
Annual Report & Accounts 2022–2023



Cambridge University
Botanic Garden



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Image above:
Pyrus regellii

Director's Report

Samuel Brockington
Curator & Acting Director

I write this in my capacity as Acting Director, covering for Beverley Glover, while she is on sabbatical. If last year we wrote that we felt we had turned the corner on the pandemic, this year feels like we have finally got back in the fast lane. We've witnessed a remarkable resurgence in visitor numbers, underpinned by rejuvenated connections with our local communities. Our calendar has been graced by a familiar line-up of events, including beloved traditions like the Festival of Plants, Sounds Green and Apple Day, all of which have radiated an extra layer of joy this time around. Moreover, this year has marked a departure as we've re-embarked on a series of ambitious projects aimed at strengthening our institution and our collections for the years that lie ahead. The space to proactively tackle these more strategic initiatives feels like a refreshing shift from previous years of reacting to circumstance.

Notable items from the contributions to this year's annual report include the launch of our community programme, which has seen us partner with local organisations to offer free access for their service users, support workers and carers. Participating groups receive up to 12 free visits annually and can take advantage of specialised workshops and guided tours. Since its inception in January 2023, the programme has attracted 46 member organisations. In a parallel effort, we are distributing complimentary admission passes in partnership with Cambridge City Council and Cambridge City Foodbank. This collaboration is designed to extend our reach to asylum seekers, refugees, and individuals relying on food banks – communities for whom the Garden might otherwise be inaccessible. Continuing this theme of reaching the

disenfranchised, we are hugely grateful to the Gatsby Foundation who have given us a generous donation to offer free travel to schools across the East of England, to help them fund school visits to the Garden, and our learning programme. Finally, we have recently celebrated the diversity of our researchers with a special trail called *'Amazing People, Enquiring Minds'*. The trail comprises 14 interpretation panels which introduce 14 individuals of different genders and ethnicities, all researchers at Cambridge, with work spanning plant and crop science, zoology, culture, archaeology, architecture, ecology and more. These diverse people all have something in common: a fascination for plants, and a drive to answer questions about the world around us today.

Last year, we were confronted by the stark realities of climate change and its incipient effects on our horticulture and collections. This year has seen us tackle several projects intended to confront this reality. Irrigation infrastructure has grown organically as the Garden has grown, but it is evident that this will need substantial investment if we are to sustain diverse collections in a changing climate. We have contracted the services of The Environment Partnership who have assembled an impressive team of engineers and specialists to take a deep dive with respect to irrigation – where we are and where we could be. Connected to this, we were this year able to conduct two expeditions to Central Asia, an area we had previously identified as key to adapting our collections to a warmer and drier climate. We have signed a Memorandum of Understanding with the Kyrgyzstan Academy of Sciences, and have benefited from their tremendous support and expertise, which saw us add over 200 wild collected species to our seed bank.

'This year we've witnessed a remarkable resurgence in visitor numbers, underpinned by rejuvenated connections with our local communities.'



We are mindful of the need for income diversification to underpin our other ambitions, which is why we appointed Paul Pomfret as Assistant Director of Audience & Enterprise. Tasked with revenue growth across multiple channels – including visitor admissions, memberships, commercial licensing and events – Paul is helping us on a path toward long-term financial resilience. In this role he is supporting three pivotal developments that will bolster our economic sustainability. First, the University has approved and financially backed plans for a state-of-the-art Welcome Centre at Station Road Gate, poised to accommodate over half of our visitor intake and offering enhanced retail spaces. Second, we have engaged the design firm Buttress to formulate a comprehensive landscape management tender, which will inform an enriched visitor experience and transformative landscape design for our Eastern Landscape. Finally, we have been preparing for a new and major addition to our events programme, Cambridge Botanic Lights, which will see us offer an after-dark winter illumination experience in December 2023, for the first time.

Collectively these major projects mark renewed commitment and energy with respect to our communities, our collections and our visitors, and importantly these initiatives will in turn strengthen our core missions of science and education in the years to come.

The Year in Pictures

November



Removal of Conifers

October



Visitors enjoying Apple Day



December



A variety of visitors enjoying the snow

The Year in Pictures

January



New path creation

The Year in Pictures

March



Flowering of the Moonflower, *Strophocactus wittii*



April



Strongylodon macrobotrys, the Jade Vine

February



Twilight



Easter trail

The Year in Pictures

The Year in Pictures

May



Lighting up the Nation

June



Festival of Plants

July



BBC interview



Sounds Green



New Artist-in-Residence, Nabil Ali

September

August



Dear Planet Earth Family Day



Dyeing the Blues course

Research

Samuel Brockington
Curator

Introduction

John Ruskin, the Victorian writer, philosopher, art critic and polymath, once wrote that “*the purest and most thoughtful minds are those which love colour the most*”. We mention this only because colour is very important to both the Garden’s Director’s and Curator’s research! And so, we thought we would focus the research exposé in this year’s annual report on two recent outputs from their extensive research programmes related to the evolution of colour in plants.

The Colour of Deceit

The floral kingdom abounds with remarkable evolutionary adaptations tailored to the needs of specific pollinators. Among the most fascinating are those flowers that engage in sexual mimicry, crafting an illusion that encompasses the visual allure, tactile feel, and sometimes even the chemical scent of female insects. This elaborate ruse seduces male pollinators in a dance of deception, culminating in pollination. The South African beetle daisy (*Gorteria diffusa*) stands out in this deceptive art. It is the sole known species beyond the orchid family to adopt such a strategy, eschewing the scent-based seduction typical of orchids in favour of a convincing display that manipulates colour and texture to beguile its pollinators.

Gorteria diffusa exhibits an intricate pattern that adeptly emulates the resting posture of female bee flies (*Megapalpus capensis*). This botanical impersonator crafts a three-dimensional facade with raised spots, enhanced by a greenish-black coloration interspersed with minuscule UV-reflective dots, creating the illusion of the glossy sheen of an

insect’s armour. This compelling mimicry secures the frequent attention of male bee flies seeking mates, inadvertently boosting the flower’s pollination rates. The mimicry of *G. diffusa* is an amalgam of three distinct elements: the precise replication of the bee fly’s exoskeletal hue, the deliberate placement of spots conjuring the image of multiple females, and the tactile quality of the spots, which adds a tangible depth to the deception.

In a paper led by Roman Kellenberger in the Director’s research group, they provide insights into the genetic underpinnings of the spot patterns found on *G. diffusa*. They discovered that these patterns are the result of gene co-option, a process where existing genes acquire new functions. Specifically, they identified three distinct instances of co-option, each responsible for one of the three key aspects of the mimicry – colour, spatial arrangement and texture.

But regarding the coloration of *G. diffusa*, the research highlights the pivotal role of the greenish-black pigment in replicating the exoskeleton of the female bee fly, achieved through the utilisation of pigments known as anthocyanins. These pigments, while usually responsible for the pinks, reds and blues in plants, undergo a transformation in *G. diffusa*. The research delineates how genes involved in iron processing are preferentially activated in the spots that mimic the bee flies. Elevated levels of iron in these areas interact with the cyanidin, an anthocyanin, altering its usual pinkish shade to a more bluish tint. This modified pigment, in concert with the floret’s inherent orange carotenoid pigmentation, produces the distinctive greenish-black colour that is instrumental to the plant’s mimicry.

‘These pigments play critical ecological roles, particularly in attracting pollinators, thus contributing to the reproductive success of the plants’.



Colour Lost and Found: The Genetic Journey from Anthocyanins to Betalains

Betalains are distinctive red and yellow pigments exclusive to the Caryophyllales order of plants and certain Basidiomycota fungi. These vibrant, water-soluble pigments endow the Caryophyllales with their characteristic colours, such as the intense red of beetroot and the delicate pink of Bougainvillea, which many visitors may recognise. Betalains are categorised into betacyanins, with red-violet hues, and betaxanthins, which display a range of yellow to orange shades. These pigments are not mere adornments; they play critical ecological roles, particularly in attracting pollinators, thus contributing to the reproductive success of the plants. Beyond their ecological significance, betalains have captured scientific interest for their potential therapeutic benefits. Research has identified these pigments as potent antioxidants and anti-inflammatory agents, suggesting their possible utility in promoting human health and preventing disease.

Betalains present a fascinating case in plant evolution; they are the only pigments to have entirely supplanted anthocyanins, which are almost universally present in flowering plants. This singular occurrence marks the only complete anthocyanin replacement documented in the vast expanse of plant evolutionary history, spanning over 450 million years – an enigma that remains largely unexplored.

In an endeavour to unravel this mystery, Boas Pucker and Nathanael Walker-Hale of the Curator’s research group have spearheaded a study probing the genetic underpinnings of this evolutionary phenomenon. Their work seeks to illuminate the

mechanisms that precipitated the loss of anthocyanins, aiming to answer the compelling questions of how and why this remarkable shift occurred.

The study reveals that within the Caryophyllales order, the phenomenon of anthocyanin loss has occurred repeatedly, with betalain pigments consistently stepping in as replacements. This intriguing pattern of pigment substitution is accompanied by a diversity of mechanisms underlying the loss of anthocyanins. The research indicates that this loss can result from the disruption of crucial enzymes involved in the anthocyanin production pathway or from the inactivation of the transcription factors responsible for initiating production of these enzymes. A significant finding of the research is the apparent irreversibility of anthocyanin loss through natural evolutionary processes. However, with the newly gained understanding of the genetic switches that turn off anthocyanin production, there arises the possibility of reactivating them. This could pave the way for engineering plants that synthesise both betalains and anthocyanins, potentially harnessing a broader spectrum of health benefits and nutritional value that these two classes of pigments offer.

Image above:
Gorteria diffusa

Horticulture

Sally Petitt
Head of Horticulture

Horticultural developments

Each year the horticultural team delivers a number of development projects to ensure that the Garden and landscapes continue to evolve. This year smaller developments included the replanting of the Grass Maze, the introduction of modern hybrids in the Rose Garden and the installation of a simplified planting of *Osmanthus x burkwoodii* and grasses at the Old Main Gate. Amongst these developments two projects stand out as highlights.

The first was the removal of a group of mature conifers, planted in the 1960s, which included *Cupressus glabra* 'Conica', *C macrocarpa* 'Donard Gold', *C. sempervirens f. sempervirens* and *Chamaecyparis lawsoniana* 'Triomphe de Boskoop'. These had grown to form a dense screen between the Lynch Walk and the Lake, casting deep shade over the Lynch Walk and the Peony Border, and obscuring views towards the Lake. Over time the foliage of a number of these trees had thinned due to intense competition, while others had required remedial arboricultural interventions to remove hazardous broken limbs. In February 2022 Storm Eunice hit the Garden and resulted in one of these impressive trees heaving out of the ground to expose the rootball. In autumn 2022, with relevant Council permission, our Landscape Team began work to clear the site, reinstate a lawn and install a new path. The Trees and Shrubs Section undertook the felling of the stand of conifers, which highlighted how dominant this planting had become, but also how much space they took up. The wood from the trees was chipped and recycled as mulch throughout the Garden. Once the site was cleared of tree waste work began on

installing a new access path from Lynch Walk to the Rock Garden and Lakeside. The meandering path was bordered along one side by the Rock Garden, and staff from the Landscape and Machinery Section installed metal edging to ensure a crisp path boundary along other stretches of path. Staff from both Sections worked together to lay the base of the path and the top dressing, which is a self-bonding aggregate suitable for wheelchair access. With the path complete the rest of site was rotavated, raked and levelled, and grass seed sown.

The redevelopment of this area was a huge undertaking for the horticultural team, and we were proud to be able to deliver all aspects of work in-house. All of our Trainee Horticultural Technicians were involved in the work, assisting with tree clearance, site preparation, installation of metal edging, path laying and lawn establishment. Throughout the project, regular visitors had the opportunity to view progress and provided positive feedback on the work, welcoming the increased sense of space and light, the improved access and the opening up of views towards the *Liquidambar styraciflua* 'Worplesdon', the Lake and beyond. The new landscape has been much admired and, once the site is cleared of a declining *Thuja plicata*, we intend to introduce a planting of small trees to add further interest to the area.

In 2012 we introduced a new meadow planting devised by Professor James Hitchmough at Cory Lodge. This was designed to be low maintenance and included a range of species selected to cope with low rainfall and well-drained soils here in the Garden. The mix included approximately 50 species from steppe and prairie regions of Asia, South Africa and North

‘Each year the horticultural team deliver a number of development projects to ensure that the Garden and landscapes continue to evolve.’



New meadow planting at Cory Lodge



New Zealand plantings in the Terrace Garden after extreme winter weather



Removal of conifers between the Lynch Walk and the Lake

‘All of our Trainee Horticultural Technicians were involved in the work, assisting with tree clearance, site preparation, installation of metal edging, path laying and lawn establishment.’

America. Many, such as *Dianthus carthusianorum*, *Galium verum*, *Echinacea paradoxa* and *Rudbeckia maxima* were sown directly onto a layer of sand. Others, including *Agapanthus ‘Black Pantha’*, *Eremurus stenophyllus* and *Stipa gigantea* were planted directly amongst the establishing seed species. As the planting established and matured we were able to enjoy a cacophony of colour, shape and texture, which changed not just seasonally, but also annually. Over time several species dwindled as they were out-competed by stronger elements such as *Galium verum* and *Origanum vulgare*.

To restore the diversity of this planting, staff in our Eastern Display Section cleared one-third of the meadow in spring this year, including the original sand layer. The first phase of reinstatement was adding a fresh sand layer to aid drainage and provide a sterile surface upon which to sow the new seed. We used the same seed mix as that used in 2012, sourcing it from the original supplier. In late April we sowed the seed mix onto the sand and irrigated to ensure sufficient moisture to encourage germination. By midsummer we were delighted to see seedlings emerging, and to even have some species, such as *Gazania linearis ‘Colorado Gold’*, *Oenothera macrocarpa* and *Castilleja integra* flowering by autumn. Confident in our methodology, we will repeat this process on the remaining two-thirds of the meadow in 2024. The newly sown plantings will be low maintenance, requiring only an annual cut with a strimmer in late winter. We are also confident that the plantings will continue to produce a succession of interest through the seasons. Based on the original incarnation, we anticipate that some species will be successful in the first few years of establishment but will ultimately be

out-competed by stronger species within the mix, creating an evolving palette of flower and interest throughout coming years.

