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Seed to tree

On 14 November 2019 some 37 members took advantage of a rare sunny day to refresh their acquaintance with Westonbirt Arboretum and to look in detail at the approach taken to growing trees from seed. DAVID HOWELLS records the visit.

We met in the Great Oak Hall, a fine and appropriately named modern building. We were greeted by 72 seed trays, brimming with seeds of all shapes, colours, forms and sizes. Without the labels it would have made a challenging identification test. Our hosts for the morning were Penny Jones (Propagator) and Alison Vry (Database and Records Manager). The day started with a general introduction by Andy Bryce (Collections Manager), who has operational responsibility for the trees. What a job!

The context—Westonbirt

Most of us had visited Westonbirt before, perhaps on many occasions. But it was useful to be reminded of its background. The arboretum consists of two areas—the Holford Arboretum and Silk Wood. The Holford Arboretum was originally farmland, with an average depth of soil of about 70 cm. The first recorded plantings were in 1829. Two venerable specimens—a *Pseudotsuga menziesii* (Douglas-fir) and *Acer macrophyllum* may date from the original collections by David Douglas.

The Holford family were long established at Westonbirt, and it was Robert Holford in particular who made the arboretum what it is, although the word 'arboretum' was not in use when he began. The planting initially focussed on

Opposite, Members mingle around a spectacular display of different seed in the Great Oak Hall at Westonbirt Arboretum where the morning presentation on growing trees from seed was given.
Below, Gathering seed under *Acer sterculiaceum* during the afternoon tour of Westonbirt Arboretum.

the old section which bears his name and from the 1870s was extended to Silk Wood, acquired earlier as an ancient semi-natural woodland. Since then this has been extensively planted but its naturalistic character remains. In 1956 the whole site was acquired by the Forestry Commission and was run at a loss for years—something which has since been addressed thanks to visitor numbers (now well over 500,000 annually) and professional marketing.

Westonbirt has some 15,000 specimen trees (excluding the woodland areas) comprising around 1,800 species, of which 113 are at risk of extinction. The site extends to 600 acres (240 ha) plus a newly acquired section of 30 acres. Each year there are some 200 to 300 plantings, roughly matched by trees that die or are removed. Chalara ash dieback (*Hymenoscyphus fraxineus*) was identified in 2015 and has now infected trees throughout Silk Wood. Those specimens will make way for new trees.

Accession policy

In theory the Arboretum has room to plant more trees, albeit at the price of the space which is a key part of the original Holford design and also the preservation of the Grade 1 Historic Landscape. In practice space is at a premium.

The response is to plant only trees and shrubs which contribute to the

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Toxicodendron vernicifluum

Arboretum and its objectives: 'To connect people with trees to improve the quality of life'. Six selection criteria are therefore applied: heritage and historic value, landscape interest, National Collections (of which the arboretum holds five), education and learning, science and research, and conservation. There is a target list of trees based on these criteria. It currently includes *Acer griseum* (a notoriously tricky tree to propagate), *Acer japonicum* 'Vitifolium', *Acer leipoense*, *Araucaria angustifolia*, *Cedrus deodara*, *Nyssa sinensis*, and *Pterocarya hupehensis*. These target trees are not necessarily rarities. They may be sought simply because the specimen at Westonbirt is weak.

Trees are sourced in various ways, including propagations from existing plants, donations, exchanges with other botanical gardens and commercial purchases. But wild seed collections remain central and account for 70 to 80% of the propagation. The seed used for propagation at Westonbirt is all gathered from native sites in order to avoid hybridisation.

Accession expeditions to temperate areas therefore take place annually.

The search is not just for species themselves but also for natural forms which may be better adapted to changing climate than the specimens now growing at Westonbirt. One recent target was seed of *Abies alba*, which is doing badly in England as a result of non-native insects.

Growing from seed: the initial phase

When Penny Jones began her work as propagator she found few textbooks on the subject, and those few tended to contradict themselves. So the approach used at Westonbirt is substantially based on experience. The results speak for themselves, with a high germination rate. The seed is handled throughout with care, attention to fine detail and a robust approach to biosecurity. The gathered seed is all is x-rayed by Forest Research (at Alice Holt) to confirm viability and detect pests. On arrival each batch of seed is given an accession number.

Nature is variable and so are seeds, which have been divided into 11 types: capsule, cone, conelet, drupe, fleshy, follicle, nut, nutlet, pod, samara and samaroid. There are many other ways of classifying them, for example in terms of the time they retain viability, or the time in the season when it is best to gather and sow them. Plants which 'ping' their seeds, notably in the family Hamamelidaceae, need early harvesting.

All seeds are subjected to tests for viability. One is the soak test: when immersed in water, seeds that sink are likely to be viable. The floaters are not. The best test, however, is simply to cut the seed. If the flesh is white and moist then it is alive.

