

# Journal of Botanic Gardens Conservation International BGjournal

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**SUPPORTING  
PLANT  
CONSERVATION  
THROUGH  
GLOBAL BOTANIC  
GARDEN FUNDS**



**BOTANIC  
GARDENS**  
CONSERVATION  
INTERNATIONAL

**Editors:**



**Suzanne Sharrock**  
Director of Global  
Programmes



**Paul Smith**  
Secretary General

Design: John Morgan [www.seascapedesign.co.uk](http://www.seascapedesign.co.uk)

Cover image: Original habitat for *Dactylorhiza pythagorae* on Samos Island, Greece (Nikos Krigas)

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Further details available from:

- Botanic Gardens Conservation International, Descanso House, 199 Kew Road, Richmond, Surrey TW9 3BW UK.  
Tel: +44 (0)20 8332 5953,  
E-mail: [info@bgci.org](mailto:info@bgci.org), [www.bgci.org](http://www.bgci.org)
- BGCI (US) Inc, The Huntington Library, Art Collections and Botanical Gardens, 1151 Oxford Rd, San Marino, CA 91108, USA.  
Tel: +1 626-405-2100, E-mail: [usa@bgci.org](mailto:usa@bgci.org)  
Internet: [www.bgci.org/usa](http://www.bgci.org/usa)
- BGCI (China), C/O South China Botanical Garden, CAS, 723 Xingke Rd. Guangzhou, 510650, Guangdong, China  
Tel: (86)20-85231992,  
Email: [xiangying.wen@bgci.org](mailto:xiangying.wen@bgci.org)  
[www.bgci.org/china/](http://www.bgci.org/china/)
- BGCI (Southeast Asia), Greetha Arumugam BGCI Southeast Asia Botanic Gardens (SEABG)  
Network Manager  
BGCI Southeast Asia Office  
Email: [greetha.arumugam@bgci.org](mailto:greetha.arumugam@bgci.org)
- BGCI (Africa), Kirsty Shaw, BGCI Africa Office, IUCN Eastern and Southern Africa Regional Office (ESARO), P.O. Box 68200 - 00200, Nairobi, Kenya,  
Tel. +254 (0)725295632 Skype: [bgci\\_kirsty](mailto:bgci_kirsty),  
Email: [kirsty.shaw@bgci.org](mailto:kirsty.shaw@bgci.org),  
Internet: [www.bgci.org](http://www.bgci.org)

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## BGCI'S GLOBAL BOTANIC GARDEN FUND

Welcome to this special edition of BGJournal, which focuses on projects funded by BGCI's Global Botanic Garden Fund.

Ninety percent of BGCI's income (and the funding we disburse) is derived from competitive grant proposals, which means that the funds are heavily restricted and usually focused on plant conservation, public engagement and human development. This gives us very little leeway when it comes to supporting botanic gardens in their basic requirements or for ad hoc activities that respond to new information or opportunities. For this reason, with the support of BGCI's International Advisory Council, we decided in 2018 to set up the Global Botanic Garden Fund (GBGC), through which lightly restricted or unrestricted funds could be channelled to meet the more fundamental needs of botanic gardens.

Although the amounts of funding we have been able to disburse through the GBGC are relatively small, we do have the flexibility to support costs relating to activities regarded by most funders as 'not very sexy', such as labelling plants, collections documentation, pest control, enhancing collections and collections management – all essential activities in a botanic garden. Furthermore, even for

the more glamorous activities relating to plant conservation, it is surprising what can be achieved with relatively small amounts of money. Often, a garden just needs costs to cover fuel, accommodation or incidentals on a field collecting trip, and a small grant makes this possible. The impacts of these small injections of cash can be huge.

In this edition of BGJournal, for example, we hear (on page 18) about the rediscovery of the endemic Malagasy ebony species, *Diospyros ketsensis*, not seen since 1926, by a team from Missouri Botanical Garden's Madagascar programme, who located a total of 17 mature plants of this extremely rare species. This species can now be protected, and is subject to a recovery program that will hopefully see the population grow.

Strengthening ex situ conservation of rare and threatened species is another important focus for botanic gardens (see the CriticalGr project on page 30), and on page 22, the target species is New Zealand's only holoparasitic endemic plant – the endangered *Dactyloctenium aegyptium* (Pua o te reinga). Of perhaps greater significance than the 600 seeds collected for the conservation of this species was the fact that the collection trip became

the first in the history of plant conservation in New Zealand which saw representatives from all six iwi in the Wellington Region, three independent conservation organisations and private conservationists collaborating to collect and sow the seed.

The Global Botanic Garden Fund has also enabled BGCI to react to unexpected events and disasters, supporting gardens with urgent but unforeseen needs. On page 26 we hear about the implementation of the Youth Pandemic Teams (YPT) approach to dealing with the Covid-19 pandemic by the Jardin Ethnobotanique du Kivu, and on page 35 you can read about a partnership project that focuses on typhoon resilience. This partnership between Northwestern University Ecological Park, and Botanic Gardens, Philippines and Dr. Cecilia Koo Botanic Conservation Center, Taiwan was awarded a BGCI/ArbNet Partnership Programme grant, a sub-set of GBGC grants that fosters partnerships between arboreta. We are extremely grateful to Morton Arboretum for the funding they provide for these grants each year.

