

# Learnings from the 8<sup>th</sup> Global Botanic Gardens Congress, Singapore

1<sup>st</sup> - 11<sup>th</sup> Aug 2024

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# Introduction

## About the Author

As a Biology graduate and early-career scientist, attending the biggest event in the Botanic Gardens calendar was a once-in-a-lifetime opportunity, helping me to fulfil my career aspirations. My goal is to contribute to the global fight against biodiversity loss, a mission that drives my work at the National Botanic Garden of Wales (NBGW).

In my role within the Science Team, I work at the National Seed Bank of Wales, which involves collecting and processing seeds of Welsh native species for long-term conservation (fig.1 & 2). This experience has deepened my appreciation for the beauty of plants and their critical roles within ecosystems; from examining detailed seed structures under a microscope to understanding their broader ecological significance.

However, I recognise that there is still so much more to learn. The Congress offered an opportunity to expand my knowledge, connect with international experts, and place our work at NBGW within a global context. Representing NBGW internationally would allow me to promote our efforts and gain valuable insights to enhance our conservation work.

This event was not just a professional milestone, but a chance to contribute to a larger global conversation on the role of botanic gardens in conserving biodiversity and shaping a sustainable future.



**Fig.1.** Collecting seeds of *Viburnum opulus*.



**Fig.2.** Inspecting seeds under the microscope.

## Project Overview

### The Congress

Co-hosted by Botanic Gardens Conservation International (BGCI) and Singapore Botanic Gardens (SBG), the 8<sup>th</sup> Global Botanic Gardens Congress (8GBGC) brought together academics, researchers, policymakers, botanic garden staff, and plant enthusiasts from across the globe to share information and experiences. The theme, “Botanic Gardens – People and Plants for a Sustainable Future,” focused on how botanic gardens can help address global challenges, such as biodiversity loss, climate change and societal issues.

Additionally, the biennial Singapore Garden Festival, hosted by SBG to coincide with the Congress, added another dimension of horticultural interest to the trip, showcasing award-winning landscape designers to create impressive garden displays, providing further cultural, ecological and creative insights.

### The City

Singapore was the ideal host city for the event, renowned as the world’s greenest high-density city, featuring impressive green infrastructure and over 400 gardens and parks (fig.3). Singapore Botanic Gardens is the only tropical botanic garden designated as a UNESCO World Heritage Site, and Gardens by the Bay boasts the iconic Supertree Grove, Cloud Forest and Flower Dome (fig.4).



**Fig.3 & 4.** Views of the Singapore skyline.

# Aims & Objectives

## 1. Expand knowledge and understanding of plant conservation and horticulture across the globe, and the role of botanic gardens in tackling global challenges.

- Attend diverse talks and workshops led by global experts.
- Tour of Singapore Botanic Gardens to learn about their conservation and research efforts.
- Participate in sessions on seed banking and tour of SBG Seed Bank to understand different global practices.

## 2. Represent NBGW internationally, and foster collaborations.

- Present a poster titled “Establishing the National Seed Bank of Wales: collecting, conserving and restoring the Welsh flora”.
- Promote NBGW's research and conservation efforts.
- Network with international delegates to explore collaboration opportunities.

## 3. Share the knowledge and insights gained with NBGW community.

- Write blog posts for the NBGW website about what I learned at the Congress.
- Give presentations to staff, volunteers, and visitors on knowledge and insights gained.
- Implement new ideas in my work where relevant.



**Fig. 5 & 6.** Above: Main stage at the Congress. Below: Entrance to Singapore Botanic Gardens Seed Bank.

# Itinerary

Date	Activity
01/08/2024	Travel to airport, fly to Singapore
02/08/2024	Arrive in Singapore (13 hr flight)
03/08/2024	First day to explore Singapore – S.E.A Aquarium, Mount Imbiah Nature Trail, Sentosa Island
04/08/2024	Visit Gardens by the Bay – Cloud Forest, Flower Dome, Supertree Grove, Floral Fantasy, Kingfisher Wetlands
05/08/2024	Attend Singapore Garden Festival
06/08/2024	Attend Congress (full day), welcome reception at Singapore Botanic Gardens
07/08/2024	Attend Congress (full day)
08/08/2024	Attend Congress (full day)
09/08/2024	Attend Congress (half day), tour of Singapore Botanic Gardens Seed Bank
10/08/2024	Full day post-congress tour of Singapore Botanic Gardens – National Orchid Garden, Learning Forest, Plant Resource Centre, Herbarium, Eco Garden, Seed Bank, etc
11/08/2024	Explore Changi Airport, and associated botanical and horticultural interests – The Jewel, Butterfly Garden, Cactus Garden
12-22/08/2024	Personal travel in Malaysia to further explore the flora, fauna, landscape and culture of South-east Asia, including visits to Penang Botanic Garden, Perdana Botanical Garden (Kuala Lumpur), and various national parks and geoparks
23-24/08/2024	Return to Singapore, fly home

