Care of the Collections

Plant Health and Biosecurity

David Knott

The plants in the RBGE living collection have never been under greater threat from 'new' (to the UK) pests and diseases as they are now. For many years, RBGE has been very careful about the source and health of any new plant material brought into each of its Gardens. However, there is a long-term trend of an increasing volume and speed of movement of plants on an international scale. This globalisation has unfortunately increased the opportunities for pests and diseases to arrive with imported plants, as well as by natural means. Among the environmental factors contributing to this increased risk is climate change. Diseases such as *Phytopthora ramorum* (sudden oak death) and *Hymenoscyphus fraxineus* (ash dieback), first recorded in the UK in 2002 and 2012 respectively, are dispersed by natural means through wind. RBGE is keen to raise awareness among all staff and visitors of the threats posed to plants in the living collection by such problem species.

As an international institution engaged in environmental and biodiversity research and whose work in horticulture, conservation and education includes the importation of seed and plants both for research and for the enhancement of our living collection, RBGE is committed to protecting the collection and the Scottish landscape from new pests, pathogens and invasive non-native species. We have developed plant health and biosecurity guidelines to raise awareness and limit damage. The principles of these guidelines include working with the Scottish Government and international community to prevent the accidental introduction and spread of harmful pests and pathogens, maintaining a quarantine facility at the Edinburgh Garden for non-UK sourced plant material, and maintaining isolation glasshouses and biosecure areas for material sourced from the UK at each of the four Gardens.

The movement of staff, tools and plant material is subject to good biosecurity practice, and procedures have been developed for the collection and handling of seed and all plants to prevent the accidental introduction and spread of harmful pests. These measures include the installation of kits for cleaning boots and equipment used on collecting trips and in potting sheds and other work areas. Only high-quality planting material which is free from pests, pathogens and other invasive species is released from the quarantine and isolation areas. These biosecurity measures, which include regular communication with all staff to inform them about correct procedures, ensure that the legislative controls for the movement of plants, seed and soil are followed.

Fig. 1 Biosecurity kits are used in the Gardens and on fieldwork to reduce transmission of pests and diseases on tools, footwear and tyres. Photo: Graham Stewart.

Invasive Non-native Species

David Knott

Invasive non-native species (INNS) are one of the greatest threats to Earth's biodiversity. Plants make up one of the biggest groups of INNS, with horticulturists – whether directly or indirectly – responsible for dispersing some of the most invasive species.

The Great Britain Invasive Non-native Species Strategy, a government policy paper (DEFRA, 2015), recognised the need to prevent the introduction and spread of potential INNS. Nearly 2,000 INNS are established in the UK, most of which are terrestrial (c. 1,800), with smaller numbers in the marine and freshwater environments (c. 80 in each). Perhaps more ominously, the total number of new species arriving in the UK is also increasing, with 10 to 12 new INNS becoming established every year. This trend is also unfortunately mirrored across Europe and the rest of the world. If it is not addressed, it is expected to continue increasing at this rate for the foreseeable future.

Using existing information on INNS, the policy paper lists plant species which are not native, are new to the UK and have the potential to be invasive. These species may already be here but not established, or they may be yet to arrive. Of the 599 non-native plants assessed, 92 are ranked as critical (in terms of requiring more detailed risk assessment as a priority), 55 as urgent, 72 as moderate risk and 380 as low risk (DEFRA, 2015).

A key contributing factor to the spread of invasive species is undoubtedly climate change, with changes in average temperature, average rainfall and dates of first and last frosts. These changes affect the number of growing days, and flowering and seeding times, and therefore they have an impact on the establishment of INNS.

Rhododendron ponticum is one of the most widespread INNS in Scotland. Along with *Gaultheria shallon*, it is being actively controlled through removal at Benmore. *Rubus spectabilis* has been actively controlled at Dawyck since the late 1970s. *Lysichiton americanum* poses a significant risk to sensitive sites, and strict controls manage dispersal of its seed adjacent to burns, streams, rivers and lochs. In the Scottish Borders it was the risk of seed dispersal from plants adjacent to the Scrape Burn – which flows into the River Tweed – at Dawyck that prompted consultation with the Tweed Forum by Dawyck staff and removal of plantings in the Garden.

These species all pose a threat to the environment, and horticulturists continue to scan the horizon for species that have the potential to cause problems. With the knowledge we have, we intend to avoid repeating past mistakes. In Scotland one species that poses a risk is *Gunnera tinctoria*, which grows prolifically in the mild and wet conditions on the west coast and in some parts of Argyll and the Western Isles. It is now spreading and competing with native species, reducing biodiversity.