A challenging winter

It seems to be increasingly hard to reflect on a year in the Garden without mentioning the weather. Last year the focus for meteorological discussion was the hot, dry summer, when the maximum temperature reached 39.9°C, and the implications of this on our collections. In complete contrast, the emphasis this year was on the intense, cold winter. Mild autumnal weather continued into December, but in mid-December we had 7cm of snow, which unusually persisted for a week here in Cambridge, and this was coupled with an annual minimum temperature of -10.2°C. This combination of a sudden drop in temperature and snow came as a shock to both staff and plants. Prior to this change in the weather we had given additional protection to a small number of plants, such as the *Pseudopanax crassifolius* in the Terrace Garden. We have, however, been lulled into a false sense of security by recent mild winters, and over the last decade we have been pushing the boundaries horticulturally, and growing species outside which might previously have failed in the colder months. Sadly, none of the *Pseudopanax crassifolius* survived the rigours of the winter, and these, along with several other shrubby New Zealand species including *Cordyline australis* in the Terrace Garden, and *Correa backhouseana* and *Phormium ‘Yellow Wave’* in the Winter Garden, succumbed to the winter weather. Two 40-year-old *Sophora* species which had grown on the south-facing wall of Cory Lodge also perished in this unusual combination of weather incidences. In



Jim Gardiner and Roy Lancaster with CUBG Trainees and Cambridge College Garden apprentices

contrast, other species, which looked as if they might also have died, such as *Musa basjoo*, *Ensete ventricosum* and *Tetrapanax papyrifer* and *Aloe polyphylla* in the Glasshouse Bays, recovered, and put on healthy regrowth during the summer of 2023.

We now face the challenge of ensuring that the Garden and its collections retain their research, educational, horticultural and aesthetic value in the future, while also meeting the challenges of a changing climate in which weather patterns are unpredictable, and in which we could expect annual temperatures to range from a maximum 39°C or higher, to a minimum -10.2°C or lower.

Future generations

Many in the horticulture industry relish the opportunity to learn from their predecessors, and also their horticultural heroes, and here in the Garden

we have a wealth of alumni whose experience we can draw upon. In recent years we have been delighted to welcome Jim Gardiner and Roy Lancaster, both previous students here in the Garden, to spend time with our Trainee Technicians. Jim and Roy have had illustrious horticultural careers, working at high profile horticultural establishments, including Royal Botanic Garden Edinburgh, Royal Horticultural Society and Sir Harold Hillier Gardens. Throughout their careers both have supported and encouraged young horticulturists, and during their annual visits to us they have provided practical horticultural and career advice and shared their colourful reminiscences of their time at CUBG. This year we were delighted to extend an invitation to Cambridge College Garden apprentices, who, along with our own Trainees, spent a wonderful afternoon in the company of two eminent horticulturists, who are horticultural heroes to many.

Learning

Samuel Brockington
& Learning Team

Educational engagements at the Garden

This year, our Garden has been buzzing with young learners, with the summer term seeing its calendar fully booked with school visits. In December, we rolled out an enhanced programme of workshops specifically tailored for Primary students. Complementing this, we introduced a more user-friendly booking system and revamped our website, providing better resources for educators. Over this reporting period, we hosted 262 school groups, translating to a remarkable total of 7,922 students. Breaking it down, primary schools led the way with 4,655 students. Secondary schools followed with 1,956 students, while 1,109 were from sixth forms. Notably, 360 of the latter attended our three-day 'Plant Responses A-level event' in collaboration with Hills Road Sixth Form College. Our youngest visitors numbered 193, hailing from early years settings. It's particularly heartening to note that 26 schools experienced the magic of our Garden for the first time. Of all the visits, 53 groups had the opportunity to engage in our immersive workshops, led by our dedicated Schools Learning Officers. Our initiative to provide free passes to local sixth form students continued to thrive. This year, we granted 634 passes to students keen on diving deeper into relevant science and art subjects. Furthermore, 182 students from Anglia Ruskin University, pursuing scientific disciplines, benefited from this scheme. A highlight of our year was the onboarding of new volunteers by our Schools Learning Officers. A robust training programme was launched during the winter months, welcoming not just new recruits

but also our seasoned volunteers. This was aimed at equipping them to helm the new workshop series. Our current team boasts 11 exceptional volunteers, a mix of retired educators and enthusiastic Cambridge students, all united in their passion for fostering learning.



'The visit greatly enhanced our classroom discussions, and the students were able to actively participate, drawing from their Garden experience.'

'Observing the plants we've been discussing in class truly brought our lessons to life.'



Families in the Garden: a year of enriching experiences

This year, the Garden blossomed with delightful engagements tailored for our family visitors. A survey we conducted in spring 2023 highlighted that families greatly appreciate the welcoming atmosphere and interactive learning environment the Garden offers. Our goal remains consistent: creating memorable, educational and fun experiences for families. This year, we believe we achieved just that! Here's a snapshot of our family-oriented offerings over the past year:

- **Monthly Family Drop-in Activities:** Held on the first Saturday of every month, these sessions invite families to indulge in plant and wildlife-themed craft activities. Thanks to their popularity, attendance this year hit an all-time high. We owe much of the success of these sessions to our dedicated team of volunteers.

- **Self-led Trails:** Families enjoyed revisiting their favourite trails like the "Bee School Summer Adventure" and "Autumn Animal Cards". We also introduced captivating new ones such as: "Little Robin's Christmas Trail" where families discovered festive plants and created beautiful paper baubles using plant rubbings. In the "Enchanted Egg Easter Trail" children unravelled plant-themed puzzles to win a delightful Easter prize. When taking part in the "Around the World Summer Trail" young explorers roamed the Garden, collected passport stamps from exotic plants and documented their journey in a travel journal.

Feedback on our trails has been overwhelmingly positive. Here are a few heartwarming comments:

'The trail unveiled some truly surprising plant facts. It provided a comprehensive Garden exploration experience.'

'The revelation of a 'sheep-eating plant' was fascinating! The trail's stamps and maps enhanced our child's learning experience.'

'Navigating the gardens became a day-long delightful pursuit. Spotting a stamp turned into an exhilarating activity for our children.'

- **Twilight & February Half-Term Activities:** In February 2023, we joined the University of Cambridge Museums' in-person Twilight events. Families turned into plant hunters, navigating our Glasshouse Range to discover rare plants. The highlight was a night-time event, drawing over 800 attendees who enjoyed a mesmerizing light display and engaging interactions with plant scientists.

- **Cambridge Festival:** Our carnivorous plants workshop, designed for children aged 12+ and adults, delved deep into the captivating world of these unique plants. Participants witnessed live prey capture, engaged in video sessions, and even crafted paper replicas of a Venus fly trap.



• **Summer at the Museums:** In collaboration with Cambridge Zero, our “Dear Planet Earth” event delved into the topic of climate change. Artist, Hilary Cox-Condron, and creative practitioner, Michelle Smith, led activities, while Professor Emily Shuckburgh distributed signed copies of her enlightening book. To further enhance understanding, the Centre of Landscape Regeneration scientists discussed their research, and Garden Guides offered special climate change-themed tours.

Lifelong learning & community initiative

From January 2023, we have been offering a full programme of courses from the Classroom in the Garden as well as continuing with a smaller online offering. Many of our courses, particularly those for botanical art, sell out and have waiting lists. During this reporting period we have delivered 62 adult courses to a total of 633 participants, 302 of which were joining us on a course for the first time. We have delivered 17 of these courses online to an audience of 160 people.

We are proud to have launched our Community Membership Scheme this year with the aim of supporting community organisations to bring their members to visit the Garden, as well as promoting the Garden as a local community resource. To be eligible, community groups must be either a charity, a community interest company, a community benefit society or an organisation that provides services directly to people who face sensory, physical, psychological or social barriers to visiting the Garden. Organisations must also have a CB postcode. Once members, groups receive seasonal newsletters and up to 12 free visits per year with the opportunity to book free hands-on

workshops and guided walks to inspire and help groups make the most of their visit to the Garden.

We have had some lovely feedback from member groups who have visited us for carnivorous plants workshops and guided walks this year:

‘Thank you so much for making our visit happen... To cut open and look inside a Trumpet Pitcher was something none of us had ever done before and it was really wonderful to see the clients and staff, really interested. We all came away with so much knowledge and Michael and Jim were discussing information they learnt about the Venus fly trap’

‘The organisation was absolutely perfect on yours and the gardens half, the flexibility and fluidity were exactly what we needed for our group as we have such varying physical care needs.’

Another part of our community offering is the distribution of community admission tickets via collaborations with Cambridge Ethnic Community Forum, South Cambs and Cambridge City Councils, Cambridge City Foodbank and Cambridge Refugee Resettlement Campaign to asylum seekers, refugees, Ukrainian guests and people accessing foodbanks for

*Images above: A workshop participant
Artist-in-residence Nabil Ali’s plant dyes*

633

Adult course participants

262

School groups hosted

302

First time participants

160

Online course participants

whom the Botanic Garden may otherwise be out of reach. We also have a small number of community scheme members who can visit the Botanic Garden as many times as they wish within the year. These include groups that provide mental health services and support services for adults with learning and physical disabilities.

In addition, we continue to welcome community groups who visit us outside of the Community Membership Scheme. These include charities based outside of Cambridge and collaborations as part of wider UCM projects. This has included the Portals to the World programme in partnership with the charity, Dementia Compass and a UCM-wide project with CUH Arts for staff and patient consultation groups about how to humanise the hospital environment for the new Cambridge Cancer Research Hospital.

The Community Membership Scheme currently has 46 member groups. Individuals visiting with member groups have accounted for 883 visits out of a total of 1,080 community visits since January this year.

Interpretation

Two new adult trails have been launched in this reporting period. In January 2023, the “Rhythms in Plants” trail was launched, which guides visitors through the ways in which plants respond to changes in day length, light levels, temperature and other climatic conditions. Since January, we have given out approximately 1,200 leaflets for the “Rhythms in Plants” trail. In July 2023, we launched the “Amazing people, enquiring mind” trail, which explores the inspiring people who do research in Cambridge. The trail guides visitors through the Garden to plants that are used by researchers across the University of Cambridge in a hugely diverse range of projects. This



Community group visit

trail has been very popular, and we have already given out 1,000 trail leaflets. For the rest of our eight adult trails, we have given out an average of 2,100 leaflets for each trail in this reporting period.

Staff

There have been a few changes to the team during this reporting period. Head of Learning, Hayley McCulloch, left the Garden at the end of September. Schools Learning Officer, Bronwen Richards, went on maternity leave in September 2023 ahead of the birth of her daughter. We are pleased to welcome Bee Carter as maternity cover in this Schools Learning Officer role. Raphaella Hull worked with us on a temporary basis throughout the summer providing essential support in planning the Adult Courses programme for 2024 and has recently been appointed as a full-time Learning Coordinator.

Curation

Samuel Brockington
Curator

We are delighted to introduce Jake Powell to our team, whose unique background as a mathematician and highly skilled computer programmer sets him apart in the context of a botanic garden. Jake's appointment is instrumental to our ongoing "BGSmartR" project, a computational analytical pipeline that he is spearheading alongside Assistant Curator, Angela Cano. This innovative project is specifically designed to analyse data from our Living Collections, serving as a compass for monitoring our progress in alignment with the goals outlined in our Living Collections Strategy. Our Living Collections can be likened to a vast, meandering river of germplasm – channelled, and harnessed for various purposes but inherently transient. The management of this dynamic flow of biodiversity is an intricate and demanding endeavour, yet it yields a wealth of data and information of significant importance, both to us and the broader botanic garden community. The data generated through the stewardship of our Living Collections sets them apart as a unique entity, defining our identity but also charting our path toward more effective management and higher-performing collections. As we eagerly anticipate the forthcoming year, Jake and Angie's expertise promises to unlock exciting possibilities and innovations within this realm, and we are keen to witness the contributions they make to our collection management.

Over the past year, our attention has been significantly directed towards our ancillary collections, particularly our herbarium and seed bank operations. This focus has been both a long-overdue commitment and a testament to the substantial progress we've made in managing our Living Collections over the past eight years. Additionally, it is a direct response to the increased



Dictamnus albus

level of expedition activity we've undertaken, with an impressive 17 expeditions conducted since 2015. These expeditions have yielded a wealth of herbarium specimens, documenting the materials we've gathered in the field. The post-expedition process involves a substantial amount of work, including the careful drying and mounting of specimens on archival paper, comprehensive database entry of collection data, labelling of herbarium sheets, and their placement within the University Herbarium stacks for future reference and study. I extend my gratitude to Mar Milan, our dedicated Curation Technician, for spearheading these efforts. Under her leadership, we've not only managed to catch up with a backlog of expeditions dating as far back as the



late 1990s, including a significant Pakistan expedition but also ensured that we are fully up to date on recent expeditions to South Africa and Kyrgyzstan. My appreciation also goes out to our team of eight volunteers, whose contributions have played a vital role in our progress.

Another significant outcome of our collecting efforts is the acquisition of vast quantities of wild-collected seeds, which will serve as the lifeblood of our collections in the years ahead. The effective management of these invaluable seed collections demands a thoughtful reinvestment in our seed banking operations, which is being carried out by Pete Atkinson, Margeaux Apple, and Nadiia Rositska. Their efforts are gradually but steadily revitalising our seed bank operations. In support of this initiative, we are grateful for the generous contribution of an anonymous philanthropist, which enabled us to acquire two large, science-grade refrigerators to enhance the storage conditions for our seed collections. As part of this effort, we have been transferring our seed stocks from domestic fridges to these new, purpose-built spaces. Seed collection management is a precise science, and we are actively gaining expertise in this area, striving to implement gold-standard practices within the context of our Garden. Looking ahead, we anticipate the annual introduction of between 300 to 500 seed lots, a leap that will have knock-on effects, from seed banking to propagation. This marks a significant shift in how we acquire collections, promising a brighter future for our collections and material exchange programmes.