# Main

## Attending the Congress

The week was very inspiring, with passionate speakers from botanic gardens worldwide discussing their work, from conserving threatened species to engaging communities. The botanic garden community was united in a show of passion and positivity, making me feel like part of a wider network, and giving global context and relevance to my work at NBGW.

Over the course of three and a half days, I attended 32 talks, five workshops and one panel discussion, across four themes:

- Green and sustainable cities
- Plant diversity and conservation
- Engaging communities
- Gardens for the future

With around 900 delegates from 75 countries, the Congress reinforced the message of collaboration and interconnectedness among botanic gardens globally. A key takeaway for me was “think global, act local,” which encourages local actions to tackle global challenges. This empowering idea highlights how the small efforts of each botanic garden contribute to conservation on a global scale, as part of a global botanic gardens network (Tan, 2024).

At NBGW, we are part of this network, and have a role in tackling global challenges. This adds extra meaning to my work in conserving Welsh flora. If every botanic garden protects its native flora, then eventually all plants across the globe will be conserved. We are acting locally and contributing to the global fight against biodiversity loss.



**Fig.7.** Our team from NBGW enjoying the first day of the Congress.

## Singapore as a 'City in Nature'

Throughout the Congress, there was a strong emphasis on greening initiatives, green infrastructure and Singapore Botanic Gardens' role in developing Singapore as a 'City in Nature.' Since gaining independence in 1965, there has been a big movement towards greening the whole island, by planting trees for shade and colour, connecting parks and green spaces, and incorporating biophilic design to integrate plants into urban landscapes (Singapore Green Plan, 2024) (fig.8, 9, 10 & 11).



**Fig.8.** The Jewel, Changi Airport, is an amazing building, bringing nature into a shopping mall.

Singapore is now the second most densely populated country, with one of the highest standards of living, and considered one of the greenest cities in the world (National Parks Board, 2024). This was not only evident from the Congress, but I also experienced this for myself as I explored the city (case example 1) – trees were abundant, covered in amazing ferns, orchids and other epiphytes. The boundaries between buildings and green spaces, as well as indoors and outdoors, were often blurred (fig.8). At times, it didn't feel like we were in a city at all, but in the middle of a jungle, with glimpses of the city skyline through the dense canopy (fig.12 & 13).

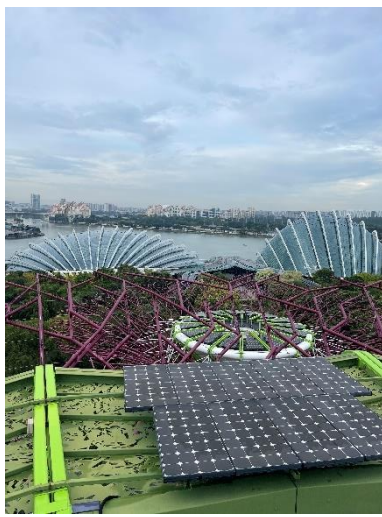
### Case Example 1: Rifle Range Nature Park

At the Congress, Leonard Ng, a landscape architect, gave an insightful talk on regenerative design projects in the city. He discussed how a disused quarry was transformed into Rifle Range Nature Park, creating a space where humans and nature coexist, and connecting the island's last primary rainforest tracts (Ng, 2024). Thoughtful design interventions have made the park rich with wildlife and offer safe visitor interactions. During our visit, we noticed features like the Colugo-inspired viewpoint, diverse habitats with varying water depths, and the park's closure at night to protect wildlife (fig.15, 16 & 17).

The Botanic Gardens were also very impressive, and not only serve as a centre of conservation, but as a beautiful place where locals and tourists alike go to relax and enjoy being in nature (fig.18 & 19).

As Stephen Blackmore (2024) stated in his presentation, we need to protect, conserve and enhance biodiversity everywhere in every kind of landscape. Singapore has recognised the need to conserve all habitats, and that cities can be important places for threatened species and biodiversity.





