Authority is required.

3. In the case of re-export, a re-export certificate issued by the State of re-export is required

Examples of plants in the different appendices include:
Appendix 1:
Abies guatemalensis, Araucaria araucana, Cycas beddomei, Cypripedium calceolus, Sarracenia jonesii, Vanda coerulea

Appendix II

Agave victoria-reginae, Cyclamen spp., Dicksonia spp. (from the Americas), *Galanthus spp., Nepenthes spp., Orchidacea spp., Sarracenia spp., Sternbergia spp.*

Appendix III

Meconopsis, Podocarpus neriifolius

The Global Strategy for Plant Conservation- Convention on Biological Diversity

The 1992 Earth Summit in Rio de Janeiro led to the adoption of the Convention on Biological Diversity (CBD) by world leaders. It was conceived as a tool for implementing Agenda 21. Agenda 21 is a non-binding action plan developed by the Unite Nations at the Earth Summit. The idea was that each local government developed its own Agenda 21 to implement. The initial aim was to achieve global sustainability by 2000 – i.e. before the 21st century. A Global Strategy was compiled for 2011 – 2020. CBD is compiling a post 2020 global strategy.

The strategies centre on:

- Understanding and documenting plant diversity
- Conserving plant diversity
- Using plant diversity sustainably
- Promoting education and awareness about plant diversity
- Building capacity for the conservation of plant diversity

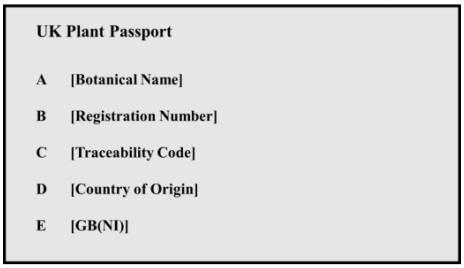
There are protocols under the CBD. These include the Nagoya Protocol which concerns the fair and equitable sharing of genetic diversity.

International Union Conservation of Nature (IUCN) Red Lists

The IUCN is an information source on the global conservation status of animal, plant and fungi species. It provides an indicator of the world's biodiversity and a tool to catalyze action. It provides information about the range, populations, habitat, ecology, use or trade, threats and conservation actions of species to aid conservation decisions.

Plant passports

A system of Plant Passports is used in Great Britain for internal movements of plants. It is a traceability document and indicates that plants meet the GB plant health standards. To deal with plant passports growers need to register with the UK Plant Health service.



Phytosanitary certficates

Phytosanitary certificates are used for plants entering Great Britain from other countries. They are also needed for movement from Northern Ireland due to post Brexit arrangements.

Plant Heritage has useful information for holders of National Plant Collections, which provides useful general guidance. The following are extracts from this:

Plant collection

For plants in National Collections, it is imperative that the plants are sourced legally and ethically and that evidence of this is retained.

Protected species - CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement that came into force in 1975.
The **import, export and use for commercial gain** of certain species requires a CITES permit. For plants, the list includes mainly orchid, cacti, succulents, medicinal plants and cycads.

Access and Benefit Sharing (ABS) - the Nagoya Protocol

The Nagoya Protocol is an agreement that is part of the Conventional on Biological Diversity (CBD), which deals globally with the fair and equitable sharing of benefits arising from the utilisation of genetic resources. Since **12 October 2014,** this legally binding international agreement covers **wild collecting** of plants and **associated traditional knowledge** from more than 130 signatory countries.

It is your responsibility to ensure that you have undertaken the necessary steps to legally obtain and utilise plant material. You will need to obtain **prior informed consent** from the owner of those resources, on **mutually agreed terms**. For example, should a plant-hunting trip be organised to country X to collect seed of

species Y, it will be necessary to find out what the legal requirements with regard to plant collecting and ABS are in that country.

If you are given plant material that has been collected under the Nagoya Protocol, you are also obliged to follow these conditions. This will be set out in a **Material Transfer Agreement (MTA)** between you and the donor. You should be able to demonstrate that you have done due diligence to determine that a plant has been collected legally. This is why it is important to keep track of sources, dates, collection numbers, MTAs and other associated research into provenance.

Plant collecting in the UK

In Britain, it is illegal to "uproot any wild plant without permission from the landowner or occupier". Harvesting other parts such as leaves, flowers or seed is allowed. However, this does not apply to land designated a SSSI or National Nature Reserve, where it is illegal to pick any part of a plant. In addition, local bylaws often apply to nature reserves or National Trust land which forbids plant collection.

There are also certain species for which wild collection is forbidden - largely orchids, ferns and other rare taxa.

Invasive species

There are some species which are illegal to import, grow or sell in the UK because of the threat of them getting out into the wild and becoming invasive. Others are illegal to plant or cause to grow in the wild.

Plant Breeders Rights

> Plant Breeders' Rights or Plant Variety Rights (**PBR** - usually written as ^{PBR}) are granted to new cultivars in order to give the breeder exclusive control over the propagating material from that plant for a certain number of years. If you have cultivars with PBRs on them, you should be aware of restrictions on the propagation and sale of these plants. You also may want to apply for PBR on cultivars that you have bred.

If you want to find out if a cultivar has a PBR attached to it, you can search on the **Community Plant Variety Office (CVPO)** website - it is free to register and use.

Plant passports and cross border import/export

Post Brexit arrangements

DEFRA are providing **updates regarding Brexit** and its effects on plant movement between Great Britain, Northern Ireland and the EU. From January 1st 2021 there are new requirements for importing and exporting plants. There are **different rules for Northern Ireland**.

Importing plants and plant material
Any plants, seeds or bulbs intended for planting, brought in to the UK will require a customs check. They will need a phytosanitary certificate, issued by the origin country. Also some high risk genera are prohibited or require a prior risk assessment and pre-notification to the relevant authority, whether being imported from the EU or from the rest of the world.

If you are buying plants online from overseas, the seller needs to comply with the rules above. Plants and plant products (other than plants for planting) up to 2 kg in weight will be allowed in passenger luggage but this will also require a phytosanitary certificate from the origin country. Failure to declare will result in the goods being confiscated.

Plant Passports for movement within the UK

As of January 1st 2021, the **UK plant passport** has replaced the EU plant passport.

Any **professional operator** moving or selling plants, cuttings, bulbs and some seeds (list below) and plant products to another professional operator **will require authorisation to issue plant passports** from APHA. A list of the plants, seeds and plant products covered by the legislation is **here.** The plant passport will have to be applied to each of the **lowest trade units** such as an individual plant in a pot, or tray of plugs.

If you sell a plant retail (face to face sales) to the end user, you **do not** need to provide that end user with a plant passport. If you **only sell retail**, you do not need to register to become a **plant health professional operator (free of charge).**

If you sell plants over the internet/mail order, or sell to another retailer, **you need to issue plant passports** with the lowest trade unit.

If you send plants through the mail but without any money changing hands (except to cover postage and packing) you do not require a plant passport.

All those involved with plants have a role to play, amateur gardeners, professional gardeners, nurseries and propagators. This is particularly important in the current extinction crisis. Some horticultural practices have led to the degradation of biodiversity and environments, but others are having a positive effect. Gardens also play an important role in saving indigenous species and plant communities, and also threatened plants from other parts of the world.

Care must be taken when purchasing plants to check the provenance. This applies to any plant material – whole plants, seeds or propagation material. As well as depleting environments if illegally collected, the movement of plants can bring in serious pests and diseases. Reputable suppliers with the correct paperwork and necessary certificates should be used.

When looking for provenance for indigenous species, local provenance is important. This is defined as within 160km in distance or 305m in altitude. Local provenance protects genetic variation that may be present in different areas.

In practical terms, this is important when creating features such as wildflower meadows and planting indigenous trees and hedgerows. Seeds and plants of local provenance are more likely to be suited to the area in terms of climate, altitude and soil conditions, and therefore more likely to thrive. Using seed and plants with local provenance maintains the genetic diversity.

Climate change makes things more difficult though, as the geographical distribution of wild plants is affected due to changing conditions. There may be incidences where the indigenous plants haven't adapted quickly enough to changing temperatures for example, or patterns of rainfall.

Element 2: Plant information sources		
AO1: Knowledge	**AO2: Application**	**AO3: Integration**
Reliable sources of information about plants to include experience-based and academic sources of information. The range of organisations involved in researching, curating and disseminating information relating to plants. The role of nomenclature standards and type specimens in plant taxonomy.	The importance of RHS Plant Finder and the International Plant Names Index when researching plant names. Methodology to describe the properties of plants, to include: • trials and research • ecosystem services • hardiness ratings • colour charts • award schemes e.g. Award of Garden Merit	The use of reliable information sources in the development of best practice in the management of plant collections and gardens.

Commentary

Horticulture is a science requiring reliable sources of information to inform and to develop horticultural practices. AO1 introduces learners to a range of information sources and considers horticultural research and the dissemination of findings.

AO2 applies the concept of reliable information sources to cover the naming of plants. The use of standard systems to identify climate resilience, drought tolerance and ecosystem sevices.

At AO3 the use of reliable information sources in the development of best practice is considered. Qualification-wide outcomes applicable to AO3 could include the use of tools to identify climatic conditions in the future to inform plant based decisions.

Introduction

An in-depth knowledge of plants is vital for anyone involved in horticulture. This knowledge is obtained through a mix of experience from working with plants and academic sources.

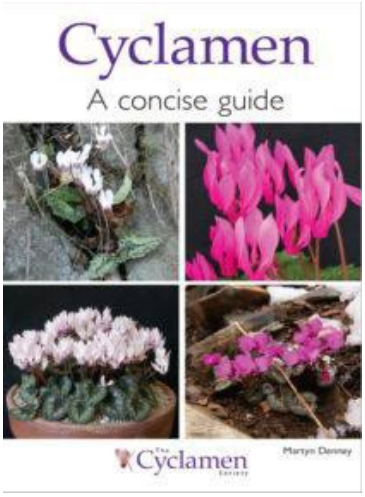
Experience is achieved from working with plants in as many environments and situations as possible and also from observing plants in different situations. Knowledge can also be gained from visiting specialist nurseries and discussing plant requirements or learning from a National Plant Collection holder.

Visiting gardens can also increase your plant knowledge, particularly ones with clear plant labelling and informative interpretation. This includes Botanic Gardens, National Trust gardens, RHS gardens, English Heritage gardens and the whole range of private gardens and public parks.

Specialist societies

There is a huge range of specialist societies for different categories of plants or specific genera. Their aims are to share and spread knowledge and promote their particular plants. They may be involved in research and may also provide sponsorship for projects. Conservation is also a key role for some. Many have freely available information online that is a great resource. Sometimes the information is only available if you become a member, becoming a member of the society may give you access to additional information or advice. Some hold regular talks, meetings, conferences, trips or tours. With the popularity of online talks now, there is greater accessibility to some of the wealth of knowledge held by the societies.

Many have journals and specialist publications.



Examples of societies that focus on a single genus of plants include:

The Daffodil Society

The Daffodil Society, established in 1898 as the specialist society of Great Britain for all who are interested in the Genus Narcissus.

We aim to promote the whole of the genus Narcissus, the botanical name for our favourite flower. The words Narcissus and Daffodil relate to the same flower but the Society uses the more common name Daffodil.

The Daffodil Society is open to everyone. Our membership includes amongst others keen gardeners, horticultural and gardening societies, professional growers, botanists and enthusiastic flower show exhibiters. We are on Facebook.

The Cyclamen Society

The Cyclamen Society is an International specialist plant society that was formed in 1977. It is based in the United Kingdom, with members in most parts of the world (60% UK, 40% ROW), plus an active Japanese Branch. The Society also has a Facebook group with over 3900 members. Its aims are to:

encourage cultivation and conservation, and extend knowledge of *Cyclamen* species, with all their variants and cultivars. In addition to the normal horticultural activities of a specialist plant society it has a research program that includes field studies (since 1987) and laboratory work in collaboration with the School of Biological Sciences at the University of Reading, UK.