Other regular contributors to the GBGF are Minnesota Landscape Arboretum and the Global Genome Initiative (GGI). On page 39, you can read about the GGI Gardens Partner Award Program, which is generously supported by the United States Botanic Garden and which, in its first year of grants enabled the collection of samples from nearly 10% of the genera and 50% of the families of all vascular plants on Earth.

Finally, a plant hunting story (page 44) is from a GGI grant partner award recipient, Northwestern University in the Philippines, who braved pandemic and typhoons to collect herbarium and genomic vouchers from an astonishing 158 genera not yet represented in genome banks.

BGCI would welcome other contributors to the GBGF, and if you are interested in supporting this worthy cause please do get in touch. As I'm sure you can see, the impacts of these small grants are enormous - from small acorns, mighty oaks grow!

**Dr Paul Smith,**  
BGCI Secretary General



Preparing herbarium specimens at the Northwestern University Ecological Park and Botanic Gardens, Philippines

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*VERONICA JOVELLANOIDES***

FEATURED GARDEN  
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OF COLLECTIONS IN SHANGHAI  
BOTANICAL GARDEN**

INTERVIEW  
**PATRICIA MALCOLM, BGCI'S  
MEMBERSHIP AND CONSERVATION  
SERVICES MANAGER**



## NEWS FROM BGCI

## CUTTINGS

Here we present a selection of the most recent news stories from BGCI. Please browse our website to keep up-to-date with the latest news and events from BGCI and the botanic garden community: [www.bgci.org](http://www.bgci.org)

## 2022 Ukraine Botanic Garden Appeal



Kryvyi Rih Botanical Garden, Ukraine

Through generous donations from numerous gardens and individuals we raised an amazing USD\$100,000 to support Ukrainian botanic gardens during 2022. Ten botanic gardens across the country have benefited, allowing them to retain their staff, keep their doors open and invite refugees and the general public to find respite from the war and learn about plants. As the conflict intensified towards the end of 2022 and as winter approached, the funds are being used by the gardens to maintain collections, infrastructure and staff. Keep updated with progress here: <https://www.bgci.org/bgci-appeals/>

Thank you for your support!

## The 7th Global Botanic Gardens Congress

BGCI's 7th Global Botanic Gardens Congress (7GBGC) has held from 25-29 September, hosted by the Royal Botanic Gardens Victoria in Melbourne, Australia. The highly successful event attracted 500 delegates from 36 countries.

Having been delayed for 18 months due to Covid and for the first time incorporating a special Education and Engagement Day, the

Congress proved to be a very special event, bringing together botanic garden representatives from every continent (except Antarctica) to share experiences, renew friendships and develop new partnerships. Key themes of the Congress covered plant conservation, climate change, greener cities, living in a post-Covid world, global conversations and impactful engagement and education. Conservation horticulture received a special focus with a well-attended workshop discussing how to mainstream, recognise and reward specialist conservation horticulture and a number of new tools to support the work of botanic gardens were launched -see below.

The final act of the Congress was the announcement that Singapore Botanic Gardens will be the host of the 8th Global Botanic Gardens Congress to be held in 2024.

To find out more and read the Congress conclusions, please visit: [Global Botanic Garden Congress | Botanic Gardens Conservation International \(bgci.org\)](http://Global Botanic Garden Congress | Botanic Gardens Conservation International (bgci.org))

## New online platforms for responsible plant exchange

Two new platforms to support responsible plant exchange have recently been launched by BGCI. The online Index Seminum hosted by BGCI is a place where botanic gardens can upload their annual seed lists, allowing all the Index Seminum catalogues to be found in one place for the first time. The tool is now ready to request seeds and to upload your 2023 catalogues.

For the exchange of material outside the Index Seminum system, BGCI has developed PlantShare, which facilitates the exchange of living plant material (cuttings, seeds, whole plants, pollen, etc.) between botanic gardens. PlantShare aims to support backing up of important collections, sharing material between institutions, and using valuable material for conservation purposes.

Features of these exchange platforms include:

- search and filter facilities such as: scientific name, family, garden, accession details or compliance regulations;
- bulk upload function;

## INDEX SEMINUM



- taxon names checked against references;
- message mechanisms between donor and requesting gardens;
- ability to create a request list with more than one person in your organisation.

Both tools are supported by peer-reviewed compliance certification in Access and Benefit Sharing, biosecurity and CITES, should institutions need this ([SheepApp \(sheepcrm.com\)](http://SheepApp (sheepcrm.com))).

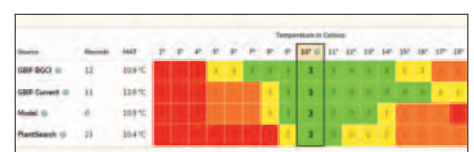
Find out more: [Index Seminum | Botanic Gardens Conservation International \(bgci.org\) and PlantShare | Botanic Gardens Conservation International \(bgci.org\)](http://Index Seminum | Botanic Gardens Conservation International (bgci.org) and PlantShare | Botanic Gardens Conservation International (bgci.org))

## Botanic Garden Climate Assessment Tool

The Climate Assessment Tool (CAT) provides guidance on the likely suitability of taxa to the predicted future climate scenarios of a selected location. It achieves this by taking datasets of current known occurrences of taxa – such as those observed in the wild, in botanic gardens, and in general cultivation – and compares the current climate of these known occurrences to the predicted climate. By comparing the two climates a suitability score can be generated.