**Fig.9, 10 & 11.** The Supertree Grove is an iconic example of innovative biophilic and sustainable design. Inspired by the eucalyptus trees of Western Australia, each Supertree collects rainwater, has solar panels on top, and is covered in climbing plants which provide habitat.



**Fig.12 & 13.** Views from the Imbiah Nature Trail, Sentosa.

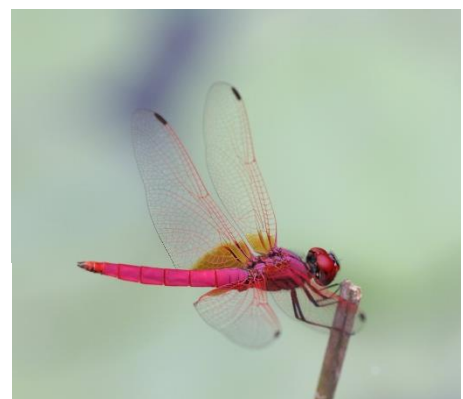
**Fig.14.** Greater Racket-tailed Drongo (*Dicrurus paradiseus*) seen while exploring one of Singapore's many nature trails.



**Fig.15, 16 & 17.** Views from Rifle Range Nature Park. Middle: The view from the Colugo deck, the design of which is meant to look like Malayan Colugo (*Galeopterus variegatus*) which glide through the forest here.



**Fig.18.** Asian Water Monitor (*Varanus salvator*) at Singapore Botanic Gardens.



**Fig.19.** Scarlet Basker dragonfly (*Urothemis signata*) at Singapore Botanic Gardens.

## Seed Banking

There was a strong presence of seed bank professionals at the Congress, allowing me to meet and network with other delegates doing similar jobs to me, from botanic gardens across the globe.

While many seed banks operate on a much larger scale than that at NBGW, it was reassuring to learn that many face similar challenges, such as the need for sustained resourcing and investment to continue their important work year on year. Miller (2024) emphasised the need for proactive investment, rather than reactive funding only in response to natural and man-made disasters.

It was inspiring and eye-opening to learn about various seed banking methods, and the unique challenges of conducting fieldwork in different regions (case example 2).

### **Case Example 2: Victorian Conservation Seedbank, Royal Botanic Gardens Victoria**

Australian botanic gardens are working towards conserving their 21,000 species of native flora, 84% of which are endemic (Broadhurst & Coates, 2017). Many target species grow in remote locations, requiring teams to use helicopter to make collections. Additionally, some seeds only germinate after fire treatment, requiring researchers to identify optimal conditions and develop unique strategies for each species (Miller, 2024).

The importance of collaboration and the broader use of seed banks were also emphasised. The Australian Seed Bank Partnership, which brings together 14 organisations, was able to rapidly respond to the 2019-2020 mega-fires that burned over 10 million hectares in south-eastern Australia. The partnership coordinated efforts to assess the impact of the fires on different plant species, collect seeds, and gather living plant material for conservation and research. Without this collaborative approach across botanic gardens, such resource-intensive fieldwork spanning state boundaries would not have been possible (Miller, 2024).

### **Further seed banking talk highlights:**

- Alternative methods for assessing seed longevity and viability (Dalziell, 2024):
  - Studying chronosequences to assess viability decline in species that have multiple collections from different time points.
  - Measuring aerobic respiration as quicker alternative to germination testing.
  - Assessing RNA integrity.
- Digitising seed collections for broader access (Kingsley *et al.*, 2022).
- Pollen banking and developing pollen conservation protocols (Foster & Wolkis, 2024).
- South Korea's Seed Vault (Na, 2024).
- AIUla's native plant nursery and seed bank, which trains local communities, and supports greening initiatives (Lee, 2024).
- Collecting seeds in remote locations via drone in Hawaii (Nyberg *et al.*, 2024) (fig.20 &21).



**Fig.20 & 21.** Drone equipment being developed to map species and collect seed from remote and inaccessible plants in Hawaii (Nyberg *et al.*, 2024). Left: Grabbing device attached to drone used to collect plant material and take it safely back to the researchers. Right: Drone used to map species on cliff sides.

I displayed my poster showcasing the National Seed Bank of Wales, its achievements, and reintroduction projects undertaken (appendix 1) (fig. 22). It was exciting to represent NBGW and share my work at an international conference, engaging with professionals and academics from around the world. This also provided opportunities to network, and I was invited to a tour of Singapore Botanic Gardens Seed Bank with other seed banking delegates from the Congress (fig.23). As an early-career scientist, this experience was thrilling and allowed me to build connections and explore potential collaborations for NBGW.