All seed is hand-cleaned, mostly by volunteers. Fleshy parts, which inhibit germination, are removed. All acers are de-winged. The seeds are also washed, with the addition of washing soda (15%) bicarbonate of soda (5%). This helps to separate out the non-seed elements of the plant material.

What treatments do the seeds need?

The critical question is what happens next. In order to germinate, all seeds need water, oxygen, light, the correct temperature and an appropriate period of time. Beyond that they have many different characteristics:

- 'Germinable' seeds require no pre-treatments and germination will be above 25%. They include *Cedrus, Chamaecyparis, Larix, Picea, Sequoia, Sequoiadendron* and *Rhododendron*.
- Moderately germinable seeds require no pre-treatments but germination will be 5 to 25%. Examples: *Cercidiphyllum* and *Catalpa*.
- Seeds that require pre-chilling. The list of examples is very long and includes *Acer, Pinus* and *Sorbus*. They need either autumn sowing or cold stratification.
- Epicotyl dormancy, where the root emerges during the first year. A second period of cold is needed before the shoot will occur.

Examples: *Davidia involucrata,* and *Chionanthus*. The requirement here is patience: sow in the autumn and wait.

- Dormant, those with a physical barrier such as a hard seed coat. This includes most plants in the pea family (Fabaceae). Plants with a waxy seed coat include *Magnolia*.
- Double dormant seeds, those with a hard seed coat and embryo dormancy. Examples include *Fraxinus, Crataegus, Tilia* and *Viburnum*. These require the most intensive treatment—scarify, then soak and stratify.

The majority of seeds are not germinable and therefore require one or more additional processes. We are making up for the absence of conditions which occur in nature, including the presence of microbes in the soil which break down the elements that inhibit germination.

Treatment processes

There are two main treatment processes: scarification and stratification.

Scarification Many seeds have hard or waxy seed coats impervious to water. The seed coat is abraded to remove a part of the hard surface, or washed to remove the wax.

Stratification In the wild, seed dormancy is usually overcome by the seed spending time in the ground through a winter period and having its hard seed coat softened up by frost, weathering action and the effect of microbes in the soil. Stratification is a period of cold moist incubation which breaks a seed's dormancy, causing the seed to be readier to germinate. More or less all conifers need this for a period of one month and broadleaves for three months. The seeds are placed in a fridge in recycled tubs, with just enough growing material to cover them, and then checked weekly. Very small seeds are placed on a paper towel—'naked stratification'.

A range of other specialist treatments can be applied. Under 'fermentation' the seeds are left to go mouldy before sowing—a process that applies to *Sorbus aucuparia*. Or seeds which require fire to germinate are put in the oven.

Sowing

Some seeds need warmth to germinate and are therefore placed in an airing cupboard. The majority, however, germinate in a cold greenhouse. Sowing is now entirely into Air-Pot® containers, which allow roots to develop naturally but which also need more management. Compost is firmed, the seed distributed or sown and then covered with horticultural grit (better than Perlite). Small seeds should just rest on top of the compost and in general it is important not

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After the arboretum tour, members were shown the propagation unit where plants are grown on before being planted out at Westonbirt or in other botanical gardens.

to sow too deeply, using a depth of around 1.5 times the circumference as a guide. Some seeds like *Cercis* need to be soaked before sowing. After that it is a question of regular watering, watching and waiting. Some seeds can take up to four years to germinate, although most are much quicker than that! Different methods have been applied to some seeds, including no treatment. It was encouraging to learn that sometimes they all come up, whatever the method!

The day did not really focus on what happens after germination, but there is of course a sequence of processes using different environments and structures—successive potting on in Air-Pot® containers, movement through greenhouses, polytunnels and the shade house. It can be up to five more years before a tree is ready for its final destination, either here at Westonbirt or in other botanic gardens. During that time the plants grown from seed are sitting alongside plants propagated by grafting and cuttings. For a visual glimpse see the YouTube video 'Tree Propagation at Westonbirt Arboretum', made when the Propagation Unit was opened in 2012.

The database of planted trees

Alison Vry emphasised the importance of good data. Sadly, all the planting data about Westonbirt for more than 50 years ago has been lost. The response is now to gather, store and disseminate information systematically, using the best of modern technology, which is developing all the time.

Since 1998 all specimen trees have been mapped into a database. The one used now—here and at other botanic gardens—is IRISGB. The software is available to the public and is used by many larger plant collections, including that at Gresgarth, as Arabella Lennox-Boyd, who was attending the day, said. First and foremost the database maps the precise position of each plant—a vital matter in a large arboretum. It naturally includes traditional information—the species, family, area of origin, provenance and accession date. This list has been expanded to include such matters as the name of the collector, the exact place of origin of seed (where known), and the processes undergone by the seed, such as the period of stratification. Some of the facts are shown on the tree

label as well as on the database. As a result one can search the database using different criteria, for example showing the species collected by Roy Lancaster in Nepal during the 1980s and where these trees are located.