It is this predictive modelling which supports informed decision-making on selection or evaluating plants for our living plant collections and landscapes.

Find out more: [Climate Assessment Tool | Botanic Gardens Conservation International \(bgci.org\)](http://Climate Assessment Tool | Botanic Gardens Conservation International (bgci.org))



## BGCI's Conservation Action Tracker



The Conservation Action Tracker provides real-time information on conservation actions for tree species. The tracker form allows practitioners to provide information for species that they are working on, or species that they know are under conservation action. The Conservation Action Tracker aims to facilitate connections between organisations working on threatened trees within the same genera, and threatened trees within the same country, as well as identify gaps in tree species conservation.

To date, the Conservation Action Tracker holds information for more than 2,750 tree species, including 1,563 threatened tree species of which 376 are Critically Endangered. With your support, we aim to obtain information for all known Critically Endangered trees on the IUCN Red List. By contributing your information to the tracker, you will be helping to develop cohesive plant conservation and facilitate connections between organisations and individuals working on similar species, promoting national and international collaboration

BGCI's Conservation Action Tracker is displayed in the **GlobalTree Portal**, which gives access to information on the almost 60,000 tree species, their distribution, conservation status, and conservation actions.

Find out more: [Conservation Action Tracker: a tool to help optimise conservation of tree species | Botanic Gardens Conservation International \(bgci.org\)](#)

## 2022 Global Botanic Garden Fund recipients

The GBGF aims to drive plant conservation, especially in smaller gardens by disbursing grants every year. In 2022, BGCI received 90 applications. Through the fund, BGCI and partner organisations are distributing 34 grants worth \$75,200 to 31 different institutions, across 24 different countries. Funding for the Global Botanic Garden Fund was made possible in 2022 by contributions from The Botanist Foundation, The Morton Arboretum, The Minnesota Landscape Arboretum, the Gibson Charitable Trust, and crowd-sourced funding through the 2021 Holiday Challenge.

Find out more: [BGCI Announces Global Botanic Garden Fund 2022 Recipients | Botanic Gardens Conservation International](#)

## Marsh Award recipients

The Marsh Awards are awarded annually by the Marsh Charitable Trust, in partnership with BGCI, in recognition of excellence by an individual in International Plant Conservation and Education in Botanic Gardens. We are pleased to announce Rudy Aguilar as the winner of the 2022 Marsh Award for Education in Botanic Gardens and Amelia Martyn Jensen as the winner of the 2022 Marsh Award for International Plant Conservation.



[Marsh award winners Rudy Aguilar and Amelia Martyn Jensen](#)

The awards were presented to the winner during a ceremony at the 7th Global Botanic Gardens Congress.

Read more about the winners here: [BGCI Announces 2022 Marsh Award Recipients | Botanic Gardens Conservation International](#)

## Updated Conservation Practitioner Accreditation



As part of a revision of all of BGCI's Accreditation Schemes, BGCI has redefined the targets required to achieve Conservation Practitioner

Accreditation and improved the application process. Conservation Practitioner Accreditation distinguishes botanic gardens from non-botanic gardens and recognises botanic organisations with a conservation of plant diversity oriented approach at the heart of their activities. The scheme aims to raise awareness and recognition of the activities that botanic gardens do exceptionally well to policymakers and funders. Accreditation results in tangible benefits for participating gardens – such as recognition, peer review, creating standards for excellence, and funding – and acts as a motivator for botanic garden leadership. To find out more and to apply, visit: [BGCI Updates Conservation Practitioner Accreditation | Botanic Gardens Conservation International](#)

## Launch of the European Beyond Xylella (BeXyl) project

The European Horizon 2020 project Beyond Xylella (BeXyl) looking at developing integrated management strategies for mitigating *Xylella fastidiosa* (Xf) impacts in Europe has recently been launched. *Xylella* infects a wide range of plants including many popular species grown in gardens, such as cherry, hebe, lavender and rosemary. The bacterium is transmitted between plants via insects which feed on plant sap.

As part of the project Consortium, BGCI through the International Plant Sentinel Network (IPSN), will be contributing by:

- engaging with botanic gardens/arboreta in the regions of interest to collect data on Xf presence in selected host plant species.
- helping to design/coordinate workshops/webinars to provide further information about Xf.
- helping in the dissemination/communication of the project outcomes.

To find out more, visit the project website: [Home - BeXyl Project](#)

## Reversing tree diversity decline: why we need all the species we've got?

According to a new report, 'Conserving and using tree diversity for global climate change adaptation and food system resilience', dwindling tree diversity is damaging to our planet's ecosystems – and ourselves – and constrains options for successful adaptation to the changing climate.

The report, which was co-authored by BGCI, was launched by the Crop Trust at the Global Landscapes Forum (GLF)'s annual Climate event, held alongside the United Nations Climate Change Conference (COP27) in Sharm El-Sheikh, Egypt.