**Fig.22.** Standing next to my poster displayed at the Congress.



**Fig.23.** Tour of Singapore Botanic Gardens Seed Bank with other seed banking professionals from the Congress.

## Singapore Botanic Gardens Seed Bank

A trip highlight was visiting the Singapore Botanic Gardens Seed Bank (fig.24). Opened the same year as the National Seed Bank of Wales in 2019, SBG Seed Bank focuses on conserving the flora of South-east Asia.

Despite being on the other side of the world, they use much of the same equipment for cleaning and processing collections, such as aspirators, sensitive scales, incubators and a heat sealer – all equipment that is very familiar to me from our labs at NBGW (fig.25-28).



**Fig.24.** Singapore Botanic Gardens Seed Bank.

However, there was also some impressive, cutting-edge equipment that was new to me, including a cryogenic storage lab, hygrometers for measuring humidity, and even their own x-ray machine for checking seed viability (fig.29 & 30). It was fascinating to see another seed bank in action, conserving seeds in a tropical environment on the other side of the world.



**Fig.25, 26, 27 & 28.** The same equipment used by SBG Seed Bank that we have at the National Seed Bank of Wales. From left to right: Selecta Zig-zag aspirator and Agriculex aspirator (used for cleaning seed), heat sealer (used for sealing foil bags before being stored in freezer), sensitive scales (used for weighing seed collections).



**Fig.29 & 30.** Left: cryogenic storage containers, for deep freezing seeds. Right: X-ray machine in dedicated room for assessing seed quality and viability.

The large size of many tropical seeds and pods was a striking contrast to the Welsh native flora I'm used to collecting (fig.31 & 32). This presents its own challenges for collecting and processing, requiring more storage space. To accommodate this, SBG Seed Bank has a dedicated walk-in drying room and adjacent freezer room, which was impressive to see.



**Fig.31 & 32.** Seed collections drying in trays prior to being processed and stored.

One standout feature of the SBG Seed Bank was the interpretive gallery, which offers visitors insightful information about the critical work being done there (fig.33). Additionally, the seed dispersal garden, featuring seed sculptures that demonstrate various dispersal mechanisms, enhances visitor understanding. The labs, designed with large windows, allow visitors to observe scientists in action (fig.34), fostering a connection between the public and the scientific work.

In contrast, I realised that our seed bank at NBGW lacks similar accessibility and interpretive elements, which may limit visitors' appreciation and engagement with our important work. However, the SBG Seed Bank was purposefully designed with visitor interaction in mind. While this approach may not be entirely applicable to NBGW's seed bank, it has inspired new ideas on how we can better communicate our mission and engage visitors with the work we do.



**Fig.33.** Information board on how seed collections are made as part of the display in the interpretive gallery.



**Fig.34.** Views into the germination testing lab from the interpretive gallery.

## Other Highlights

While in Singapore, we made the most of being in such an amazing city by exploring many of the horticultural and wildlife attractions that the city has to offer (fig.35-42).



**Fig.35, 36 & 37.** Visiting the Cloud Forest, Gardens by the Bay, a climate-controlled conservatory designed to replicate the cool, misty conditions of South-east Asia's tropical highlands. This impressive 58-metre-high glass dome houses one of the world's tallest indoor waterfalls (left), and offers an immersive experience, showcasing the rich biodiversity of the region's unique ecosystems.



**Fig.38, 39 & 40.** The Flower Dome, which is next-door to the Cloud Forest, imitates the cool-dry climate of the Mediterranean – similar to that of our Great Glasshouse at NBGW, therefore housing many of the same plant species. It was interesting to see familiar plants displayed in different ways, and provided ideas for new species and planting methods.



**Fig.41 & 42.** Flowers of the old Tembusu Tree (*Fagraea fragrans*) at Singapore Botanic Gardens, which appears on the Singapore \$5 note. Tan (2024) highlighted the cultural significance of this tree, where local people would come to take pictures on the low branch, which has now been fenced off to protect the tree.

## Conclusion

In conclusion, this trip was memorable and highly valuable, both on a personal and professional level. I learnt a great deal about plant conservation, successfully networked with fellow delegates, and had a wonderful time exploring the city with my colleagues, who have now become great friends. Being surrounded by passionate, like-minded individuals was truly inspiring.