Betonica betoniciflora

Image above: Seed collecting in Kyrgyzstan

Friends

Anna Patterson Lee
Head of Development & Communications

We remain extremely grateful to the Garden's biggest supporters – our fantastic Friends. Their love of the Garden and enthusiasm for our events and news is always both appreciated and inspirational.

8,555 (2,823 single and 2,866 joint) Friends joined/renewed between 1 August 2022 and 31 July 2023. This is 109 less than the previous year and 133 more than the year before, so the Friends membership has decreased in size, which (excepting during the Covid-19 pandemic) has not previously occurred, though does seem to be a sector-wide phenomenon.

In the Friends Office, we have moved to scanning (instead of printing) corporate application forms and as of January 2023, we are now emailing Direct Debit advice notifications, removing the need to print, envelope and post 3,684 letters each year.

This year the Friends visited:

- Kelmarsh Hall Gardens and Coton Manor
- Sussex Prairie Gardens and Sheffield Park and Garden
- Wolfson College Garden
- Evenley Wood Garden and Thenford Gardens and Arboretum
- Mannington Hall and Houghton Hall and Gardens
- St John's College Garden
- Royal Botanic Gardens Kew

In the Garden, there were two (quickly sold-out as usual) wreath-making workshops, a Guide to Birdsong talk, Early Bird Tours, a Behind-the-Scenes Tour and the Friends Evening Highlights tour. This year's Friends Annual Lecture was given by Jonathan Drori and was a fascinating exploration of some of the most interesting, and sometimes bizarre, plants around the world.



Bonython Garden visited during the Friends holiday

The Friends holiday was in June and visited the Great Gardens of Cornwall. The holiday was a busy, but very successful trip – over seven days Friends visited Montacute House and Gardens, Pinetum Park and Pine Lodge Gardens, Tremenheere Sculpture Gardens, Barbara Hepworth Museum and Sculpture Garden, Abbey Gardens, Tregothnan Estate and Tregothnan Tea Plantation, Treliissick, Lamorran House, Bonython, Glendurgan and Stourhead.

Visitors & Events

Nicci Steele-Williams
Head of Visitor Services

It was a real pleasure to move on from Covid-19 restrictions during the reporting period and return to normal operations, with the added benefits of what we had learned about and from our visitors over the pandemic. In the period concerned, we welcomed a record-breaking number of visitors to the Garden – 348,996 – and held all of our usual popular annual events, meaning that more people visited and enjoyed the Garden than ever before.

Apple Day

In October half term 2022, we were thrilled to have our annual Apple Day return after the 2-year hiatus. Despite the very wet hours at the start, it was a super day notwithstanding the rain, and great to see Apple Day back again and enjoyed by all. Numbers were down on previous years, with 2,552 visitors, which was not a surprise given the weather and the gap in holding the event. Apples were tasted, identified, analysed, discussed and generally enthused about all day long. There were tours and pop-up food/drink, drop-in family craft sessions, music on the Main Lawn and good humour all round, with lots of highly appreciative comments by visitors and participants about the event. People departed clutching bags of apples, juice and cider, eating toffee apples and twirling apple/seed bird feeders...

The scale of the event means that all teams of the Garden are involved in preparing and running Apple Day, staff and volunteers alike, so this really was a very welcome return to a Garden collaboration enjoyed by so many visitors.



Apple Day

‘At the start of 2023, our snowdrop trail was enthusiastically received as usual, and brought many to the Garden for frosty walks and fresh air.’

Winter events

In anticipation of holding our first Winter Lights event in 2023, we decided to say farewell to the ‘*Magic and Mayhem*’ displays of the last two years of the pandemic for Christmas 2022, holding instead a Christmas trail for families from mid-November, ‘*Little Robin’s Christmas Trail*’. This was very much enjoyed by adults and children alike.

At the start of 2023, our snowdrop trail was enthusiastically received as usual, and brought many to the Garden for frosty walks and fresh air.

Festival of Plants

At Festival of Plants on Saturday 10 June, we were blessed by wonderful sunny weather. 3,409 visitors enjoyed a fascinating and fun day celebrating the wonder of plants. As with previous years, the Plant Science tent was full of scientists from across the University, guided tours took in the seasonal sights and the Talking Plants tent engaged visitors with some of the latest plant science research. To add to the fun, family activities were very well attended in the Schools Garden and there was music, plus plant and food stalls, on the Main Lawn.

Sounds Green

Our regular summer concert series, Sounds Green, continued many years of musical enjoyment on the Main Lawn for our visitors. On the four Wednesdays of July, 5,414 visitors enjoyed evenings of live open-air music from the Cambridge Summer Music Festival. This season’s performers were returners Prime Bass and Honey & the Bear, plus Arun Ghosh Quintet and Bones Apart. Unfortunately, the weather this year was not generous to this outdoor event, with sporadic wet



Festival of Plants



Sounds Green

conditions throughout the evenings. This certainly did not stop everyone from enjoying themselves! The Main Lawn was as ever full of dancing, chatting and musical enjoyment.

This year’s series was again kindly sponsored by Birkett LLP.

Science on Sundays

Between March and July, once a month, visitors to the Garden could again enjoy Science on Sundays drop in talks. This programme of free, informal, monthly science talks brings the latest discoveries in plant science, as well as research linked to the plant collection at the Garden, to our visitors in a 30-minute nutshell. This year’s programme included a wide range of subjects – from computing how plants evolved their growth over long time scales to how the

electrons generated by photosynthesis can be used to create electricity, and from the fascinating world of freshwater microbes to parental traits in crops.

Exhibitions

We were pleased to welcome the International Garden Photographer of the Year (IGPOTY) exhibition back to the Garden, 15 March – 3 May. As for last year, the exhibition also included winners of the visitor photo competition for images of the Garden itself. Over 300 photographs of the Garden were entered and judged by a small panel comprised of IGPOTY and CUBG staff, including our Director. First place was awarded to Elizabeth Dougherty, for her *Glimpse of Molten Gold* photograph. Second place went to Gillian Plummer for her *A Splash of Colour* and third place to David Wikramaratna for *Morning Magnolia*. The three



‘Over 300 photographs of the Garden were entered and judged by a small panel comprised of International Garden Photographer of the Year and CUBG staff, including our Director. First place was awarded to Elizabeth Dougherty, for her *Glimpse of Molten Gold* photograph.’

‘Our Moonflower, *Strophocactus wittii* (formerly *Selenicereus wittii*), flowered again in March 2023, which again generated a lot of interest. As the flower was quite high up, and the timing couldn’t be predicted, online was the only viable way of seeing, and showing, this now popular spectacle.’

Image above:
International Garden Photographer of the Year Exhibition

winning images featured in the Garden’s exhibition, alongside a selection of highly placed photographs from the competition’s main categories.

Guided Tours and Trails

Our fantastic team of volunteer guides continued their role delivering excellent tours to visitors, both free regular Sunday tours and *ad hoc* charged tours. Including those at events, there were 99 free tours given to 1,159 visitors, and 46 charged tours to 779 visitors.

Adult Trails

We had new adult trails in the reporting period, including both Rhythms in Plants and Amazing People, Enquiring Minds, the latter publicising the work of researchers across the University with related interpretation boards throughout the Garden. These supplemented the range of trails already in place, including Medicines from Plants, DNA in the Garden, Plants and Climate Change, Plant Speciation and Trees of the Botanic Garden.

19,000 of our adult trails were used over the year, up from 16,350 the previous year.

Moonflower

Our Moonflower, *Strophocactus wittii* (formerly *Selenicereus wittii*), flowered again in March 2023, which again generated a lot of interest. As the flower was quite high up, and the timing couldn’t be predicted, online was the only viable way of seeing, and showing, this now popular spectacle. There were 37,000 website views with 32,600 views of the timelapse film on YouTube amounting to 4,500 hours of watch time (that’s 188 days!). With 18 posts across social media and 8 stories on Instagram & Facebook we reached 232,000 people across all the social media posts.

99 Free tours given to visitors

232,000 Moonflower social media interactions



Focus on Collecting Expeditions

Samuel Brockington
Curator

Margeaux Apple
Collections Coordinator

This year marked a significant deepening of our ties with Kyrgyzstan. We successfully conducted two joint expeditions in collaboration with our team, the National Academy of Science of the Kyrgyz Republic (NASKR), and the Kyrgyz branch of Flora and Fauna International (FFI).

Kyrgyzstan, nestled in Central Asia, is bordered by Kazakhstan to the north, China to the east, and Tajikistan and Uzbekistan to the south and west. Its striking mountainous terrain, covering over 90% of its expanse, ranks it as the world's third most mountainous country, trailing only Bhutan and Tajikistan. This diverse topography translates into a rich ecological tapestry. Throughout our expeditions, our teams navigated a spectrum of ecosystems: from mountain steppes and forested valleys to alpine meadows and semi-desert regions. The flora we researched and gathered showcases the captivating biodiversity and broader ecosystems of Kyrgyzstan. Our journeys spanned two extensive loops, each passing through areas renowned for their unique biodiversity. We spearheaded two main expeditions. The spring expedition was aimed at conducting comprehensive botanical surveys to identify plants of interest. In contrast, the late summer venture focused on seed collection to enrich the living collections in Cambridge and Bishkek. Our immediate plan is to use these seeds to enhance our current collections, with visions of rejuvenating the Asia bed in the Rock Garden and potentially crafting a Central Asia section within the broader landscape. Surplus seeds will either find a place in our seed bank or be extended to other botanical gardens.

In our initial expedition loop, we embarked from Bishkek, the capital, charting a course through the



Crataegus remotilobata



Rosa beggeriana

‘We made stops at 33 distinct sites, amassing several hundred herbarium entries and approximately 215 seed lots.’

central and western territories of Kyrgyzstan. Our journey extended southward to Arslanbob and ventured west to the Besh-Aral State Reserve. This expansive route showcased remarkable altitudinal variations, ranging from 662 meters to a staggering 3,155 meters above sea level. We made stops at 33 distinct sites, amassing several hundred herbarium entries and approximately 215 seed lots, which encompassed trees, shrubs, bulbs, and succulents.

One of our notable stops was Arslanbob, located in the Jalal-Abad Region. This town is nestled amidst a vast walnut and fruit forest, veiling the adjacent valleys. Our team was fortunate to collaborate with Bolot Tagaev, a local conservationist and a dedicated member of the FFI staff. Bolot, with his deep-rooted commitment to plant conservation in the region, introduced us to his conservation efforts for the endangered Niedzwetzky's apple (*Malus niedwetzkyana*) and showcased a safeguarded Bukharan pear (*Pyrus korshinskyi*) population. These species bridge the gap between familiar cultivated plants and their wild counterparts. The valleys predominantly featured cultivated walnut trees (*Juglans regia*) interspersed with intriguing tree species, including diverse hawthorns (*Crataegus pontica*, *C. songarica*, *C. turkestanica*).

Venturing west from Arslanbob led us to a contrasting, arid landscape, a departure from the verdant broad-leaved forests. This terrain was adorned with potential drought-resistant trees and shrubs, complemented by a myriad of herbaceous flora. Field days typically culminated with our team collecting samples until dusk. Evenings were devoted to species identification, using guidebooks under torchlight, and carefully placing specimens between newspaper

sheets for drying. On nights dedicated to seed collection, tasks often extended to the wee hours, with a record time of 2 am, only to resume collecting at first light. Though fieldwork invigorates our staff, it's a testament to their dedication and passion, far from a leisurely excursion!

One of the standout moments from this first loop was our expedition to the Sary-Chelek Biosphere Reserve. The day was marked by varied weather—rain, hail, and eventually sunshine—yet through it all, the challenge of traversing the persistent mud remained. Our trail led us along the southern rim of Lake Sary-Chelek, situated at an impressive altitude of 1,900m. This picturesque path was framed against the backdrop of seemingly infinite mountains. Descending towards the lake, the hillsides were sporadically covered with towering trees like Schrenk's spruce (*Picea schrenkiana*), Semenov's fir (*Abies sibirica* subsp. *semenovii*), and birch (*Betula* sp.). The understory was just as captivating. The pearlbrush (*Exochorda racemosa* subsp. *racemosa*) stood out with its radiant white blossoms, while the smaller maple (*Acer platanoides* subsp. *turkestanicum*) and the flowering currant (*Ribes meyeri*) added to the rich tapestry of the region. The pinnacle of our hike was reaching the crest of the steepest slope, revealing an awe-inspiring alpine meadow below. This herbaceous spread showcased a plethora of familiar plants. Among them were the ornamental onion (*Allium aflatunense*), the herbaceous peony (*Paeonia intermedia*), and the eye-catching *Iris alberti*.

During the second loop of our expedition, our focus shifted to the northeast region surrounding Lake Issyk-Kul. This area, notably more mountainous, provided diverse altitudes for exploration, ranging from 1,255 to

‘To our elation, later that day, nature granted us a serendipitous moment. The *Trollius lilacinus* unveiled itself, its dainty flower peeking through the snow.’