The Scottish Rhododendron Society

This is a vast genus of woody plants with possibly a thousand species and still more being discovered. The geographic range and variety of habitat-from tropical to alpine, the size, from small leaved shrubs to forest trees, the varieties of bark, foliage and flowers make this group of plants an immense subject for study. Rhododendrons generate great passion and enthusiasm in those who seek to find new species, identify and conserve existing ones or simply grow and propagate them.

There are many specialists in our society but the majority are keen amateur growers with an interest in all types of plants

Others include The Rose Society, The Peony Society, The National Chrysanthemum Society and many more!

Some specialist groups have closed in recent years, such as the Heather Society.

Examples of societies for group or types of plants include:

The Hardy Plant Society

The Hardy Plant Society (HPS) is a national group which also has local groups. Within the HPS are further specialist groups such as The Shade and Woodland Group.

British Cactus and Succulent Society

Objectives:

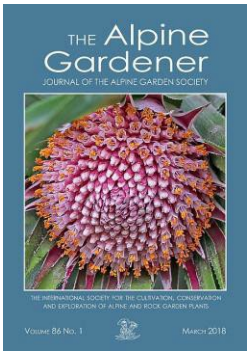
> To advance the education of the public by study, culture and propagation of cacti and other succulent plants and to promote the conservation of such plants.
>
> In furtherance of these general objects but not further or otherwise the society may:
>
> 1. Gather and disseminate particulars of cultivation and propagation.
> 2. Hold meetings, shows, lectures, exhibitions, visits to collections, exchange plants, seeds and study materials, publish journals, books, manuals and other materials and such other activities as may promote the objects.
> 3. Raise funds and invite and receive contributions from any person or persons whatever by way of subscriptions, publication of books, manuals and other materials and otherwise provided that the society shall not undertake any permanent trading activites in raising funds for its primary charitable objects.

The Alpine Garden Society (AGS)

> We are an international, UK based, charitable organisation primarily concerned with the cultivation of alpine and mountain plants from around the world. The AGS is also involved in the study and conservation of alpine plants in the wild.

The AGS has a valuable online encyclopaedia, with a searchable database of plants which is available for all to use. There is also an image library with over 16,000 images that is accessible to all. The images are of alpines in the wild and garden situations and are searchable. Alpine plant encyclopaedia - Alpine Garden Society

A quarterly journal is produced – The Alpine Gardener. Other activities include a seed exchange, local groups, virtual talks, and displays at national shows. They are very much involved in conservation and run an AGS Trainee Scheme. There are also articles on the website, such as ‘Captivating campanulas for the rock garden’.



International Dendrology Society (IDS)

> The aims are to promote the study and enjoyment of trees and other woody plants, to bring together dendrologists from all round the world, and to protect and conserve rare and endangered plant species worldwide. This last aim is now even more relevant with increasing industrial development and threats to plant species.

The IDS is developing an extensive online database for woody plants hardy in temperate areas. This database, called Trees and Shrubs Online is based on two books. The first is Bean's 'Trees and Shrubs hardy in the British Isles', the second is an IDS publication – 'New Trees'.

Trees and Shrubs Online

Exercise:

- Search The Alpine Garden Society online encyclopaedia for information on *Sempervivum arachnoideum*
- Search the International Dendrology Society online database for information on *Ginkgo biloba*

Botanical Gardens

Botanical gardens produce journals which are described below. There are also many valuable resources available online and opportunities to increase a knowledge of plants in the gardens. Visiting the gardens is obviously an excellent way to increase plant knowledge as well.

The following are some examples of botanic gardens:

Royal Botanic Gardens Kew

Kew Gardens has a 'Plant Profiles' with a selection of plants to research. They have expert led tours and talks at the gardens.

Kew is also involved in research. There are over 470 scientists working at Kew and collaborating with over 100 countries worldwide. There are specialists in the regulation of international trade in plants and medicinal plant names.

There are many different research projects carried out to protect biodiversity and to explore useful populations of plants and fungi. Examples include:

Native Seeds for Restoration – diversity and resilience in the UK

This research project supports the effective selection and use of native seed in the restoration of climate resilient, genetically diverse plant populations in the UK.

Genomic resources for healthy ash trees

This project is searching for genes in ash trees to overcome ash dieback and the emerald ash borer.

Cambridge Botanic Gardens

Cambridge Botanic Gardens have 9 National Plant Collections (described below). These are – Alchemilla, Bergenia, Fritillaria, Geranium (species and primary hybrids), Lonicera (shrubby species and primary hybrids, Ribes, Ruscus, Saxifraga and Tulipa. Many of the collections have developed from the research work carried out and are rich in wild sourced material.

Research is carried out at the Botanic Gardens, with an example of a research programme being 'The evaluation & development of floral traits'.

University of Bristol Botanic Gardens

The aims of the University of Bristol Botanic Gardens are to:

Educate

- Provide plants, advice and assistance for teaching and research within the University of Bristol.
- Be accessible to students, educational and scientific organisations and the general public.
- Educate about our dependency on the continued survival of the world's plant resources.
- Maintain diverse, correctly named and professionally curated living collections of plants.

Communicate

- Encourage and foster interest in plants within the local community of Bristol.
- Display our collections in an attractive and informative manner.
- Communicate information about our collections through courses, study days, tours, the media and publicity.

Conserve

- Conserve and display native species of local and national importance.
- Develop and maintain unique plant collections of national and international importance.
- Maintain a living gene bank of threatened species from the South West of England.

The University of Bristol Botanic Gardens have some very informative evolutionary displays, including the Angiosperm phylogeny display:

The Angiosperm phylogeny display represents the latest understanding on the evolutionary relationships and classification of flowering plants inferred from comparisons of their DNA sequences. The paths within this collection take the form

of a branching tree (phylogeny) of the flowering plants beginning with the most ancient group, the basal angiosperms, from which all the other major lineages of flowering plants have diverged.

The display starts with a raised pool, home to many waterlily species, including *Nymphaea odorata.* Planted around the pool are other 'basal angiosperms', *Schisandra chinensis* and *Kadsura japonica* climb up wooden tripods, while underneath *Illicium anisatum,* a relative of the star anise, grows. A beautiful collection of Magnolias including: *Magnolia stellata* and *Magnolia dolsopa* flower in spring. Tender plants are plunged out during summer such as the pepper relative *Macropiper nigrum* - and the edible cherimoya, *Annona cherimola.* Some plants in this collection are too tender and must remain in the glasshouse including the most ancient basal angiosperm *Amborella trichopoda.* From the basal angiosperms two paths radiate out into the display. One is planted with 'Monocots' and includes palm, orchid, lily, grass, iris and ginger plant families. The second is planted with 'Eudicots' and includes poppy, buttercup, protea, geranium, daisy and pea families. A walk through the display illustrates the rich diversity of flowering plants which can be traced back to a common ancestor group. Interpretation boards give information at key positions in the display.

Amborella trichopoda

Plant Heritage

Plant Heritage (formerly known as NCCPG) aims to conserve the diversity of garden plants. The charity carries out this role through the National Plant Collection scheme, Plant Guardians and local group networks.

The plant records are stored in their plant records system – Persephone.

Garden plants are valuable for many reasons

Reference

National Plant Collections are living reference libraries where all the plants in a genus or group can be seen together, compared and researched. When funding for botanic gardens and parks is under threat, the need to earmark, support and conserve these collections becomes more urgent. A collection holder can become the

authority/expert on a plant group, able to provide advice, conduct research and be a resource for others.

Historical

The plants collected from around the world by plant hunters or bred by the head gardeners on country estates are as much a part of our history as our stately homes and art. They feature in stories, legends, works of art and songs, providing a living link to our ancestors and culture. National Plant Collections recognise the value of this history and help preserve it.

Horticultural

From cottage gardens and allotments to the grand estates, they were all founded on plants such as old pinks, florists' violas, extravagant tulips, Malmaison carnations and dainty auriculas. These often need specialist cultivation and may represent a body of knowledge built up over a lifetime. Sadly, these specialist skills are easily lost along with the plants so by keeping the plants in National Plant Collections, we are also keeping the knowledge about them.

We're not all about the past though - there are constantly new developments in plant breeding and the best of these will enrich our gardens and National Collections for years to come.

Global context

The world of plant conservation is constantly changing and Plant Heritage has a role in supporting this in order to ensure resilience to environmental and societal change.

We were founded under the principle that we should '*…conserve the unique gene pool of accumulated variation from centuries of selection and breeding, a resource of great economic potential and heritage value.'* (Brickell, 1977).

This need not only remains but has been strengthened through the Convention on Biological Diversity **2022 Kunming-Montreal Global Biodiversity Framework,** which sets as one of its long term goals that *'genetic diversity within populations of wild and domesticated species, is maintained'*, with a target by 2030 *'to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation'.*

As an example of ex situ conservation of domesticated species, National Collections are contributing to global efforts to halt biodiversity loss.

National Plant Collections® are registered and documented collections of groups of plants, such as a particular genus, a particular species or a group of plants with a similarity. For example, there is a National Collection® of *Calluna vulgaris* at RHS Gardens Wisley, *Buddleja* spp. at Paignton Zoo, Devon and British double flowered plants in an individual collection.

They have to be available for people to see, and this may be through appointment or open days for some private collections. Other collections are held by botanic gardens, plant nurseries, local authority parks and groups of people. There are about 95,000 plants in collections and over 700 collections.

These collections and the knowledge and expertise of individual growers provide a wealth of information and a valuable resource.

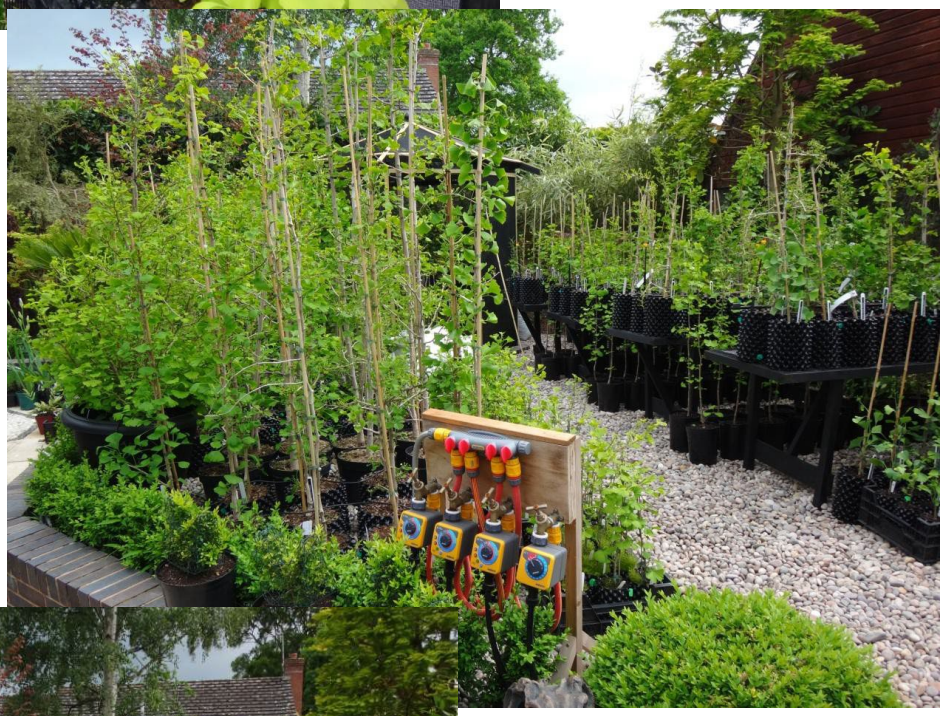
There is also a scheme for Plant Guardians. The aim is to bring more information about rare and unusual garden plants into the public domain. A record of these plants is kept by Plant Heritage and they encourage sharing of the plants. This is useful for plants that may have disappeared from the trade as fashions change.

Case Study – The National Plant Collection of *Ginkgo biloba* & cultivars

The National Collection of *Ginkgo biloba* & cultivars was certified by the NCCPG in 2017. It has over 300 cultivars of *Ginkgo biloba,* currently housed in a domestic garden. This is a tremendous conservation resource for a fascinating and ancient tree.