The report highlights that the majority of current tree-planting commitments toward reforestation and climate mitigation agreements fail to take the importance of tree diversity into account. Instead they focus on monoculture plantations of fast-growing exotic species like eucalyptus and pine that fail to deliver improved ecosystem functioning, and enhanced biodiversity and resilience effects.

To find out more and read the report, please visit: [Reversing tree diversity decline: why we need all the species we've got? | Botanic Gardens Conservation International \(bgci.org\)](#)

## Researchers complete first comprehensive threat assessment of all U.S. Trees

For the first time, researchers have completed threat assessments for all 881 native tree species in the contiguous United States, resulting in a comprehensive checklist and



The Royal Botanic Garden, Jordan

synthesis that will serve as a critical baseline to guide future tree conservation efforts. The new assessment of U.S. trees reveals that 11-16% of tree species in the contiguous 48 U.S. states are threatened with extinction, with the most common threat being invasive and problematic pests and diseases.

Find out more: [Researchers Complete First Comprehensive Threat Assessment of all U.S. Trees | Botanic Gardens Conservation International \(bgci.org\)](#)

## BGCI Accreditation

The following gardens have achieved botanic garden accreditation since the last issue of BGjournal. Congratulations to all:

- Royal Botanic Gardens and Domain Trust – Australia - BGCI Accredited Botanic Garden
- Orchard of Flavours - Portugal - BGCI Accredited Botanic Garden
- Royal Botanic Garden, Jordan – BGCI Advanced Conservation Practitioner Accredited

Find out more about BGCI's Accreditation Scheme here: [About the BGCI Accreditation Scheme | Botanic Gardens Conservation International](#)

## Royal Botanic Garden, Jordan achieves Advanced Conservation Practitioner Accreditation

Congratulations are due to the Royal Botanic Garden (RBG), Jordan for achieving BGCI's highest accolade of Advanced Conservation Practitioner Accreditation.

The Garden was founded as a non governmental, non profit entity in 2005 to conserve the native flora of Jordan.

Its mission is:

*"To ensure native flora conservation through ecological restoration and providing a research and demonstration site to address the environmental challenges of our times and generating hope for the future".*

The collections assessment carried out as part of the Accreditation process revealed that RBG holds 795 taxa in its plant collection. Of these, 48 taxa are unique in ex situ collections worldwide, and 332 taxa are present in five or fewer ex situ collections globally. The collection includes 14 taxa that are globally threatened according to the IUCN Red List. Of these 14 taxa, 5 are held in five or fewer ex situ collections worldwide.

RBG's collection includes 294 taxa that are threatened at some level (regionally or globally) according to assessments stored in the BGCI ThreatSearch database. Of these 294 taxa, 4 taxa are uniquely conserved at the Royal Botanic Garden Jordan and 68 taxa are held in five or fewer ex situ collections worldwide.

The BGCI Advanced Conservation Accreditations are approved by BGCI's International Advisory Council. They noted that:

*"The progress made by the Garden in a short period has been remarkable and highlights what is possible with a great team and outstanding leadership"*

Find out more about RBG Jordan here: [Welcome to the Royal Botanic Garden of Jordan | Royal Botanic Garden](#)



## PLANT HUNTING TALES

Team of conservation horticulturists and botanists assessing the population and site conditions (Emma Simpkins)

# UNDERSTANDING GROWING CONDITIONS OF A PLANT ONLY KNOWN FROM ONE LOCATION: *VERONICA JOVELLANOIDES*

With approximately 356 threatened species and 88 species that are data deficient (Simpkins et al., in prep) about half of Auckland's flora is threatened or at risk. 11 species are endemic to the region (one of which is extinct) (Auckland Botanic Gardens, 2022) and many of Auckland's threatened plant species are range restricted, limited to a few individuals or single populations. The huge numbers of threatened species in the region highlights the vital role

of botanic gardens in plant conservation, both in terms of managing plant pressures *in situ* and maintaining back-up *ex situ* collections.

Auckland Botanic Gardens (ABG) has an *ex situ* conservation programme that aims to incorporate more threatened species into the garden, ensuring that these have provenance information and hold useful genetic diversity for future recovery projects. ABG's focus is to connect people with plants and gardens. One

of the most important collections for plant conservation, is the Threatened Native Plant Garden. In this garden, threatened species of Auckland and Northland are displayed in replica natural habitats. A few threatened species per habitat with their common non-threatened associates are displayed together, mimicking what would be seen in the wild. Interpretative signage of one threatened species per habitat highlights its plight and provides further engaging information as well as a 'call to action' for visitors.





*Veronica jovellanoides* among leaf litter (Emma Simpkins)

A few years ago, ABG were given wild provenance material of *Veronica jovellanoides* to display in the Threatened Native Plant Garden. This species is only known from a single location which is north of Auckland in a low-lying mixed podocarp/hardwood forest. It was only discovered in 2007 so this relatively recent discovery has raised many questions about its distribution and ecology. It's been visited by the local botanical society (Davidson & Hall, 2009) who did a thorough search of the area for more plants following the finding of the original site. The forest *V. jovellanoides* grows in is very unusual for Auckland with cool conditions, low humidity and low light levels, making it the perfect place for cold-loving plants to exist. Because

of its limited distribution, this species is listed Nationally as Critical. It produces small white flowers from October to December. Although it grows easily in nursery conditions and is easy to propagate from rooted pieces, keeping it alive in a garden is much harder. The specific climatic conditions that *V. jovellanoides* experiences in the wild are challenging to replicate in a garden where light and moisture levels need to be just right. For our horticultural staff, we needed to learn more about the species to better support its ex situ conservation.