3,434 meters above sea level. Beyond its distinct flora, this leg of our journey starkly highlighted the undeniable impact of climate change on such pristine environments. It underscored the urgency and significance of collaborative conservation efforts. On the fourth day, our team ventured to within a mere 100km of the Chinese border, with the specific intent of locating the elusive *Trollius lilacinus*. Despite facing unforeseen blizzards en route, culminating in a flat tyre, our initial search yielded no trace of this rare species. These real-life challenges are a testament to the unpredictability and intricacy of plant collection missions in the wild. A single night of snowfall can pose severe threats to our drivers and simultaneously obscure the presence of specific plant communities. The petite, blue-hued *Trollius lilacinus* is emblematic of the myriad plants threatened by escalating global temperatures. Given the vast altitude differential of nearly 3,500m between its natural habitat and Cambridge, the prospects of cultivating it ex-situ (outside its native setting) for conservation are slim. Consequently, in-situ (within the country) conservation strategies are under active consideration. In this endeavour, collaboration with conservation entities like Flora and Fauna International becomes pivotal. Similarly, institutions such as Gareev Botanic Garden and the National Academy of Sciences of the Kyrgyz Republic play an instrumental role in steering these conservation decisions.

To our elation, later that day, nature granted us a serendipitous moment. The *Trollius lilacinus* unveiled itself, its dainty flower peeking through the snow. Accompanying it were the *Callianthemum alatavicum* and the small shrubby honeysuckle (*Lonicera semenovii*)—species perfectly adapted to the exposed scree terrain. Elated with this discovery, we

eagerly gathered our samples and retraced our steps, anticipating the warmth awaiting us in our vehicle.

One of our considerations in these expeditions is the continued collaboration with our Kyrgyz partners and how can we move forward with collaboration while continuing to develop our own collection in accordance with the Living Collections Strategy. A second consideration is the impact that heightened levels of expeditionary work have on other collections within CUBG, namely the herbarium and our seed bank. With respect to the herbarium, we are increasingly collaborating with the University Herbarium, to help process, mount and store the specimen sheets that are amassing through our collecting expeditions. The work of Mar Milan has been crucial here, leading on a whole new area of work, and managing substantial and valued teams of volunteers to help us process and stay on top of collected material. With respect to the seed bank, as we bring in ever more valuable wild collected seed, it is evident that our current facilities and processes need an overhaul. We are grateful to the donation that has allowed us to purchase two new high-capacity scientific fridges that will allow us to accommodate and better store our existing and incoming material. This is an essential first step, in what we hope will be better resourced commitment to our seed collections, which now lie at the heart of our Living Collections Strategy.

Finally, we are deeply grateful to our Kyrgyz partners at NASKR and the FFI, for organising a fantastic route, sharing so much of their knowledge and culture and hosting us so well. This trip would also not have been possible without the fantastic efforts of many staff at CUBG, in particular the horticulture and curation teams.



Images left to right from top left: *Ephedra intermedia*; *Acantholimon alberti*; *Achillea filipendulina*; *Pyrus regellii*; *Allium carolinianum*; *Betula tianschanica*

Development & Communications

Anna Patterson Lee
Head of Development & Communications

It has been another busy and varied year for the Development and Communications office. From facilitating a live broadcast to over 12 million people during the King's Coronation Concert to talking about a new tulip species, launching the campaign for the new Cambridge Botanic Lights winter trail, managing the huge interest around another Moonflower flowering and publicising a full year of Garden events, there has been a broad range of interesting Garden projects to tell the world about.

A varied programme of social media posts and stories, combined with both proactive and responsive media and press projects, has kept our audience growing and informed about the many different areas of Garden activity and expertise.

We were delighted to receive a fantastic grant from The Gatsby Foundation to support the Schools Bursary Scheme, a new sponsorship from Mills & Reeve for the Easter Trail and a welcome repeat sponsorship from Birketts for Sounds Green. A new but long-planned activity has been the launch of pop up Friends recruitment stall in the Garden on event days, and we have continued to run a regular programme of Henslow Circle events.

We would like to thank all of our Henslow Circle patrons for their continued support of the Garden, and also to thank our generous individual donors and everyone who sponsors a tree or bench in the Garden.

This year the team has grown with the addition of a full time Communications Assistant, which has grown our horizons and capacity, and we are also ably supported by some wonderful volunteers, to whom we are extremely grateful.



Filming the rehearsal for Lighting up the Nation

198% Facebook Profile visits up

1,205,383 CUBG website views

Communications Numbers

CUBG website:

- 1,205,383 page views from 213 countries
- Most visits to the website on any given day was Wednesday 15 March with 18,990 users – when the Moonflower opening was streamed on our website

Instagram

- 18,244 total followers
- 16,793 profile visits (10.5% increase)

Facebook

- 20,353 total followers
- 30,107 profile visits (198.8% increase)
- Reach: 601,329 (64.2% increase)

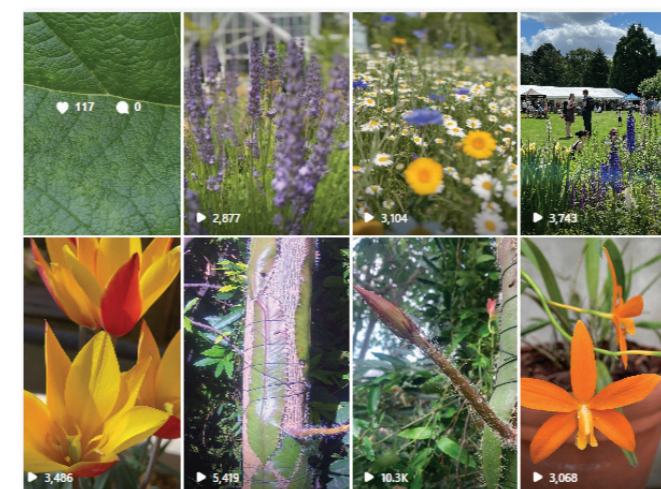
Twitter

- 16.9k followers
- 715.8k total impressions
- The top tweet was about the Moonflower, with 23,056 impressions and 1,782 engagements (second place was Coronation Concert with 17,864 impressions and 547 engagements)

YouTube

- 62,252 views
- 2,598 subscribers (up 246 from last year)

TV: 4 appearances – 2 national, 2 local
Radio: 20 appearances – 19 local, 1 national
Newspaper: 8 appearances – 5 local, 3 national
Magazines: 5 appearances – 2 local, 3 national
Online: 39 appearances – 17 local, 20 national, 2 regional



Research Facilitated

Curation Team

Research supported and facilitated

In the past year we have supported research by providing researchers with material of 172 accessions.

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, funded by the BBSRC, NERC, HFSP, EU Marie Curie Actions, Leverhulme Trust, Isaac Newton Trust, and the Cambridge University Botanic Garden Research Fund. Material maintained at CUBG, analysed in the experimental plots, or accessed from living collections, for projects including:

- The relationship of floral morphology to pollination success in *Vicia faba*, with Dr Jane Thomas (National Institute of Agricultural Botany), Roger Vickers (PGRO) and Jake Moscrop (PhD student).
- Molecular evolution of key developmental pathways in plants, with Dr Samuel Brockington (Curator, CUBG), Thea Kongsted (PhD student) and Dr Eva Herrero (post-doc).
- Development and evolution of insect-mimicking petal spots in *Gorteria diffusa*, with Dr Paula Rudall (RBG Kew), Dr Allan Ellis (Stellenbosch University), Dr Udhaya Ponraj and Dr Roman Kellenberger (postdocs), and Farahnoz Kohjayori (PhD student).
- Development, function and evolution of iridescence in plants, with Dr Paula Rudall (RBG Kew), Professor

Richard Bateman (RBG Kew), Professor Ulli Steiner (Adolphe Merkle Institute, Switzerland), Professor Jeremy Baumberg (Department of Physics, University of Cambridge), Professor Silvia Vignolini (Department of Chemistry, University of Cambridge), Dr Edwige Moyroud (Sainsbury Laboratory Cambridge University), and Dr Chiara Airoidi and Dr Humberto Herrera-Ubaldo (postdocs).

- Evolution and development of nectar spurs in *Linaria*, with Ben Fisk (PhD student).
- The relationship of floral morphology to pollination success in strawberry, with Hamish Symington (PhD student).
- Development and evolution of prism cells in the epidermis of California poppy petals (with Kristina Buch, PhD student).

Dr Samuel Brockington, Curator:

Research programme funded by NERC, the NSF and DEFRA, using material grown in the experimental glasshouses and across the living collections, primarily focussed on three main areas: Caryophyllales and betalain synthesis, the genus *Tulipa* and the genus *Eriospermum*.

- Sequencing transcriptomes in Caryophyllales in collaboration with Stephen Smith (University of Michigan) and Ya Yang (University of Minnesota).
- Metabolomic survey of Caryophyllales, focussing on tyrosine derived metabolites (with Hiroshi Maeda, University of Wisconsin)

‘In the past year we have supported research by providing researchers with material of 172 accessions.’

- Studying the phylogeny, evolution and diversity of tulip species with Brett Wilson (PhD student) and Flora and Fauna International (FFI).
- Sampling material for genomic sequencing projects in Caryophyllales e.g. to generate highly contiguous assemblies for *Macarthuria*, *Stegnosperma*, and *Achatocarpus*, with Nathanael Walker-Hale (PhD student).
- Studying the evolution of transcriptional regulation in betalain pigmentation with Jasmina Dzurlic (PhD student).
- Studying morphological patterns in betalain pigment distribution across separate origins of Caryophyllales, with George Garnett (PhD student).
- Studying the evolution and function of catecholamines – animal-type neurotransmitters in plants, with Saswata Dey (PhD student).

University of Cambridge

Department of Plant Sciences

Professor Sir David Baulcombe, FRS (RNA Silencing and Disease Resistance Group)

Use of the Experimental Glasshouses to propagate the progeny of *Solanum lycopersicum* x *S. pennellii* hybrids through to the F4 generation, to investigate 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.

Professor John Carr (Plant Virology Group)

Certain dicistroviruses reside in plants without causing disease but will infect and kill insects, such as aphids, a major crop pest, when they feed. It has been hypothesised that plant-resident discistroviruses have a mutualistic relationship with plants by providing protection against aphids. Thus, it is conceivable that in addition to providing pollination services, bees might render plants an additional benefit by spreading aphid-pathogenic viruses. This idea will be investigated by sampling bees, aphids and plants under field conditions and by using deep sequencing to compare.

Professor Julian Hibberd (Molecular Physiology Group)

Rice, millet and wheat are grown for anatomical analysis, RNA isolation and deep sequencing as part of a project to understand the genetic differences between the more common C3 photosynthesis and the more efficient C4 photosynthesis. We are also developing transformation protocols for hornworts, using plants from the Garden’s living collection.

Dr Johannes Kromdijk (Environmental Plant Physiology Group)

Growing plants in the research glasshouses to study the regulation of stomatal opening during C4 photosynthesis. Also growing maize for profiling mesophyll and bundle sheath cell-specific transcriptomes in response to photoinhibitory conditions.

Dr Adam Pellegrini (Disturbance Ecology and Ecosystem Function Group)

Prairies and grasslands cover an expansive portion of the world's surface and can contribute significantly to the Earth's carbon cycle. The largest driver of carbon dynamics in these ecosystems is fire. As the climate changes, the majority of grass-dominated ecosystems will experience increased fire frequency and intensity, leading to carbon flux into the atmosphere and soil nutrient depletion. The resulting communities that sprout after a fire are important for re-assimilation of carbon and soil recovery; however, little is known about the physiology of these communities. Below ground traits are especially poorly explored and important drivers of ecosystem function. This project uses the rich diversity of grasses found in Cambridge University Botanic Garden to examine the belowground physiological traits of "fire-philic" and "fire-phobic" grass species to inform 1) the evolution of root traits in the Poales and 2) the effect of fire on root functional traits – which in turn affect carbon and nutrient cycling. To complete this project, we will need to take root cores to access fine root tissue of a number of the grass species grown outside in the common garden area. Additionally, we would like to calculate above ground to below ground biomass ratios by collecting entire plants where possible.

Professor Alison Smith (Plant Metabolism Group)

The Botanic Garden has provided space for the Algal Innovation Centre glasshouse facility, to allow different algal species to be grown to establish what role algae can play in the development of a low carbon economy.

Barbara Neto-Bradley (Forest Ecology and Conservation)

The goal of sampling the collections is to test chlorophyll fluorescence imaging equipment for measuring damage to evergreen oak leaves (*Quercus phillyreoides*, *Quercus myrsinifolia* and *Quercus glauca*) following exposure to freezing temperatures.

Dr John Ferguson (Environmental Plant Physiology)

The goal of sampling the collections is to develop a protocol for testing the heat/cold tolerance of leaf tissue using chlorophyll fluorescence. The goal of this project is to then apply this method to a wide range of taxa that spans vast geographic climes. With

geographic coordinate information it would then be possible to test for associations between thermal limits and climate.

Benjamin Fisk (Evolution and Development)

The goal of sampling the flowers of *Angraecum sesquipedale* to support research into nectar spur development. Spur development in this species is famous, but nobody has looked at what the cells are doing in the developing spur. The plan is to image the mature spur (and an immature one if possible) and count the number of cells in a single file from the base to the tip of the spur. We would then randomly select ~100 cells from different regions of the spur (base, mid, tip), trace these cells and extract shape parameters from each cell. By looking at metrics like cells/mm and cell aspect ratio in the mature flower or across two time points, we should get an indication of which mechanism is at play.

Jeremy Fonvielle (Ecosystems and Global Change)

The goal of this research is to characterise the cell wall structure of sedges (*Carex acutiformis*, *C. appropinquata*, *Eleocharis palustris*) and understand peat formation/degradation in the Fens. See website for further information on the Centre for landscape regeneration (<https://www.clr.conservation.cam.ac.uk/>).

Dr Hamish Symington (Evolution and Development)

The goal of this research is to investigate the timing and pollinator relevance of the colour change of *Catalpa* flowers. This will be achieved by emasculating various *Catalpa* flowers and leaving others open to pollination and watching the timing of their colour change. Additionally, some flowers (ca. <50) will be harvested for stigma receptivity tests in the lab.