The importance of collaboration was emphasised throughout the Congress, with a message of connecting people with plants into the future. Community engagement was at the forefront of discussions, empowering people to take action to combat biodiversity loss and protect plants across the globe, benefiting both ecosystems and societies. I was struck by the message to 'think global, act local' and will endeavour to do my utmost to conserve Welsh flora, and empower our audiences to do the same.

Since returning, our group has shared the insights we gained at the Congress during an all-staff presentation, and we plan to write a series of blog posts detailing our experiences in Singapore. I feel that I have achieved my primary goals for the trip and will continue to share and apply the knowledge gained with the NBGW community. This experience will undoubtedly influence my work at the seed bank and continue to contribute to my growth throughout my career in conservation.



## Acknowledgements

I'd like to give my utmost gratitude to the RHS and Merlin Trust for awarding me the bursaries which allowed me to undertake this trip. This was a once in a lifetime experience, and I am incredibly grateful to have received this funding that enabled me to attend the 8<sup>th</sup> Global Botanic Gardens Congress in Singapore.

I am also incredibly grateful to Singapore Botanic Gardens and BGCI who organised and hosted the Congress and to the staff for giving us such a warm welcome. I'd like to extend my gratitude to the National Botanic Garden of Wales for bringing this opportunity to my attention, supporting my application, and allowing me the time to attend the Congress.

Special thanks to Elizabeth, Mia and Freddy who came on the trip with me, and made my time in Singapore so fun and memorable.



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# Appendices


## Appendix 1. Poster presented at the Congress

### Establishing the National Seed Bank of Wales: collecting, conserving and restoring the Welsh flora

E.M. Baker<sup>1,2</sup>, E.A. James<sup>1</sup>, L.T. Franzen<sup>1</sup>, L. Jones<sup>1</sup>, K.J. McGinn<sup>1</sup>

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The National Botanic Garden of Wales is a charity dedicated to the advancement of knowledge in plant science and conservation; particularly in Wales, Great Britain and the Western European Seaboard. It is the custodian of significant collections and heritage assets for Wales, and is striving to lead the way in regenerative farming and biodiversity management.

#### Introduction

Seed banking is a vital tool to conserve the genetic diversity of plants for the future. It acts as an insurance policy against potential extinctions, and ensures that seed of suitable origin is available for future conservation and research.

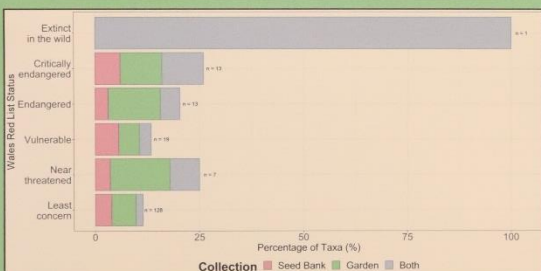
The distribution of over 40% of plant species in Wales have declined since the 1950s<sup>1</sup>, and 18% of Welsh species are now threatened with extinction<sup>2</sup>. Gap analysis in 2019 showed that around 75% of Welsh plants had not yet been banked from Welsh populations.

Since 2018, the National Botanic Garden of Wales has developed its own seed bank, with a focus on Welsh native flora to ensure banked collections contain Welsh provenance seed<sup>3</sup>. Wales is home to many endemic and endangered species, and edge-of-range populations which are potentially genetically distinct<sup>4</sup>, making it crucial to capture this diversity within seed bank collections.



#### The National Seed Bank of Wales

- Established:** 2018
- Objective:** To conserve Wales' threatened wild plants.
- Achievements:**
  - 123 accessions from over 100 taxa.
  - 12% of Welsh flora represented within our banked and living collections.
  - Contributing towards UK National Tree Seed Project and UK Threatened Flora Project, run by the Millennium Seed Bank (Royal Botanic Gardens, Kew).
  - Aiming to represent all 1,493 Welsh flora species<sup>4</sup>.
  - Supported six in-situ conservation and reintroduction projects.
- Importance:**
  - Capturing genetic diversity of Welsh populations within ex-situ seed collections.
  - Assist in future species recovery, reintroduction projects and research.