In June 2022, staff from ABG went on a field trip to visit the wild site and to better understand the natural habitat in order to apply

observations and learnings to its care in cultivation. There were several small populations at the site that we visited. These are monitored annually by the Department of Conservation. Some herbicide is also taken during these trips in case weeds are encroaching on the populations. We quickly found the original population (the first population found in 2007) which is clustered and sparse along the banks of a stream. There may have been some regression in the population since the last monitoring trip, but generally the population was healthy and no immediate weed threats were observed. Several other sites, some of which were translocation sites, were found and one was relocated after 9 years of searching. It appears these populations are maintaining, rather than spreading in size.

One of the key purposes of ABG staff joining on this trip was because an ex situ collection is being established at the gardens. ABG will also be involved in the propagation of plants for translocations. Translocations have been relatively unsuccessful to date, and we need to build our understanding of this species before attempting this again. Curators (conservation horticulturists) and propagation staff join field work regularly to expand their plant knowledge, but also to see and experience first hand, the environmental conditions these plants naturally occur in.



Ella Rawcliffe, Botanical Records and Conservation Specialist, will be leading the ongoing ex situ programme at the gardens (Emma Simpkins)



Ex situ plants at Auckland Botanic Gardens nursery are flourishing and flowering (Emma Simpkins)

It's important that horticultural staff are actively involved in field work so they can bring the knowledge gained to the curation of plants. They make observations on the soil, moisture, light, aspect, associated species and other environmental factors that will help them to replicate these conditions in the garden and nursery. Horticultural skills are critical for plant conservation, and therefore we need to support opportunities for staff to develop such skills and look critically at plant requirements prior to introducing new species into our collections.

Even when you might be looking for one or a few target species on a trip, you cannot help but get distracted by other botanical beauties, and that was the case when we stumbled upon a single blue mushroom (*Entoloma hochstetteri*). It is well known to New Zealanders as it features on the \$50 note, so it was very exciting to see one for the first time. It was so popular in fact, that when I shared this photo of it on twitter over 18,000 people liked it. This fungus is commonly associated with podocarp forests, so it's not surprising we encountered it on this trip.

Following our trip, we then collated our observations and used these to select sites at ABG that would be suitable for planting. We paid close attention to soil moisture and light levels. We needed to find places that did not dry out during summer, had low light



An exciting find, the blue mushroom (*Entoloma hochstetteri*) while exploring the forest. (Emma Simpkins)

levels (i.e. dappled light) and low humidity. The gardens soil is mostly clay and finding a site that has minimal clay is challenging, but important to minimise summer drying and prevent the need for watering. There is no irrigation in most of the garden so establishing a self-sustaining planting is critical. The natural population of *V. jovellanoides* occurred on northerly facing slopes and we also took this into consideration. There are several small streams throughout the gardens which we decided were the most appropriate sites for planting and best replicated the natural environment and conditions. The ABG plantings done in August 2022 will be closely monitored over the summer and provide more cultivation information that will inform future translocations. They have already started to flower (they had not yet flowered in the gardens during previous planting attempts) which is a good sign of favorable conditions.

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Ariel view of the Shanghai Botanical Garden

## FEATURED GARDEN

# HISTORY AND FUTURE STRATEGY OF COLLECTIONS IN SHANGHAI BOTANICAL GARDEN

## Introduction

The Shanghai Botanical Garden (SHBG), which covers an area of 81.86 hectares, is located in Xuhui District, the cultural and educational center of southern Shanghai, adjacent to the Huangpu River. It was established in 1974 and is a comprehensive botanic garden (BG) focusing on plant introduction, acclimatization and exhibition of plant diversity, horticultural research and popular science education. Shanghai, as a mega-city in China and a representative of the Yangtze River Delta cities, was the first to come into contact with the ideas of western BGs.

In this paper, we focus on the plant collection and introduction of Shanghai's regional BGs, covering almost 100 years of BG construction

and its collection history before and after SHBG establishment. We also reflect on the formulation of future collection strategies to participate more effectively in the Global Strategy for Plant Conservation promoting the Chinese Plant Conservation Strategy Initiative (2021-2030) for Collective Conservation in Chinese Botanical Gardens and the construction of the National Botanical Garden System.

## Historical collection<sup>1</sup>

The historical collection of SHBG began roughly in 1917 with the preparation of the Shanghai County Botanical Garden in the form of a nursery. This was also the time when the concept of modern botanical gardens was introduced to China from the West. Then the County Botanical Garden was turned into a municipal horticultural yard,

which gradually evolved from its name and function to producing seedlings and wood production, indicating the discontinuation of its construction as a BG. Almost around the same period, Shanghai Municipal Education Bureau set up, for teaching purposes, the 'school-affiliated' BG and this was subsequently transferred to the jurisdiction of Shanghai government in 1928 and the site moved. In 1933 the establishment of a municipal BG was approved. This consisted of 12 theme gardens and was open to the public. The BG properties gradually appeared, but due to the Japanese occupation of the city of Shanghai in 1937, the BG construction was abandoned.

