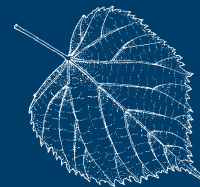


University Botanic Garden Annual Report 2013-2014



CAMBRIDGE
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Botanic
Garden



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CAMBRIDGE



Director's Report

This year we rethought the Garden's senior staff structure, and put plans and people in place to develop a research-focused collections strategy.

Having now seen a full calendar year through as Director of the Garden, it is interesting to see how our activities and priorities change with the seasons. It is clear that spring and summer are our busiest times, and there is a palpable sense of excitement in the Garden after January as new life begins to return to the plantings and the visitors start to flood in. Late spring and early summer see the education team at the peak of business, welcoming several schools on educational visits every day and running a variety of adult courses throughout the week. By late summer the combined effect of thousands of visitors and little rain begin to take their toll, and the horticulture team are noticeably stretched to maintain the Garden at its usual peak of horticultural excellence. My favourite time in the Garden is the autumn, when the sense of new beginnings and planning for next year is at its height. These plans include the horticulture team's thoughts on new plantings and landscape, the education team's new programme of courses for next year, and the visitor services team's plans for new events and activities in the Garden. But this year the sense of new things to come has been greatly enhanced by the changes to our management structure and by the consequent opportunity to rethink our collections policies and our landscape strategy.

As I reported last year, our former Curator and Deputy Director, Dr Tim Upson, accepted the post of Director of Horticulture at the Royal Horticultural Society after 17 years at the Garden. Tim took up his new post in March 2014. We have restructured his post, and are very grateful for the University's support in developing two new senior positions. The new Curator post is a University Lecturer position, established in the Department of Plant Sciences but funded through the Garden's budget. We are delighted that Dr Sam Brockington, currently a Natural Environment Research Council Research Fellow in the Department of Plant Sciences here in Cambridge, has accepted the position, and will take up his role in April 2015. Sam will have responsibility for all the collections in the Garden, and his first project will be a thorough review of our collections policy, to define a strategy for what species we should collect in the decades ahead. Because of this increased resource it is wonderful to see the Garden staff getting excited about the chance to really develop the collection to provide world-leading research opportunities. As the report on pages 14-15 explains, plant science is facing an unprecedented set of demands to help address a range of global challenges. With our new Curator and

new collections strategy coming in to play next year, we will be able to play our full role in these challenges as a unique collection-based plant science research organisation.

The second senior post that we established is that of Head of Estates and Operations. Mr Carl Tatterton is joining us in January 2015 to fill this role, and brings a good deal of experience of managing similarly complex sites as a result of a 30 year career in the British Army. Our intention is that this dedicated post will allow us to progress a range of projects such as those to enhance café capacity, the quality and appearance of our boundaries, and visitor service facilities particularly at the Station Road Gate. We look forward to the exciting developments to come.

Horticultural developments this year have focused on careful maintenance of our tree collection, with many specimens subject to thinning or reducing in response to the tree survey carried out in 2013. Although this process has forced us to say goodbye to some old favourites in the Garden, we are taking the opportunity to develop the tree collection with a focus on trees able to withstand the dry conditions of a Cambridge summer, particularly in the face of likely climate change. We also took advantage of the opportunity to plant out Tim Upson's research collection of lavenders, in the area between the experimental plots and the University's Plant Growth Facility. The lavenders make an attractive display, particularly when combined with Peter Yeo's research collection of *Geranium*. Planting the two together has allowed us to tell our visitors an engaging story of how understanding species relationships contributes to our understanding of the processes and patterns underlying the evolution of biodiversity.

As you will see on page 8, the Garden is very grateful to Mr and Mrs Chris and Sarah Adams, who generously provided us with the funds this year to move our long-wished-for Garden Room project forward. Over spring 2015 a timber-clad eco-classroom will be erected in the Schools' Garden, providing the facilities to support our Schools programme whatever the weather. In recognition of Mr and Mrs Adams's generosity, the classroom will be named "The Geoffrey and Eileen Adams Garden Room", in memory of Mr Adams's parents.

Professor Beverley Glover
Director

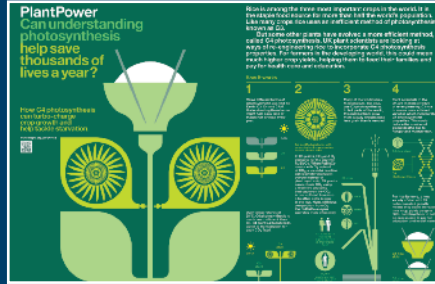
The year in pictures...



In October Apple Day returns to the Garden after a five year absence.



The WI are inspired by plant forms in the Glasshouse Range to create Hooked on Plants, a crochet installation.



Science and Plants for Schools commission and distribute their first in a series of plant science posters for schools.



In December, the Arts Picturehouse premiers community films inspired by the Garden's oral history project, Voicing the Garden.



A programme of tree works is undertaken over the winter. Some trees are felled but many undergo remedial work to prolong life. Major limb reduction to the stand of Caucasian wingnut confirms extensive decay.



Curator of the Garden for 17 years, Dr Tim Upson leaves to take up the position of Director of Horticulture at the Royal Horticultural Society.



In April the Garden is awarded a Brother UK bursary from Plant Heritage to produce clean, virus-free stock of heritage tulip variety 'Captain Fryatt'.



May's Festival of Plants, showcasing plant science research excellence in the region, attracts record numbers.



First Saturday Family Fun Days remain very popular.



The Brilliant Club visit in May, one of 264 school visits this year.



Around 5,000 people enjoy the late opening Sounds Green picnic proms in July.



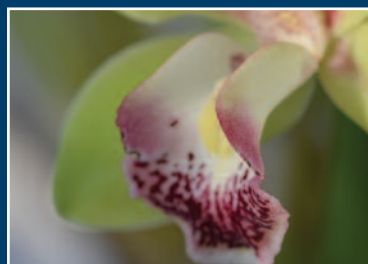
A pergola for growing grape vines to augment our Mediterranean flora collections is commissioned with support from an In Memory Gift.



We welcome a record number of visitors through the year, 250,568 in total.



A new digital exhibition, Changing Perspectives: a Garden Through Time, curated by Dr Pippa Lacey, is launched on-line at the start of 2014.



An Orchid Festival in February fills the Glasshouse Range.



Following a site visit, many tree specimens are accorded champion status either locally or nationally by the Tree Register. *Albizia julibrissin* (left) 'Rosea' and *Sophora cassioides* (right) are singled out for particular mention.



The Garden and University Herbarium together provided Henslow and Darwin material for Discoveries, an exhibition hosted at the Fitzwilliam Museum in May. That brought together treasures from across the University's collections for the first time.



The What's On programme of courses runs at 82% occupancy.



An extra kilo of poppy seed is added to the annual meadow mix this summer to mark the centenary of the start of World War I.



Dame Fiona Reynolds DBE, former Director General of the National Trust and now Master of Emmanuel College, becomes Chair of the Botanic Garden Syndicate.



In September we welcomed seven trainees to the Certificate in Practical Horticulture and Plantsmanship, thanks to the funding from Perennial to support an additional trainee post.

Horticulture and Estates



FELLING *POPULUS* x *CANADENSIS* 'SEROTINA'

Extensive tree works to ensure the safety and longevity of the collection

The year has again been one of horticultural change within the Garden, with many areas being changed, adapted or developed in response to horticultural or safety needs. The tree survey of summer 2013 provided a baseline from which to manage our tree stock into the future, but also identified trees which posed safety hazards. This year has seen much follow-up work by our Trees and Shrubs Section in response to this survey. We reluctantly removed the towering *Populus* x *canadensis* 'Serotina' in the autumn colour area, which was showing signs of significant decay and dead wood, and undertook extensive dead wooding of much of the collection. As a consequence of a varied and considered approach, we have ensured the retention of other significant accessions for the future. Two such examples include the Caucasian wingnut (*Pterocarya fraxinifolia*), and the Cambridge oak (*Quercus* x *warburgii*). Upon inspection the *Pterocarya* was found to have serious decay in a number of stems, and given its proximity to a major access route through the Garden, posed a significant hazard. These stems were reduced to remove the risk of failure in this prominent position, and safe stems were retained. While this work initially appeared to be drastic, it has allowed for the establishment of emerging suckers to replace those stems which were removed. In contrast, the Cambridge oak is situated away from major access routes, and by installing a cleft oak fence around the tree, we have been able to prevent access beneath the canopy and allow the tree to mature gracefully, without the need to remove dead wood.

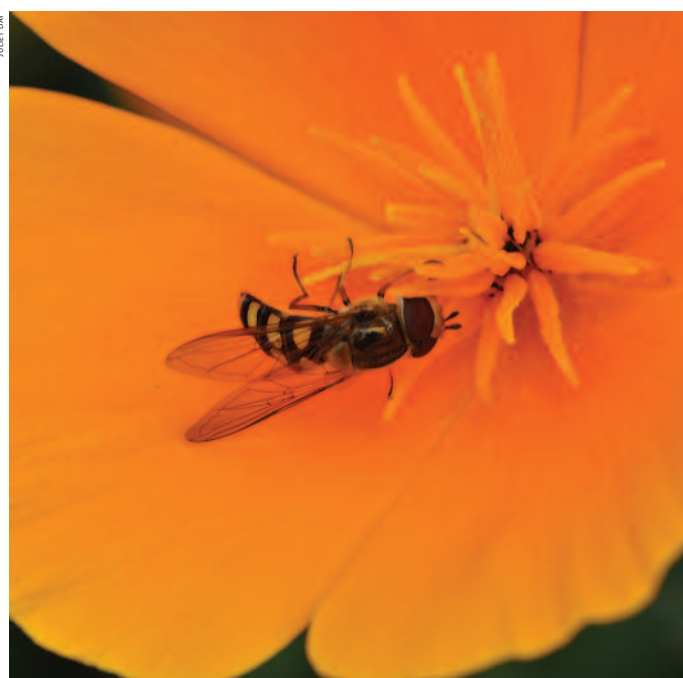
Work will continue into 2015 to complete all works identified by the survey, and although this will mean the loss of a number of other favourites within the collection, it will ensure we are in a strong position to welcome both new tree accessions and increasing numbers of visitors.

The Trees and Shrubs Section has also been progressing the redevelopment of the boundary running from the Station Road entrance along the eastern edge of the Autumn Garden. The intent is to enhance the planting to provide not only necessary screening of neighbouring properties, but also to offer a valuable habitat for wildlife. Retained species include *Acer campestre* (field maple), *A. cappadocicum* (Caucasian maple) and *Carpinus betulus* (hornbeam). Amongst these we have planted a wave of the native *Betula pendula* ssp. *pendula*, which is renowned for supporting invertebrate populations, along with the Mediterranean *Quercus ilex* (holm oak), whose evergreen canopy will provide further habitat for invertebrates and birds. We have also introduced a selection of the common oak, *Quercus robur* 'Fastigiata Koster'. Slender in habit and renowned for supporting wildlife, it is a welcome addition to the planting. Shrubby content includes *Corylus avellana*, and further shrub plantings, which will include autumn fruiting *Viburnum* species will further enhance the diversity of plants, and also of wildlife, while providing valuable lower level screening along this boundary.

Perennials and annuals for colour in key spots

Many of the existing herbaceous and woody species in the Autumn Garden were planted approximately 25 years ago. In recent years we have re-evaluated these plantings, with a view to enhancing autumn interest and providing an intensity of colour, shape and form for visitors. The removal and thinning of some dominant specimens, such as *Cortaderia selloana* and *Cotoneaster horizontalis*, along with the pruning of dominant shrubs such as *Cotinus x dummeri*, gave us scope to introduce new species. The herbaceous content has been carefully considered to provide a reduced palette of high impact autumnal interest, which include *Echinacea purpurea* 'Bressingham Hybrids' and *Rudbeckia fulgida* var. *deamii* planted in large swathes. Future plantings of trees, shrubs and bulbs within this area will further increase the autumnal interest, and provide greater focus to this area.