Other Departments, University of Cambridge

Matt Wilkinson

Department of Zoology

In this research project, three moth light traps will be set up in the Botanic Garden the evening before the collection visits, and the lights left on overnight. Moths will be identified, collected, and later placed in a – 25 degree C freezer in the Dept of Zoology. The moth specimens will form the basis of a practical

Claire Wallace

Department of Zoology

The goal of this project will be to capture wild *Bombus terrestris* queens and rear colonies in the CT rooms at Zoology. The aim is to capture approximately 70-80 bees on site over a period of 10 weeks. Removing queens in these numbers from the landscape will have no negative consequences on local bee populations, particularly as *B. terrestris* is the most common and resilient species in the UK.

Eva Hellman

Sainsbury Laboratory/Department of Geography

The goal of our research is to integrate tree growth into climate models. It has been shown that photosynthesis does not fully describe the effects of trees on climate, but growth is a better approximation. We look at tree growth in different conditions to make climate predictions more accurate. For this we would need a few micro-cores (2cmx3mm) to test a microscopy protocol.

Li Yu

Department of Biochemistry

This research is motivated by the discovery that one Xylo-transferase for xyloglucan was shown highly expressed in *Coffea* roots by qRT-PCR. Now we want to use *Coffea* roots to check the presence of the xylose side chain in xyloglucan.

Emma Jenkin

Sainsbury Laboratory/Department of Geography

In this research we will measure and collect samples in the Botanic Garden to compare C3 and C4 plant photosynthesis and integrate results in a model. The measurements in the Botanic Garden involve measuring gas exchange with the Targas-1, measuring leaf area and plant height, and chlorophyll content with a SPADS meter. The samples collected will be processed at SLCU for chlorophyll content and sugar content.

External Researchers – UK

Dr Julia Mackenzie

Anglia Ruskin University

The goal of this research is to conduct behavioural experiments in the Garden on colour ringed birds over a few months. It will contribute to a multi-lab

collaborative research project (<https://themanypbirds.com/projects/study-1-neophobia-in-birds>) and will involve putting up some feeders/recording behavioural responses with a video camera.

Samuel Furse

Royal Botanic Garden, Kew

The hypothesis of this project is that lipid metabolism evolved in early angiosperms in a way that was later able to support animal pollinators nutritionally. We are collecting gymnosperms and angiosperms from as wide a breadth of taxa as possible and include the oldest living species we can (e.g. Araucariaceae and Ginkgoaceae). To test this hypothesis, we are looking to compare the lipid composition of gymnosperms and angiosperms (leaves and seeds), male and female plants, and leaves and pollen. As the lipids present in plants can be ascribed entirely to endogenous biosynthesis, these comparisons will indicate how lipid metabolism differs by species/ taxa, sex and tissue. This will therefore show which lipids the systems produce. If the lipid metabolism in angiosperms has evolved in a way that would later support animal pollinators, evidence of a reduction in biosynthesis of some lipids and/or an increase/ emergence of others (either throughout the plant or in pollen) would be expected.

Dhanya Radhakrishnan

Imperial College London, Department of Bioengineering

Plants possess remarkable regeneration potential. However, there exists a gradient in the regenerative potential even across the same plant family. Using Brassicaceae as the pilot clade, we will take comparative approaches to identify key evolutionary targets in the molecular network regulating plant innate regeneration. We will first create a map of diversification in regenerative competence within the focus clade, Brassicaceae, identifying the species that are least to most regenerative. The differential degree of natural regenerative competence will be correlated to the differences in molecular network architecture, using comparative transcriptomics. These candidate molecular targets of regeneration will be validated by rationally designed and constructed molecular network engineering employing synthetic biology technology. The plants engineered with elevated regenerative competence will be assessed for developmental abnormality and altered fitness level,

in order to probe the evolutionary consequence of excess regenerative competence.

Pablo Gomez

Royal Botanic Garden, Kew

The goal of this research project is to understand the nature of *Quercus coccifera* and *Q. ithaburensis* in living collections.

Rosie Kressman

Bangor University

The goal of this research is to update the original Species Action Plan for *Cotoneaster cambricus* for conservation purposes.

A-level Students

Wallington County Grammar School

My team and I, who are A-Level students at Wallington County Grammar School, are participating in Cambridge's Davidson Inventors Challenge which involves solving the UN's Sustainable Development Goals. Our project requires a sample of duckweed, more specifically: *Wolffia microscopica*, *Wolffia arrhiza*, *Wolffia globosa* or *Wolffia hyalina*. The goal of this project is to address growing food security concerns caused by climate change and an ever-growing population by attempting to create a food bar from duckweed that is not only highly nutritious but also has a lengthy shelf-life.

Miranda Hobson

Royal Botanic Garden, Edinburgh

Online survey 'Epiphytic Lichens in Botanic Gardens'. By tracking species diversity in botanic gardens, opportunities for management and conservation of these important organisms will be strengthened across the UK and Ireland communities. This will raise the profile of lichens in botanic garden tree and shrub collections and identify locations of valuable living genetic resources to further their conservation and research.

Martha Craven

Oxford Archaeology East

I am a trainee archaeobotanist at Oxford Archaeology East and as part of my traineeship I am trying to build my reference collection of native and archaeophyte cereals, "weeds" and other plant remains. I hope to collect seeds and some seed

cases throughout the period of May to October; dependent on the time at which the various plants set seed. Studying archaeobotanical assemblages forms such a fundamental part of understanding the past; especially in relation to such things as diet, trade, economy, ritual, textiles and climatic conditions. A modern reference collection is of vital importance to the examination of this material. Plant remains can be severely distorted due to the processes of waterlogging, dessication, mineralisation, carbonisation and taphonomy and so it is of great importance to compare it to modern specimens.

Shruti Kotain

Anglia Ruskin University

I am an international student from India, studying Masters in Animal Behavior: Application in Conservation at Anglia Ruskin University. My dissertation project is on 'Understanding the Flight Initiation Distance of European Robins. The project will help us to understand how the escape behaviour of European Robins (*Erithacus rubecula*) with respect to Flight Initiation Distance is affected by perceived approaching threats involving different human stimuli. According to the hypothesis, it is expected that FID increases with the level of eye contact of approaching humans (direct or indirect), for example, the chances of FID in birds are higher when approached with direct eye contact than indirect. Also my second hypothesis is that FID varies in when humans approach with different colour of clothing. For example, it is expected that FID would increase when the colour of the clothes are dark because birds are threatened by dark colour thinking it is a predator. So this experiment will help us understand whether or not colour affects the behaviour of birds with respect to FID.

Nicole Zhou

University College London, Institute of Archaeology

This project is a dissertation project of an MSc Conservation of Archaeology and Museums at the University College London. It aims to identify the consolidation materials applied on ancient Egyptian basketry objects of these collections during early interventions, analyse effects of it on basketry material and object preservation, and further discuss the approaches to minimise undesirable effects by conducting remedial treatment. An accelerated

ageing experiment is designed as part of the research, using reed materials similar to those used in ancient Egyptian basketry, such as *Arundo donax* and *Phragmites australis*.

Alex Pryor

University of Exeter

We are interested in sampling *Pinus cembra* (leaves, bark, wood), that we could incorporate into a reference collection. Specifically, we are building a reference database of phytoliths from different plant tissues from a range of species, to try and identify some phytoliths we have found at an ice age archaeological site located in eastern Europe (created by ice age hunters around 25,000 years ago). Our goal is to identify which plant parts and, if possible, which plant species were being brought to the site.

Scott Galloway

Royal Botanic Garden, Edinburgh

I have agreed with RBGE to carry out a 4 year growing trial of my research collection of *Bergenia* (circa 130 accessions) as part of my PhD. In doing so, I will be able to observe their growth, response to changing climatic conditions, voucher specimen each plant for the herbarium and take leaf material for molecular research (plastid and nuclear data investigations of species and hybrids). All of this will build upon the genetic work I have completed so far-producing the first comprehensive phylogeny of the genus – help to verify the validity of Peter Yeo's morphological work at CUBG in the 1960s/70s and support a future up-to-date revision and monograph of the genus. I have been awarded funding from the Hardy Plant Society to collect *Bergenia* I don't have in the collection but that have some horticultural or historical significance – such as Yeo's Cambridge hybrids bred during the 1960s and the early Victorian hybrids from Thomas Smith of Newry, Ireland. CUBG hold many of these plants and I would like to visit to photograph the plants in situ in the Garden, take cuttings of the plants to grow as part of the trial at RBGE and voucher specimen these once they have rooted and established in Edinburgh.

Jerry Bowdrey

Colchester and Ipswich Museums

This request is motivated by our writing a guide to British and Irish Cynipid galls. To examine the utilisation of non-native species of *Quercus* by native

Cynipid gall wasps. This will enable a full list of possible hosts to be included in the guide. The study will involve examination of host plant organs (mainly leaves, buds, twigs and flowers) for the presence of Cynipid galls and digital photography of any found.

Sara De Lucena Rigat

Year 12 International Baccalaureate Biology HL student

I am a year 12 International Baccalaureate Biology HL student in the process of planning and conducting an experiment for my Internal Assessment. In this I investigate the effects of five different types of plant management on species richness, calculated using Simpson's Diversity Index. I am going to conduct this experiment using a quadrat and a plant-species-identifier (App) and have selected another four locations where the plant management approaches are: cow grazing, footpaths, no treatment, and lawn mowing.

Richard Sewell

National Bat Monitoring Programme

The National Bat Monitoring Programme is an annual survey of bat populations in the UK. Permission is requested to conduct monitoring at CUBG on two separate visits in July.

Jonathan Shanklin

Cambridge Natural History Society

Leading a "fungal foray" at CUBG to identify and record fungal diversity.

Olivia Grace Murell

Manchester Metropolitan University

In partnership with the Chester Zoo and the IUCN's Carnivorous Plant Specialist Group, we are working to determine the status of *Nepenthes* in ex situ collections worldwide. Our overall research goal is to assess the genetic diversity of *Nepenthes* collections ex-situ compared to the genetic diversity that remains in wild populations.

Richard Dolby

Battlefields Trust

This research is being carried out on behalf of the Battlefields Trust into the location of the Battle of Assandun in 1016AD located somewhere in Essex. The site is said to be close to a hill covered in ash trees. Ash grows well in most soils whether slightly acidic or alkaline, but I am interested in what would favour

the growth of ash at the expense of say, oak, birch and other broad leaved trees.

Garden Moth Scheme

National moth monitoring scheme

Every Friday morning, since March 2018, a small group of volunteers have been in the Garden at the crack of dawn, checking a light trap, situated near the Glasshouse Range, for moths caught overnight. The moths caught in the trap are identified, recorded and then released. The moth trapping in the Garden forms part of a national moth monitoring scheme called the Garden Moth Scheme and is one of three moth trapping locations in Cambridge. The list of moths recorded in the Garden is added to a number of local and national databases. These databases can then be used by research scientists to understand changes in moth populations over time, impacts of climate change and to make assessments about ecosystem health.

External Researchers – International

Summer Blanco

University of Georgia, Plant Biology Department, United States

This research is focussed on working on a large-scale phylogenomics project of the genus *Geranium* (for which we aim to reconstruct species relationships across the entire genus using many nuclear genes). Our goal is to include samples for all species of *Geranium* in our analyses, if possible. The resulting phylogeny will serve many purposes and will provide a robust framework for other studies in this system. Specifically, my dissertation focuses on the evolution of anther colour in *Geranium*.

Celine Vanhee

Sciensano, Belgium

Development and validation of a qPCR and ddPCR methodology to screen for the presence of *Nicotiana* sp. in claimed "tobacco-free" products available on the Belgian market.

Gabi Harris

Pennsylvania State University, Department of Geosciences, United States

Taxonomic study of conifer foliage macrofossils from earliest Oligocene Argentina, coinciding with the

first Antarctic glaciation, provides the opportunity to assess the effects of tectonic isolation and entrance into the icehouse world on the emergence of endemic lineages in Patagonia. Cupressaceous conifer foliage shares features with the extant monotypic genus *Austrocedrus* (Cupressaceae), a conifer that today is endemic in the southern Andes. We are studying potential South American fossils of *Austrocedrus*, bridging the biogeographic link since the genus is otherwise only known from two Oligocene Tasmanian fossils.

Andrea Appleton

Harvard University, Department of Organismic & Evolutionary Biology, United States

The genetic program underlying floral organ identity is largely conserved, but some flowers have evolved novelty in which organs are modified into new structures to yield more than four organ types. One such novel structure is the staminode, which is a stamen that has evolutionarily become sterile. Staminodes are present in many lineages, are important for species classification in many clades, and have evolved an array of forms in response to selection for alternative functions. Staminode morphology and pollination biology have been well-characterised, but little is known about the genetic underpinnings of these structures, despite their potential in illuminating how morphological novelty and diversity evolve. Staminodes in Loasaceae are particularly striking in their sheer amount of morphological and functional variation. Even the same flower can host multiple types of staminodes, such as those of subfamily Loasoideae, which contain staminodial nectar scales and filamentous staminodes in addition to fertile stamens, totalling to six unique organ types in one flower. I propose to determine the cellular and genetic foundations of staminodes in Loasaceae using a combination of genetic and cell biology techniques.

Anne Rodier

Vegepolys Innovation, France

This R&D project is aimed at identifying a plant sample by barcoding (*Amorphophallus konjac* vs *A. muelleri*) using molecular tools.

Nicole Giraud

DNA Gensec, France

We would like to check the genetic references of *Amorphophallus kojac* and *A. muelleri* available on the Genbank.

Tracy Cook

Huntsville Botanical Garden, Plant Conservation & Curation, United States

HBG would like to know how many *Cotinus obovatus* are in your collection and what percent is wild-collected with provenance info vs. cultivated stock. This is to inform an ex-situ collection project.

Darach Lupton

National Botanic Gardens Dublin, Ireland

Many years ago, Prof. David Webb, former Chair of Botany at Trinity College Dublin amassed a substantial collection of European Saxifrages. My understanding is that plants/seeds were shared between Trinity Collection Dublin and Cambridge BG. I am keen to explore the possibility of re-starting his collection and am curious to understand the status of those plants at CUBG.