The collection is available to view by appointment or open days, and the plants are displayed at RHS Shows, gaining Gold Medals.

The plants are mostly grown in Air-Pots to encourage healthy root systems.



Royal Horticultural Society

The RHS provides a wealth of plant information. The gardens at Wisley, Rosemoor, Hyde Hall, Bridgewater and Harlow Carr have an enormous number of plants and planting styles to view, in a range of situations. There is also much plant information available online, including an advice service.

Members receive extra benefits with the monthly magazine 'The Garden'. 'The Plant Review' is a quarterly journal that can be subscribed to, which has more in-depth articles about specific genera, species, cultivars or groups of plants, and up to date news of scientific research and taxonomy and nomenclature. Recent changes in plant nomenclature can be found here.

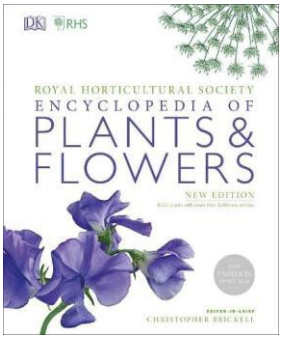
The RHS is also involved in research, the Hilltop at Wisley is described as 'the UK's first dedicated horticultural science centre of excellence'. The aims are to protect the future of plants, people and the planet. The research projects include one on plant health to investigate box blight. A large scale aim is to research and record cultivated plants, provide accurate names and gather information to be used in a horticultural database. This would then provide an online resource for the UKs' garden plants and herbariums.

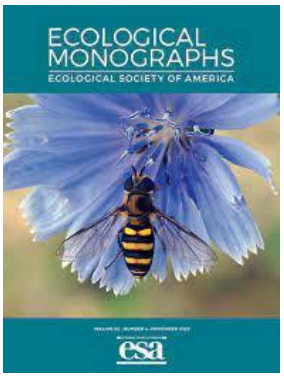
Many citizen science projects are also carried out by the RHS.

The RHS holds many valuable historic and contemporary books and journals in the Lindley Library. (As described in Topic 1)

Books

There are, of course a huge range of horticultural books for plant information. These include plant encyclopedias and plant monographs.





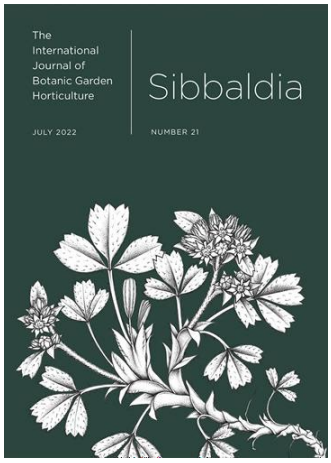
Journals

Many of the plant societies have regular journals, as described above. Some are moving to online access to the journals rather than hard copies. These generally have up to date and specialist information.

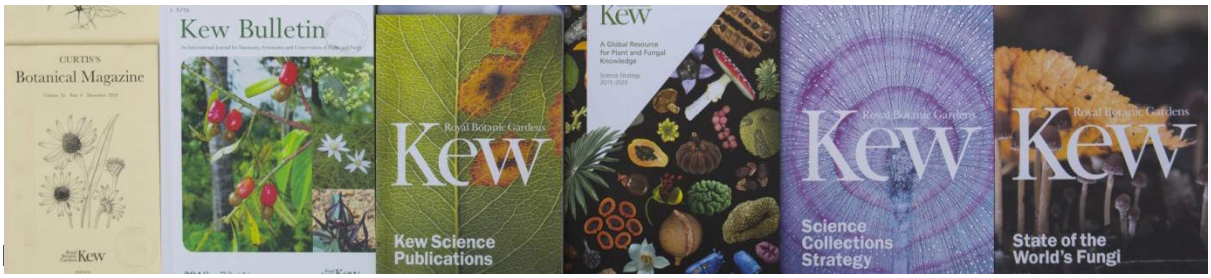
The RHS, as well as the members journal 'The Garden' has a further specialist publication issued quarterly, Previously named 'The Plantsman' it is now called 'The Plant Review'. This has detailed articles on specific genera or species of plants and up to date information on classification and nomenclature.

Sibbaldia is a free online journal from the Royal Botanic Gardens Edinburgh:

> Horticulture in botanic gardens is incredibly varied. Horticulturists are in the middle of all the activity as guardians and promotors of the main attraction, the plants. A huge amount of information and knowledge is amassed by horticulturists over the years because so much of horticulture is based on experience and observation. Traditionally communication about growing plants is by word of mouth and shared with close colleagues. Historically, gardeners are given vocational, practical training and the knowledge held by those who look after the plants is essential to the future of horticulture and botanic gardens themselves.
>
> Subjects covered in Sibbaldia include: cultivation methods and protocols, curation and management of collections, landscaping projects, species descriptions, garden history, how gardens are used, education in gardens, and plant records. Papers are illustrated in full colour. Our readership extends from horticulturists and garden managers to students, conservationists, plant scientists and interested amateurs and plant enthusiasts around the world.
>
> https://journals.rbge.org.uk

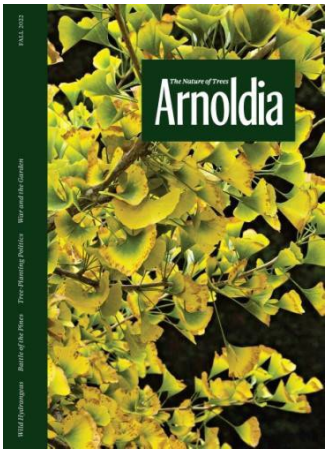


Kew Bulletin is ‘an international, peer reviewed journal for the taxonomy, systematic and conservation of vascular plants & fungi’. It is published quarterly by Springer and available online and hard copy. Kew also has a range of other specialist publications.



Kew also produces Curtis's Botanical Magazine. This is the 'longest running botanical periodical featuring colour illustrations of plants. Articles combine horticultural and botanical information, history, conservation and economic uses of the plants described'.

There are also many journals produced across the world. Arnoldia is an example, from the Arnold Arboretum of Harvard University, USA, with information on temperate woody plants. It has been published since 1911 and older back issues are available digitally.



HortWeek, or Horticulture Week and many years before, The Gardener's Chronicle is a publication for professional horticulture. A subscription is needed to view articles, such as the Plant Library.

HortWeek | Latest horticulture industry news and jobs

Plant Network

In 1994 there was a meeting at Oxford University organised by David Ingram, Peter Wyse Jackman and Timothy Walker. They invited people involved in maintaining plant collections. PlantNet- Plant collection network of the British Isles, was established after this at a workshop at RBGE. The name later changed to PlantNetwork:

> **PlantNetwork is a charity and membership organisation that provides training and network support to gardens and gardeners throughout Britain and Ireland. We have been doing this for more than 25 years – and look forward to connecting gardens and their gardeners for many more years to come!**

Through its work, PlantNetwork contributes to maintaining and developing the horticultural and plant conservation skills for which our gardens are renowned. The goals of PlantNetwork are:

- Supporting gardens and plant collections for conservation, knowledge and enjoyment.
- Providing networking and professional development for the plant network community.

Since being formed in 1996, PlantNetwork has brought together both institutional and private members and now represents over 300 gardens including all the major public horticultural and botanic gardens in the countries.

If you work in gardens, from botanic gardens and arboreta to public parks; have a professional interest in amenity or botanical horticulture; manage or care for a documented plant collection; or wish to learn more about gardening in the gardens of Britain and Ireland, then membership of PlantNetwork is for you.

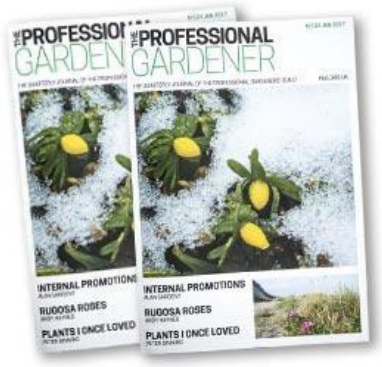
Although membership is needed for full access to resources, there are freely accessible copies of seminars, podcasts etc. online.

Home | PlantNetwork

Professional Gardeners Guild

The aims of the Professional Gardeners Guild are to promote professional contact and to share information and skills. This is carried out by learning and traineeships, a quarterly journal, seed exchange, and through national and regional meetings which encourage general exchange of ideas, views, plants and information.

Meetings, training, horticultural advice - Professional Gardeners' Guild (pgg.org.uk)



THE PROFESSIONAL GARDENER

The Chartered Institute of Horticulture

The Institute of Horticulture was established in 1984 with the aim of fostering a close relationship between all sectors of professional horticulture throughout the UK and Ireland. On 21st July 2014 the Institute became Chartered and is now known as the Chartered Institute of Horticulture (CIH).

This recognition has enhanced the status of horticulture as a profession which demands high level skills and continuing professional development. Chartered status has also strengthened the influence and therefore the voice of the CIH and all horticulturists with government and policy makers.

The Chartered Institute of Horticulture (CIH) is the only organisation that can truly claim to bring together all professionals involved with every aspect and facet of the diverse industry that is horticulture. There are organisations concerned with such specialist areas but most horticulturists, whatever the career path they have chosen within horticulture, see themselves as part of the broader industry.

Membership of the Institute provides a unifying force that draws together horticulturists who may be pursuing very different career paths and 'uniting a growing profession'.

The Chartered Institute of Horticulture

The aims of the Chartered Institute of Horticulture include providing a peer to peer network to encourage the exchange of information and to promote knowledge transfer and best practice. Although membership based and open to anyone employed in horticulture, it also has some information freely available online, such as webinars on particular plant groups.

Garden Organic

Garden Organic runs research and citizen science projects. Their Heritage Seed Library keeps a valuable source of both plant knowledge and genetic diversity alive.

Exercise:
Search for the following online:

- A National Collection of a plant you are interested in.
- A current research project or citizen science project run by the RHS.
- A current research project run by Kew.
- A current research project at a different botanical garden – possibly one that is reasonably local to you.

Nomenclature

There needs to be a universal code for naming plants in order to learn about them and exchange knowledge. Plants need to be accurately identified. This is of particular importance for botanists, plant nurseries, garden designers and researchers. It is vital to know accurately what you may be buying, selling, specifying, describing or researching.

Codes of nomenclature are aimed at providing a unique name for a plant so there is no confusion.

The International Code of Nomenclature for algae, fungi and plants

The International Code of Nomenclature for algae, fungi and plants was adopted in 2017 at the 19th International Botanical Congress, Shenzhen, China.

This supersedes the previous International Code of Botanical Nomenclature.

The code states that:

'The purpose of giving a name to a taxonomic group is not to indicate its characters or history, but to supply a means of reference to it and to indicate its taxonomic rank'.

The code has six principles:

PRINCIPLE I

The nomenclature of algae, fungi, and plants is independent of zoological and prokaryotic nomenclature. This *Code* applies equally to names of taxonomic groups treated as algae, fungi, or plants, whether or not these groups were originally so treated

PRINCIPLE II

The application of names of taxonomic groups is determined by means of nomenclatural types.

PRINCIPLE III

The nomenclature of a taxonomic group is based upon priority of publication.

PRINCIPLE IV

Each taxonomic group with a particular circumscription, position, and rank can bear only one correct name, the earliest that is in accordance with the rules, except in specified cases.

PRINCIPLE V

Scientific names of taxonomic groups are treated as Latin regardless of their derivation.

PRINCIPLE VI

The rules of nomenclature are retroactive unless expressly limited.

To sum this up –

- The code applies to all organisms that are currently called algae, fungi and plants
- Nomenclatural types (described below) are used to apply names
- The first published name is always used
- There is only one name for each taxonomic group
- The scientific names follow rules of Latin
- The rules are applied to names in the past

When plants names are changed, perhaps as the result of finding an earlier published name or the rule of priority, the older name becomes a synonym.