In 2011 – 2012 we replaced the diseased *Aesculus hippocastanum* (horse chestnut) on the Hills Road boundary with semi-mature specimens of silver lime, *Tilia tomentosa*. This has been underplanted in subsequent years with an annual meadow mix. This has created a horticultural dilemma about how to treat this planting on an annual basis, as some species inevitably self-seed much more effectively than others. If we either rely on self-seeding or over-sowing of an untreated area, there will be a floral imbalance in which stronger species become dominant. In order to ameliorate this, we cut down and removed the seed heads and rotavated the site prior to re-sowing the mix afresh. The selected mix included Californian poppy (*Eschscholzia californica*), cornflower (*Centaurea cyanus*), fairy toadflax (*Linaria maroccana*), tickseed (*Coreopsis tinctoria*), red orache (*Atriplex hortensis*), and larkspur (*Delphinium ajacis*). To this we added Flanders poppy (*Papaver rhoeas*) to commemorate the centenary of the outbreak of World War I. This highly effective planting provided a succession of flower and colour throughout the summer and well into autumn.



ESCHSCHOLZIA CALIFORNICA

A bumper crop of Champion Trees

The Garden's tree collection has received recognition this year by way of a visit from Owen Johnson, Hon. Registrar, The Tree Register. Owen is responsible for recording champion trees – those with greatest height or girth – throughout the United Kingdom and Ireland. Owen's report noted that: "Your list of champions has lengthened, as there have been remarkably few losses since my last visit ten years ago and various rare youngsters are now big enough to qualify." Amongst the stalwarts of our collection which appeared on the latest revision were *Quercus x warburgii* (Cambridge oak) in the Gilbert Carter Woodland, and the *Pinus gerardiana* beside the Terrace Garden, and both were recognised as champion trees for the United Kingdom and Ireland for both girth and height. Others have United Kingdom and Ireland status for either girth, as with the *Zanthoxylum simulans* in the woodland, or for height, for example, *Malus tschonoskii* near the Station Road entrance. It is surprising to note that a number of our more recent additions rate alongside these as United Kingdom and Ireland girth champions, including *Tilia nobilis* to the west of the Gilbert Carter woodland, which was accessioned in 1995, and also *Cercidiphyllum japonicum* 'Pendulum', which was planted in 1997. Other notable trees, such as *Catalpa x erubescens* 'Purpurea' and the *Emmenopterys henryi* are listed as champion trees for Cambridgeshire. In total, some 275 trees were recorded as being of champion status in Cambridgeshire, and of these 61 are United Kingdom and Ireland champions.



TREESCAPE FROM MAIN LAWN



ENCYCLIA COCHLEATA



NEW PERGOLA

Developing and maintaining our systematic collections

After much hard work improving the soil, which had become impoverished as a result of temporary facilities associated with the construction of the Sainsbury Laboratory, we were able this year to plant up the area to the south of the Plant Growth Facility, adjacent to the research plots. In one area the lavender and rosemary collections of Dr Tim Upson were planted out, where they will benefit greatly from this southerly aspect. This collection formed the basis for his monograph 'The Genus Lavandula' which described 39 species. The bed to the southern side of the path dissecting the Experimental plots has been planted with 40 *Geranium* species and hybrids representing the research work of Dr Peter Yeo. Included in this collection are the species which have given rise to over 300 cultivars available today, along with the hybrids 'Peter Yeo' and 'Elizabeth Yeo'.

In order to maintain the integrity of the Systematic Beds, work here is principally restricted to the maintenance of the beds and the propagation of some 6000 annual and tender perennials for planting out each summer. The majority of these tend to be tried and tested favourites, selected to demonstrate key taxonomic characteristics, while also demonstrating the diversity of a given family. In order to retain this stock an annual programme of seed collection is carried out on the Systematic Beds. Seed is harvested from burgeoning seed capsules, preferably on dry, sunny days. Once gathered it is air dried in our seed store prior to cleaning and decanting into glass containers for cold storage, which helps ensure its medium-term viability. While we anticipate that this will ensure a supply of any given annual or tender perennial for several years, there is an annual requirement to replenish a small percentage of our seed stock. Given the unpredictability of our summer weather there are occasions on which plants don't produce sufficient viable seed, and these gaps are plugged by seed sourced either from the seed lists of other botanic gardens or from commercial seed catalogues.

While much of the work on the Systematic Beds is given over to regular maintenance, such as weeding, edging, mowing, cutting down

and lightly forking over, there are instance where more radical intervention is required. Some perennials are reluctant to be tamed, spreading and intermingling readily, which can impede identification and correct labelling. This has been the case with the Cucurbitaceae and Polygonaceae families, and we have taken the opportunity to assess both invasive habit and identification. The perennial, climbing cucurbit, *Thladiantha oliveiri*, has spread throughout the bed, impeding the growth of other representatives of this family. In the Polygonaceae, the various knotweeds represented here had grown into one indistinguishable mass. In both instances, desired accessions have been lifted and grown on in our nursery for replanting in freshly prepared and re-shaped beds once the offending species have been eradicated. In several other beds on Systematics, pernicious weeds such as bindweed and ground elder have penetrated existing plantings. This has resulted in us lifting individual species, especially on the Cyperaceae and Rosaceae beds, to grow on and clean up in our nursery, while simultaneously eradicating established weeds on the beds prior to replanting. We have encountered similar difficulties with pernicious weeds on the limestone rock garden, where *Equisetum arvense* (horsetail) has slowly penetrated the American plantings. Here we have lifted existing plantings for replanting, but also removed the infected soil. Such is the tenacity of this invasive weed that after various treatments it is still emerging in the foot of the excavations and also appearing between rock work, and we will need to extend this approach into the coming year.

A new pergola

The Mediterranean plantings at the west end of the Glasshouses have been steadily enhanced during recent years. This year, we were able to further enhance this landscape with the installation of a bespoke green oak pergola, which frames the access path to the north of the Mediterranean terrace. In order to provide a setting befitting of the structure, the paving beneath the pergola was re-laid, and plantings along its length were enhanced, with grape vines to be added.



CYMBIDIUM 'GROUVILLE'



SEED BANK

Glasshouse highlights – orchids and changing environments

The Glasshouses provide a welcome refuge for our winter visitors, and this year to further highlight the interest in this protected environment during the bleaker months, we reinstated the Orchid Festival. The Festival provided an opportunity to work in collaboration with the Writhlington School Orchid Project, who delivered workshops for local schools and Garden staff, provided interpretation on orchid conservation, and who advised on plant selection for our orchid trees. We installed two permanent orchid trees in the Range, each supporting a population of epiphytic orchids. The first, in the cool corridor, hosted orchids which occur in the cool slopes of Sikkim, including *Dendrobium densiflorum* and *Coelogyne flavida*. The second orchid tree displayed tropical species from the hot valleys of Sikkim, and this one, situated in the Palm House, grew *Bulbophyllum careyanum*, *B. sikkimensis* and *Aerides odorata*. An eye-catching display of *Vanda* hybrids was suspended above the *Victoria* pool in the Tropical wetlands house, and our expanding collection of *Cymbidium* was incorporated amongst permanent plantings in the corridors.

In recent years we have adopted a new approach to the management of our glasshouse environments, generally reducing growing temperatures while increasing ventilation. This has generally reaped rewards throughout the houses, with plants developing less soft growth and growing more typically to form. The benefits of this change are evident in the Continents Apart display, where we have also re-dressed beds, pruned and introduced new species. Plants have responded positively, and many, including the Australian *Banksia longifolia* and *Hakea suaveolens*, have flowered well. In the South African plantings, existing species such as *Protea magnifica* and *Acmaenia heterophylla* have clearly benefitted from this change.

We have been gradually developing the South African collection, and have successfully germinated new accessions, including *Erica verticillata* and *E. canaliculata*. These have been incorporated in the South African display here, and further highlight the diversity of this species-rich country.

Replanting the stream banks

The stream is a key feature of the Garden, and provides a pleasant point for visitors to enjoy the ambience of this location, admire the striking spring plantings, and to watch wildlife. The impact of lingering visitors at its western end had been detrimental to the integrity of the stream bank, so we have rebuilt and strengthened it this year. Additional supporting materials were added to the stream edge, and the grass area behind back-filled with soil, and reseeded to provide once more the perfect point at which to linger and admire the surroundings, which include a newly planted border at the stream's edge. Having been cleared of encroaching ground elder, and the soil improved with humus and leaf mould, a mix of marginal plants suitable for this location have been introduced. Plantings beneath the *Cercidiphyllum japonicum* 'Pendulum' include *Lobelia siphilitica*, *Primula japonica*, *Hosta fortunei* 'Aureomarginata', *Gunnera tinctoria* and *Dicentra spectabilis* 'Alba', selected to provide spring and early summer interest.

Sally Pettitt, Head of Horticulture

Horticultural work experience placements

Via the Employability Partnership / School work experience programme

Zoe Rowe, Sawston Village College, 2 – 13 June

Ursula Morris, Netherhall School, 16 – 27 June

Patricia Tamutyte, Melbourn Village College, 30 June – 11 July

Horticultural work placement

Joe Bassett from Yotes Court garden, Kent, 7 – 18 April, working in Glasshouse Section extending experience for his work at Yotes Court.

Education



COMMUNITY PROJECT

Schools

With our new schools officer, Bronwen Richards, settled into our team we have been able to restart our assisted schools visit programme and after-school gardening club in the Schools' Garden, and extend our sixth form student passes scheme (successfully piloted at Hills Road Sixth Form College last year) to include students studying Biology, Art, Photography, Geography and Applied Science at Long Road Sixth Form College. In total there were 264 school visits with 7,583 school children visiting the Garden through our schools programme this year.

During the Garden's Orchid Festival in early 2014, we worked on a joint project with staff and students from Writhlington School's award-winning Orchid Project to deliver orchid propagation sessions for secondary school students. Aided by the loan of a portable laminar flow cabinet from BigNeat, the workshop gave attendees from Sawston Village College and Hills Road Sixth Form College the opportunity to have a go at micro-propagation of orchid seedlings in a sterile environment, and the Writhlington students went on to run this session for our own horticulture staff too. We have also begun work on a small project with the science department at Parkside Academy's Coleridge Campus to develop a wildlife garden on their site. We hope our work with secondary schools will continue to increase as a new student engagement project we are running jointly with SAPS and SLCU begins to deliver projects next year.

Schools' Garden

We are delighted that following a generous donation from Mr Chris Adams in memory of his parents Geoffrey and Eileen Adams, we were able to begin the planning of a new classroom based in the Schools' Garden. The project was submitted for planning permission in September 2014 and we hope work will begin in early 2015.

Throughout the year we have been indebted to our volunteers and the Garden's horticulturalists in managing and developing the plantings in the Schools' Garden. We have also been lucky to have the support of a local project called 'Woodskills', which offers an opportunity for young people under 18 who are in the Criminal Justice System to contribute to their community through making items from reclaimed timber. Led by Paul Waldmann, a new set of three compost bins were built for the Schools' Garden and a selection of flat-packed bird boxes provided for a joint activity we ran with the Museum of Zoology.

Adult courses and workshops

This year saw a successful move to online bookings, through the University's e-sales online shop, for the adult courses programme. This move has created a significant increase in new participants in our adult courses programme. Courses this year were well attended and often oversubscribed, in particular our *Learn to Garden* series of courses, led by our horticultural staff, were all fully booked and received excellent feedback from participants. In total 486 adults took part in the 50 courses run at the Garden this year. Next year we aim to run around 60 and increase the number of plant science based courses. During the year we also ran a session for 'Cambridge Explorations', a course linking all the University's Museums and Collections, which was developed by the University's Institute of Continuing Education (ICE), and we also hosted sessions on the ICE Evolutionary Biology Certificate course, which were led by our Curator, Dr Tim Upson and Director, Professor Beverley Glover.

Community

As our community programme develops we have used this year to pilot a few new projects as well as to extend those we have already started, and as a result we are creating closer links with a number of local community organisations and groups.