Mansa Srivastav

Yale University, Department of Ecology & Evolutionary Biology, United States

The project is looking at the global phylogeny and biogeography of *Lonicera* using RADSeq technique. We aim to build a nuclear tree of the lineage sampling ~110 species out of a total 140 species reported. The resulting tree will be used to infer the biogeography of *Lonicera*, answering where and when the lineage originated and when and through which routes it came to occupy its current pan Northern Hemisphere distribution. The tree will also be used to understand the genetic drivers of whole organ fusion in *Lonicera*.

Oleg Alexandrov

All-Russia Research Institute of Agricultural Biotechnology, Russia

5S rDNA is organized as a cluster of tandemly repeated monomers that consist of the conservative 120 bp coding part and non-transcribed spacers (NTSs) with different lengths and sequences among different species. The polymorphism in the 5S rDNA NTSs of closely related species is interesting for phylogenetic and evolutionary investigations, as

well as for the development of molecular markers. In this study, the 5S rDNA NTSs will be amplified with universal 5S1/5S2 primers in some species of the Ruscaceae family. The PCR products will be sequenced and analysed. This study may be another step in the investigation of the molecular evolution of Ruscus plants and may be useful for the development of species-specific DNA markers in this family

Kashish Kamra

Gachon University, Department of Life Sciences, South Korea

Iridaceae consists of approximately 2,200 species of monocotyledonous herbs in 66 genera. The goal of this study is to (1) develop a molecular phylogeny of Iridaceae, with particular focus on within genus sampling; (2) compare molecular tree results with morphology data; (3) confirm accurate position of the Iridaceae with other families using genomic data.

Gary Krupnick

Smithsonian's National Museum of Natural History, United States

In this research project we are conducting an ex situ conservation study of *Heliconia* in order to maximise protection of the most threatened species.

Michael Burkart

Botanischer Garten der Universität Potsdam, Germany
I am interested in information on size & age of *Ceiba pentandra* in your collection, which form it is (spiny forest form, spineless savannah form, spineless African cultivated form, spineless SE Asian cultivated form, others), and whether the fruits are dehiscent or not.

Benjamin Adroit

Swedish Museum of Natural History, Sweden

This research is about understanding *Parrotia* species in cultivation worldwide. My research aims to gain a comprehensive understanding of *Parrotia* species and their ecological niche.

Emily Bruns

BGCI US, United States

Botanic Gardens Conservation International U.S., in partnership with the San Diego Botanic Garden and United States Botanic Garden, is conducting a botanic garden collections survey of *Vitis* and *Muscadinia* (grape) taxa (including hybrids) native to North

America. Results from this survey will inform gap analysis and conservation actions for this priority crop wild relative group.

Aleksandra Liszka

Jagiellonian University, Department of Plant Biotechnology, Poland

The goal of this project is to sample tree branches. Analysis of primary cell wall diversity in trees to elucidate mechanisms used by pathogens to infect them.

Andreja Urbanek Krajnc

University of Maribor, Department of Agriculture and Life Sciences, Slovenia

Faculty of Agriculture and Life Sciences University of Maribor is involved in mulberry research within the ARACNE (“Advocating the Role of silk Art and Cultural heritage at National and European scale”) project partnership coordinated by Dr. Silvia Cappellozza, CREA Padua, Italy. One of the project objectives is to study the genetic relationship of the mulberry in order to trace its ancient path from Asia to Western Europe. In particular, we want to record the most important mulberry species, in particular *M. alba* and *M. nigra*.

Kate Dudgeon

University of Barcelona, Institute of Environmental Science and Technology, Spain

I am a post doctoral researcher on the ERC-funded project, DEMODRIVERS, led by Dr Umberto Lombardo, based at the Institute of Environmental Science and Technology at the Autonomous University of Barcelona (ICTA-UAB). The research project I am working on aims to identify when the first settlers to the Llanos de Moxos region in SW Amazonia, Boliva, started using/domesticating specific plants and also to reconstruct changes in plant-use and land-use cover. We are identifying which plants were present throughout the Holocene by analysing phytoliths, microscopic plant silica bodies which can provide an indicator of the types of vegetation, in some cases specific taxa and identify cultivars. As part of the project, we are building a new phytolith reference collection of plants found in the Llanos de Moxos region today and in the past, based on previous studies.

Seanna Walsh

National Tropical Botanical Garden, United States

In partnership with the Chicago Botanic Garden, we are working to determine the status of *Hibiscus clayi* in ex situ collections worldwide. One of our research goals is to assess the genetic diversity of collections ex situ compared to the genetic diversity that remains in wild populations, create pedigrees, and use that data to inform which additional founders need to be brought into collections to support reintroduction efforts over the long-term.

Plant material supplied to other gardens

CUBG supplied 43 accessions of 46 taxa to 14 other gardens:

Affiliation	Contact's Country
Università di Pisa	Italy
University of Cambridge	UK
Krohn Conservatory	United States
National Trust for Scotland	UK
Magic of Life Butterfly House	UK
RHS Garden Wisley	UK
Chatsworth House Trust	UK
National Botanic Garden of Wales	UK
Eden Project	UK
Royal Zoological and Botanical Gardens Rotterdam	Netherlands
National Botanic Garden of Wales	UK
Chodas Botanic Garden	UK
The Living Rainforest	UK
Ness Botanic Gardens	UK

Plant material accessioned

During the period 1 October 2022 to 30 September 2023, the Garden received 711 plant accessions. These represented 648 taxa of which 136 were cultivars. 346 of these taxa were of wild origin, 50 of indirect wild origin and 307 of Garden origin. Of these 118 are recorded as being endangered.

The Garden supplied 10 lots of seed via index seminum which included 30 taxa sent to 7 countries.

Publications

E Bailes, J Moscrop, S Mitchell, M Dorling, T Wood, J Thomas, B Glover 2023 Bumblebee responses to variation in pollinator-attracting traits of *Vicia faba* flowers. *Ecology and Evolution*, 13,e10617.

J Patrick, H Symington, W Federle, B Glover 2023 Bumblebees negotiate a trade-off between nectar quality and floral biomechanics. *iScience* 26 (11).

TE Kongsted, BJ Glover 2023 Phylogenetic analysis of bHLH classes III and IV in land plants and their algal relatives. *New Phytologist*, 240,1717-1721.

RT Kellenberger, BJ Glover 2023 The evolution of flower colour. *Current Biology* 33 (11), R484-R488.

G Centenaro, BJ Glover, A Piermattei, PW Thomas, T Čejka, U Büntgen 2023 The importance of botanic gardens for global change research - New insights into Cambridge's hidden truffle kingdom. *Plants, People, Planet* 5 (3), 329-334.

RT Kellenberger, U Ponraj, B Delahaie, R Fattorini, J Balk, S Lopez-Gomollon, KH Müller, AG Ellis, BJ Glover 2023 Multiple gene co-options underlie the rapid evolution of sexually deceptive flowers in *Gorteria diffusa*. *Current Biology* 33 (8), 1502-1512.

A Murphy, S Jiang, J Elderfield, A Pate, C Halliwell, BJ Glover, N Cunniffe, J Carr 2023 Biased pollen transfer between virus-infected and non-infected plants by bumblebees favors the paternity of infected plants in cross-pollination. *iScience* 26(3).

E Cullen, Q Wang, BJ Glover 2023 How do you build a nectar spur? A transcriptomic comparison of nectar spur development in *Linaria vulgaris* and gibba development in *Antirrhinum majus*. *Frontiers in Plant Science* 14, 1190373.

E Moyroud, CA Airoidi, J Ferria, C Giorio, SS Steimer, PJ Rudall, CJ Prychid, S Halliwell, JF Walker, S Robinson, M Kalberer, BJ Glover 2022 Cuticle chemistry drives the development of diffraction gratings on the surface of *Hibiscus trionum* petals. *Current Biology* 32 (24), 5323-5334.

CA Lugo, C Airoidi, C Chen, AJ Crosby,

BJ Glover 2022 Morphoelastic modelling of pattern development in the petal epidermal cell cuticle. *Preprint from bioRxiv* <https://doi.org/10.1101/2022.10.30.514439>

BD Wilts, PJ Rudall, E Moyroud, Y Ogawa, S Vignolini, U Steiner, BJ Glover 2022 Ultrastructure and optics of the prism-like petal epidermal cells of *Eschscholzia californica* (California poppy). *New Phytologist* 236 (2), 792-792.

B Delahaie, G Mellers, RT Kellenberger, M Fernández-Mazuecos, R Fattorini, SF Brockington, AG Ellis, BJ Glover 2022 The phylogenetic history of the *Gorteria diffusa* radiation sheds light on the origins of plant sexual deception. *bioRxiv* 2022.12. 22.521170.

BJ Glover 2022 A lesson for botanic gardens from the Covid-19 pandemic: reaching wider audiences through online activity. *Sibbaldia* 1885 DOI 10.24823.

HM Schilbert, BJ Glover 2022 Analysis of flavonol regulator evolution in the Brassicaceae reveals MYB12, MYB111 and MYB21 duplications and MYB11 and MYB24 gene loss. *BMC genomics* 23 (1), 1-17.

MA Sinnott-Armstrong, R Middleton, Y Ogawa, G Jacucci, E Moyroud, BJ Glover, PJ Rudall, S Vignolini, MJ Donoghue 2022 Multiple origins of lipid-based structural colors contribute to a gradient of fruit colors in *Viburnum* (Adoxaceae). *New Phytologist* 237,643-655.

BJ Glover 2022 Elephants, rainbows, flowers and bees: Interdisciplinary research driven by botanic garden collections. *Plants, People, Planet* 5,169-177.

A Reed, PJ Rudall, SF Brockington, BJ Glover 2022 Conical petal epidermal cells, regulated by the MYB transcription factor MIXTA, have an ancient origin within the angiosperms. *Journal of Experimental Botany* 73, 5490-5502.

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T Feng, B Pucker, T Kuang, B Song, Y Yang, N Lin, H Zhang, MJ Moore, SF Brockington, Q Wang, T Deng, H Wang, H Sun 2023 The genome of the glasshouse plant noble rhubarb (*Rheum nobile*) provides a window into alpine adaptation. *Communications biology* 6 (1), 706.

M Alejandra Guerrero-Rubio, N Walker-Hale, R Guo, H Sheehan, A Timoneda, F Gandia-Herrero, SF Brockington 2023 Are seven amino acid substitutions sufficient to explain the evolution of high l-DOPA 4,5-dioxygenase activity leading to betalain pigmentation? Revisiting the gain-of-function mutants of Bean et al. (2018). *New Phytologist* 239,2265-2278.

B Pucker, SF Brockington 2022 The evidence for anthocyanins in the betalain-pigmented genus *Hylocereus* is weak. *BMC genomics* 23 (1), 1-4.

B Wilson, GA Lazkov, KT Shalpykov, SF Brockington 2022 *Tulipa toktogulica* (Liliaceae), a cryptic, endangered new species from the western Tien-Shan, Kyrgyzstan. *Phytotaxa* 566 (1), 1-12.

S Lopez-Nieves, J El-Azaz, Y Men, CK Holland, T Feng, SF Brockington, JM Jez, HA Maeda 2022 Two independently evolved natural mutations additively deregulate TyrA enzymes and boost tyrosine production in planta. *The Plant Journal* 109 (4), 844-855.

B Pucker, N Walker-Hale, WC Yim, JC Cushman, A Crumm, Y Yang, SF Brockington 2022 Evolutionary blocks to anthocyanin accumulation and the loss of an anthocyanin carrier protein in betalain-pigmented Caryophyllales. *bioRxiv*.

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DF Correa, PR Stevenson, MN Umaña, LS Coelho, DA Lima Filho, ... A Cano et al 2023 Geographic patterns of tree dispersal modes in Amazonia and their ecological correlates. *Global ecology and biogeography* 32 (1), 49-69.

MJ Marca-Zevallos, GM Moulatlet, TR Sousa, J Schiatti, LS Coelho, ...A Cano et al. 2022 Local hydrological conditions influence tree diversity and composition across the Amazon basin. *Ecography* e06125, 2.

Á Cano, FW Stauffer, T Andermann, IM Liberal, A Zizka, CD Bacon, ... 2022 Recent and local diversification of Central American understory palms. *Global Ecology and Biogeography* 1.

Weather

Katie Sarll
Nursery & Experimental Horticulturalist

In general, the winter was mild, with some very cold temperatures towards the end. The spring was warm and wet, the summer had some high temperatures and long dry spells, although the total rainfall for the year was above average.

October was mild, the rainfall was a little above average at 63.3mm.

November proved to be a wet month with 102.9mm; heaviest deluge on the 17th at 14.1mm.

December was a very cold spell from the 8th to the 29th with a minimum temperature of -10.2 on the 9th.

Very cold weather set in during January, with -7.7°C on the 16th. There were only small amounts of rain for the second half of the month.

February was, again, very cold, with -7.7°C on the 8th, coupled with no rain for fifteen days.

March saw substantial rainfall of 127mm (the monthly total is usually under 50mm) and five continuous days of hail.

April was cold with a wet start to the month, and intermittent days of warmth. The highest temperature was recorded on the 15th at 18.8°C. Rainfall throughout and higher than average at 39.8mm for the month.

Rain fell on most days during the first half of May; the second half was in contrast mainly dry. On the 8th we had 21.8mm of rain. Warm temperatures throughout the month with a high of 21.9°C.

June was a very dry and consistently hot month, getting wetter towards the end with 10.4mm on the 28th. The highest temperature was recorded at 31.5°C.

July was mild overall, with the hottest temperature of 28.6°C on the 7th. Wet throughout the month, with 16.1mm on the 14th.

August was another mild month, with 27.8°C on the 10th. It was wet throughout with 16.2mm on the 4th.

In general, the winter was mild, with some very cold temperatures towards the end. The spring was warm and wet, the summer had some high temperatures and long dry spells, although the total rainfall for the year was above average.