Nomenclatural standards and type specimens

A reference point is needed for plant identification as stated in the purpose of the International Code of Nomenclature for algae, fungi and plants. Type specimens, or nomenclatural types are the tools to provide this reference point.

The code states that:

> ***7.1.*** The application of names of taxa at the rank of family or below is determined by means of nomenclatural types (types of names of taxa). The application of names of taxa at the higher ranks is also determined by means of types when the names are formed from a generic name.

> ***7.2.*** A nomenclatural type (typus) is that element to which the name of a taxon is permanently attached, whether as the correct name or as a synonym. The nomenclatural type is not necessarily the most typical or representative element of a taxon.

The type specimen is the individual plant when the species (or a lower taxon) was formally described and given its scientific name. This explains why it may not be the most representative example – it is just the first one that was officially described and named.

Dried specimens or images are used to provide the standards and type specimens. These have typically been stored in herbaria, e.g. in botanic gardens.

The RHS are more concerned with garden plants and have a growing herbarium of cultivars. The RHS describe a nomenclatural standard as:

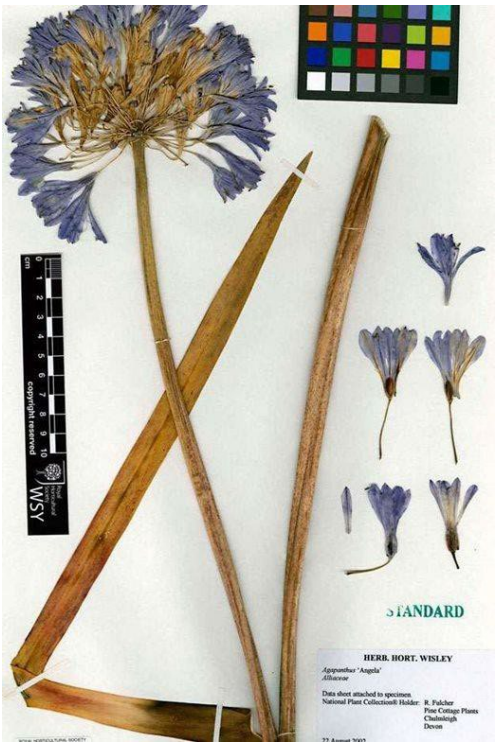
‘the specimen or image that forms the definitive reference to interpret the name of a cultivar’.

The specimen or image is called a type specimen. ‘This provides a permanent reference point to determine the correct application of scientific names’.

The RHS Herbarium has nearly 5,000 nomenclatural standards.

The type specimens of plants are scattered throughout herbaria. This makes it more difficult for scientists to access them as they need to physically visit the herbarium to see a type specimen. Some organisations are starting to digitalise these to provide easier access worldwide.

A 21st century type specimen of *Mimulus peregrinus* at the Herbarium RBGE



The nomenclatural standard for *Agapanthus* 'Angela', RHS Herbarium

International Plant Names Index (IPNI), World Flora Online

There are several valuable databases where you can check the names of plants and their plant authorities – the first person who officially published the name.

The International Plant Names Index is an index of plant names published under the ICN. It is hosted by Kew and is produced by a collaboration between The Royal Botanic Gardens Kew, The Harvard University Herbaria and The Australian National Herbarium.

1.4 million plant names can be searched, and it also links to World Flora Online and RBG Kew Plants of the World Online.

International Plant Names Index (ipni.org)

> The *World Flora Online* (*WFO) Plant List* is the most comprehensive and authoritative list of vascular plants (flowering plants, conifers, ferns and their allies) and bryophytes (mosses, hornworts and liverworts). It is maintained by the global taxonomic community as a free and open-access resource.

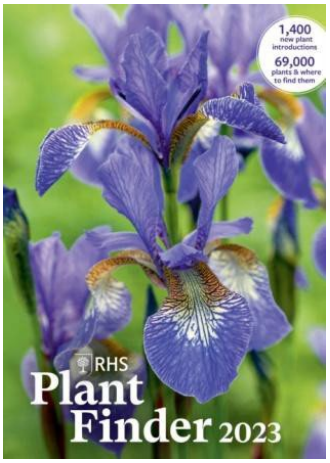
The WFO Plant List | World Flora Online

> Plants of the World Online is an international collaborative programme that has as a primary aim to make available digitized data of the world's flora gathered from the past 250 years of botanical exploration and research.

Plants of the World Online | Kew Science

The RHS Plant Finder

The RHS Plant Finder is published annually and is also available online as 'Find a Plant'. It is an index of 69,000 plant names and has useful extra information. This provides a valuable resource for checking current plant names and their availability.



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RHS Plant Finder *helps you:*

- Find a specific plant and where you can buy it
- Find a plant with a particular name, such as the name of your daughter
- Look for specialist nurseries near you
- Learn the correct name to use for a plant
- Know which plants are good for pollinators
- Select AGM fruit and vegetables from their descriptions
- See the horticultural classification of genera with large numbers of cultivars (for example, which tulips are Fringed, Lily-flowered, Triumph or Parrot cultivars)
- Find out which plant groups have had nomenclatural name changes since the previous edition
- Identify which plants are listed as invasive and banned from sale within the UK

Horticultural Taxonomy Group (Hortax)

The Horticultural Taxonomy Group, or Hortax, is a small group of European plant taxonomists and horticulturists with an interest in the classification and nomenclature of cultivated plants. Formed in 1988, the Group seeks to discuss and address current issues of cultivated-plant taxonomy, to promote best practice and encourage a wider understanding of the naming of cultivated plants.

Hortax published a useful guide – Plant Names, A Guide for Horticulturists, Nurserymen, Gardeners and Students.

Methodology to describe the properties of plants

An accurate plant name is vital, but further information is needed to understand how suitable that plant will be for a particular situation or use.

Trials and research

Plant trials are a valuable method of assessing their health, performance and resilience to climatic conditions. It is crucial to understand the resistance of plants to particular pests and diseases. The ornamental value of a plant is also of key importance, and factors such as time and length of flowering, flower and leaf colouring and form of plant, growth rates etc are also studied. Many other research projects are carried out at a range of botanic gardens as described earlier.

The RHS carry out regular plant trials at Wisley and also at different garden and nursery sites in the UK. This has been an important role of the RHS for over 100 years. Using different sites, such as the RHS Garden Bridgewater, RBGE, RHS Garden Rosemoor, National Trust gardens and commercial nurseries provides the opportunity to see how plants perform in different conditions – both climatic and soil conditions.

The trials may be for one year, three years or five years depending on the type of plant. The plants are assessed by a panel of industry experts during the trial. Roundtable assessment is sometimes carried out by a panel of experts when it isn't practicable to carry out a field trial.

Exercise:

Search the RHS website to see the trials that are currently being carried out.

The plants that are judged to perform the best are given the RHS Award of Garden Merit (AGM) and may be given the symbol below:

Commercial growers of plants need to register with the RHS to use the symbol.

The criteria for an AGM include an assessment whether the plant is:

- Excellent for ordinary use in appropriate conditions
- Available
- Good constitution
- Essentially stable in form and colour
- Reasonably resistant to pests and diseases

The assessment then needs to be ratified by the relevant RHS Plant Committee.

Once awarded an AGM, this doesn't mean that the plant will always have the award. It might be the case that in future trials it does not perform as well. There is a rolling review programme to make sure the AGM plants are regularly assessed. It does, however, give growers and buyers an idea of the reliability of the plant.

Ecosystem services

The role that individual plants, groups of plants or plant combinations play in an ecosystem is also vital to know.

An ecosystem can be defined as:

> a geographic area where plants, animals and other organisms as well as weather and landscape, work together to form a bubble of life. Ecosystems contain biotic, or living parts as well as abiotic, or non-living parts. Biotic factors include plants, animals and other organisms.
>
> National Geographic Society

Ecosystem services were adopted as a main framework in 1995 by the Convention on Biological Diversity. Ecosystem services can be defined as:

The variety of goods and services that people depend on and which arise from the ecosystem.

Ecosystem services often result from intervention by people and it is useful to think of them as co-produced by ecosystems and society. Horticulture provides many examples here, as every garden or designed landscape is co-produced.

Plants are evaluated to assess the ecosystem services they offer, which include:

- Regulating ecosystem services (air quality, climate, water run-off, erosion, pollination)
- Cultural ecosystem services (spiritual, recreation, cultural, human benefit)
- Supporting ecosystem services (nutrient cycling, water cycling, soil formation)
- Provisioning ecosystem services (food, fibre, biomass, fuel etc.)

Many plants provide a combination of different services.

Regulating ecosystem services

Plants regulate the climate. They take in carbon dioxide through the process of photosynthesis and store the carbon. Unless this is harvested or burned, the carbon returns to the soil. Plants are therefore a vital carbon sink.

Plants, and particularly trees, can cool the atmosphere through transpiration.

Plants in general improve air quality, but some are particularly good. Research was carried out by NASA to find out which indoor plants are more efficient at removing impurities from the air. This research was to find plants for a sealed environment that the astronauts would be in. The findings are applicable to any indoor environment and particularly useful for offices. Many plants are efficient at removing common indoor toxins such as benzene, formaldehyde, xylene, ammonia and trichloroethylene. These toxins are released by items such as synthetic carpets, paints, household cleaners and furnishings.

Below are some examples of indoor plants that are particularly effective.

Chlorophytum comosum *Spathiphyllum wallisii* *Chamaedorea elegans*

Outdoor plants are also vital for cleaning up contaminated soil through a process termed 'phytoremediation'. Forest Research has carried out work on using trees to remove contaminants from soil, and also to prevent the pollutants from reaching the soil. Vegetation can prevent soil erosion, leaching, surface water run-off and wind erosion.

The plants that are good at removing pollutants such as copper, zinc, nickel, chromium and lead are called hyper-accumulators. Willow trees, such as *Salix viminalis* have been found to be good at reducing zinc levels in the soil. *Festuca rubra* is good at removing copper, lead and zinc making a good plant for reclaiming mine spoils. There is a global database of plants which are hyperaccumulators:

Global Hyperaccumulator Database (uq.edu.au)

Plants are also effective in flood control. A diverse indigenous planting along a roadside, for example, can slow water movement and prevent flooding.

Pollination is another vital ecosystem service. The RHS have carried out research and used their own expertise and the knowledge from gardeners and beekeepers to develop 'Plants for Pollinators'

They have compiled lists of plants which are particularly good for attracting pollinators. Many pollinators are declining in numbers, so this is of particular importance. We would not be able to produce many of our food crops without this ecosystem service. The logo can be found on plant labels, online plant sales, seed packets etc. Commercial growers and nurseries can register to use the logo under certain guidelines. The RHS regularly review the plant list.

Cultural ecosystem services

The services, or benefits provided by gardens and designed landscapes of all sorts was described in Unit 1, discussing various roles and purposes of these horticultural spaces.

Ecosystems link people culturally by sharing in the appreciation of the beauty of outdoors, and provide recreational, educational and spiritual opportunities.

Different types of plants play particular roles in these ecosystem services. Some plants have particular religious or spiritual associations. Plants used in a sensory garden have particular roles in stimulating different senses. The scent of plants is of great value, often being particularly evocative or calming.

Lavandula angustifolia

Plants from different cultures and countries can play an important part for people from different cultures and countries. Food plants or herbs that are more familiar can provide a link to home.

Plants that are bright and cheerful can be used to lift mood.

Helianthus annuus

Supporting ecosystem services

Plants are the base of the food chain in nearly all ecosystems.

Certain plants have the ability to capture gaseous nitrogen and make it available to the plant. These include peas and beans and also some trees such as *Alnus glutinosa.* Nodules on the roots of alder contain the bacteria *Frankia* which absorb atmospheric nitrogen and convert it to forms of nitrogen the tree can use. This not only feeds the tree, but improves the surrounding soil fertility. It makes this tree a useful pioneer species in ecological successions.