Fig. 2 *Meconopsis* 'Slieve Donard' 2019.0608 has been planted at Dawyck in streamside beds where *Lysichiton americanum* has been removed. Photo: David Knott.

As custodians of RBGE's living collection we must be aware of our responsibilities not to enable the spread of INNS, particularly with regard to the possibility of plants escaping out of the Gardens. We must consider and debate the most appropriate design and use of species in the landscape to avoid those which are, or might become, INNS. Finally, and most importantly, we must be prepared to remove and destroy those that cause a problem.

Reference

DEFRA (2015). Policy Paper: The Great Britain Invasive Non-native Species Strategy. Available online: https://www.gov.uk/government/publications/the-great-britain-invasive-non-native-species-strategy (accessed August 2021).

Micropropagation and In-vitro Cultivation

Duncan Young

Micropropagation is the propagation of plants using small pieces of plant material, or plantlets, that are placed in containers with a sterile growing medium (agar). Propagation of plants in this way occurs 'in vitro', meaning in a test tube or glass container. The plants are grown in controlled conditions with set levels of light and temperature (Davidson, 2019).

The disease *Phytophthora ramorum* (sudden oak death) was discovered in Scotland in 2002 (Scottish Forestry, n.d.). When plants are infected with this disease, it can be transferred to new propagules if conventional methods of vegetative propagation are used.

Fig. 3 *Rhododendron macabeanum* producing shoots from a flower bud in vitro. Photo: Duncan Young.

Micropropagation techniques offer a solution to this problem as new flower buds can be used, which are less likely than other plant parts to be infected.

RBGE cultivates over 10,000 rhododendron specimens collected from across the range of this diverse genus. Many accessions are of historic importance and are over-mature, and therefore more susceptible to pests and diseases such as scale or mildew. Conventional propagation methods are rarely successful before the parent plant dies. Micropropagation techniques have been successfully used on 77 individuals which have been planted out across all four of RBGE's Gardens. A further 297 accessions have been identified as being in decline and are targeted for micropropagation. RBGE has a leading role in the Global Conservation Consortium for Rhododendron (BGCI, n.d.), and staff have put in place a system for tracking species in vulnerable, threatened or endangered IUCN categories. This tracking process enables staff to prioritise species for micropropagation. Having successfully grown rhododendrons using these techniques, the use of growth buds of other genera that are in poor condition and usually difficult to propagate will be trialled.

In-vitro techniques have been used to germinate vulnerable and endangered native orchids as part of the Scottish Plant Conservation Programme. Terrestrial orchids are difficult to grow from seed due to the dust-like size of the seed and the requirement for a mycorrhizal association. Staff have also been developing native mycorrhizal inoculation for the agar. This inoculation is valuable because each species has its own association with a species of mycorrhizal fungus and when both species are present, germination and growth is improved.

References

BOTANIC GARDENS CONSERVATION INTERNATIONAL (n.d.). Global Conservation Consortium for *Rhododendron.* Available online: https://www.bgci.org/our-work/plant-conservation/global-conservation-consortia/global-conservation-consortium-for-rhododendron/ (accessed September 2021).

Davidson, N. (2019). Micropropagation of heritage rhododendron collections at the Royal Botanic Garden Edinburgh. *Sibbaldia,* 17: 189–200. doi: https://doi.org/10.24823/Sibbaldia.2019.274

SCOTTISH FORESTRY (n.d.). Phytophthora ramorum in Scotland. Available online: https://forestry.gov.scot/sustainable-forestry/tree-health/tree-pests-and-diseases/phytophthora-ramorum#:~:text (accessed September 2021).

New Reekie – *Amorphophallus titanum*

Paulina Maciejewska-Daruk

Amorphophallus titanum, commonly known as titan arum or the corpse lily, flowered for the first time in Scotland in 2015, at the Edinburgh Garden. The Edinburgh plant was nicknamed 'New Reekie', derived from 'Auld Reekie', the historical nickname of Scotland's capital, from the Scots word for the many smoking chimney stacks packed close together that created a strong-smelling fug over the city. When the corm arrived in 2002 from Hortus Botanicus Leiden in the Netherlands it was no bigger than an orange, but by 2010 had grown into a 153.9 kg record-breaking specimen. A special scale for weighing baby elephants was borrowed from Edinburgh Zoo to check its weight.