September was warm, the highest temperature for the year was recorded at 32.4°C on the 9th, then temperatures started to cool. It was wet throughout with 24.5mm on the 20th. This proved to be the second highest rainfall for the year at 71.3mm for the month and contributed to a slightly above average total rainfall of 575.2mm for the year.

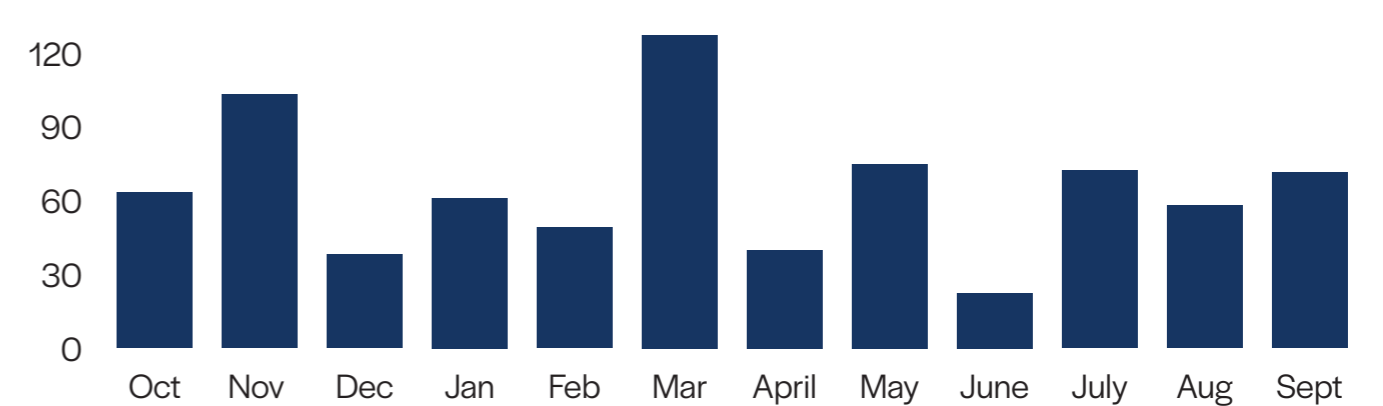


32.4°C Year's highest temperature

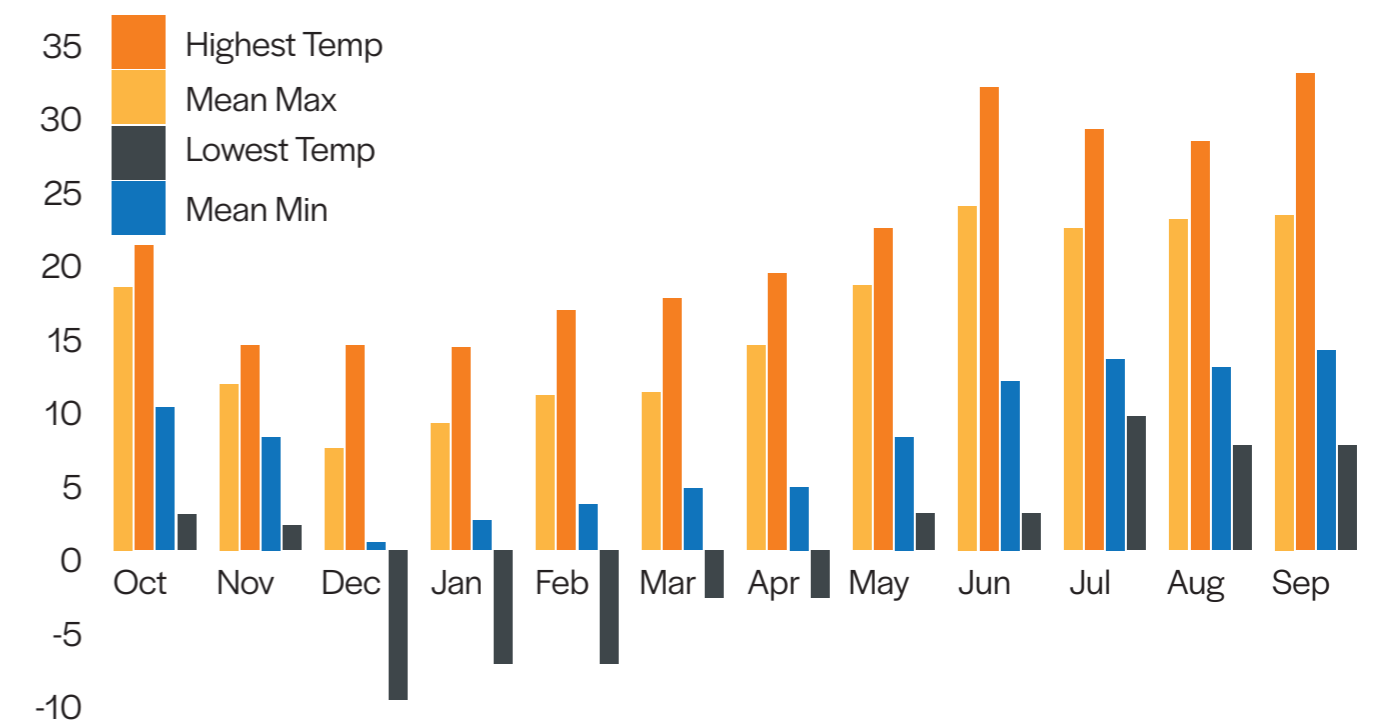


-10.2°C Year's coldest temperature

2022–2023 Monthly Rainfall [mm]



2022–2023 Monthly Temperatures [°C]



Funding

Rachel Agnew
Finance Manager

As anticipated, activity resumed with gusto, facilitated by an almost full complement of Botanic Garden staff and volunteers, enabling a full programme of events and activity throughout the year.

Income generally was slightly up, and we were grateful to receive an increased number of donations and accompanying gift aid, helping to fund operational costs to include the pay costs of a Horticultural Trainee and purchase of a much-needed seed bank refrigeration unit.

Trading revenues were slightly down overall, particularly from Admission, however Friends and Corporate Friends Membership revenues increased with visitors and local companies opting to support the Garden and become Friends (free entry throughout the year).

2022 saw the return of Apple Day and a new Craft Beer event, helping to restore lost revenue.

Other events such as the Easter *'Enchanted Egg Trail'*, Festival of Plants and the Sounds Green live music series were popular, with the Easter Trail and Sounds Green events attracting sponsorship locally.

Grant funding was received from various sponsors to include UKRI (£14.6k – Enhancing Research Culture) supporting interpretation and provision of the *'Amazing People Enquiring Minds'* trail showcasing University of Cambridge researchers.

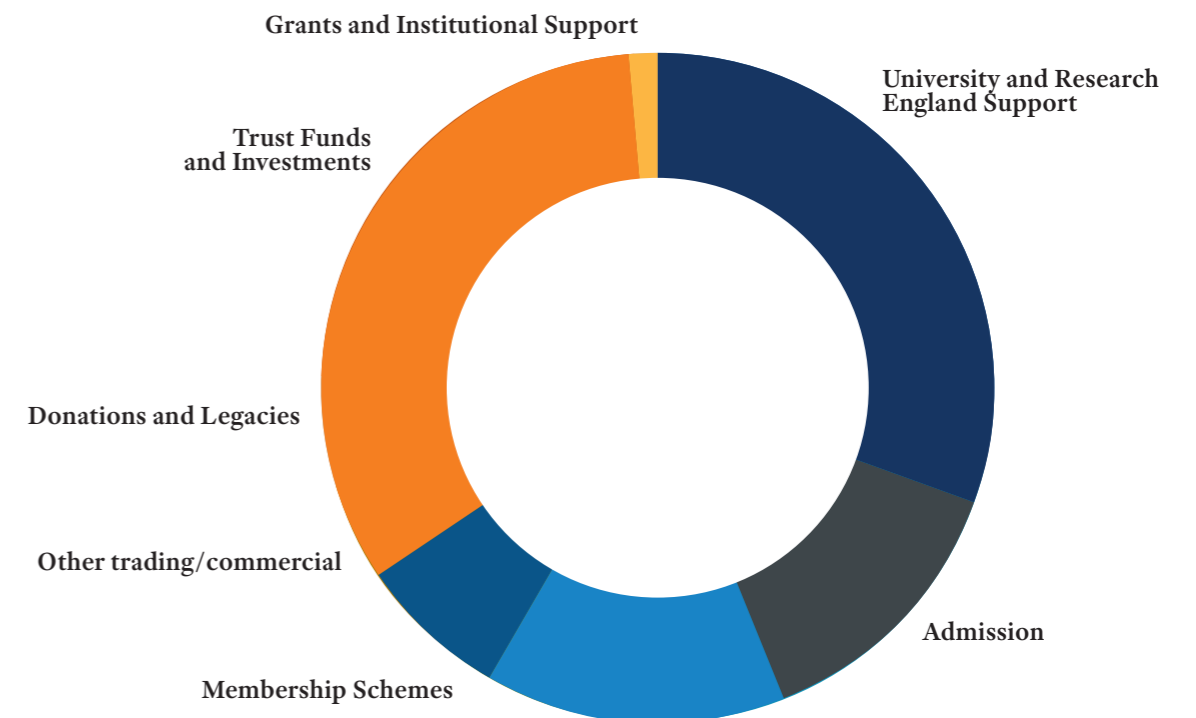
Operational costs increased significantly, pay costs in particular, where additional staff were recruited, or previously vacant roles filled. Temporary cost of living pay increases were awarded throughout the winter months to help support staff through the cost-of-living crisis (University funded) with further increases awarded to some staff towards the end of the year.

Further investment was made in the Cambridge University Endowment Fund, increasing distribution revenue with the anticipation of capital growth longer term.

Other funding was necessarily committed in support of planned activity and future projects.

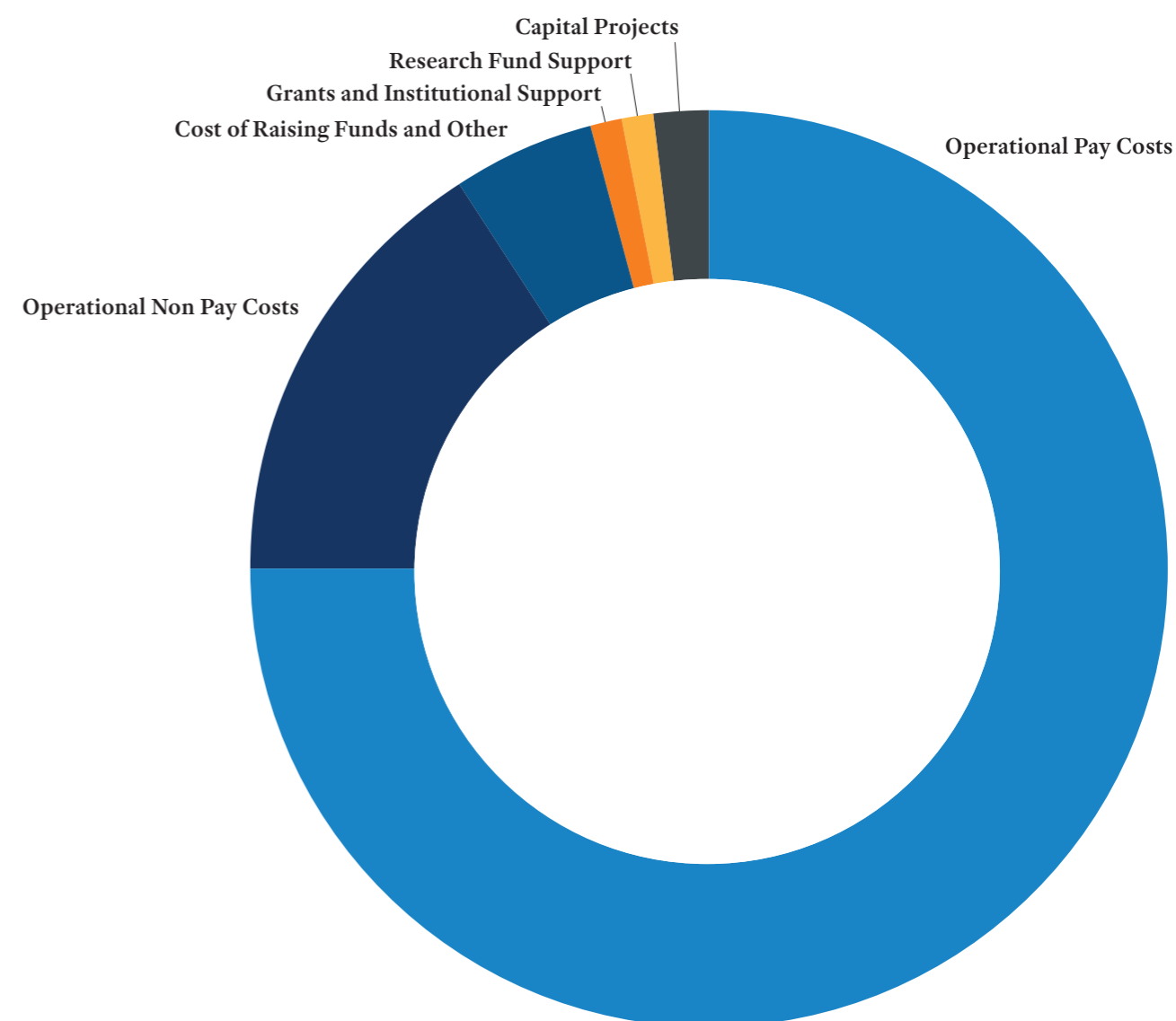
'Income generally was slightly up, and we were grateful to receive an increased number of donations and accompanying gift aid.'