One of our most successful projects is our programme with the St Paul's Thursday group, members of which have mental health problems or learning difficulties. This group has been visiting the Garden each month for about 18 months and they are enjoying more and more adventures in the Garden under the guidance of our community officer Sally Lee, with help from Jenny Egbe, one of our education volunteers. This regular monthly walk in the Garden takes in seasonal changes in the Garden, plant-inspired art and craft projects, wildlife observation and even Tai Chi. A favourite visit for everyone this year was a behind-the-scenes tour of the University Herbarium and the chance to have a go at making specimen sheets.

We also host regular guided tours for the visually impaired. For these people, who either have no vision or only partial vision, the beautiful colours and shapes of plants and pure pleasure they bring can sometimes be forgotten. In addition, visiting places like the Botanic Garden can sometimes be difficult. To assist people facing problems like these, the Garden offers free tours for members of CamSight, a Cambridge charity that supports people suffering from sight loss. These tours take place once a month and have been running for more than seven years. The tours are planned and led by our volunteer Garden Guides who do a wonderful job of tracking down the most interesting plants and making them accessible for everybody on the tour.

Another ongoing community project is our work with the Cambridge Young Carers, who have participated in plant-based art workshops at the Garden during the school holidays for the past four years. These workshops provide an opportunity for the young people to spend time outdoors, connecting with nature, catching up with friends and

simply having a break from their everyday caring role. This year the young carers visited during the Easter holidays to work with local artist, John Wiltshire. Together they experimented with Indian inks and water sprays to create images of imaginary landscapes. The group visited again during the summer holidays as part of a UCM project called Self Portraits led by artist Kim Noce. The children spent the morning discovering our amazing cacti, carnivorous plants and, most exciting of all, the squirting cucumbers, before spending the afternoon creating plant-inspired animations.

One of our pilot projects this year has been with two local care homes, The Hope and St George's. This project was inspired by 'PAT dogs' – specially trained dogs that visit care homes to provide animal friendship for those who are no longer able to have their own pets. With this in mind our community officer, Sally Lee, piloted a project using the therapeutic value of plants for the elderly, especially for those who cannot easily go outdoors or who perhaps used to be keen gardeners. The project aims to take the Botanic Garden to them, by bringing along different plants each month that stimulate memories and passion for plants. So far we have taken along branches of beautiful autumn leaves, a selection of different orchids, plants from the Winter Garden and carnivorous plants. At the sessions we look at the different shapes and colours of the plants, learn about where they come from and their stories and examine textures and smells.

This year we have also begun a small community gardening project. It started with us assisting the St Paul's Centre in coming up with a planting plan following its redevelopment, and assisting in the design for landscaping the area around a new community room at Hanover Court. This in turn led to bulb planting and seed sowing sessions with residents at Hanover Court and St Paul's school, and we then helped out at a Veggies on the Veranda Project at the new CB1 development. We hope to become even more involved in community gardening over the next year.



GUIDED TOUR FOR THE VISUALLY IMPAIRED



CAMBRIDGE SCHOOL OF ART PROJECT



PLANTING WITH DINOSAURS AT BIG WEEKEND



PATTERNS AND STRUCTURES

Family events

Our family Saturday and holiday events continue to attract a good crowd of attendees with over 500 children attending sessions at the Garden through the year, as well as those hosted offsite at the City Council's Big Weekend and SummerDaze run with Cambridge City Council and the University Museums. Following the success of the summer trails introduced last year, we developed a series of three new trails – each running for a 4 month period – to add to our explorer backpacks or work as stand alone trails for families to pick up and use on their visits. The first of the year, timed to coincide with the University's Science Festival, led young visitors around the garden hunting for plant patterns, the second, 'Planet Botanic' with a focus on plant families, challenged children to find mottos for seven plant families during the summer, and a final trail, 'Garden Giants', will launch in the autumn of 2014 with a focus on trees and wand-making activities.

Festival of Plants

For this year's Festival of Plants we created a 'Plant Lab' in our classroom and along with colleagues from SAPS and SLCU we delivered hands-on science demonstrations including glow in the dark plants, hydrophobic plant surfaces and the amazing drilling seeds of *Erodium grinum*. A series of self-led introductions to common features of plant families were set up in the Systematic Beds, and canopy tours of the Glasshouse Range were led by the Garden's trainees. Also on view for the week leading up to the festival were art works made by students from the Cambridge School of Art at Anglia Ruskin University, who used the Garden as inspiration for a 'site-specific' module on the second year of their Fine Art degree course.

University of Cambridge Museums (UCM)

Our work with the University's other museums and collections continues to expand. We joined them, as always, for Twilight at the Museums, running a session in our beautifully-lit Glasshouse Range called 'Darkness and Deception' which looked at the tricks plants use to attract pollinators. The event attracted 1,557 visitors. As part of a UCM widening participation project, 240 students from North

Cambridge Academy visited the garden between 15-17 July and used specially-created 'Discovery Packs' to explore and make links between the collections. The pack included laminated seeds from the Garden, a picture of botanist and explorer Sir Joseph Dalton Hooker and a photograph of the *Sicyos villosa* specimen held in the University Herbarium, which was collected by Charles Darwin in the Galapagos and is now extinct.

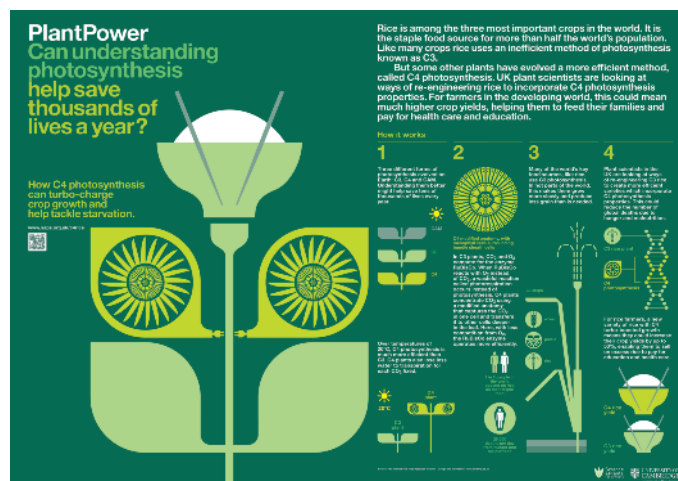
As this partnership develops, the numbers of ways in which we are interacting with the Museums continues to increase and we are running joint events and working collaboratively across all three strands of our programme. For example, the education officer from the Museum of Archaeology and Anthropology joined us to run a family event 'Celebrate Sticks', bringing along a number of items from the Museum's handling collection and showing our young visitors how to make arrows. We are currently working with colleagues at the Polar Museum on a possible schools project looking at exploration and plant hunters, and we ran a series of adult events and talks at four separate University Museums for the Curating Cambridge programme in autumn 2014.

University Festivals and Outreach

With the University's Science Festival this year taking the theme of Patterns and Structures, we launched our Plant Patterns trail for families, ran a Patterns in Plants talk and tour for adults which introduced plant identification techniques on the Systematic Beds and plant collecting and classification in the University Herbarium, and ran sessions for schools at the Science Festival's schools roadshow. During the Festival of Ideas we ran an exhibition in our Glasshouse Range which was the outcome of a community project called 'Hooked on Plants'. A group from the new Cambridge City Women's Institute worked for months to create crochet plants based on plants from our Glasshouse Range which then went on display for visitors to see during the Festival.



'HOOKED ON PLANTS' CROCHET DISPLAY



POSTER FOR SCHOOLS AND COLLEGES, EXPLAINING C4 PHOTOSYNTHESIS

Conferences

Flis Plent and Sally Lee represented the Garden at the Botanic Garden Education Network (BGEN) 2013 conference, giving presentations on our work with UCM on the Thresholds poetry project and on the development of our new trails for families.

Education volunteers

Our loyal and enthusiastic group of education volunteers continued to help us deliver school visits, gardening club and weekend events, as well as helping with re-stocking our explorer backpacks, digging and planting in the Schools' Garden and supporting our community programme. We thank them all heartily for their help and support of our programme. Next year we will begin to recruit a few more to bolster our numbers.

Science and Plants for Schools

School laboratories can be drab and uninspiring, and teachers are often looking for ways to invigorate them. So this year SAPS produced two posters on contemporary plant science using bright, modern infographics to introduce young scientists to some new topics and brighten up school laboratories. The first was sent into every school and college in the UK teaching post-16 biology, and explained how research into C4 photosynthesis might help address hunger in the world. The next – on epigenetics – was made available on request and 700 schools and colleges requested one to display.

This year SAPS also focused on producing electronic resources for teachers, commissioning four 'how to' videos for our most popular practicals, which also feature A level Biology students from Long Road Sixth Form College demonstrating how straightforward and enlightening the activities can be. SAPS also produced two high quality animations explaining core biological principles to assist teachers when they engage their students with what can be complicated ideas in plant science. The videos and animations have already received more than 20,000 views between them on our YouTube channel.

In February 2014 SAPS ran an innovative 2-day event in partnership with the Biotechnology and Biological Sciences Research Council (BBSRC), challenging 7 scientists and 10 teachers to work together to develop new educational resources inspired by the latest research into crops. 'Harvest the Curriculum' yielded a number of great ideas among all the participants, but also demonstrated the value of giving biology teachers the time and opportunity to refresh their scientific knowledge in order to take that inspiration back into their classrooms.

SAPS, with its focus on science education for 14-19 year olds, has been funded by the Gatsby Charitable Foundation for more than 20 years as part of a wider programme of support for plant science. Last year a joint proposal to Gatsby from the Botanic Garden and the Sainsbury Laboratory was successful in obtaining increased funding in order to expand our range of activities over the next 3 years. In this way we intend to bring greater coherence, and more innovation, to the ways in which we directly engage and inspire 11 -21 year olds with plant science.

The first activity in this new programme was the 2014 Gatsby Plant Science Summer School, a residential week of fantastic talks, tutorials, workshops and social events designed to motivate top bioscience undergraduates to consider a future with plant science. Initially conceived by Dr Celia Knight at the University of Leeds, the Summer School has a very successful track record and 2014 was no different. 99% of the 80 students who attended felt more interested in plant science following the summer school, with 97% likely to study plant science in their second year and 91% more interested in a career in plant science.

Flis Plent, Head of Education

Voicing the Garden

Voicing the Garden was a one-year project, funded by the Heritage Lottery Fund and the Cambridge University Botanic Garden Association (CUBGA), to collect, celebrate and share the stories of the people behind the plants – the people who have made, grown up in or simply enjoyed the Cambridge University Botanic Garden. The resulting archive of over sixty interviews conducted by volunteers with current and former members of staff, long-standing visitors and new converts to the Garden is a rich mix of inside tracks, personal meanings, conflicting viewpoints, loves, loathes, life changing experiences, characters and recollections.

As a research resource legacy, Voicing the Garden tells rich and illuminating stories of both change and permanence. We no longer light cones of nicotine shreds as pest control in the Glasshouse Range, for example. The switch from solid fuel heating of the Glasshouse Range (which required round-the-clock shovelling shifts) to an oil-fired boiler put Dick Bragg out of a job. Visitors are now allowed to bring picnics and 'perambulators'. Saplings planted out post-war on former allotment land are now large and impressive specimens. The Garden is no longer free. But the Garden's horticultural training scheme is still imbued with the same supportive culture that has set the dedicated off on their careers with excellent plant knowledge and practical skills for the last 60 years and more. And through all the landscape change, the Voicing the Garden archive confirms that this 40-acre oasis in the middle of Cambridge is still a magical place for generations of visitors, a place of both solace and celebration, a place that fosters both personal and professional conversations and exchanges. This is the kind of permanence we are proud of.



A SUNDAY KEY COULD BE PROCURED FOR £2 RETURNABLE DEPOSIT

What is striking is how diverse in voice and sometimes anarchic these unofficial histories are, the antithesis of the official guide book to the Garden. Voicing the Garden has set us in awe of how the trainees took advantage of the drought of '76 drying out the Lake to set fire to the methane released when thinning the congested waterlilies, putting around 300 mallard to flight with singed tailfeathers! We discover that the way to get off work twenty minutes early in the 1960s was to offer the Supervisor an eel freshly lifted from the stream. We are invited to picture the daughters of a former Garden Director jumping their ponies over the Winter Garden hedges or EM Forster coming to tea and becoming besotted with their pet goat. We long to have taken part in the 'slow bicycle race' at staff parties or joined the 1950s Glee Club which all horticultural trainees had to attend on a weekly basis.