The Centre for Ecology and Hydrology and the Forest Research carried out research on tree planting to capture ammonia emissions. This was funded by the Scottish Environment Protection Agency. The work centred on preventing the damage from agricultural emissions. Excess ammonia in the atmosphere leads to soil acidification which damages habitats and the extra nitrogen in the soil results in a loss of biodiversity. The ammonia also reacts with pollutants and results in poor air quality for human health.

As a result of this research, an online tool is now freely available. Suitable tree species and planting distances, and design are recommended.

Tree Shelter Belts for Ammonia Mitigation | Tree Shelter Belts (ceh.ac.uk)

Green manure crops have long been used to provide both a regulating and supporting role in ecosystems. Some, such as *Vicia faba,* add nitrogen to the soil from their root nodules. All provide a groundcover which prevents leaching of nutrients, soil capping and erosion and add organic matter to improve soil structure and biodiversity.

Phacelia tanacetifolia is a rapid growing annual green manure crop which holds a lot of nitrogen.

Other plants that fix nitrogen include *Elaeagnus umbellata* and *Caragena arborescens.*

Plants recycle water taking up vast quantities and releasing some of this as water vapour into the atmosphere. Some plants can be used to filter water, such as reed beds.

Provisioning ecosystem services

Plants for provisioning ecosystem services include world food crops, such as maize, wheat and rice. They also include fruit, vegetables and herbs – a kitchen garden or allotment is a wonderful provisioning ecosystem! Fibre crops include cotton, jute and hemp. Tree or plant materials, such as wood chips supply biomass materials for energy. Wood pulp is used to produce paper. Many plants are used for medicines.

Hardiness ratings

The hardiness of a plant is vital to know, so it will withstand the climate or micro-climate where it is planted. This is getting more difficult with the extremes of climate change, but is perhaps even more important to assess. The hardiness rating should be looked at in conjunction with other conditions. Some plants may be hardier over winter if they are in a drier site, for example.

The RHS developed standard ratings in 2012, which superseded their older ratings of H1 - H4:

Rating	Temperature ranges °C (°F)	Category	Definition
H1a	warmer than 15 (>59)	Heated glasshouse - tropical	Needs to be grown as a house plant or under glass all year round.
H1b	10 to 15 (50 to 59)	Heated glasshouse - subtropical	Can be grown outdoors in summer in sunny and sheltered locations but generally performs best as a house plant or under glass all year round.
H1c	5 to 10 (41 to 50)	Heated glasshouse - warm temperate	Can be grown outdoors in summer throughout most of the UK while daytime temperatures are high enough to promote growth.
H2	1 to 5 (34 to 41)	Tender - cool or frost-free glasshouse	Tolerant of low temperatures but will not survive being frozen. Except in frost-free inner-city areas or coastal extremities requires glasshouse conditions in winter, but can be grown outdoors once risk of frost is over
H3	-5 to 1 (23 to 34)	Half-hardy - unheated glasshouse / mild winter	Hardy in coastal / mild areas except in hard winters and at risk from sudden (early) frosts. May be hardy elsewhere with wall shelter or good microclimate. Can survive with artificial winter protection.
H4	-10 to -5 (14 to 23)	Hardy - average winter	Hardy through most of the UK apart from inland valleys, at altitude and central / northerly locations. May suffer foliage damage and stem dieback in harsh winters in cold gardens. Plants in pots are more vulnerable.
H5	-15 to -10 (5 to 14)	Hardy - cold winter	Hardy through most of the UK even in severe winters. May not withstand open or exposed sites or central / northerly locations. Many evergreens suffer foliage damage and plants in pots will be at increased risk.

Rating	Temperature ranges °C (°F)	Category	Definition
H6	-20 to -15 (-4 to 5)	Hardy - very cold winter	Hardy throughout the UK and northern Europe. Many plants grown in containers will be damaged unless given protection.
H7	colder than -20 (< -4)	Very hardy	Hardy in the severest European continental climates including exposed upland locations in the UK.

These hardiness ratings are applied to all the RHS AGM plants, and are also shown in the RHS Plant Search.

Colour charts

Descriptions of flower, fruit and leaf colour vary tremendously in different sources. A standard is needed to refer to in order to accurately describe plants and also to identify and name them. The RHS Colour Chart was first published in 1938 with 100 plates. It is updated every few years and now has 920 colours. Each colour has a number and a letter code as well as a name.

It has become a standard reference, not only in horticulture, but also other industries including food, cosmetic, pharmaceutical and fashion!

Element 3: Applied plant knowledge		
AO1: Knowledge	**AO2: Application**	**AO3: Integration**
The research, communication and use of plant information, to include: • botanical description • origin, natural habitat, geographic spread • folklore / medicinal uses • natural method of propagation • biodiversity rating • conservation status • predictive nature of scientific names • advantages of scientific names	Horticultural applications of plant information for: • species selection • plant management • interpretation • botanical plant descriptions The importance of taxonomic principles in management of National Plant Collections® e.g. labelling and verification.	The impact and importance of exploration and plant introductions on horticultural heritage. The application of plant knowledge to management techniques.

Commentary

Horticulturists require the ability to develop and increase their plant knowledge during their careers, or as their passion for a particular group of plants grows. At AO1 The concept of using reliable information sources to research plant information is studied along with the advantages that the use of scientific plant names afford.

At AO2 the application of plant knowledge is considered within the context of the management of National Plant Collections® and in the selection and management of plant species. Areas such as botanical plant descriptions are included to allow learners to develop a basic knowledge of the use of plant keys, and an ability to provide accurate plant descriptions.

At AO3 the impact of reliable plant-base knowledge is considered on the propagation of plant species or the horticultural techniques used in the management of gardens. Qualification-wide outcomes that can be applied in AO3 include the application of plant knowledge with reference to sustainability and climate resilience.

Introduction

Research is carried out by scientists, and grower/garden led formal and informal trials. For this research to be of use it needs to be communicated well. The results of research are sometimes published in journals. A lot of research is now being made available online which provides much easier access worldwide. The specialist societies discussed in Element 2 play an important role in researching and communicating plant knowledge.

Botanical description

Botanical descriptions of individual plants are required to communicate accurate information. These may be written in different ways, but an understanding of the terms used in basic botanical glossaries is important.

The descriptions may be found in plant books such as encyclopedias, online sites such as the RHS or Trees and Shrubs online, plant labels in nurseries and garden centres and seed catalogues. Certain horticultural roles require an ability to write accurate botanical descriptions.

The following are examples of botanical descriptions from different sources for the same plant.

Trees and Shrubs Online

Berberis darwinii

> An evergreen shrub of dense habit, from 6 to 12 ft high; branchlets covered with a dense, reddish-brown down. Leaves very dark, glossy green, stalkless, hard in texture, obovate, 3⁄4 to 1 1⁄2 in. long, the apex three-spined, and with one to several spiny teeth down each side; they spring in tufts from the axils of short, multiple spines. Flowers on drooping racemes 1 1⁄2 to 2 in. long, each flower on a slender stalk longer than itself, deep golden or orange-coloured, tinged with red; petals elliptical notched at the tip. Fruit plum-coloured, roundish oval, the size of small peas. *Bot. Mag.*, t. 4590.

RHS

Berberis darwinii

Darwin's barberry

A dense, medium-sized evergreen shrub, with dark glossy green, broadly oblong, sparsely-spined leaves, and drooping racemes of rich orange flowers, tinged red in bud, followed by blue-black berries.
Ultimate height 1.5 – 2.5 m
Ultimate spread 1.5 – 2.5 m
Time to ultimate height 10 – 20 years
Hardiness rating – H5

Flora: The Gardener's Bible
Berberis darwinii

Evergreen shrub native to Chile and Argentina. Leaves dark green, toothed with spines, pale green beneath. Flowers deep yellow or orange in pendulous racemes. Oblong purplish black fruits with a bloom.
Height up to 3m
Spread up to 3m

You need to know the botanical terms that would be used in a simple plant glossary.

Botanical terms that are needed for the descriptions of *Berberis darwinii* above are:

obovate, elliptical and raceme

Exercise:

Choose one plant example and look up as many standard plant reference sources that you can to find descriptions.

Define any botanical terms that are used.

See if there is much variation between the descriptions.

Write a description for your selected plant that would be suitable for the label in a garden centre.

Plant keys

Plant keys are useful for identifying plants. These are systematic methods of working through categories, to arrive at the species you are trying to identify. It is a kind of detection system in which you sort through a number of clues until the identity of the individual plant you are trying to identify is arrived at.

A short example is:

You have identified the plant as a red poppy, but there are four species

1. Capsule glabrous (without hairs) [go to 2]

   Capsule with long, stiff hairs [go to 3]

2. Capsule a little longer than wide *Papaver rhoeas*

   Capsule > 2x as long as wide *P. dubium*

3. Capsule almost spherical *P. hybridum*

   Capsule >2 x as long as wide *P. argemone*

Papaver rhoeas

Longer keys will start at a more basic point, such as selecting whether the plant is monocotyledonous or dicotyledonous, or higher up the taxonomic ranks and working down to a particular species.

Origin, natural habitat, geographic spread

The origin and natural habitat are important to know for plant selection. Suitable plants can be chosen for particular soils and climates for example. Sustainable and ecological planting design looks carefully at the origins of plants to match the conditions.

The country of origin will give a clue to the hardiness of the plant, and whether it will survive outdoors where you want to plant it.

The natural habitat will give guidance as to whether it is suitable for the position you are planning. A plant with a woodland habitat needs similar conditions, perhaps with dappled shade provided under the canopy of a deciduous tree. A plant from a mountainous region is likely to need a well drained soil and open site. A coastal garden will need plants that are from the same natural habitat to thrive in the salt laden winds.

A standard reference source for plant information will provide these details, or a combination of sources may be needed for a fuller picture.

Plants of the World Online include maps and a description to show where the plant is indigenous and where it has been introduced. E.g.:

Berberis darwinii

Native to:

Argentina South, Chile Central, Chile South

Introduced into:

California, Great Britain, Ireland, New South Wales, New Zealand North, New Zealand South, Oregon, Tasmania, Victoria

Sometimes plants have become invasive in areas they have been introduced to and their geographic spread is then unwelcome.

An example is *Impatiens glandulifera* which was introduced into Britain in 1839.

According to CABI Invasive species molecular research showed that it was introduced on many occasions. It has become one of the UK's most invasive species and is listed as an invasive non-native plant on Schedule 9 of The Wildlife and Countryside Act 1981. It is an offence to plant or cause it to grow in the wild.

It is certainly a very attractive plant, which explains the numerous introductions. It does, however, cause huge problems in waterways, ditches and wasteland. It competes with other plants for water, light, nutrients and pollinators with its rapid growth and ability to survive in low light levels. This results in a reduction in biodiversity. The seed dispersal method is very efficient with explosive seedpods and large numbers of seeds.

As I. glandulifera is an annual, where it dies back it leaves large areas of bare soils. This can be very damaging on river banks leading to erosion. The dead plant material can also cause problems by blocking waterways and causing flooding. A fungal bio-control was approved for use in 2014 and research is ongoing.

Folklore/medicinal use

There is much folklore surrounding plants and plants have been used throughout history for medicinal uses. Plants also hold vast untapped resources that may prove useful for future medicines, which is one of many reasons for conserving plants and in particular, biodiverse habitats.

Monastic gardens have long cultivated plants for medicinal purposes. A physic garden can be seen at Buckfast Abbey, Devon, for example, which is still a Benedictine monastery.

The folklore surrounding plants will have carried through generations in the past by word of mouth. Some is available now to read in books, e.g. *Discovering the Folklore of Plants,* Shire Classics, Margaret Baker. There are also many online sources e.g.The Woodland Trust:

Woodland Trust

Our lives have been so closely linked with trees since prehistoric times, they've been the subjects of legends, folklore and mythology.

Blackthorn has long been considered a magical tree. In Celtic mythology, it was considered to be a home to fairies.

It has been referred to as a witch's tree and anyone carrying a walking stick made from blackthorn wood was suspected of being a witch. A blackthorn staff was thought to be effective for warding off evil spirits.

Prunus spinosa

Oak has a long history of folklore throughout Europe and was sacred to many people, including the ancient Greeks, the Norse and the Celts.