In 1947, a small BG was constructed within Zhongshan Park, covering an area of nearly 90 acres, with a plan to collect about 700 species of native plants arranged according to the Classification System of Engler, with a Rose Garden, Rhododendron Garden, Bamboo Garden, and Vine Garden, etc. In 1950, the field collection began, and according to records, grew to include 400 species of woody plants alone at that time. However, the BG did not expand further because of the limited conditions in the park.



View of the garden

In 1958, there was a proposal to rebuild the Shanghai BG in Sheshan, a suburb of Shanghai with better natural conditions, for popular science, teaching and research. Later, due to the special political and economic difficulties of the country, the BG construction was discontinued and the process of building a BG in Shanghai was once again interrupted. However, during the 10 years of construction in Sheshan, in addition to general planting, seed exchange relations were established with more than a dozen BGs both domestically and abroad, introducing more than 4,000 seeds and breeding more than 500 species of trees and shrubs, providing new materials for landscaping and gardening in the Shanghai area.

During the same period, to meet the needs of urban construction and landscaping, the city of Shanghai planned and built the Longhua Nursery (1953-1973), which mainly focused on the introduction and cultivation of grasses, potted flowers and valuable ornamental trees, with a total of more than 600 species of plants introduced in 20 years. This also included more distinctive plants such as Penjing,



Construction scene from 1908

orchids, rhododendrons, camellias, chrysanthemums, etc. A parent garden was also established on the south side of the present Penjing Garden, with diverse tree collections. This provided important material for the future construction of SHBG, laid the foundation for the city's landscaping and the establishment of the first collection nursery in 1973.

### Post 1974: The construction & development collection

As it was no longer possible to construct SHBG based on Sheshan BG, it was decided to build SHBG on the site of Longhua Nursery, and the construction was officially approved in March 1974. At the beginning of the con-

struction, SHBG decided to collect plants mainly from East China and introduce, as appropriate, plants with ornamental and economic values from all over China and abroad. The long-term plan called for the collection of 5,000 species of plants (excluding varieties), including 2,000 open-field plants, 2,000 conservatory plants and 1,000 medicinal plants. In 1973, the introduction list was compiled and in 1974, the first collection trip was made to southern Zhejiang and northern Fujian. In the early stage of construction, a dedicated seed introduction team was set up to carry out plant collection and seed exchange, and through its 20 years of independent operation, played a great role in promoting seed introduction at SHBG. During this period, collections were made mainly in East and Central China, including Zhejiang, Fujian, Anhui, Jiangxi, Hunan, and Sichuan, and the number of species increased rapidly through collecting seeds for sowing, directly collecting wild seedlings, and establishing introduction bases. 1975 saw the establishment of introductory bases in West Tianmu Mountain in Zhejiang, Huangshan in Anhui, Dayu County in Jiangxi, Zhanjiang in Guangdong, and Hainan Island, with staff based locally to collect wild seedlings and plant them for a period of time before introducing them back to Shanghai. The footprints of the pioneers of SHBG, led by Mr Zhuang Maochang, can be found from Changbai Mountain and Xiaoxinganling in the northeast to Diaoluo Mountain and Jianfengling in Hainan Island, and from Tianmu Mountain in Zhejiang to the Yunnan-Guizhou Plateau in the southwest.



View of the lake within the garden

According to the limited information available, SHBG conducted surveys and produced catalogues of introduced plants at different levels of detail in 1976, 1983, 1993, 2003, and 2013. A total 1,495 species of plants were introduced in 1976, 984 species were preserved alive at the end of 1977, and the number of plant species increased to nearly 3,000 in the decade to 1983. In 1993, 20 years since SHBG was established, the total number of introduced plants was 3,033 taxa (including species and subspecies), and by 2003, this had reached more than 5,000 taxa. The most recent systematic survey of plants introduced to SHBG was in 2013, with a total of 6,813 taxa (see Table 1).

In the process of collection and introduction, during this period, the team gathered experienced with plants from far and near, some easy and others more difficult to manage. There was a gradual shift from extensive introductions to a focus on specialized species and the introduction and conservation of rare and endangered plants. A collection of dominant taxa and characteristic theme gardens gradually emerged. Representative taxa are Ericaceae, Theaceae, Orchidaceae, Aceraceae, Magnoliaceae, Piperaceae, Iridaceae, Bromeliaceae, Gesneriaceae, Zingiberaceae, Araceae, Marantaceae, Coton-easter, Berberis, Ilex, Viburnum, Cornus, Prunus, Chaenomeles, Malus, Spiraea, Lonicera, Hypericum, Begonia, Hosta, Clematis, ferns and succulents, as well as the traditionally famous flowers such as peony, plum blossom, bamboo and chrysanthemum.