We hear from the schoolgirls who weeded the Garden during the war and then grew up to bring their own grandchildren, and from the parents who have grieved here.

The project has connected people and generations. Former members of staff have rediscovered each other at meetings of CUBGA, the Garden's organisation for staff and staff alumni. Members of the public have put us in touch with friends and relatives with stories to tell. The volunteer interviewers, without whom this project would not have been possible, brought a fresh perspective on understanding the Garden.



TIME FOR A PHOTOGRAPH WHILE DIGGING THE PITS DAVID HINKS, ROY JONES, SID BOGGIS AND DICKIE COUGHLAN UPSIDE DOWN



THE SIZZLING SUMMER OF 1976 DRIED OUT THE LAKE COMPLETELY



2 SEPTEMBER 1989 – SUD SENSATION AS PRANK GETS POOL BUBBLING



CUBG CRICKET TEAM 1950s



2 JUNE 1980 – PLANTS FROM A LOST WORLD
NORMAN VILLIS

An engagement programme was developed with partner organisations to connect the generations creatively through the material gathered. The Voicing team went out on the road taking a mini exhibition and talk to libraries, community groups and care homes. The initiative encouraged a great many contributions, and residents at the Manor Care Home were inspired to create their own happy memory tree. Working with the Cambridgeshire Film Consortium, excerpts from the oral history interviews became the inspiration for a series of short films: young adults from Squeaky Gate, a creative arts charity, wrote, directed and performed a music video; a school from King's Hedges learnt drawing skills to animate the story of Tony Offley, who could tame robins to hop into his jacket pocket; Nicci Driscoll, from Anglia Ruskin University, won a short film competition to animate the story of the day a visiting poodle pushed alpine supervisor, Harold Langford, too far, as remembered by 1970s horticultural trainee, 'Tiny' French. The Cambridgeshire Film Consortium collated all the newly commissioned films with archive footage for a special premiere at the Arts Picturehouse in December 2013, thereby bringing the interviews and their potential for creative connections across generations and communities to a wider audience.

The Arts Picturehouse premiere also celebrated the launch of the project website, voicingthegarden.com, which shares all the material gathered during the project. The website is not only an on-line oral history archive but has become a digital repository for an amazing range of records and memorabilia brought by the interviewees – photos of staff fishing in the Glasshouse pools, the work diary of a

horticultural trainee from half a century ago, a wonderful Super8 film of a 1953 garden party for staff, the cracked leather doctor's bag that held the wages in cash – disbursed every Friday lunchtime, the batting averages of the Botanic Garden cricket team, an original and much sought-after 'Sunday Key', aerial photographs of the Garden in development, reports and publications. Inspired to contribute, the Cambridge News scanned and made available their news clippings featuring the Garden; even the briefest survey gives great insight into how the Garden has been perceived and reported over the last half-century.

The project website has been designed to both perpetuate and archive the project: visitors can upload their own memories and snapshots of the Garden to the on-line Memory Board. These digital postcards are already painting a wonderfully diverse picture of motivations to visit from being a place to remember lost friends to the amazing experience of seeing a banana growing in the Glasshouse for the first time in the post-war years. Visitors are also invited to pinpoint their favourite spots in the Garden and to share short stories, poems, artwork and even musical compositions in the Anthology section, devised to recognise and celebrate the rich creative responses that the Garden continues to inspire.

**To discover and share in the stories, please visit
voicingthegarden.com**

Juliet Day, Development Officer

Research

The diversity of roles the Garden plays in research, both across the University and more widely, is astonishing. Pages 16-19 of this Annual Report provide a summary of research conducted in 2013-2014. As well as the perhaps expected role in providing access to plant collections and horticultural support for botanical projects, the Garden also provides underpinning facilities supporting research in Architecture, Biochemistry, Chemistry and Zoology. The Zoology Department here in Cambridge has always been a key research user of the Garden, as of course the vast majority of animals depend on plants for their food supplies and their homes. However, it is always good to see that use extending beyond our own University. The Garden has enjoyed a particularly long and fruitful collaboration with Anglia Ruskin University, exploring how various tree plantings influence foraging and brood success of some of our native birds. This collaboration has had two-way benefit, with some of our plantings, especially on the eastern boundary, developing to reflect the results of these studies and maximise the opportunities for invertebrate and bird life.

Securing a global food supply

Despite the interesting animal life in the Garden, it remains the case that our major research focus is on plant science. For the last few years there has been a growing recognition in the plant sciences community that the majority of the solutions to the problems the world faces in feeding an ever-growing human population will have to be found by plant scientists. This recognition has been mirrored by a growing acceptance both by politicians and by funding bodies of the need to focus on scientific research that can improve crop yield in a sustainable way. In 2009 Professor John Beddington, then the UK government's chief scientific advisor, brought these issues to public attention by talking of a "perfect storm" resulting from shortages of food, energy and water. Professor Beddington predicted that this storm would arise in 2030, based on data suggesting that global population would rise by 33%, demand for water by 30%, and demand for food and energy by 50%. It is a privilege to be in a position to support scientific research that aims to mitigate some of these problems.



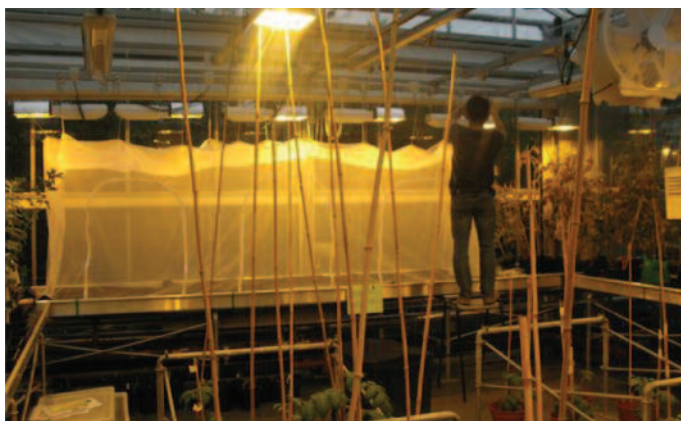
SECURING A GLOBAL FOOD SUPPLY

Surprising interactions between plants and fungi

It is often surprising how little we understand of the fundamental biology of our crop plants. Dr Uta Paszkowski, based in the Department of Plant Sciences here in Cambridge, has a research programme dedicated to understanding the basic principles of an interaction with an enormous potential to enhance food production. Most plant species, including crops, form a mutually beneficial relationship with fungi from the Glomeromycota group. These fungi interact with plant roots in a symbiotic association called an arbuscular mycorrhiza (AM). This association confers great nutritional benefit to the plants, with the fungi providing nitrates and phosphates from the soil to the plant, in exchange for sugars that the plant produces through photosynthesis. As a result, the plants grow stronger and, if they are crops, can yield more food. However, plants cultivated under standard European agricultural conditions, receiving high amounts of fertilizer, don't seem to get full benefit, including our key cereal crop wheat. Uta's work focuses on molecular mechanisms underlying the formation and functioning of AM symbioses in rice and maize. She is particularly interested in understanding the communication between a fungus and a plant root in the soil that allows the mycorrhizal association to form. Establishment of AM symbioses relies on the continuous orchestration of signals to achieve recognition and coordination of the interacting organisms, and Uta is determined to identify the genetic components of this dialogue. Once we understand how plant and fungus come together, we will be in a better position to design strategies to improve similar associations in key crop plants. The Botanic Garden supports Uta's research by growing the rice and maize plants she needs for her work, both in a specially designed tropical glasshouse "behind the scenes" and also in our outdoor experimental plots. We did discover a few problems with this plan this year – it turns out that the Botanic Garden squirrels are very fond of maize cobs!



APHIDS ON *CHENOPODIUM*



BUMBLE BEE FLIGHT ARENA



COFFEE PLANT

Increasing photosynthetic output in rice

Dr Julian Hibberd, also in the Department of Plant Sciences, works on a different aspect of crop yield. Julian is interested in understanding how the particularly efficient method of photosynthesis used by maize works. This system is called C4 photosynthesis, and it allows more energy to be harvested from the sun than in the usual C3 form of photosynthesis. This efficiency explains why maize plants grow so quickly and so tall. C4 photosynthesis is most effective in environments where there is plenty of sunshine and plenty of water, and so would be ideal for rice, the world's most important food crop. But rice has never evolved C4 photosynthesis. Julian's research group have devoted many years to carefully unpicking the mechanisms of C4 photosynthesis in a range of plant species, many grown here at the Botanic Garden. They are now working with colleagues at the International Rice Research Institute in the Philippines to translate some of these discoveries into higher yielding rice varieties.

Unusual guests in the Botanic Garden glasshouses

Our experimental glasshouses are in the private part of the Garden, and are the domain of Pete Michna (Experimental Section Supervisor) and Sally Hughes (Experimental Section Assistant). Their horticultural colleagues often tease them about the dull plants they grow – maize, rice, tomatoes – compared to the exotic lovelies in the rest of the Garden. However, some of the requests Pete and Sally get are nothing short of extraordinary. Dr John Carr, in the Department of Plant Sciences, is interested in plant viruses, how they affect plant growth, and how they are carried by insect vectors. In recent years he has made the striking discovery that plant viruses manipulate the smell and taste of the plants they infect in a way which influences the feeding and behaviour of aphids. Some viruses are clever enough to make the plant smell good to aphids but taste bad – ensuring a regular supply of aphids that quickly move on to other plants, taking the virus with them. This is of course very bad news for crop yields, and John hopes that by understanding the interactions between plant, virus and aphid he can develop strategies to minimise virus infection of our crop plants. His usual model system is the tomato, and Pete and Sally are used to growing large numbers of tomato plants for research. But their faces were a picture the day that we explained that John wanted to grow tomatoes in the Experimental Glasshouse, infect them with a virus, and then infest them with aphids not the usual sorts of visitors horticulturalists want to see! To make matters worse the project has recently taken a new turn, discovering that pollinating insects are also influenced by these

altered plant scents. So to add insult to injury Pete and Sally now have a greenhouse full of tomatoes, viruses, aphids ... and a bumblebee colony. Things are never dull in the experimental glasshouses.

Using the living collection to enhance human nutrition

Not all of the research we support that focuses on food security involves simply growing known crop plant species. Many scientists believe that the next generation of advances in crop productivity will come from exploring how the wild relatives of our domestic crop plants do things. For example, wild relatives of potato are resistant to the potato blight that caused the Irish potato famine, and wild relatives of wheat can tolerate much higher levels of salinity than can our modern cultivars. By exploring the functional diversity around key crops we should gain insights that can be applied to the species we commonly grow, and a Botanic Garden is ideally placed to provide access to a living collection of wild plants, many of them related to crops. One external project that we have supported this year took advantage of our collection of coffee species to explore how healthier forms of coffee could be developed. Professor Cathie Martin, at the John Innes Centre in Norwich, is interested in developing crop plants with improved health benefits. Epidemiological studies show that moderate coffee consumption is associated with many health benefits, including a lower risk of cardiovascular disease, Alzheimer's and type 2 diabetes. Studies have shown that the caffeoyl quinic acids (primarily chlorogenic acid) present in relatively high quantities in coffee are responsible for the health-promoting properties, and also influence aroma and taste. Genes that regulate chlorogenic acid production have not been identified in coffee, so Cathie and her team sampled DNA from the coffee species in the Garden's collection (*Coffea canephora* and *Coffea arabica*) to explore how coffee makes these important molecules. The identification and characterisation of these genes are important research objectives to aid the production of coffee with optimised characteristics for taste, aroma and health benefits. The team found it impossible to grow coffee from seed in their own research glasshouses, and comment that their research is entirely dependent on the fantastic care and attention that our plants receive from Glasshouse Supervisor, Alex Summers.

It is a privilege for the Garden to support these various research activities, and an important part of our remit to play our role in supporting research that will support and sustain global food supply.