Oak's association with the gods of thunder may have come from the phenomenon that oaks are often split by lightning being the tallest trees standing in the landscape.

More recently oak was the sacred wood burnt by the druids for their mid-summer sacrifice. In fact the word 'druid' means 'oak man'.

Folklore told that the following saying about its leaves emerging would predict the weather for the summer.

If the oak before the ash,
Then we'll only have a splash.
If the ash before the oak,
Then we'll surely have a soak.

In modern history, tradition has it that Charles II hid in an oak tree at Boscobel when pursued by the Roundheads. Since then, children wear oak leaves on 29 May to commemorate Royal Oak Day (now known as Oak Apple Day).

Quercus robur

Hawthorn was a powerful supernatural force for good or evil and has been associated with sacrifice and protection.

It's the only British plant to be named after the month in which it flowers. The appearance of its blossom was the herald of the end of winter and the beginning of summer and the saying ‘Ne’er cast a clout till May is out’ almost certainly refers to the opening of the flowers, not the end of the month.

The hawthorn was thought to be the ancestor of the maypole and was the source of May Day garlands and the May Queen was often crowned with May blossom. The rhyme ‘here we go gathering nuts in May’ referred to the collection of knots (not in fact ‘nuts’) of may blossom. Superstitions about the flowers, especially about the terrible consequences of bringing them indoors, are widespread.

Crataegus monogyna

Silver birch is important spiritually in many religions both historically and today.

It is known by the druids as the Goddess Tree and the Lady of the Woods and is associated with light, new beginnings, love and fertility. It was a tree of enchantment with the power to protect against evil spirits and the evil eye.

In medieval Britain, a bundle of birch twigs was carried by the local magistrate on his way to court as a symbol of his authority and as a means of correction. The use of the birch as a punishment probably originates in the need to drive out evil spirits.

Betula pendula

Plants used for medicinal purposes in the past may have had varied effects! There are many old and modern herbal books available.

The Doctrine of Signatures dates back to classical scholars such as the Greek physician Dioscorides (circa 40 – 90CE). This theory is based on the idea that certain physical attributes of plants are signs that indicate their therapeutic or healing value. Common names for many plants indicate this, such as lungwort *Pulmonaria* spp. and eyebright, *Euphrasia officinalis.*

In 1518 King Henry VIII issued a charter with the aim of regulating medicines. The charter transferred the power from the church to The Royal College of Physicians. In 1618 he tried to standardise practices further by ordering all physicians to obtain a copy of '*Pharmacopoeia Londinensis'.* This text was all in Latin and didn't actually include any remedies.

Nicholas Culpeper made herbal remedies available to the masses by translating the book and including recipes for using the plants. The book was much cheaper, and possible for far more people to understand. It took away much of the secrecy surrounding the Royal College of Physicians.

John Gerard's '*The Herball', or Generall historie of plantes*', published in 1597, can be viewed online via the Biodiversity Heritage Library. Biodiversity Heritage Library (biodiversitylibrary.org)

'*The Herball*' describes medicinal uses of plants but also includes stories of the folklore surrounding certain plants.

Gerard's Herbal

Herbal remedies are still widely used and plants have provided some very valuable medicines. It is more common now for a synthesised version to be used rather than the original plant, but they have nevertheless provided the basis for a lot of current pharmaceutical drugs. Examples of plants used in this way include *Filipendula ulmaria* and *Taxus baccata.*

The story of Aspirin – a versatile medicine with a long history

Herbal medicine has used salicylic acid, the natural substance related to synthetic aspirin, from myrtle, willow and meadow sweet, since ancient times (at least 2500 BCE). Ancient history has many examples of humans using salicylic acid for medicinal purposes; there are clay tablets from the Assyrians in the Sumerian period (around 4000 years ago) in which willow leaves are recommended for rheumatic disease, the Egyptians describe the use of willow leaves or myrtle for joint pain or inflammation and Hippocrates (460-377 BCE) recommended an extract of willow bark for fever, pain and child birth. Ancient Chinese, Roman and Native American civilizations have all long recognised the benefits of plants containing salicylic acid for their medicinal benefits.

Meadow sweet, another source of acetylsalicylic acid, was one of three most sacred herbs to the Druid Celts (the other two are water-mint and vervain) and is one of the 50 ingredients in the drink 'Save' mentioned in Chaucer's 14th century Knight's Tale (known as Medwort or Meadwort).

It was an English clergyman, Reverend Edward Stone who carried out the first scientific study of the benefits of willow bark when he used it successfully to treat fever 'ague' in 50 of his parishioners. He documents this in a letter to the President of the Royal Society in 1763 .

In 1828, Johann Andreas Buchner, Professor of Pharmacology at the University of Munich purified salicin from willow bark. A number of scientists worked on refining the process, but it was Professor Hermann Kolbe, at Marburg University who first worked out the chemical structure of salicylic acid and made it synthetically in 1859. Unfortunately, it had an unpleasant taste and irritated the stomach. The first clinical trial of salicylate was recorded in 1876, by Thomas MacLagan, a doctor from Dundee who used salicin to obtain complete remission of fever and joint inflammation in his patients who were suffering from acute rheumatism.

Salicylic acid is a benzene ring with a phenol (HO) group and a carboxylic acid (COOH) group. Whereas other scientists had focused on the carboxylic acid group, Dr Felix Hoffman, a German chemist at Friedrich Bayer and Co, concentrated on the phenol group and managed on August 10th 1897 to acetylate the phenol group and produce pure stable acetylsalicylic acid (ASA) for the first time. In this work he was supported and inspired by a number of other scientists including Arthur Eichengrün, Carl Duisberg and Wilhelm Siebel. Dr Hoffman's discovery was the first time a drug had been made synthetically and was the birth of both aspirin and the pharmaceutical industry. After recognising the importance of Hoffman's discovery Professor Heinrich Dreser, Head of the Pharmacology Institute at Bayer, tested it first on himself, then in a series of animal experiments before successful clinical trials in humans.

The new compound was named and registered Aspirin on February 1st 1899. The 'A' comes from acetyl and 'spir' from the first part of Spirea ulmaria (Meadowsweet) a botanical source of salicylic acid.

International Aspirin Foundation

Filipendula ulmaria

(syn. *Spiraea ulmaria*)

Yew clippings to make chemotherapy

There are two chemotherapy drugs that were originally developed from yew trees:

- docetaxel (Taxotere) was first made from the needles of the European yew tree
- paclitaxel (Taxol) was made from the bark of the Pacific yew tree

Some UK firms used to collect yew tree clippings as part of the process of making the drugs. But they are no longer doing this. Both drugs can now be made synthetically in the laboratory.

Cancer Research UK

Taxus baccata

Natural method of propagation

Knowledge of a plant's natural method of propagation is useful in several ways.

- It will tell you how the plant will spread when it is planted out.
- The natural method of propagation may be the most straightforward method to use for increasing plant numbers. It may be useful for commercial propagation.
- Knowledge of seed dormancy will contribute to successful germination
- It may tell you how you can store the plant, e.g. dormant bulbs or corms

The height and spread of plants is generally included in plant descriptions. The natural method of propagation is sometimes included too.

Different methods of natural propagation should be considered when you select plants for different planting styles.

For a meadow where you are looking for greater biodiversity it is important not to select any particular plants that spread too readily and could become dominant. They will compete with the other species and suppress them.

For a naturalistic, new perennial style, plants that spread are useful, but again care needs to be taken that there aren't any particularly aggressive plants that will take over.

Self seeding plants are useful for colonising walls and paving.

Natural methods of propagation can be used for different garden styles and effects.

Biodiversity rating

There are global biodiversity ratings based on eight criteria - The Global Biodiversity Standard. There are also Biodiversity Indicators by the Joint Nature Conservation Council (JNCC), the public body that advise the government on nature conservation. These are regularly updated for the UK as a whole.

There are also less complex systems that are useful for garden areas.

A simple calculation to determine the biodiversity rating of a garden involves conducting a survey to establish the number of plant species, or the number of plant and animal species in a garden.

There are many different formulae to use. The following calculation is an example:

The number of species in an area ÷ the total number of individuals in an area = biodiversity index

The number generated can then be compared with that from other garden areas, and compared over time to give a guide to the biodiversity status of an area.

Examples:

1. A mass planting of roses in a 4m x 5m garden area. The roses are regularly sprayed with pesticides and the bed is kept weed free.

The roses are all of the same species

There are 20 roses in the area

The biodiversity rating is:

The number of species in the area (1) ÷ total number of individuals in the area (20) = biodiversity index (0.05) which is low

2. A 4m x 5m cutting garden

There are 35 plant species of plants, including weed species

There are 500 plants in the area

There are 120 invertebrates of 35 species

There is a toad and a frog

Altogether there are 35 species of plants, 35 species of invertebrates and 2 species of vertebrates

Altogether there are 500 plants, 120 invertebrates and 2 vertebrates

The biodiversity rating is:

The number of species in the area (72) ÷ total number of individuals (622) = 0.12

This is higher than the rose garden.

Exercise:

The monoculture rose bed has a very low biodiversity index.

Calculate the biodiversity index for each of the following options:

1. Replace some of the roses with different species, to make the total species of roses 5.
2. Underplant the rose bed with 30 herbaceous perennials of10 different species .
3. Plant 30 bulbs of 6 different species in the rose bed.
4. Carry out all three of the above.

Suggest any other methods you could use to increase the biodiversity index whilst maintaining the ornamental value of the rose bed.

Conservation status

Some endangered plants are protected by CITES as described in Element 1.

The IUCN Red List has standard categories for endangered plants:

EX – extinct

EW – extinct in the wild

CR – critically endangered

EN – endangered

VU – vulnerable

NT – near threatened

Botanic Gardens Conservation International (BGCI) is a member of the IUCN Red List Partnership. An example of its conservation work is on tree assessment.

The organisation works with the Global Tree Specialist Group to jointly co-ordinate the Global Tree Assessment. This is a far reaching programme, aiming to provide conservation assessments for the entire world's tree species. It has produced Red List publications for endangered trees. BGCI uses the RED List information to monitor and support the ex-situ collections of threatened species.

Ex-situ conservation is conservation outside of the plant's natural habitat.

In-situ conservation is conservation within the plant's natural habitat.

Both have an important role to play, and ex-situ conservation can provide a safe haven for plants that can then be re-introduced into the wild. Although the botanic gardens have a crucial role here, gardens still play an important part too.

Plant Heritage is the charity for the conservation of garden plants. Gardens of all sizes play an important role here. The Plant Heritage website and the National Collection holders all play a crucial role in the conservation of garden plants, and the research and dissemination of knowledge.

Predictive nature of scientific names

There are many plant names that give you a lot of information about the plant. They may be descriptive, suggesting a flower colour, leaf shape etc. They may indicate the country or region the plant originated from.

Others show the habit of a plant or size, and some the natural habitat.

Magnolia grandiflora – 'large flowered'

Wisteria sinensis – 'Chinese wisteria'

Sempervivum arachnoideum

'Always living'

'Spider's web'

Fagus sylvatica

'of the woods'

Armeria maritima

'near the sea'

Saxifraga sp.

'from a rocky habitat – literally, breaking rocks'

Advantages of scientific names

To communicate clearly with someone you need to be able to speak the same language. The universal language for communicating about plants is the use of scientific names.

Scientific names have many advantages including the following:

- A unique name is provided
- The use of scientific names aids communication
- Scientific names are used worldwide
- The use of scientific names avoids confusion

It is vital to use the correct scientific names for research, garden design and selling plants/trading.

The following article from The Royal Botanic Gardens, Kew, highlights the importance of scientific names:

The medicinal names maze and why it matters to us all – How the work of our Medicinal Plant Names Service (MPNS) enables safer and more effective communication by those using medicinal plants

Liz Dauncey

Kew is at the forefront of plant name research and hosts the world's major names and taxonomy databases: *The International Plant Names Index*, *World Checklist of Selected Plant Families* and *The Plant List*.