A walk around the arboretum

Our afternoon walk of about two hours was led by Hugh Angus. Formerly Head of Collections, he is now an enthusiastic volunteer. We looked at a succession of interesting trees, discussed them individually and then walked quite swiftly to the next one. The plantings of Robert Holford formed the backbone of Westonbirt. Having helped to finance many plant expeditions, he then planted at Westonbirt the seeds and plants that were brought back. Rather than position the trees according to species or native geographic location, Holford planted his arboretum aesthetically, in a broadly picturesque style, with vistas and three main rides.

For all arboreta, and perhaps all good gardens too, a major challenge is the management of space. Given the tendency of trees to grow, it is important to preserve elements of open space, including the long vistas. Indeed the retention of open ground between Holford's arboretum and Silk Wood is a key part of the Grade 1 Historic Landscape. The Holford family planted certain species in relatively large quantities. In order to safeguard this heritage, those same 21 species are used in similar quantities in the new plantings. They have been designated as 'signature plants' and include *Pinus* × *holfordiana*. A further ten plants are used regularly for structure and shelter.

The fruit of *Rhodotypos scandens* (left), is made up of four small drupes.

Everyone whose garden is open to the public (or who has magpies) know that labels can disappear. It was encouraging that labelling remains a strength at Westonbirt, with about 10% being replaced every year. This means a lot of work for staff and volunteers but it is worthwhile. One useful feature of the labels is that common names are used as well as the normal botanic ones.

We paused at a number of trees, some familiar others not.

Xanthocyparis vietnamensis, an endangered species of conifer endemic to the limestone mountains

Above, *Aextoxicon punctatum* is a large evergreen dioecious shrub native of the southern Andes. The flowers (left) are followed by hard olive-like drupes. The leaves are smooth above and have a layer of peltate scales below.

in northern Vietnam, was discovered and named by scientists at Kew, as recently as 1999. This tree showed both juvenile and adult foliage.

Rhododendron quinquefolium is Hugh's favourite rhododendron. This specimen is about 70 years old and bears masses of white twin bells. It is slow and very difficult to propagate, so is unsurprisingly scarce in commerce.

Cathaya argyrophylla was introduced into cultivation from China only in 1998. This individual is growing well and has just started to cone.

We paused at a fine specimen of ***Quercus robur***, probably dating from the very earliest days of planting. Its magnificent bark is lightened by lichen. It bears a high canopy, possibly the result of hazel coppice shading out the lower branches at an earlier stage of the tree's life.

Aextoxicon punctatum is an evergreen native to the sub-Antarctic forests of the southern Andes. It prefers a humid atmosphere and benefits from mist coming in from the sea. This species was first introduced by Harold Comber in the 1920s, but most individuals are from recent introductions. It is now grown in a number of collections throughout the United Kingdom and in the western United States, and is commercially available. This specimen was in flower and is growing well. It could reach around 15 m.

Keteleeria davidiana is a rare evergreen conifer native to Taiwan and southern China. It is scarcely in cultivation here, but this specimen looks reasonably healthy.

We paused to look at three species collected by Ernest Wilson:

- A good grouping of ***Rhododendron williamsianum***. Its distinctive leaves are bronze when they emerge.
- ***Acer oliverianum***.

The group pauses to discuss a specimen of *Platanus orientalis* with Hugh Angus their guide.

- ***Ehretia dicksonii***. This is curiously shaped tree with dense upright growth rising from everywhere. It remains unfamiliar, with a few specimens in major collections. That is unlikely to change.

Acer carpinifolium is one of Westonbirt's 21 'signature trees', visible in some numbers across the site.

Platanus orientalis. This large specimen looked particularly attractive at this season with a thick covering of butter-yellow leaves on the ground. As elsewhere, attractive algae grow on the trunk.

Toona sinensis is the only member of the mahogany family to be hardy in northern Europe. A tall tree in its native China and south-east Asia it is also familiar in continental Europe (a street tree in Paris) but is not much cultivated in the UK. Perhaps it is a tree for the future, given climate change. This specimen is growing strongly, currently to about 15 m, and has flowered. Roger Kitchen reminded us that the species is also cultivated in Australia.

Returning to the building complex we passed ***Cornus capitata***, covered with its impressive strawberry-like fruits. They can be eaten, but only by the curious or the desperate.

Late in the afternoon we were able to see something of the Propagation Unit, putting flesh on the bones of what we had been discussing during the morning. A few IDS members were last seen cleaning seeds.

An enjoyable and educative day, beautifully organised by Antonia Johnson, working in conjunction with Penny Jones.