Professor Beverley Glover, Director

Research supported and facilitated

The Botanic Garden maintains and makes accessible the living plant collection of the University of Cambridge. Research and teaching is supported through: the plant collections of over 8000 species; the Experimental Section which provides supported glasshouse and open ground research plots; and through use of the 40-acre landscape. In addition to home-grown research the Garden supports a wide range of projects throughout the University of Cambridge and collaborates with a great many external partners.

Cambridge University Botanic Garden

Professor Beverley Glover, Director:

Research programme focussed on the evolution and development of flowers, plant/pollinator interactions, and plant surface properties. Material maintained at CUBG or accessed from living collection, for projects including:

- Petal surface evolution in *Solanum*, with Dr Sandy Knapp (The Natural History Museum) and Katrina Alcorn (PhD student).
- The relationship of floral morphology to pollination success in *Vicia faba*, with Dr Jane Thomas (National Institute of Agricultural Botany) and Emily Bailes (PhD student).
- Molecular evolution of key developmental pathways in plants, with Dr Sam Brockington (Department of Plant Sciences, University of Cambridge) and Dr Chiara Airolidi (post-doc).
- Evolution of floral form and pollinator type in Antirrhineae, with Cecilia Martinez (PhD student).
- Development and evolution of insect-mimicking petal spots in *Gorteria diffusa*, with Dr Paula Rudall (RBG Kew), Dr Allan Ellis (Stellenbosch University) and Greg Mellers (PhD student).
- Development, function and evolution of iridescence in plants, with Dr Paula Rudall (RBG Kew), Professor Richard Bateman (RBG Kew), Professor Ulli Steiner (Department of Physics, University of Cambridge), Professor Jeremy Baumberg (Department of Physics, University of Cambridge), Dr Silvia Vignolini (Department of Chemistry, University of Cambridge), Dr Edwige Moyroud (post-doc) and Alison Reed (PhD student).
- Evolution of epidermal cell morphology, with Lin Taylor (PhD student).
- The effect of plant viral infection on pollinator attraction, with Dr John Carr (Department of Plant Sciences, University of Cambridge), Dr Alex Murphy (post-doc), Dr Niels Groen (post-doc) and Sanjie Jiang (PhD student).
- Evolution and development of nectar spurs in *Linaria*, with Dr Mario Fernandez-Mazuecos (post-doc).
- Interactions between petal surface and pollinator claw morphology, with Dr Walter Federle (Department of Zoology, University of Cambridge) and Jonathan Patrick (PhD student).
- Provision of liverworts, mosses, ferns, lycophytes and cycads for undergraduate teaching.

Dr Tim Upson, Curator and Deputy Director (until March 2014):

- Maintaining collections of *Lavandula* and *Rosmarinus* for systematic research.

In collaboration with Tim Pankhurst, Plantlife Fenland Officer based at CUBG:

Maintaining collection of fen plants for conservation including:

- Testing *Viola persicifolia* (Fen violet) seed for viability from Wicken Fen.
- Regenerative strategies for *Liparis loeselii* (Fen orchid), with Pete Atkinson (Plant Records Officer) and Pete Michna (Experimental Supervisor).

Department of Plant Sciences, Cambridge

The following groups were supported in their work:

Professor Sir David Baulcombe, FRS

(RNA Silencing and Disease Resistance Group)

Use of experimental glasshouses to propagate the progeny of *Solanum lycopersicum* x *S. pennellii* hybrids, to investigate transgressive segregation in hybrid plant populations. Transgressive segregation results in plants that have heritable properties that are outside the range of the parents, and this work aims to understand the molecular biology of this important trait so that it can be harnessed more efficiently for crop improvement.

Dr Sam Brockington (Molecular Systematics and Evolution Group)

The Garden has been supporting a collaborative research project: "From Cacti to Carnivores: Using Transcriptomics to explore the evolution of the hyperdiverse and globally distributed Caryophyllales". The central goals of this project are to evaluate the transcriptomic and phylogenetic locations of shifts in evolutionary rate and to determine to what degree these shifts are correlated with changes in life history and ecophysiology, using the globally distributed and highly diverse angiosperm order Caryophyllales as a case study. The Caryophyllales, which contain ~6% of all flowering plant species, represent an ideal group for this project because they possess exceptional diversity in life history, ecology, and physiology, ranging from arid-adapted succulent cacti and halophytes to rainforest trees and carnivorous pitcher plants. A minimum of 300 Caryophyllales transcriptomes will be generated from approximately 300 species. These are grown at least to the stage of young plants at which point key tissues (meristems and young leaves) are harvested, and RNA extracted. RNA is used as a template in next generation sequencing in order to obtain a minimum of 10,000 genetic loci from each species. For all harvested material, reproductive material is pressed and accessioned in the University of Cambridge Herbarium.

Yang, Y., M. J. Moore, S. F. Brockington, D. E. Soltis, G. K.-S. Wong, E. J. Carpenter, Y. Zhang, L. Chen, Z. Yan, Y. Xie, R. F. Sage, S. Covshoff, J. M. Hibberd, M. N. Nelson, and S. A. Smith. In press. Dissecting molecular evolution in a hyperdiverse plant clade using transcriptome sequencing. *Molecular Biology and Evolution*. Yang, Y. and S. A. Smith. Advanced Access. Orthology Inference in Nonmodel Organisms Using Transcriptomes and Low-Coverage Genomes: Improving Accuracy and Matrix Occupancy for Phylogenomics. *Molecular Biology and Evolution*. doi: 10.1093/molbev/msu245

Dr John Carr (Virology Group)

John Carr's research focuses on the interactions between plants and their viruses, with particular interest in how insects vector those viruses. He has used the experimental glasshouses to grow tomato plants and carry out controlled pollination experiments with bumblebees. He has used the experimental plots to grow bean plants to attract natural aphid herbivores that could be used in controlled experiments on beans within the Plant Growth Facility. Pete Michna, Experimental Section Supervisor, gave valuable advice when aphids were found on *Chenopodium album* growing nearby, enabling the group to successfully passage these aphids to broad beans for use in further experiments.

Dr David Coomes (Forest Ecology and Conservation Group)

Working with members of the Chemistry Department the group has been measuring isoprene emissions from *Eucalyptus* saplings, some of which have had holes cut in the leaves to simulate the effects of herbivory while others have been left as control plants. The work was conducted in the tropical display house with support from Glasshouse Supervisor Alex Summers.

Professor Howard Griffiths (Plant Physiological Ecology Group)

Tropical Epiphytes and other succulent plants with Crassulacean acid metabolism. In conjunction with field work in Trinidad and Tobago, we are comparing the limits to distribution and tolerance to exposure of bromeliad epiphytes, which use roots largely as holdfasts, and trap water and nutrients in overlapping leaf bases or via leaf trichomes. In Mexico, we have been making long-term eddy flux measurements of water loss and carbon uptake to compare with *Agave* plants grown at the Botanic Garden, as part of a general comparison with other bioenergy crops, such as *Miscanthus*, maintained by the Garden.

Dr David Hanke (Plant Growth Substances Group)

Work by the staff of the Garden in growing potato tubers of the variety 'Majestic' every year for the past 35 years has culminated in the publication of our discovery of the mechanism of tuber dormancy. This work would not have been possible without skilful husbandry by the staff of the Garden, ensuring year on year a consistent supply of experimental material of the highest quality, and we are profoundly grateful for the legacy of past work and for their continuing contribution to the project.

Jennifer R. Bromley, Barbara J. Warnes, Christine A. Newell, Jamie C. P. Thomson, Celia M. James, Colin G. N. Turnbull and David E. Hanke (2014) 'A purine nucleoside phosphorylase in *Solanum tuberosum* L. (potato) with specificity for cytokinins contributes to the duration of tuber endodormancy' *Biochemical Journal* 458, 225-237.

Dr Julian Hibberd (Molecular Physiology Group)

Species of *Flaveria* grown for RNA isolation and deep sequencing to define changes in gene expression between leaves with C3 photosynthesis and leaves with the more efficient C4 photosynthesis.

Dr Uta Paszkowski (Cereal Symbiosis Group)

Plants are involved in interactions with a wide variety of microorganisms. The mutually beneficial arbuscular mycorrhizal (AM) symbiosis is the most widespread plant-fungal association between roots of terrestrial plants and fungi of the Glomeromycota. Mutualism is manifested in a bi-directional nutrient exchange in which the fungus receives photosynthates from the plant and enhances its mineral, particularly phosphate nutrition. The research of my laboratory focuses on the identification and characterization of molecular mechanisms underlying the development and functioning of AM symbioses in the crop plants maize and rice. We have engaged in complementary genetic approaches, namely forward genetic mutant screens in maize and reverse genetics in rice combining transcriptomics and functional genomics in rice. Mutants are grown in the Botanic Garden's greenhouses and experimental plots for genetic characterization and seed amplification.

Professor Alison Smith and Dr Matthew Davey (Plant Metabolism Group)

The Botanic Garden has provided space in a frost-free horticultural polytunnel for the erection of a new algae growth facility co-funded by the INTERREG NW Europe strategic initiative 'EnAlgae' (www.enalgae.eu <<http://www.enalgae.eu/>>). The facility showcases a 300L photobioreactor with patented low energy design by Steve Skill, EnAlgae collaborator, as well as several other smaller photobioreactors. The facility is used in several experimental programmes, including a collaboration with Cambridge Water to explore the potential use of algae in remediation of waste streams, as well as outreach activities to industry and schools.

Dr Edmund Tanner (Tropical Ecology Group)

Edmund Tanner has been growing beech and oak seedlings in organic soils derived from compost made from two grasses, *Cortaderia* and separately *Miscanthus*, to discover if they can take carbon compounds from the soil via their mycorrhizas. These two grasses have different kinds of photosynthesis which results in different concentrations of the stable isotope carbon 13. The tree seedlings have the same kind of photosynthesis, C3 (named for the number of carbon atoms in the first product of photosynthesis) as the *Cortaderia*. Samples of leaf material have been taken from the tree seedlings and the carbon 13 concentration measured. The results show that the concentrations are the same whether the soil is C3 or C4, which shows that the trees are not taking carbon from the soil via their mycorrhizas.

University of Cambridge

Dr Siobhan Braybrook (Sainsbury Laboratory)

Testing whether organ growth is associated with changes in cell wall chemistry in meristems of *Ginkgo*, *Pinus* and *Puerus* obtained from the Garden, along with a project sampling leaf epidermal cell shape from a wide range of species.

Professor Nick Davies (Department of Zoology)

Ecology undergraduates did a project on how distance from cover influenced feeding behaviour of blue tits and great tits under threat from attack by sparrowhawks.

Professor Paul Dupree (Department of Biochemistry)

Using Garden facilities to grow *Selaginella moellendorffii* plants. Research is focusing on the evolution of plant cell walls and whether their structure has changed over time. In particular, the group is looking at the structure of cell wall arabinogalactan proteins as well as the structure of cell wall xylan. We recently proposed a new model for assembly of plant cell walls in dicots. The model arose from precise structures we discovered in the cell wall polysaccharide xylan. These structures could impact plant growth and form through the ability to form strong vascular tissues. Therefore, understanding when the xylan structures arose is important, and we have used the expertise and collection of plants at the Botanic Garden to investigate xylan structure across the plant kingdom.

Dr Walter Federle (Department of Zoology)

Dr Federle's group investigates two ant-plant interactions from South East Asia, in which insects have developed specialisations to slippery plant surfaces:

(1) *Macaranga* ant-trees have hollow stems and are permanently inhabited by colonies of specialised *Crematogaster* ants, which protect them efficiently against herbivores. Many *Macaranga* species have waxy stems which are very slippery for insects. However, the specialised ant partners have no difficulty climbing the slippery surfaces and are therefore well protected against generalist predators and competitors. We investigate the mechanisms underlying the "wax-running" ability by studying the ants' locomotion and attachment forces on different substrates.

(2) *Nepenthes* pitcher plants are famous for conspicuous leaves that have evolved into organs capable of capturing and digesting arthropods. Nitrogen derived from digested prey helps these plants to survive in nutrient-poor habitats. We investigate the functional morphology and trapping mechanism of the pitchers in the field and in the laboratory. We study how insects are trapped by aquaplaning on the microstructured and fully wettable pitcher peristome. In a recent project with Ian Wilson (Chemical Engineering) we investigate the rheological properties of pitcher plant digestive fluids that are important for insect capture.