These databases collate information about all the scientific names that have been published for plants, and present the current consensus on which are the accepted names that should be used and which are synonyms (alternative names for the same species, subspecies, variety or forma).

There are approximately 1.6 million published plant names but only an estimated 350,000 plant species, so the potential for confusion is clear. However, for anyone conducting scientific research on plants, involved in regulating illegal plant trade, or working in any of the many industries that use plants and their products, it is important to know which names relate to which species and which is the current accepted name. This is all the more important for medicinal plants, where the consequences of confusing different species can be very serious.

The major names and taxonomy databases are aimed primarily at a scientific audience, and only deal with the scientific names of plants. In the wider world, however, plants are known by a range of other names, such as common, trade and pharmaceutical names. It is these names that people use when talking to each other or even when prescribing medicinal plants or reporting suspected poisoning from plant material. And yet, unlike scientific names, there are no rules to govern which name is used for each plant. Because medicinal plants cross regional and national borders and herbal traditions, they are known by a number of different names. In addition, a single name can be used for more than one plant. Using the wrong plant in a herbal preparation has important social and economic consequences: manufacturers have to make costly product recalls, and individuals can suffer adverse health effects and even death.

Scientific plant names are an important tool for garden designers and landscape architects. Plants are carefully selected that suit a particular site and fulfil certain roles, such as ornamental, sensory, screening etc. Unless the plants can be specified accurately, the design intention will not be achieved. The scientific names need to be used at every stage. Seeds and propagules need to be accurately named. The plants need to be accurately named at nurseries and garden centres.

Element 4: Managing plants within botanic and other gardens		
AO1: Knowledge	**AO2: Application**	**AO3: Integration**
The concept of living collections. The role and benefits of plant records. The information contained within plant records.	The advantages and limitations of plant records. The use of digital tools/apps to manage plant records.	The value of plant and historical records. Methods and importance of sharing plant record information with others in professional bodies e.g. Botanic Gardens Conservation International, National Plant Collections (Plant Heritage)

Commentary

Many gardens and designed landscapes keep records of their plant collections. The more formal the collection the more detailed such records are. AO1 explains the concept of plant records along with the information they contain.

This is applied at AO2 through the study of the advantages and limitations of plant records along with the use of digital tools and apps in the management of living collections.

At AO3 the value of plant and historical records in the management of gardens and designed landscapes is considered. The networks through which such information is shared are also considered.

Introduction

Living collections of plants, as described in previous elements, can be held in all sorts of gardens and situations - from large botanical gardens to small private gardens. To be of value for conservation, research, education and communication, it is vital that they are named and recorded correctly.

Plant Records

Plant records need to include a variety of detail. At its most basic it is a record of the plant name. This could simply be a gardener keeping the plant labels in a tin from any new plant purchased. At the other extreme are the very sophisticated databases used by botanical gardens. Collection holders use a variety of databases to curate and manage their plant collections. Some larger organisations may use more than one database to fulfil different roles.

Plant labels provide vital records, but also need to be backed up in case they get lost or stolen!

The example above, from Cambridge Botanic Gardens shows the scientific name, common name, family name, the natural distribution of the plant, the accession number and the provenance. Here, the W is for wild, showing that it was collected from the wild.

An accession number is a unique identity number or code which can be used to track the plant. There are different systems for accession numbers, but a common one is to start the number with the year of acquisition.

Some databases are designed more for conservation organisations, others for public use, and some a combination of the two.

The different information that may be held includes:

- Current scientific plant name, any synonyms, common names
- Plant description
- Images

- The source of the plant
- If grown from seed – origin of seed
- Wild collected or cultivated
- Nursery that supplied the plant
- Plant collector who supplied it
- Whether propagated on site
- Age of plant, including when it was planted
- The position of the plant in the garden or glasshouse/GPS co-ordinates
- Accession numbers
- Health status
- Hardiness
- Age of plant, including when it was planted
- Conservation status
- Legal paperwork
- Plant maintenance observations
- Additional notes that are relevant

A minimum requirement for plant records for National Plant Collections is that it includes the correct scientific name, the date acquired and the source.

Plant databases provide a valuable resource for research, conservation and education. A database can be accessible all over the world and allows for easy exchange of knowledge.

Some databases have very sophisticated search facilities, which allow all sorts of questions to be answered, and provide valuable links and statistics. They can give an overall picture of the conservation status of many plants.

There are limitations to databases. The database needs to be kept up to date to be accurate and valuable. The database doesn't necessarily give the same insight as actually seeing the plant or collection.

BG- Base

BG-Base was initiated in 1985 by the Arnold Arboretum of Harvard University, Boston and the Threatened Plants Unit (TPU) of the World Conservation Monitoring Centre (WCMC) in Cambridge.

It is a PC based database app. The aims were to meet the needs of individuals and institutions holding living or preserved collections, such as botanic gardens, arboreta, herbaria, horticultural societies and individual collections. In the UK there is a support centre at RBG Edinburgh.

BG-BASE is designed to manage information in six broad categories:

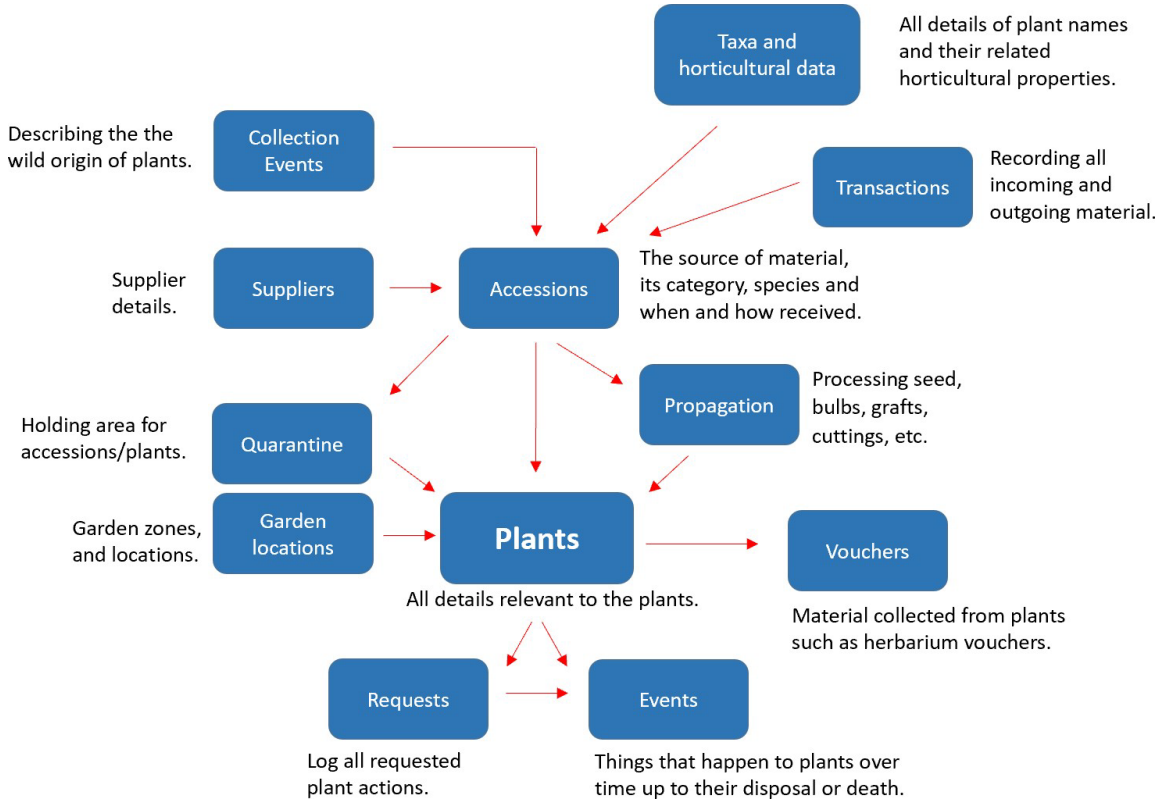
1. collection management (living collections, herbarium and museum collections, seed banks, DNA repositories, etc.)

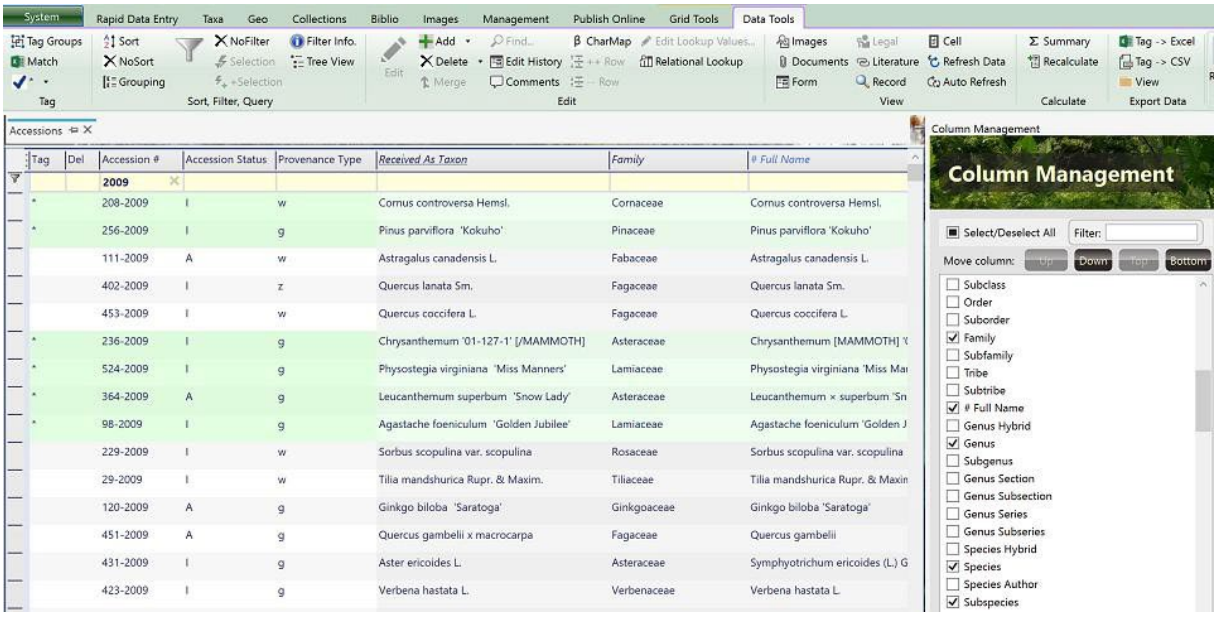
2. taxonomy / nomenclature (any level from kingdom down to sub-form, cultivar, cultivar group, etc.)
3. distribution (from global down to exact latitude/longitude)
4. bibliography (books, journals, unpublished references, images, etc.)
5. conservation (threats, conservation status, protected areas, laws and conventions, etc.)
6. people management (addresses, institutional affiliations, education programs, events tracking, etc.).

It has a query tool that will search for all sorts of information and a names table with botanical and horticultural rules of nomenclature built in.

BRAHMS

The BRAHMS project is run by the University of Oxford. It is part of wider research to explore and document biodiversity. BRAHMS is a database for managing natural history collections, botanic gardens seed banks, taxonomic research and field surveys.





Candide

Candide is an app for plant lovers. The company started in Bristol in 2017. It provides an encyclopedia, garden tours, talks from head gardeners and a social network platform.