Income	2022-23 £K	2021-22 £K
University and Research England Support	1,145.8	1,079.2
Admission	859.9	1,019.0
Membership Schemes	375.9	347.9
Other trading/commercial	402.1	352.5
Donations and Legacies	199.9	166.1
Trust Funds and Investments	925.8	804.7
Grants and Institutional Support	38.2	63.5
Total Income	3,947.6	3,832.9



Expenditure	2022-23 £K	2021-22 £K
Operational Pay Costs	2,514.5	2,041.3
Operational Non Pay Costs		
Collections, Conservation and Horticulture	259.1	77.5
Learning and Outreach	14.4	8.5
Development and Communication	25.5	22.2
Estates and Maintenance	22.8	51.6
Administration and Systems	146.4	146.9
Other Operational	62.4	45.2
Cost of Raising Funds and Other	172.2	113.7
Research Fund Support	40.9	0.0
Grants and Institutional Support	34.1	34.8
Capital Projects	60.0	0.0
Total Expenditure	3,352.3	2,541.8
Total Income less Total Expenditure:	595.3	1,291.1
Less: Earmarked funds held for future planned expenditure	-611.6	-1,285.2*
Funds remaining for discretionary use	-16.3	5.9

*Includes specifically funded activity and commitment of funds towards the Garden's Capital Projects.



‘We are hugely thankful for the numerous donations received at our ticket offices, online or in our donation boxes.’

Donations

Celebration and Commemorative Bench Scheme and Sponsor a Tree Scheme

Thank you to all those that have sponsored a tree or adopted a commemorative bench, celebrating a special person or occasion, and supporting the valuable work of the Garden.

Individual Gifts and Donations

Grateful thanks to those individuals funding specific activity this year, supporting capital projects, the salary of a Horticultural Trainee, the purchase of a seed bank refrigeration unit and the pilot of a new community scheme.

We are also hugely thankful for the numerous donations received at our ticket offices, online or in our donation boxes, thank you, as always, for your generous support.

Legacies and Bequests

Olive Perraton Bequest for Friends of the Botanic Garden £5,000

Grants, Trusts and Societies

BGCI 2nd Instalment Sustainability Project £7,000
 UKRI Enhancing Research Culture £14,600
 BBSRC grant towards further development of the CUBG Circadian Trail £5,000
 NPO Collections in Action £1,000
 The Tansy Trust £2,000
 Plant Heritage UK £100

Corporate and other support

Mills and Reeve LLP sponsorship of the Easter Trail 2023 £5,000

Birketts LLP sponsorship of Sounds Green Summer Music Series 2023 £5,000

Thanks also goes to the Henslow Circle, Friends and Corporate Friends for their generous and unwavering support, and to those who continue to make significant gifts over and above the annual renewal subscription.

...and lastly thanks to all our visitors and those who have chosen to Gift Aid admissions, subscriptions, and donations helping to support the continuing work of the Garden.

Development of Cambridge University Botanic Garden has been possible thanks to the generosity of generations of supporters.

The Garden receives donations from a broad range of supporters in a variety of ways – this year we were delighted to be one of the beneficiaries of a sponsored kayak paddle from Cambridge to the sea.

Syndicate & Cory Managers

Four meetings of the Botanic Garden Syndicate were held during the year under the Chairmanship of Dame Fiona Reynolds.

Syndicate members

Professor David Coomes, Professor Jon Drori (external), Dr Laurie Friday, Dr Ian Furner, Mr Donald Hearn, Professor Christopher Howe, Professor Henrik Jönsson, Professor Rebecca Kilner, Professor Kamal Munir, Mr Charles Anderton (student member for one year), Professor Julian Hibberd and Dr Rosy Thornton. The Secretary was the Garden’s Director, Professor Beverley Glover.

Cory Managers

The Cory Managers met four times during the year (including once by circulation) under the Chairmanship of Professor Julian Hibberd (Head of the Department of Plant Sciences).

Managers for the year were:

Mr Michael Allen, Professor David Cebon, Professor Howard Griffiths, Dr Kate Maxwell, with Mr David Sizer as the representative of the Director of Finance.

Corporate Friends

Redwood Friends

Abcam PLC [AstraZeneca](#) Cambridge Design Partnership Ltd [Cantab Asset Management](#) Costello Medical [CUP&A](#) Domino UK Limited [GMSL](#) Microsoft [Mills & Reeve LLP](#) MRC Toxicology Unit [Nu Quantum Ltd](#) RealVNC [Secondmind AI Ltd](#)

Oak Friends

AKT II Ltd [Ansys UK Ltd](#) Arcus Foundation [ARM Ltd](#) [AstraZeneca](#) [Birketts LLP](#) Cam Medical PCN [Cambridge Bid Ltd](#) Cambridge City 4 PCN Ltd [Cambridge Commonwealth, European & International Trust](#) Cambridge Consultants Ltd [Cambridge Crystallographic Data Centre](#) Cambridge Econometrics [Cambridge Education Group](#) Cambridge Flow Solutions Ltd [Cambridge Innovation Capital Ltd](#) Cambridge Institute for Sustainability Leadership [Cambridge Intelligence](#)

[Ltd](#) Cambridge Investment Management Ltd [Cambridge Mechatronics Ltd](#) Cambridge Quantum Computing Limited [Cambridge University Development & Alumni Relations](#) Cambridge Water [Cambridgeshire Police Federation](#) Cambustion Limited [Carter Jonas](#) Churchill College [Clare Hall](#) Cogentia Healthcare Consulting Ltd [Conte-ai](#) Department of Architecture [Department of Biochemistry, Wellness, Equality and Diversity Committee](#) Department of Genetics [Department of Geography](#) Department of Material Science and Metallurgy [Department of Pharmacology](#) Department of Physiology, Development & Neuroscience [Department of Psychology](#) Department of Zoology, University of Cambridge [Department of Pathology](#) [Cambridge University](#) Department of Pure Mathematics and Mathematical Statistics [Downing College](#) EMBL-EBI Staff

‘During this period there were 120 Oak and 14 Redwood Friends, which is an increase from 114 Oak and 13 Redwood Friends the previous year.’

Association [Emmanuel College](#) Engineering Department [Entrust](#) Eversheds Sutherland [Evonetix Ltd](#) Faculty of Education [Faculty of Law](#) FEBS: Federation of European Biochemical Societies [Fitzwilliam Museum](#) Five AI [Geant](#) Genomics plc [Gilead Sciences](#) Graphcore [HCR Legal LLP](#) Hills Road Sixth Form College [Hoare Lea](#) Howes Percival HP UK [Development Ltd](#) IFM Europe Ltd [Institute of Astronomy](#) University of Cambridge Institute of Criminology [Intrasonics Ltd](#) Isaac Newton Institute for Mathematical Sciences [John Lewis Cambridge](#) Judge Business School [Kennedys KJ Tait Engineers](#) [lowRISC](#) CIC Lynfield Management [Mander Portman Woodward \(MPW\)](#) Cambridge Marshall Sports and Social Club [Mott MacDonald](#) MRC-Cognition and Brain Sciences Unit [MTK Wireless Ltd](#) Nash Matthews LLP [Natural England](#) NIAB [Pembroke College](#) Penningtons Manches

Cooper LLP [Peters Elworthy & Moore](#) Qualcomm Sports & Social Club [Raspberry Pi Foundation](#) Reg Genome [Research Office](#) Sagentia Innovation [Samsung AI Center](#) Samsung Cambridge Solution Centre Social Club [Sancton Wood School](#) Saunders Boston Limited [Savills \(UK\) Ltd](#) School of Clinical Medicine [Scott Polar Research Institute](#) Select English [School of the Humanities and Social Sciences](#) Siemens Industry Software Ltd [Simmons Wavelength Limited](#) Softwire St [Andrews Tutorial Services Ltd](#) St Faith’s School [St Mary’s School](#) Stantec UK Ltd [Stephen Perse Foundation](#) Sixth Form Stephen Perse Foundation [Taylor Wessing](#) The Biodiversity Consultancy Ltd [The Gurdon Institute](#) The Leys School [The Tuesday Project Ltd](#) Thomson Webb & Corfield [University of Cambridge, Information Services](#) Vine FX [WeWork](#) WSP Yusuf Hamied Department of Chemistry

Botanic Garden Staff

Director

Beverley Glover
PA to Director: Jane Adams

Assistant Director (Audiences & Enterprise)

Paul Pomfret

Administration

Departmental Administrator: Wendy Godfrey
Assistant Administrators: Richenda Collins and Caty Cooke
Learning Administrator: Lucy Watts
Friends Administrator: Sacha Watson

Curation

Curator: Sam Brockington
Assistant Curator: Ángela Cano
Plant Records Officer: Pete Atkinson
Collections Co-ordinator: Margeaux Apple
Curation Assistant: Mar Millan and Nadiia Rositska (from September)
Biodiversity Informatician: Jake Powell (from March)

Development

Head of Development and Communications:
Anna Patterson Lee
Marketing and Communications Co-ordinator:
Helen Needham
Marketing Assistant: Katy Lawrence (from July)

Estates

Head of Estates and Operations Manager: Carl Tatterton
Estates Manager: Phil Starling

Finance

Finance Manager: Rachel Agnew
Finance Coordinator: Tracey Brock (to April), Mayur Joshi (from August)
Finance Administrators: Elaine Dalton and Rebecca Chapman

Horticulture

Head of Horticulture: Sally Petitt

Horticultural Displays: Team Leader - Paul Aston;
Senior Horticulturist Western Display - Rut Gallmeier,
Assistants - Pete Wrapson, Alice Riches, Ciaran Bradshaw (to July), Jonathan Strauss (from July);
Senior Horticulturist Eastern Display – Andrea Topalovic Arthan, Assistant – John Kapor

Garden Landscapes: Team Leader – Mark Crouch (to April); Senior Horticulturist Landscape and Machinery – Adrian Holmes, Assistant – Ross Gildea;
Assistant Trees and Shrubs – Richard Denham and Lewis Dearn (from January)

Glasshouses: Team Leader Glasshouses and Nursery – Luigi Leoni; Senior Horticulturist Nursery & Experimental – Simon Wallis, Assistant – Katie Martyr; Glasshouses Senior Horticulturist – Kathryn Bray, Assistant – Barbara Griffith

Weekend Horticultural Assistant: Melina Yakas (to July)

Botanic Garden Staff

Trainee Horticultural Technicians September 2022 – September 2023

Oliver Berney, Emma Peirce, Cheye Pollard, Aidan Hopkinson, Jordan McLean, Matthew Stepka, Thomas Lovell

Learning

Head of Learning: Hayley McCulloch (to September)
Learning Officer: Sally Lee
Schools Learning Officer: Bronwen Richards, Hannah Elkington, Bridget Carter (maternity cover from September)
Community Learning Co-ordinator: Louise Campbell

Visitor Services

Head of Visitor Services: Nicci Steele-Williams
Deputy Head of Visitor Services & Team Leader:
Laura Welford
Team Leader: David Evans and David Radley (from April)
Visitor Services Assistants: Amanda Wilkins, Lucinda Fudge, Sue Baker, Alicia Lloyd, Saphia Kaikati, Katrina Rose (to May), Eilidh Bodfish, Tom Austin, Chris McFarlane
Visitor Services Receptionist: Heloise Toop

Gatsby Plant Science Education Programme

Head of Programme: Dan Jenkins
Project Manager (Schools) Alex Jenkin
Project Manager (Higher Education): Claire Pennycuik
Project Coordinator (Schools): Jamie Biggs
Project and Communications Coordinator (Higher Education): Sarah Barnert

SAPS Seconded teacher: Chris Graham

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; trustee of the Royal Botanic Garden Edinburgh; Chair of the Science Advisory Committee of the Royal Botanic Garden Edinburgh; member of the Council of the European Society for Evolutionary Developmental Biology; Chair of the Council of Scientists of the Human Frontier Science Programme; member of the Botanical Society of America; member of the British Society for Developmental Biology; Fellow of the Linnean Society; patron of the Cambridgeshire Gardens Trust; vice president of the Cambridgeshire Beekeepers' Association; member of the Advisory Board of New Phytologist; Strategic Advisor to 'Plants, People, Planet'; member of the Editorial Board of Current Opinion in Plant Biology; member of the Natural Environment Research Council's Peer Review College; gave talks to Granta Probus, the Gregor Mendel Institute of Molecular Plant Biology, the Cambridgeshire Gardens Trust, the Barrington Society, Hills Road Sixth Form College and the Shrewsbury Darwin Festival.

Professor Samuel Brockington: Academic Lead for the Cambridge University Herbarium; co-Chair of the Collection-Connections-Communities Strategic Research Initiative, Trustee and council member for the Bedfordshire, Cambridgeshire,

and Northamptonshire Wildlife Trust (BCN-WT); Chair of BCN-WT Conservation, Education and Communities Committee, member of the Great Fen Steering Group; Trustee for Thrive (Social and Therapeutic Horticulture); is a fellow of the Linnean Society; member of the High Value Biorenewables Network; member of the Botanical Society of America; member of the Darwin Tree of Life Plant Steering Group.

Paul Pomfret continued to serve as a trustee for Middleton Hall Trust.

Carl Tatterton continued as a trustee of the Hobson's Conduit Trust.

Helen Needham continued as a member of the Great Days Out In & Around Cambridge committee.

Sally Pettitt continued as chair of the Merlin Trust (which provides travel awards to young horticulturalists) and as a member of the Borde Hill Garden Council. She continues to serve on the RHS Education Committee and the RHS Joint Rock Garden Committee.

Luigi Leoni has joined the RHS Orchid Committee as an Associate Member.

Dan Jenkins: elected Fellow of the Royal Society of Biology, elected as a member of the Royal Society of Biology Curriculum Committee; continued as a member of the Plant Science Group, Biology Education Research Group and the Education Policy Advisory Group at the Royal Society of Biology.

Claire Pennycuick continued as a member of the Careers Committee of the Royal Society of Biology.

Alex Jenkin: elected as a member of the Biology Education Research Group and continued as a member of the Outreach and Engagement Working Group of the Royal Society of Biology.



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