Red List Status	Seed Bank (%)	Garden (%)	Both (%)
Extinct in the wild	0	0	100
Critically endangered	~10	~10	~80
Endangered	~10	~10	~80
Vulnerable	~10	~10	~80
Near threatened	~10	~10	~80
Least concern	~10	~10	~80

**Fig.1.** Percentage of Welsh flora (n=1,493) from each red list status that is represented either in the Seed Bank, Living Collection (Garden) or both.

#### Case Study: *Rumex rupestris* (Polygonaceae)

IUCN Red List: Vulnerable | Wales & Great Britain threat status: Endangered<sup>4</sup>



- One of the world's rarest dock species.
- Currently found in only two locations in Wales and has recently become locally extinct from a third location, Dunraven Bay Special Area of Conservation.
- Erosion and rock falls have contributed to the extinction of the species in this area, exacerbated due to more frequent and extreme weather events.
- Seed from this population was collected and propagated at the National Botanic Garden of Wales before it was lost.
- The seeds from these plants were used to grow 60 plug plants, which were subsequently reintroduced to carefully selected sites.
- The remaining seed is stored in the seed bank.
- The exact location of each plant was recorded using GPS.
- Will be monitored by Natural Resources Wales over the next few years to determine the success of the reintroduced population.

#### Case Study: *Tortula canescens* (Pottiaceae)

Wales<sup>5</sup> & Great Britain<sup>6</sup> threat status: Endangered

- Involved in the conservation of *Tortula canescens*, a rare bryophyte species, with the aim to grow material for in-situ population bolstering.
- Tortula canescens* is mainly a coastal moss, growing on acidic soil that is intermittently desiccated during the summer.
- Only two populations in Wales, and almost entirely limited to the Cornish coast in England.
- We have been testing propagation methods, using a more common species, *Tortula subulata*.
- Both moss species grew well in incubators set at 20°C and 24 hours light, without the need for any prior stratification.
- Demonstrates how seed bank facilities can be applied to conservation horticulture projects.
- The next conservation target is the endangered moss *Bartramia stricta*<sup>6</sup>.

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## Appendix 2. Abstract of poster presentation

**ABS-00125**

### **Establishing the National Seed Bank of Wales: collecting, conserving and restoring the Welsh flora**

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Keywords: *ex situ* conservation, moss, reintroduction, seed bank

Seed banking is a vital tool for conserving the genetic diversity of plants for the future, acting as an insurance policy against potential extinctions. With almost half of vascular plant species having declined in abundance and distribution in Wales over the last 50 years, it is more important than ever that efforts are made to conserve these species. Since 2018, the National Botanic Garden of Wales has been developing its own seed bank, with a focus on Welsh native flora to ensure banked collections contain Welsh provenance seed. Wales is home to many endemic and endangered species, and many genetically distinct populations, therefore it is important to capture this diversity within seed bank collections. The National Seed Bank of Wales now contains over 200 accessions from 120 taxa, ensuring the enduring survival of many of our rarest native species. The seed bank has already been able to contribute to the *in situ* conservation and restoration of multiple species, developing skills within horticulture and science to support Wales wide initiatives. We have been working to grow *Rumex rupestris*, a species of European conservation importance, from the seed bank collections for reintroduction to areas where it is locally extinct. Research is also being undertaken on the rare moss *Tortula canescens*, providing a case study for the *ex situ* propagation and transplanting of moss, supporting future bryophyte conservation. The ability of this recently formed seed bank to rapidly support ongoing and newly established conservation projects demonstrates the importance of regional seed banks and botanic gardens to local conservation.

### Appendix 3. Final budget breakdown

<b>Item</b>	<b>Cost</b>	<b>Company</b>
Fights	£1,495	Singapore Airlines
Conference ticket (incl. admission to Singapore Garden Festival and tour of Singapore Botanic Gardens)	£796.97	BGCI
Accommodation	£234.14	D'Nova Hotel
Bus to/from airport	£45.50	National Express
Travel Insurance	£33.20	Admiral
Singapore eSim	£12.50	MobiMatter
Public Transport	£24.12	Various
Food/drink	£99.77	Various
Gardens admissions	£64.20	Gardens by the Bay
Other	£69.41	Various
<b>TOTAL</b>	<b>£2,875</b>	
<b>Funding</b>		
RHS Bursary Award	£2,000	
Merlin Trust International Horticultural Travel Bursary	£500	
Personal Contribution	£375	

## Appendix 4. Congress programme

For the full programme of the 8<sup>th</sup> Global Botanic Gardens Congress visit:

<https://www.8gbgc.sbg.org.sg/Site/Programme>