The first flowering spectacle in Scotland finally happened on 26 June 2015. The flower reached an above-average size of 267 cm from the top of the corm to the top of the spadix and stirred enormous interest among the public, attracting over 20,000 visitors. Since then, New Reekie has not disappointed, flowering again on 1 August 2017 and for a third time on 23 June 2019, when it reached its tallest height yet of 281 cm.

During its second flowering, the flower was pollinated using pollen sent from Cambridge University Botanic Garden (CUBG), the Royal Botanic Gardens, Kew, the Eden Project and Paignton Zoo. For a number of reasons the flower did not produce viable seeds. However, the male pollen was collected from the flower and was sent to CUBG and the Eden Project, who in turn used it to pollinate their own flowers.

The third flowering presented an opportunity to pollinate New Reekie with pollen sent again from the Eden Project. The first seeds to develop were sown on 26 February 2020, and one successfully germinated. Several more seeds were collected on 13 May and these all germinated.

Other offspring of RBGE's titan arum, propagated from a leaf cutting in 2010, have now reached maturity, and three have already flowered for the first time, the first in August 2019 and two more in June and July 2020.

Horticulturists have been monitoring the plant's condition and keeping detailed records of its development to better understand the species. International and local collaboration has brought New Reekie's offspring to life, and this will continue to be essential for safeguarding the genetic diversity of this and other endangered plant species in the future.

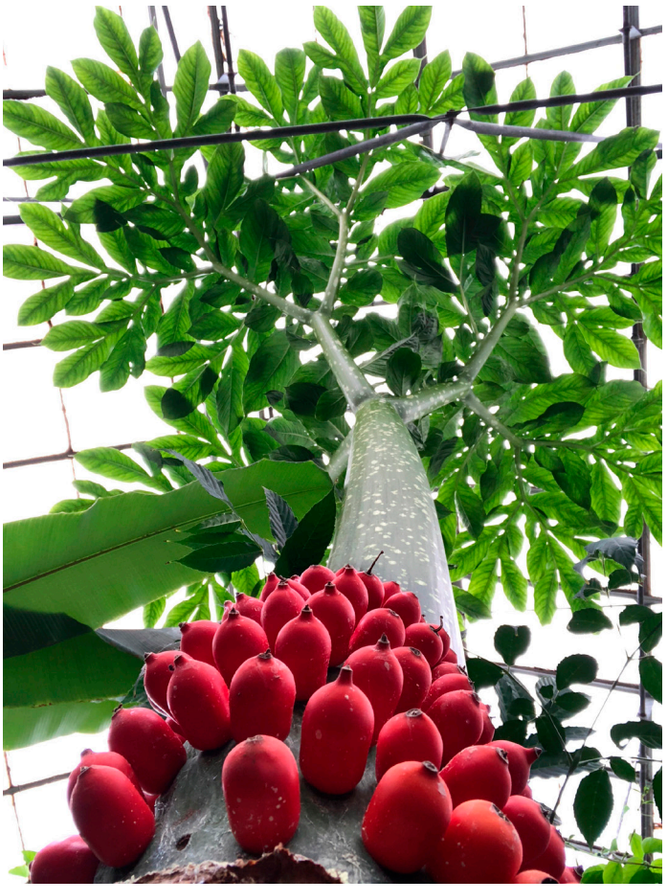

Fig. 4 Ripening fruits and the mature leaf of New Reekie in March 2018. Photo: Axel Dalberg Poulsen.

Sustainable Cultivation Practices

Kate Hughes

The cultivation of the living collection has an environmental impact that RBGE has sought to reduce since an Environmental Management System was set up in 2004. The biggest impacts on the environment from the cultivation of plants, aside from the use of fossil fuels to heat the glasshouses, are caused by the chemicals used to control weeds, pests and diseases, the fossil fuels used to run equipment and vehicles, and the peat included in compost mixes.

Biological controls have been in use for many years at RBGE, and since 2017 a specific programme has been in place, with additional resources allocated to reduce chemicals to a bare minimum. Staff looking after the glasshouse collections have experimented with introducing very large numbers of the predatory insect *Cryptolemus* sp. (a type of ladybird) at specific points in the season to control *Pseudococcus longispinus* (longtailed mealybug). The placement of the insects has been chosen carefully in order to maximise their effectiveness. The temperature settings in the glasshouses have been adjusted to slow down the rate of reproduction of the pest without negatively impacting plant growth. Such measures have increased the consumption of mealybug by the cryptolemus, and chemical controls are no longer used on these collections. The cost implications of the mass introductions have been offset by the reduction in purchase and number of applications of chemicals. More information is available in Ives (2020).