Both projects are supported by the collections and specialist material grown at the Botanic Garden.

Whitney, H. M. and Federle, W. (2013). Biomechanics of plant-insect interactions. *Current Opinion in Plant Biology* 16, 105–111.

Scharmann, M., Thornham, D. G., Grafe, T. U. and Federle, W. (2013). A novel type of nutritional ant-plant interaction: ant partners of carnivorous pitcher plants prevent nutrient export by dipteran pitcher infauna. *PLoS ONE* 8, e63556.

Thornham, D. G., Smith, J. M., Grafe, T. U. and Federle, W. (2012). Setting the trap: cleaning behaviour of *Camponotus schmitzi* ants increases long-term capture efficiency of their pitcher plant host, *Nepenthes bicalcarata*. *Functional Ecology* 26, 11–19.

Bohn, H. F., Thornham, D. G. and Federle, W. (2012). Ants swimming in pitcher plants: kinematics of aquatic and terrestrial locomotion in *Camponotus schmitzi*. *Journal of Comparative Physiology A* 198, 465–476.

Bauer, U., Di Giusto, B., Skepper, J., Grafe, T. U. and Federle, W. (2012). With a flick of the lid: a novel trapping mechanism in *Nepenthes gracilis* pitcher plants. *PLoS ONE* 7, e38951.

Bauer, U., Clemente, C. J., Renner, T. and Federle, W. (2012). Form follows function: morphological diversification and alternative trapping strategies in carnivorous *Nepenthes* pitcher plants. *Journal of Evolutionary Biology* 25, 90–102.

Dr Devin O'Connor (Sainsbury Laboratory)

Dr O'Connor is using a comparative approach to try to understand how changes in auxin mediated patterning were involved in the evolution of unique aspects of monocot vascular development. He is using *Acorus* grown in the garden facilities for immuno-localizations of PIN proteins.

Zoe Panayi (Department of Architecture)

This research involves speaking to gardeners about the types of plants within the temperate house, the climate and the kinds of services and building materials which are appropriate for this kind of greenhouse. This research contributed to a building proposal which was presented in a portfolio as part of a studio submission.

Jonathan Patrick (Departments of Zoology and Plant Sciences)

This project involved working with the honey bee hives in the garden for approximately 1 month (July 2014) on a project testing a potential control device for the *Varroa* mite, a serious pest to bees (they attach to and feed off the bees and bee larvae). The device was a bee grooming post (bees groom themselves and each other but it is not known if they can use other objects to groom the mites off). The project involved counting mite drop out of the hives (caught onto sticky boards underneath the hives) and comparing numbers before and after the device went into the hives.

Dr Sebastian Schornak (Sainsbury Laboratory)

Plants engage with fungi to improve access to nutrients such as phosphate. We have sampled liverwort species from the Botanic Garden (*Lunularia cruciata* and *Pellia endiviifolia*) and stained them to detect fungal structures. We found that *Pellia endiviifolia* harbours fungal structures. Comparing early land plant symbiosis with the root symbiosis of higher plants will allow us to highlight evolutionary aspects of symbiosis establishment in different parts of plants.

External collaborations

Carl Baker (Edgehill University)

As part of a pilot study examining physiological differentiation in the genus *Tilia*, some leaf material was taken from CUBG. Levels of chlorophyll and accessory pigments were measured and contrasted between four *Tilia* species (*T. platyphyllos*, *T. heterophylla*, *T. dasystyla* and *T. cordata*).

Philippa Bell (Open University)

Recording temperature data over 24 hour intervals under different trees.

Siobhan Gardiner (Cranfield University)

Siobhan's PhD studentship involves the development of vanilla (*Vanilla planifolia*) and is under the supervision of Prof Leon A. Terry. It is believed that genetic variation, geographical location as well as post-harvest curing techniques are all factors influencing the final chemical profile of vanilla, and she aims to systematically compare different varieties of vanilla to aid the understanding of vanilla production and performance with regards to flavour and aroma. Trying to gain access to green vanilla pods outside the UK proved extremely difficult. Since spring of 2014, Siobhan has been paying close attention to the *V. planifolia* specimen in the Garden's public tropical glass house. Working alongside glasshouse supervisor Alex Summers, Siobhan has hand pollinated the specimen to produce pods, and also proposed measures to improve the chance of flower/pod production in subsequent years.

Professor Cathie Martin and Daniel Knevi (John Innes Centre)

Regulation of chlorogenic acid biosynthesis in coffee. Coffee is the most consumed food product in the world. Epidemiological studies show that moderate coffee consumption is associated with many health benefits, including a lower risk of cardiovascular disease, Alzheimer's and type 2 diabetes. In vitro studies show that the Chlorogenic acids (CGA) and related compounds, present in relatively high quantities in coffee, are responsible for the health-promoting properties, aroma, and taste. Plants produce chlorogenic acid along with other related compounds via the phenylpropanoid pathway; a secondary metabolic pathway present in plants. Genes that regulate this pathway have been studied in other plant species (e.g. Arabidopsis, tomato, snapdragon), but have not been identified in the coffee species in the Garden collection (*Coffea canephora* and *Coffea arabica*). The identification and characterisation of these regulatory genes are important research objectives to aid the production of coffee with optimised characteristics for taste, aroma and health benefits.

Dr Julia Mackenzie (Anglia Ruskin University)

This study was conducted on Blue Tits and Great Tits nesting in the Garden which is surrounded by a mixture of residential housing, shops and offices and busy roads. The Garden contains many plant species with a wide variety of origins. It is consequently an ideal study site in which to examine the responses of native birds to exotic flora in the fragmented habitat typical of urban environments. In addition, the Garden is open to the public and attracts a large number of visitors, and consequently the resident tits are habituated to the presence of humans, thus enabling us to observe foraging behaviour at close range and reduce the likelihood of habitat-specific variation in bird detectability.

John Poland

Winter Key to Trees and Shrubs: An identification guide to twigs, bark and silhouettes of deciduous woody plants of Britain & Ireland. John Poland is preparing a comprehensive winter key to trees, shrubs and woody climbers of the British flora (including native, naturalised & widely planted species). This tool will enable the user to easily and rapidly identify 350 species of woody plants in a winter state without leaves, flowers or fruits with just three turns of a page, often correctly identified in under 60 seconds. Unlike traditional keys, they are written using a series of unique modular or 'polychotomous' keys. The use of accurately labelled specimens from Cambridge University Botanic Garden to check keys and descriptions has been of paramount importance.

Dr Jonathan Shanklin (Cambridge Natural History Society)

The Cambridge Natural History Society conducted their annual "fungus foray" on October 19 2013. A group of around 20 participants found at least 40 species of fungus, of which 24 had been seen the previous year and 5 were new to the Society's list for the Garden. The best find was striated earthstar, *Geastrum striatum*. Full details were published in the annual excursion report, which is available to members of the Society as a pdf or in printed form on request.

Tim Pankhurst (PlantLife)

The endangered fen orchid, *Liparis loeselii*, is the principal focus of a collaboration between Plantlife and the Botanic Garden, also involving RBG Kew, RSPB, Norfolk and Suffolk Wildlife Trusts, Butterfly Conservation and Natural England. We have been trying to understand better the reproductive strategy of this European protected species. This has involved a programme of seed-baiting to a) locate and identify the symbiotic fungus that it relies upon for germination, b) assess the suitability of potential reintroduction sites, and c) develop an ex-situ population, both for study and as stock for reintroduction. A small population is now maintained at the garden which will serve as a core for propagation. We are looking to extend this work to include yellow early marsh orchid *Dactylorhiza incarnata* ssp *ochroleuca*, which is critically endangered in the UK.

Collaborative work on the endangered fen violet, *Viola stagnina*, has involved trying to germinate seeds gathered from an in-situ seed dormancy experiment at Wicken Fen NNR and growing the plant for observation in the fen display; likewise, the stand of critically endangered crested buckler-fern, *Dryopteris cristata*, maintained at the Garden is subject to observation as part of its conservation strategy in the wild.

Dr Peter Stroh (Botanical Society of the British Isles)

A Vascular Plant Red List for England was published in September 2014. The publication assessed the extinction threat for all native and archaeophyte taxa found in England, finding that one fifth of all species were threatened, with many having declined by over 30% since 1930. A free download is available at <http://www.bsbi.org.uk/england.html>. Pete's focus has now turned to coordinating the third Atlas of Britain and Ireland, due to be published after fieldwork has been completed in 2019.

Continued involvement with CUBG staff in the introduction of the extinct endemic *Bromus interruptus* (interrupted brome) using seed from plants that were previously established in the Botanic Garden from the last known wild population. Seed sown at the introduction site in Whittlesford, Cambridgeshire, have germinated and themselves set seed, and monitoring with CUBG staff is ongoing. A paper detailing the history of *B. interruptus* in Britain and attempts at reintroduction has been drafted by Pete and CUBG staff, and will be submitted to Nature in Cambridgeshire for the 2015 edition.

Plant Material provided to other Gardens

University Botanic Garden Amsterdam

Victoria cruziana Orbign

RSPB Lakenheath

Conservation display at visitors centre

Chatsworth House

Victoria cruziana Orbign

Chelsea Physic Garden

Various plant material

Duchy College, Cornwall

Tulipa 'Captain Fryatt'

Royal Botanic Garden Edinburgh

Dryopteris cristata (L.) A. Gray

Oxford Archaeology East

Various plant material

Gibraltar Botanic Garden

Various plant material

British Pteridological Society

Davallia rhizomes

Royal Botanic Garden Kew

Various plant material

Churchill College

Orchids

Botanic Garden Dresden

Aristolochia cathcartii Hook. f.

Botanical Garden Stellenbosch

Victoria cruziana Orbign

Tresco Abbey Gardens

Various plant material

Wuhan University

Hippuris vulgaris L.

Plant material accessioned

For the period 1st October 2013 to 30 September 2014 the Garden accessioned 968 plants of which 154 were of wild origin. Of note are wild origin seeds for a number of endemic plants of the Canary Islands and plants of *Welwitschia mirabilis* from Namibia supplied to us via Chelsea Physic Garden. 138 seed lots were added to the seed bank.

Publications by Botanic Garden staff and associates

- Glover, B.J. (2014) Understanding flowers and flowering: an integrated approach. 2nd edition. Oxford University Press, 292 pages.
- Wilts, B., Whitney, H., Glover, B.J., Steiner, U. & Vignolini, S. (2014) Natural helicoidal structures: morphology, self-assembly and optical properties. *Materials Today* 1: 177-185.
- Bennett, T., Brockington, S.F., Rothfels, C., Graham, S., Stevenson, D., Kutchan, T., Rolf, M., Thomas, P., Wong, G., Leyser, O., Glover, B.J. & Harrison, C.J. (2014) Paralogous radiations of PIN proteins with multiple origins of non-canonical PIN structure. *Molecular Biology and Evolution* 31: 2042-2060.
- Ellis, A., Brockington, S., de Jager, M., Mellers, G., Walker, R. & Glover, B.J. (2014) Floral trait variation and integration as a function of sexual deception in *Gorteria diffusa*. *Philosophical Transactions of the Royal Society Series B* 369: 20130563.
- Dumanli, A., Kamita, G., Landman, J., van der Kooij, H., Glover, B.J., Baumberg, J. Steiner, U., Vignolini, S. (2014) Controlled, Bio-inspired Self-Assembly of Cellulose-Based Chiral Reflectors. *Advanced Optical Materials* 2: 646-650.
- Vignolini, S., Moyroud, E., Glover, B.J. & Steiner, U. (2013) Analysing photonic structures in plants. *Journal of the Royal Society Interface* 10, 20130394.
- Upson, T.M. (2014). *Emmenopterys henryi* (Rubiaceae). *Curtis's Botanical Magazine* 31(1): 66-79.
- Upson, T.M. (2014). *Tetradium daniellii* (Rutaceae). *Curtis's Botanical Magazine* 31(1): 48-57.
- Buffin, M. & Upson, T.M. (2014). Chapter 1 – Plant Diversity. In: The Fundamentals of Horticulture: Theory and Practice. Ed. C. Bird, Cambridge University Press.
- Upson, T.M. (2014). Into the Wintry Spotlight. *The Garden*. 34-30.