### Seed exchange

Seed exchange work first began in the 1950s-1960s during the construction of the Sheshan Botanical Garden. In 1980, the first Seed Exchange Catalogue of the SHBG, containing 770 species of plants, was compiled and the catalogue was sent to institutions abroad. The catalogue was based on the seeds of plants collected in the field, and in addition to Latin names, it also recorded information on the time, place, altitude, ecological environment and collector, in order to meet the needs of botanists and experts in the acclimatization of introduced species. From the beginning of its release, the exchange catalogue was valued by various international botanical gardens, arboreta, parks, and research and teaching institutions which requested to establish seed exchange

No of taxa (species and sub-species)				
Year	Ferns	Gymnosperms	Angiosperms	Total
1993	48 (18 families/ 24 genera)	171 (10 families / 35 genera)	2,814 (158 families / 899 genera)	3,033
2013	100 (30 families / 44 genera)	133 (11 families / 29 genera)	6,622 (177 families / 1,257 genera)	6,813

Table 1: The increase in the number of taxa held at SHBG from 1993 to 2013.



Cymbidium House

relationships. More than 400 institutions were exchanging seed regularly and this reached a peak of more than 600. The seed exchange at the SHBG has been closely linked to the extensive plant introductions (1974-1981), special family and genus introductions (1981-1999) and cultivation and propagation research (2000-2011) and has also expanded the international influence and reputation of SHBG.

### Current status of collection of and future strategy

Shanghai Botanical Garden currently holds a total of 3,500 species and more than 7,000 varieties and cultivars with several important conservation taxa such as Magnoliaceae, Iridaceae, Theaceae, Ericaceae, Aceraceae, Orchidaceae, Bromeliaceae, Gesneriaceae, as well as distinctive and renowned theme gardens, such as the Penjing Garden, Chinese Cymbidium House, Magnolia Garden, Maple Garden, Rhododendron Garden, Conifer Garden, Herb Garden, etc. These were all determined in the early stage of the

In March 1995, the Royal Horticultural Society awarded Mr. WANG Dajun of SHBG the Veitch Commemorative Medal in recognition of his outstanding contributions in the field of seed exchange and international communication on horticulture. In 1996, the then British Deputy Prime Minister, Mr. Heseltine, requested the seed exchange catalogue of SHBG through the British Foreign Office, and in his letter, he spoke highly of the seed exchange catalogue and paid a special trip to SHBG during his visit to Shanghai.

Garden's establishment for collection, research and construction, demonstrating the importance of the historical heritage and long-term activities of BGs in the collection and conservation of species. Up to now, SHBG has conserved a wide range of taxa (see Table 2) including 351 species of rare and endangered plant species (belonging to 66 families and 170 genera).

Family	No. of taxa
Magnoliaceae	nearly 200
Iridaceae	450
Theaceae	460
Ericaceae	180
Orchidaceae	650
Aceraceae	42
Bromeliadaceae	1,100
Gesneriaceae	350
Begoniaceae	150

Table 2. No of taxa per family represented in the SHBG collections

It is one of the richest collections of rare and endangered plants in China, with 105 species of national Class I protected plants and 246 species of national Class II protected plants. Many of these species have been able to adapt to the new ecological environment of Shanghai. Species such as the Jack Tree (*Sinojackia xylocarpa*), Chinese Swamp Cypress (*Glyptostrobus pensilis*), Katsura (*Cercidiphyllum japonicum*), Amur Cork Tree (*Phellodendron amurense*), *Acer amplum* subsp. *catalpifolium*, *Yulania zenii*, *Neolitsea sericea*, and Hardy Rubber Tree (*Eucommia ulmoides*) have grown well, and Dawn Redwood (*Metasequoia glyptostroboides*), Ginkgo (*Ginkgo biloba*), *Eucommia ulmoides*, and Chinese Tulip Tree (*Liriodendron chinense*) have been widely used.

Among the longest history of introduction, the most distinctive theme gardens are the Penjing Garden and Chinese Cymbidium House. The Penjing Garden covers an area of 4.3 hectares and houses the first Penjing Museum in China. It contains more than 2,000 pots of various types of bonsai, making the Penjing garden one of the richest and best quality bonsai collections worldwide. The art



### The Penjing Garden

The Penjing Garden uses mostly natural rocks and bamboo for its pavilions and corridors and the tiled walls of Jiangnan houses are used to build courtyard walls and exhibition rooms. Powder walls provide a base to set off the artistic shapes of rocks and stump bonsai, creating a simple and natural, poetic and interesting Jiangnan courtyard. The Penjing Garden has many garden spaces of various sizes, forms and

contents, forming a spatial sequence of alternating sizes, distinct primary and secondary ups and downs, both colorful and harmonious. Each space has its own main and supporting scenery and strives to focus on the main scenery, highlighting the main bonsai. The bonsai created by the bonsai masters of SHBG have won many international awards and have promoted bonsai skills in many countries, playing an important role in international communications and national foreign affairs.

of bonsai originated in China during the Tang Dynasty and has a history of more than 1,300 years. The Penjing Garden of SHBG was inherited from the Longhua Nursery and during its twenty years of construction, it has collected and created a large number of bonsai, including more than 100 years of stump bonsai, miniature bonsai, wall hanging bonsai, rock bonsai, giant bonsai, etc. There are more than one hundred species of trees and more than ten species of stones, forming

the Shanghai-style (Hai-Pai) Penjing with local characteristics of Shanghai and it has become one of the five major schools of bonsai in China.