CANDIDE

Iris

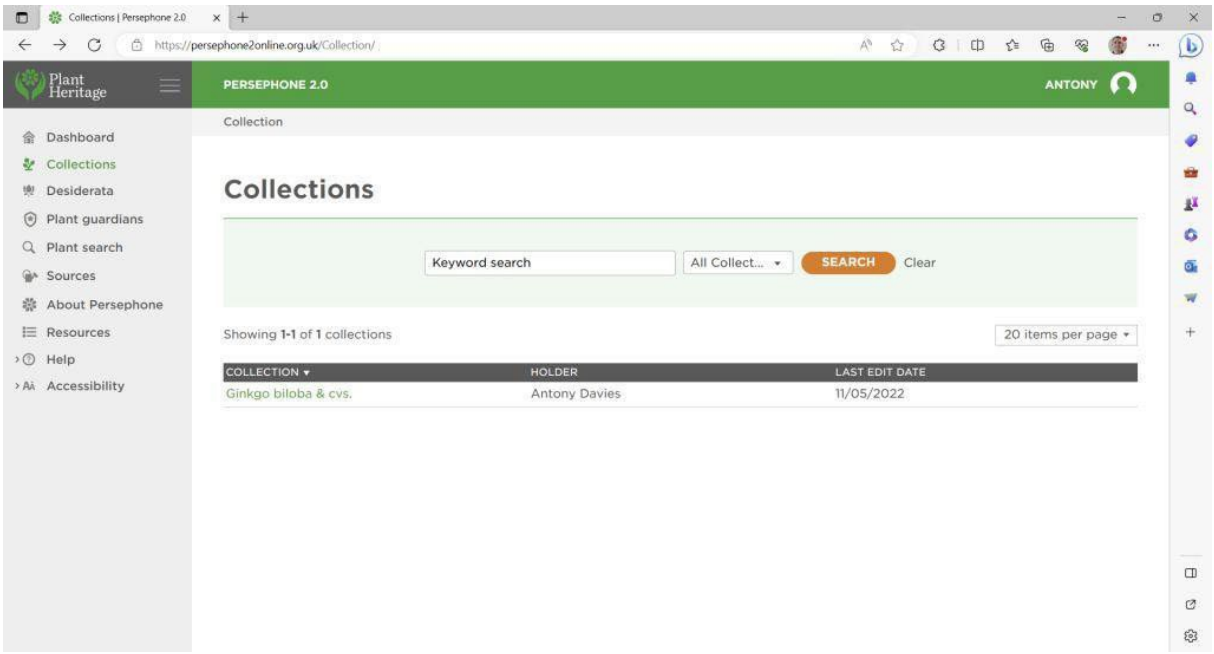
Iris is a collection management system for living and preserved botanical collections. It is particularly designed for sharing information with the public.

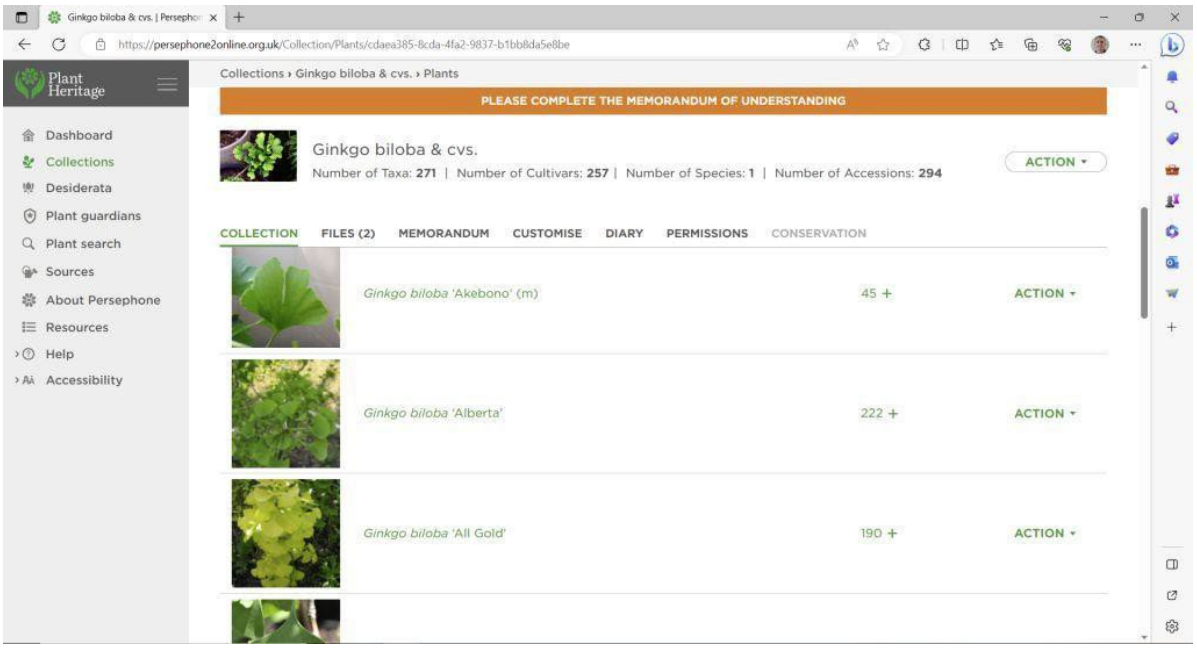
For example, it is used by Sheffield Botanical Gardens and can improve the visitor experience. The database holds a document of the plants in the garden. Visitors can use the app whilst visiting the gardens to locate particular plants they are interested in, and to find out more information. It can also be used at home to explore the gardens.

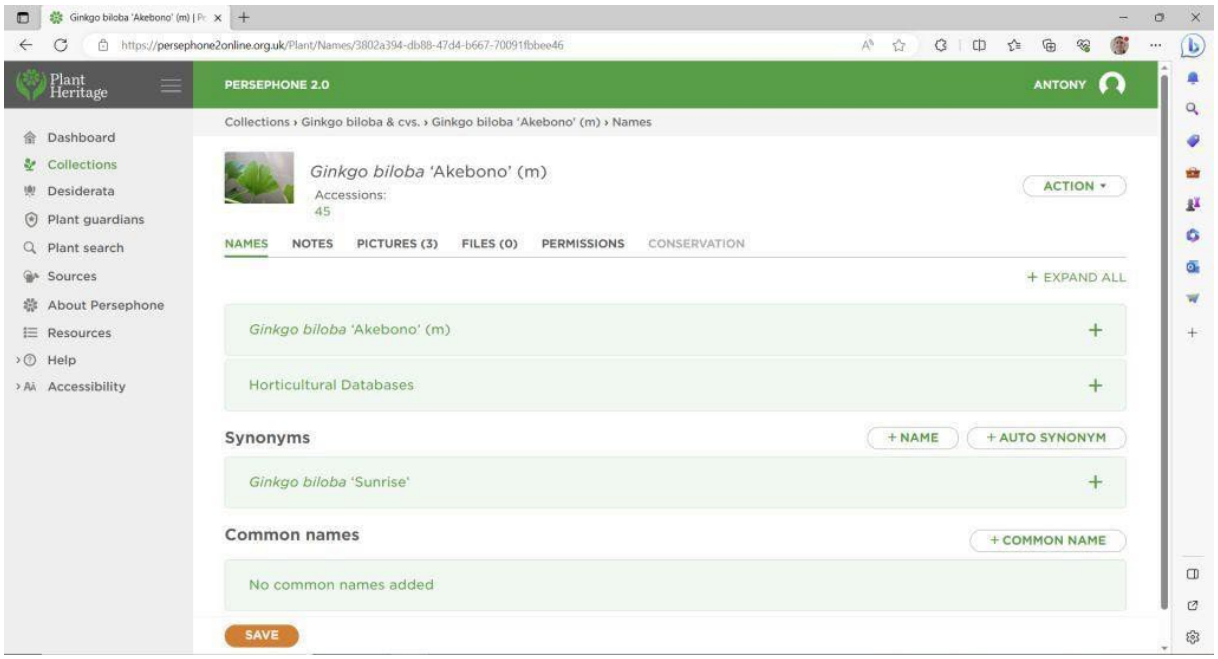
Persephone

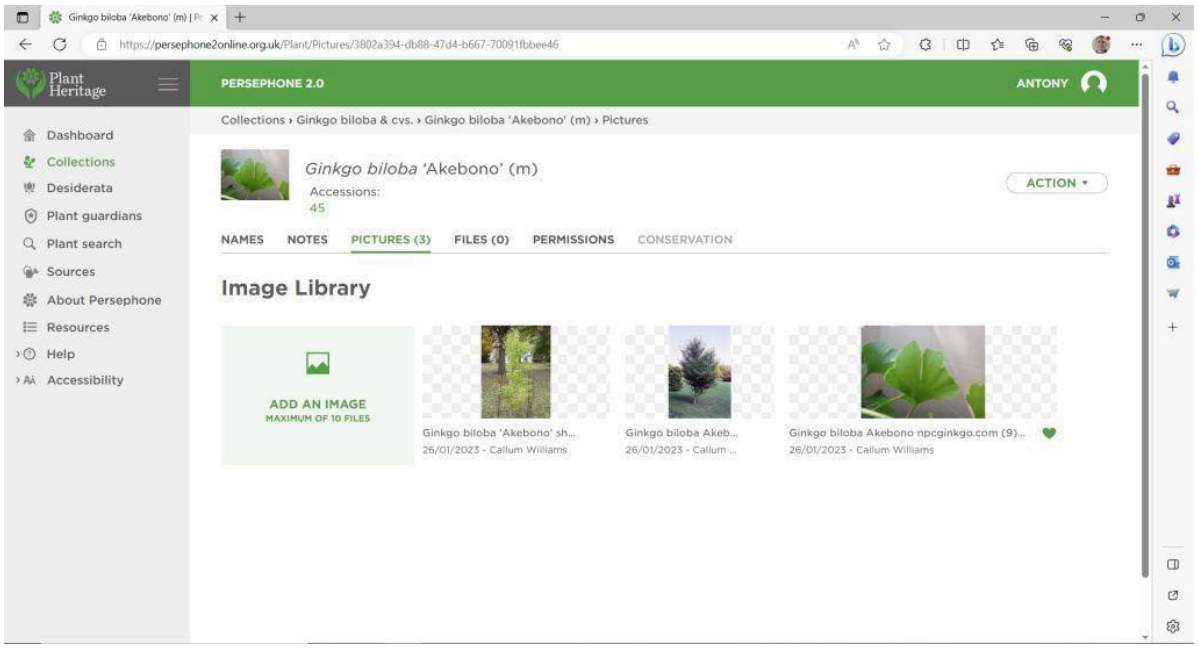
Plant Heritage use Persephone for their online horticultural database.

Below are examples from the Persephone database for the National Collection of *Ginkgo biloba* & cvs.






Ginkgo biloba 'Akebono' (m) | Pe
https://persephone2online.org.uk/Plant/Names/3802a394-db88-47d4-b667-70091fbbee46
Plant Heritage
PERSEPHONE 2.0
ANTONY
Dashboard
Collections
Desiderata
Plant guardians
Plant search
Sources
About Persephone
Resources
Help
Accessibility
Collections › Ginkgo biloba & cvs. › Ginkgo biloba 'Akebono' (m) › Names
Ginkgo biloba 'Akebono' (m)
Accessions:
45
ACTION
NAMES
NOTES
PICTURES (3)
FILES (0)
PERMISSIONS
CONSERVATION
+ EXPAND ALL
Ginkgo biloba 'Akebono' (m)
Horticultural Databases
Synonyms
+ NAME
+ AUTO SYNONYM
Ginkgo biloba 'Sunrise'
Common names
+ COMMON NAME
No common names added
SAVE


Ginkgo biloba 'Akebono' (m) | Pe
https://persephone2online.org.uk/Plant/Pictures/3802a394-db88-47d4-b667-70091fbbee46
Plant Heritage
PERSEPHONE 2.0
ANTONY
Dashboard
Collections
Desiderata
Plant guardians
Plant search
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Accessibility
Collections › Ginkgo biloba & cvs. › Ginkgo biloba 'Akebono' (m) › Pictures
Ginkgo biloba 'Akebono' (m)
Accessions:
45
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NAMES
NOTES
PICTURES (3)
FILES (0)
PERMISSIONS
CONSERVATION
Image Library
ADD AN IMAGE
MAXIMUM OF 10 FILES
Ginkgo biloba 'Akebono' sh...
26/01/2023 - Callum Williams
Ginkgo biloba Akeb...
26/01/2023 - Callum ...
Ginkgo biloba Akebono npcginkgo.com (9)...
26/01/2023 - Callum Williams