Funding

With the new Director in post, the Garden, with renewed momentum, continued to build upon its activities, attract more visitors and increase vital revenues needed to support general operations.

During the year the Garden was fortunate to receive various legacies and 'in memory' donations enabling the provision of the new 'Garden Room' (a much needed classroom for children – due for completion in 2014-15) and the installation of an attractive new pergola situated next to the glasshouses.

Income received from the Friends, UCM, CUBGA, general donations and Gift Aid helped to support many projects and activities such as 'Voicing the Garden' and the 'Tropical Wetlands House Project', complementing the Visitor experience and relationship with the Garden. Funds were also committed to support estate projects due to commence in 2014-15, including new directional signage and interpretation, a new cycle park and new plantings.

Focus during the year was on education, science and profile, with the Director and staff promoting the Garden and its facilities nationally and internationally, enhancing the Garden's position as a scientifically important collection of living plants. To further extend this aim, it is hoped that an endowment fund will be formed to contribute towards maintaining scientific research at the Garden for the future.

Volunteers played an enormously vital role – giving up their time and knowledge for the benefit of the Garden and its visitors. During 2013-14, 2992.5 volunteer hours were worked, saving the Garden an estimated £43,361 in pay costs! The Garden would like to acknowledge this with grateful thanks.

INCOME		£k	£k
Funding Source	Details	2013-14	2012-13
University Support	Pay	658.0	621.0
	Non Pay	51.0	38.4
	Non Recurrent	3.0	62.3
Trust Funds	The Cory Fund	475.4	460.2
	Other Trust Funds	12.1	13.2
Admissions Income	Gate takings (to include events and tours)	351.6	330.5
Earmarked Funds	Friends (to include income for activities)	179.8 See breakdown below	165.6
	Other Specific Donations and Trade (inc events)	157.9	78.2
Projects Grants/Funding		208.4 See breakdown below	19.3
Education Courses and Events		45.7	44.4
Science and Plants for Schools		159.5	186.5
Donations – General		109.2	8.9
Other/Miscellaneous income		3.7	43.3
Total Income		2,415.3	2,071.9**

Breakdown of Income (Friends: Earmarked Funds)		
Friends of the Botanic Garden – Subscriptions	169.1	154.8
Friends of the Botanic Garden – Outreach programme	9.0	9.2
Friends 25 Fund	0.2	0.4
Investment Income and Interest Earned on Earmarked Funds Held	0.0	0.3
Other	1.5	0.8
Total	179.8	165.6**

Breakdown of Income (Project Grants/ Funding)		
Tilia – Limes Project (Funded through Gift Aid and Donations)	0.0	1.0
Community Art Project - % for Art	0.2	0.2
Voicing the Garden (Funded by Heritage Lottery Fund Wildlife Travel, CUBGA and Garden reserves)	0.5	11.8
Moth Monitoring - (Funded by the Amateur Entomologists Society and Garden Reserves)	0.0	0.3
Connecting Collections (Funded by University of Cambridge Museums)	5.0	2.0
Tropical Wetlands House Project (Funded from Friends Reserves)	0.0	0.3
Cory Lodge Meadow Project (Funded from Garden Reserves)	0.0	3.7
Pergola Project (Funded through a Specific Donation, Gift Aid and Garden Reserves)	3.0	
Interpretation (HEIF5 Funded)	49.7 See Note 1	
Garden Room – Classroom for Schools (Funded by a Specific 'Giving in Memory' Donation and Specific Garden Reserves)	150.0 See Note 2	
Total	208.4	19.3

Notes

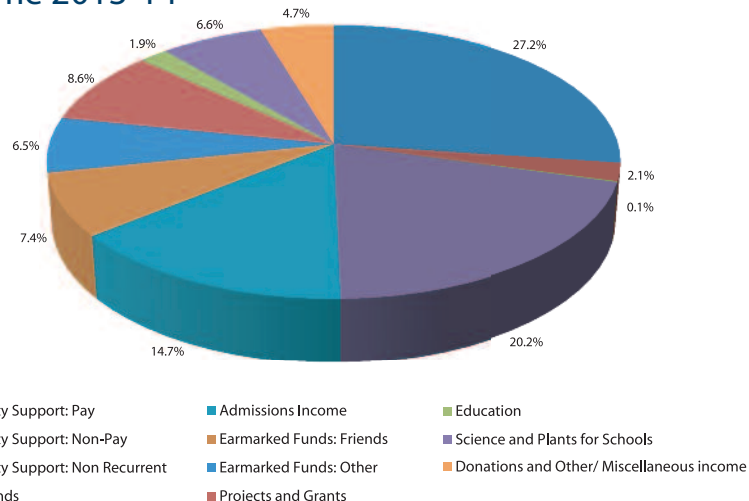
1. CUBG were successful in securing a grant from the HEFCE funded HEIF5 (Higher Education Innovation Funding) initiative to review the Garden's interpretation.
2. CUBG were grateful to receive an 'In Memory' donation enabling the build of a new dedicated classroom for children - supporting the Garden in its aim to educate and enthuse young people in Plant Science and Botany.
3. Costs of pay increased along with Garden activity and the recruitment of key staff.
4. The finances for Science and Plants for Schools moved to the Sainsbury Laboratory at Cambridge University from 1 April 2014.
5. The reduction in expenditure shown, when compared to 2012-13, is solely attributable to a change in reporting for General Garden Running Costs, where costs are now shown from the direct funding source.
6. Figure includes a reserve credit transfer of £89k towards Estate costs from Admissions and Donations.

* Cambridge University Botanic Garden Association – CUBGA ** Calculations include minor rounding errors.

Expenditure		£k	£k
Expenditure Type	Funding Source	2013-14	2012-13
Pay	University Support	658.1 See Note 3	608.1
	Trust Funds	449.4 See Note 3	416.4
	Admission and Tours	294.5 See Note 3	251.9
	Earmarked Funds: Friends	52.2	53.6
	Earmarked Funds: Other	26.9 See Note 3	0.0
	Projects Grants/Funding	0.0	1.9
	Education Courses and Events	0.0	0.0
	Science and Plants for Schools	125.7 See Note 4	183.7
		1,606.8	1,515.5*
Non Pay	University Support	54.6 See Note 5	117.6
	Trust Funds	30.1	20.0
	Admission and Tours	147.6	66.7
	Earmarked Funds: Friends	25.8	23.9
	Earmarked Funds: Other	-13.4 See Note 6	26.0
	Projects Grants/Funding	30.3 See breakdown below	33.2
	Education, courses and events	34.8	27.5
	Science and Plants for Schools	138.0	97.5
	Donations – General	42.6	-2.3
	Others/Miscellaneous	2.0	44.4
		492.4	454.6**
Total Expenditure		2,099.2	1,970.1

Breakdown of Expenditure (Project Grants/ Funding)		
Schools' Garden Fund and Project	0.0	1.8
Limestone Rock Garden Project	0.0	2.0
Community Art Project - % for Art	4.9	8.2
Voicing the Garden	11.5	0.8
Moth Monitoring	0.0	0.3
Connecting Collections – University of Cambridge Museums	0.5	0.1
Tropical Wetlands House Project (Funded by the Friends)	0.0	2.7
Cory Lodge Meadow Project	0.0	9.2
Pergola Project	3.0	0.0
Garden Room – Classroom for Schools	10.0	10.0
Mill Stone (Funded by CUBGA* and from Garden Reserves)	0.4	0.0
Total	30.3	35.1**
Total Income less Total Expenditure:		
Less: Earmarked funds held for future planned expenditure	-248.0	-91.7
Funds reinvested by Cory and Trust Fund Managers	-1.0	-9.9
Funds remaining for discretionary use	67.2**	0.1

Income 2013-14



Director's Research Grants active in 2013-2014

- 2014-2016: EU Marie Curie Intra-European award: *Linaria Speciation*. Euro 221,606 (with Dr Mario Fernández-Mazuecos, Plant Sciences, Cambridge).
- 2014-2016: Isaac Newton Trust: *Linaria Speciation*. £20,756.
- 2013-2014: Cambridge Returning Carers Scheme: £9,979.
- 2012-2015: Leverhulme Trust: Payback: do plant viruses compensate their hosts by helping attract pollinators? £241,000 (with Dr John Carr, Plant Sciences, Cambridge).
- 2012-2014: EU Marie Curie Intra-European award: Nanopetals. £164,239 (with Dr Edwige Moyroud, Plant Sciences, Cambridge).
- 2011-2013: Royal Society Joint International Project Grant: Petal spot evolution in populations of the Cape daisy *Gorteria diffusa*. £9,730 (with Dr Allan Ellis, Stellenbosch University, South Africa).
- 2009-2013: Leverhulme Trust: Iridescence and structural colour in plants. £297,000 (with Prof Ulli Steiner, Cavendish Lab, Cambridge and Dr Paula Rudall and Prof Richard Bateman, RBG Kew).

The Gatsby Plant Science Education Programme

- 2014-2017: Gatsby Charitable Foundation: £1,500,000 to support *Science and Plants for Schools*, *PlantLab*, and the *Gatsby Plants Summer School* (held by the Director with Professor Ottoline Leyser, Director of the Sainsbury Laboratory Cambridge University).

Syndicate and Cory Managers

Four meetings of the Botanic Garden Syndicate were held during the year, one under the Chairmanship of Professor Keith Richards and three from January 2014 under the Chairmanship of Dame Fiona Reynolds. Syndicate members were Professor Sir David Baulcombe, Professor Paul Brakefield, Dr David Coomes, Professor Nick Davies, Dr Laurie Friday, Dr Ian Furrer, Mr Donald Hearn, Professor Nick Jardine, Professor Ottoline Leyser and Dr Mike Rands. The Secretary was the Garden's Director, Professor Beverley Glover. The Syndicate again were pleased for the opportunity to meet the Botanic Garden staff following their July meeting.

The Cory Managers met four times during the year under the Chairmanship of Professor Sir David Baulcombe for three meetings and the Acting Chairmanship of Dr Alan Munro for the July 2014 meeting. Managers for the year were Mr Michael Allen, Professor Howard Griffiths and Dr Alan Munro, with Mr Jonathan Appleton as the representative of the Director of Finance.

Botanic Garden Staff – October 2013 to September 2014

Director

- Professor Beverley Glover

Garden Curator, Deputy Director

- Dr Tim Upson (to March 2014)

Administration

- Administrator: Brigid Stacey
- Deputy Administrator: Wendy Godfrey
- Finance Officer: Rachel Agnew
- Deputy Finance Officer: Anouska Arthur
- Finance Administrator: Elaine Dalton
- Assistant Administrators: Pat Smith (to April 2014), Sue Wreford (to July 2014), Richenda Whitehead (from July 2014), Caty Cooke (from July 2014)
- Outreach Administrator: Emma Daintrey
- Outreach Assistant: Heidi Bradshaw (to July 2014),
- PA to Director/Deputy Director: Jane Adams

Visitor Services Team

- Visitor Services Section Supervisor: Nicci Steele-Williams
- Deputy Section Supervisor & Team Leader (Tuesday-Thursday): Laura Welford
- Team Leader (Friday-Monday): David Evans
- Visitor Services Assistants: Andrew Bryant, Jennifer Hills, Amanda Wilkins, Lucinda Fudge, Hannah Winter (maternity cover from December 2012), Susan Baker, Robin Gough (to May 2014), Jacqui Riley (to June 2014), Sam Kuper, Andrew Cameron, Kate Smith (from July 2014), Greg Smith (from July 2014), Phoebe Monk, Alicia Lloyd, Clare Hall

Development

- Development Officer: Juliet Day

Education

- Head of Education: Flis Plent
- Education Officer: Sally Lee
- Schools Education Officer: Bronwen Richards

Estates and Collections

- Curator: Dr Tim Upson (to March 2014)
- Estates Manager: Philip Starling
- Plant Records Officer: Pete Atkinson
- Plant Records Assistant: Mar Millan
- Librarian: Jenny Sargent

Horticulture

- Head of Horticulture: Sally Pettit
- Alpine & Woodland Section: Supervisor – Helen Seal; Assistant – Simon Wallis
- Demonstration & Display: Supervisor – Peter Kerley; Assistant – Paul Aston
- Experimental Area: Supervisor – Pete Michna; Assistant – Sally Hughes
- Glasshouse Section: Supervisor – Alex Summers; Assistant – Alan Langley
- Landscape & Machinery: Supervisor – Adrian Holmes; Assistant – Alistair Cochrane
- Systematics Section: Supervisor – John Kapor; Assistant – Julie Clos
- Trees & Shrubs Section: Supervisor – Mark Crouch; Assistant – Ian Barker
- Trainee Horticultural Technicians: From September 2013 to August 2014: Brendan Arundel, Kevin Doidge, Darren Minney, Julia Andersson, Ruth Gomez-Martin, Thomas King. From September 2014: Cathy Hawes, Sean McDill, Sam Peczek, Seth Ratcliffe, William Renwick, Imogen Velouria, Giulio Veronese.