Increasing the use of biocontrols also means managing expectations of both staff and visitors away from pristine displays to the occasional part-eaten leaf or signs of insects on plants and other surfaces. Interpretation is being installed to explain to visitors why there are signs of life on the plants and to present the long-term benefits of a display managed to encourage beneficial insects.

The use of glyphosate to control weeds has been greatly reduced and replaced with a combination of two controls. One is to spray a solution

of acetic acid on the soft tissues of weeds. The second is hot-water foam weeding. Both techniques cause the foliage to burn, weakening the plant, with the hot foam method particularly effective at killing the roots of perennials.

Fossil fuel use for chainsaws, blowers, strimmers and lawnmowers has been reduced by implementing a procurement programme to replace old equipment over several years. The first electric lawnmower was installed in 2018. Electric equipment is also quieter and lighter to handle which has benefits for operators and visitors.

RBGE first started to reduce its reliance on peat in compost mixes in the 1990s, and the most frequently used compost mixes have been peat-free for many years. Different grades of milled pine bark and a wood-based substance, Sylvafibre®, are used in place of peat. These are mixed with charcoal, grit, perlite and vermiculite in varying proportions depending on the species cultivated.

Reference

Ives, J. (2020). Biological controls in botanic gardens. *Sibbaldia*, 18: 117–125. doi: https://doi.org/10.24823/Sibbaldia.2020.292

Fig. 5 Biological controls are applied by hanging sachets containing the predatory organism on plants where the pest is prevalent. Photo: Kate Hughes.

Impacts of Covid Restrictions on the Living Collection and Garden Landscapes

David Knott

In early March 2020 RBGE's horticultural team, like so many others, watched nervously as the impact of Covid-19 spread across the world. It quickly became apparent that safeguarding the health of the horticultural staff and the survival of the living collection, particularly those plants being cultivated in glasshouse environments, would require significant changes in the working regimes of each of the Horticulture teams. All four Gardens closed to the public on 17 March, and during the following week plans were drawn up to make sure there were sufficient staff available to look after the living collection at each Garden. A key consideration was human biosecurity to ensure that the Scottish Government guidelines on social distancing and safe working practices could be observed.

After the national lockdown began on 23 March a small number of horticultural staff undertook essential maintenance in the glasshouses and protected environments at each of the four Gardens. This vital work ensured that some of the most important plant material in the living collection was prioritised. This material includes plants used in RBGE's scientific research programmes and young, wild-collected plant material being grown on for planting out in all four Gardens. As well as looking after the living collection in the protected environments, an even smaller team undertook a limited amount of time-critical maintenance outdoors, ensuring where possible that the worst of the weeds were kept under control and that the grass was cut.

At the Edinburgh Garden this comprised a rota of two teams of horticulturists observing strict human biosecurity protocols to avoid cross-contamination. They looked after internationally important collections of *Begonia*, Gesneriaceae and Zingiberaceae; the displays in the Front Range of glasshouses and Palm Houses; the traditional and modern Alpine Houses; and the alpine section glasshouses and frames containing an extensive collection. In the Temperate Nursery the next generation of plant material collected on fieldwork carried out by RBGE staff in China, Nepal, Chile and Japan was prioritised.

At Benmore Botanic Garden essential maintenance included watering and time-critical work in the Nursery area, and checking the Fernery daily, with water transported by bowser during the prolonged dry spell. Pest and weed control was also carried out in a few selected areas of the Garden.

At Logan Botanic Garden a skeleton workforce was deployed to carry out essential duties such as watering and grass cutting. The normal workforce in early spring, which includes a number of intern students, was reduced from ten people to two. This tends to be one of the busiest times of year, with more than 5,000 half-hardy perennials being planted out. A small planting of each taxon was made to ensure that propagation material would be available in autumn for next year's display.

At Dawyck Botanic Garden staff worked on a rota to carry out time-critical maintenance.

At each Garden these small teams of dedicated horticulturists rose to the challenges created by this unprecedented situation, which at the Regional Gardens also included daily checks on many of the buildings and infrastructure. Most importantly, they maintained the living collection and garden landscapes, which has not only ensured their future health but has also meant that each Garden was ready to reopen as soon as restrictions lifted, enabling visitors to enjoy them again with very little deterioration in the displays.