Botanic Garden staff activities

The following members of staff have contributed to external organisations and groups in connection with their posts:

- Professor Beverley Glover: fellow of Queens' College; member of the Council of the European Society for Evolutionary Developmental Biology; member of the Botanical Society of America; member of the British Society for Developmental Biology; Fellow of the Linnean Society; member of the Linnean Society's Education Committee; Patron of the Cambridgeshire Gardens Trust; Vice-President of the Cambridgeshire Beekeepers' Association; Associate Editor for *Naturwissenschaften*; member of the Advisory Board of *New Phytologist*; member of the Editorial Board of *Current Opinion in Plant Biology*; member of the Natural Environment Research Council's Peer Review College; serves on the Royal Society's Small Grants Panel; gave invited lectures at the Institute of Plant Sciences at the University of Bern and at the University of Greenwich; gave lectures at the Cambridge International Science Summer School and the Cambridge Alumni Festival; gave invited or keynote talks at the UK Plant Evolution meeting in Edinburgh, the Human Frontier Science Programme meeting in Lugano, the European Society for Evolutionary Developmental Biology meeting in Vienna, and a DFG meeting on "Adaptomics" in Bad Neuenahr.
- Juliet Day continued as Chair of Great Days Out around Cambridge.
- Daniel Jenkins continued as a member of the UK Biology Education Research Group.

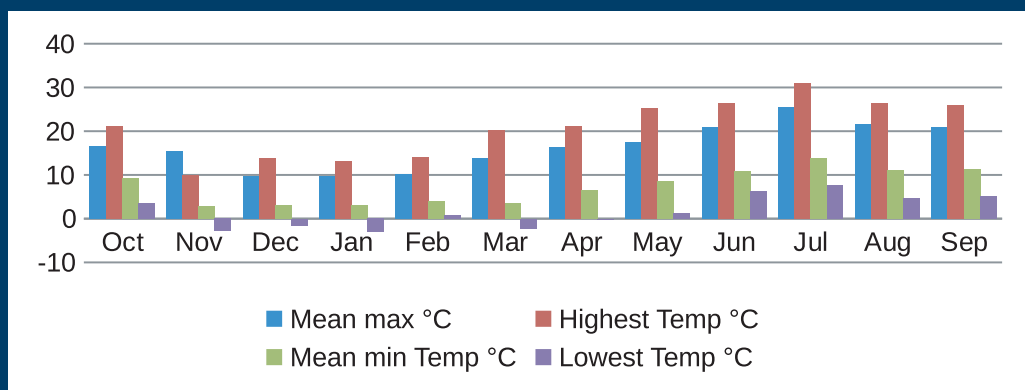
- Ginny Page continued to serve on the UK Plant Sciences Federation Executive Committee.
- Sally Pettit continued on the Advisory Committee of the Chelsea Physic Garden and as Trustee of the Merlin Trust.
- Helen Seal became the Professional Gardeners' Trust awards manager.
- Harriet Truscott continued as a member of the 'Nucleus' association of professional biology organisations.
- Dr Tim Upson continued as a Trustee of PlantNetwork; as Vice-Chair of the Plant Conservation Committee of Plant Heritage and was elected chair in July 2014; as an Editorial Consultant to The Plantsman, published by the Royal Horticultural Society; and as committee member of the Horticultural Taxonomy Group (Hortax). He attended the 5th Global Botanic Garden Conference, 20-26th October 2013, in Dunedin, New Zealand.
- Alex Summers joined RHS Tender Ornamental Plant Committee.
- Simon Wallis joined RHS Joint Rock Committee.

The Cambridge Certificate in Practical Horticulture and Plantsmanship

- Congratulations to Brendan Arundel, Kevin Doidge, Darren Minney, Julia Andersson, Ruth Gomez-Martin and Thomas King on their successful completion and award of the certificate.

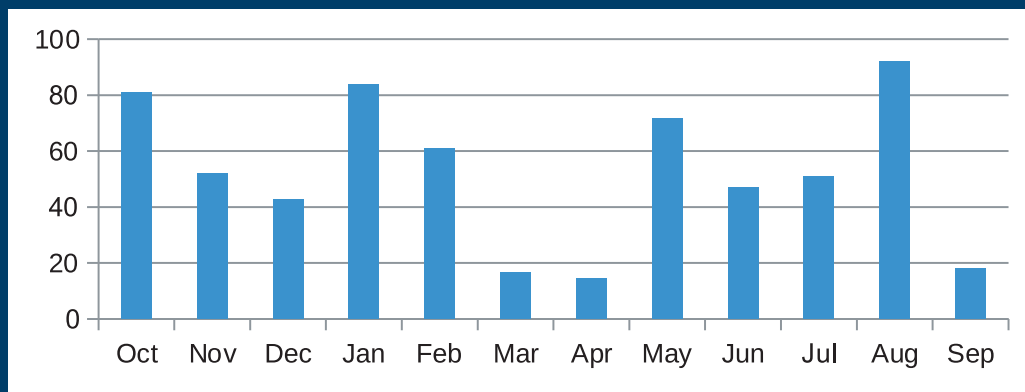
Weather

Monthly Temperatures



Note: Some measurements were taken from the Cambridge Digital Technology Group weather station in west Cambridge due to some anomalies in thermometer readings within the Botanic Garden.

Rainfall (mm)



Overall, this academic year was predominantly warm and slightly wetter than average. Autumn was an extension of summer and the winter unusually mild and wet with some localised flooding within the Garden. Our spring was very early, starting in February, and was also dry with the ground cracking in some places. Summertime was warm, but often quite wet which meant lush vegetation right up until the end of September.

The academic year began with a very average September, cooling off slightly after a hot summer. October was both milder and wetter than normal with 75.9mm of rain and the first of autumn's light ground frosts. November had our first wintry weather with a hail shower on the 20th and several hard frosts. December proved to be mixed, from very mild spells to persistent ground frosts, and below average rain. January was wet, mild and stormy. We had 83.8mm of rain and it was the wettest January since 1995, with only five wetter Januaries on record. Three thunderstorms occurred along with several instances of hail and there were consistent light ground frosts throughout the month.

February turned mild and very wet, which pushed us into an early spring. After January's wet month, February rain totalled 60.9mm and a fall of 23.1mm on the 6th caused localised flooding within the Garden and across the nation. There were also several storms and gales throughout the month causing the Garden to close on the 14th and 15th. March was mixed but warm and much drier than average

with only 16.6mm of measurable rain and a maximum temperature reading of 20.2°C. Several heavy hail showers passed through that lay on the ground to the following day and the dry weather caused the ground to dry out and crack. April extended the mild and dry spring with only nine days of measurable rain totalling 14.5mm. The ground continued to be cracked and dry even with light falls of rain.

May proved fine and mild with a heat wave mid-month during which we recorded a maximum temperature of 25.5°C on the 19th. It was a wetter than average month with 71.7mm of measurable rain. June was consistently warm and sunny with a maximum temperature reading of 26.9°C on the 9th. Three thunder storms passed through with average rainfall. The hottest month of the year was July with three readings of 29°C and the year's maximum of 31.0°C on the 18th, as well as the highest air minimum of 19.2°C in the same evening. With all this heat came six instances of thunder, though not all the thunder storms passed directly over the Garden.

August was wetter than normal with 91.9mm of measurable rain. This included the wettest day of the year when 33.7mm of rain fell on the 8th. It was cooler than normal and had three thunderstorms and one hail shower. September rounded off the year by being dry and mild with the highest maximum reaching 26°C and an average of 21°C and only 18.1mm of rain fell.

Sally Hughes, Experimental Assistant

Thank You

Gifts, donations and support received in Annual Report period 1 October 2013 – 30 September 2014

In Memory Gifts

- Chris Nicholls and family, in memory of Dr Gaynor Thomas, £250

Legacy Giving

- Dennis Harry Alsop, a legacy of £20,000
- (Katherine) Monica Beck, a legacy of £225,000

Individual Gifts and Donations

- Chris and Sarah Adams, for the Geoffrey and Eileen Adams Garden Room, £150,000
- Hilary and Michael Cowan, £25,000

Donors to the Cory Library

- Alpine Garden Society
- Paul Aston
- Bill & May Block
- Beverley Glover
- Linda Hinton-Meade
- Sylvia Norton
- Philip Oswald

- Sally Pettit
- Lady Jane Renfrew
- Mr Robinson
- Jennie Sharp
- Helen Stearn
- Tim Upson
- Adrian Young

We would also like to thank all those Friends of Cambridge University Botanic Garden who continue to make gifts over and above the annual renewal subscription.

Grants, Trusts and Societies

- Perennial, £19,770
- Plant Heritage/Brother UK bursary award, £400

Corporate and other support

- Cambridge Partnership for Plant Sciences, for Festival of Plants, £1000
- Mills & Reeve towards Sounds Green late night openings, £800
- Sainsbury Laboratory Cambridge University, for Festival of Plants, £1000

Corporate Friends

AAAS Science International	Cambridge University Department of Chemistry	Open University
Abbey College	English Heritage	Peters Elsworth and Moore
Alertme.com Ltd	Eversheds LLP	Ramboll UK Ltd
Bellerbys College	Fauna & Flora International	Real VNC Ltd
Birketts LLP	Geomerics Ltd	Royal Albert Homes
Brookgate Development Management Ltd	Hills Road 6th Form College	Saunders Boston Limited
Cambridge Assessment	Hope Residential Nursing Home	Savills (UK) Ltd
Cambridge Centre for Sixth Form Studies	Howard Ventures Ltd	Sony Computer Entertainment Europe Ltd (SCEE)
Cambridge Crystallographic Data Centre	John Lewis Cambridge	St Mary's School
Cambridge Education Group	MPW (Mander Portman Woodward Ltd)	Stephen Perse Foundation (Perse School for Girls)
Cambridge Prog for Sustainability Leadership (CPSL)	Marks and Clerk LLP	Strutt & Parker
Cambridge Silicon Radio Ltd (CSR)	Marshall Sports & Social Club	Sylvia Newman Garden Design
Cambridge University Institute of Biotechnology	Metis Arts	Thales E-Security Ltd
Cambridge University Press	Microsoft Research Ltd	New School of English
Cambridge Water Company	Mills and Reeve LLP	Transversal Corporation Limited
Cambustion Limited	Mott MacDonald Ltd	Trustonic Ltd
Cantab Asset Management	Murray Edwards College	Tucker Gardner Residential Ltd
Cantab Capital Partners LLP	Nash Matthews LLP	University of Cambridge Safety Office
Churchill College	Natural England	Wolfson College
Clare Hall	NetNames Brand Protection Ltd	Workplace Law
Collabora Dante Ltd	NHS Cambridgeshire and Peterborough CCG	WSP
Deloitte LLP	NIAB	

... and thank you to everyone who visited the Garden

- Visitor numbers through ticket offices (including Friends, groups and paying visitors) 250,568
- Adult Education course participants 486
- Educational visit participants 7,583