The orchid collection and display are divided into two parts: one is the collection and introduction of tropical orchids in the conservatory, which currently includes about 600 species of orchids; the other is the Chinese Cymbidium House, which mainly collects and displays traditional Chinese orchids and related orchid culture. The Chinese Cymbidium House was planned to be built in the 1950s and completed in 1965. The name of the house was inscribed by ZHU De, one of the Founding Fathers of China, and it is a brick and wood structure in the style of Jiangnan residential houses. Other buildings include the cymbidium culture building, tea room, foyer, pavilions, exhibition gallery, and greenhouse. Among them, the most precious are 22 pots of orchids, such as 'ZHU's New Plum' and *Cymbidium hookerianum* gifted by ZHU De, and a large number of orchids gifted by General ZHANG Xueliang and Japanese friends.



Conservatory

## Future collection strategy

In the future, SHBG will combine the 14th Five-Year Plan (2020-2025) and the 2035 visionary goal, focusing on three types of collection: historical collection, research collection and rare and endangered species collection. At the same time, strengthening the scientific and long-term nature of the collections, systematically collecting specimens, seeds, DNA, *in vitro* materials, literature and archives of key taxa. During the 14th Five-Year Plan period, the total number of species collected and preserved in the SHBG will increase to 5,000 with 10,000 varieties and cultivars, and by 2035, the total number of taxa preserved is aimed to exceed 20,000, with the proportion of species exceeding 50%, covering all rare and endangered species in the Flora of Eastern China, and continuously increasing the proportion of independently collected and introduced species and wild plants.

### 1. Priority areas for introduction

Choosing the correct site for plant introduction is essential for success. Generally speaking, introduction from the same or similar climate zone is the most likely to be successful. The Shanghai area is classified as the northern subtropical zone, but because of the influence of the ocean, its main meteorological conditions are slightly more moderate than those of Nanjing and Wuhan in the same climate zone and rather similar to Hangzhou, Changhua, Yixing and Liyang mountains on the northern edge of the central subtropical zone. Therefore, the Yixing and Liyang mountains in East China, Tianmu Mountain in West Zhejiang, Changhua, Tiantai Mountain in East Zhejiang, Siming Mountains, Mt. Lushan in Jiangxi, Mt. in Anhui, Dabie Mountain and Jihua Mountain are naturally the most ideal



Shanghai International Flower Show

places from which to introduce new species, also conforming to the principle of nearby introduction. From the analysis of meteorological data, a considerable number of tree species could be successfully introduced, so prioritization of species is important. Secondary priority areas are the north subtropical Yangtze River basin, such as the west of Hubei and eastern Sichuan in central China, which contains more endemic genera and species. The vertical distribution of mountainous areas in western and southwestern China is also worthy of attention. Usually, alpine plants at low latitudes can be successfully introduced northward, and the range of introductions can be further shifted to the south.

### 2. Priority taxa for introduction

The botanical garden should prioritize the collection and conservation of threatened species, focusing on the enhancement of conservation efficiency and the success of reintroduction, while strengthening scientific research for effective conservation. The priority direction of future introductions in the SHBG will focus on species with important scientific research, economic, ecological and

cultural values, and the priority direction of introductions will be considered from two aspects. First, the key characteristic taxa established at the beginning of the garden. These have a good research foundation and continue to have advantages to this day. It is also clear that most of the plants in this category are adapted to the climatic conditions of Shanghai and have a high success rate of *ex situ* conservation, such as Iridaceae, Magnoliaceae, Ericaceae, Theaceae, Orchidaceae, Aceraceae, Rosaceae (*Cotoneaster*, *Malus*, *Chaenomeles*). Second, to meet the needs of future biodiversity conservation strategies, botanical garden construction and urban development, the focus will be on introduction and conservation of rare and endangered species (IUCN Red List of Threatened Species, Red List of Chinese Plants and National List of Key Protected Wild Plants), conservatory plants (Gesneriaceae, Begoniaceae, Bromeliaceae, Araceae, ferns and succulents, etc.), bonsai, flowering shrubs (*Ilex*, *Viburnum*, *Hibiscus*, etc.), perennial herbaceous flowers and vines such as *Hedera*, *Clematis*, and *Akebia*. Further efforts will focus on improving the relevant conservation platforms and research systems, such as the Gesneriad Conservation Center of China (GCCC) - Shanghai Branch, and the National Forestry and Grass Administration Research Center for the Expansion and Relocation of Rare and Endangered Plants of the Magnoliaceae, to provide material security for the sustainable use of plant resources.

#### ENDNOTES

<sup>1</sup>We regard the collection before 1974, when the site of the SHBG was formally established, as the 'historical collection' and the collection post 1974 as the 'collection during the construction and development period', or 'construction & development collection'.



Rose Garden

## INTERVIEW

PATRICIA  
MALCOLM

As this issue of BGjournal is focused on projects supported by BGCI's Global Botanic Garden Fund, it seemed only appropriate to interview the person doing all the hard work behind the scenes to make the scheme a success. We are therefore very pleased to feature this interview with Patricia Malcolm, BGCI's Membership and Conservation Services Manager.



**BGCI's Global Botanic Garden Fund aims to support 15-20 grants per year – do you get many more applications than this and how do you decide who will benefit?**

The Global Botanic Garden Fund was launched in 2019, just before the COVID-19 pandemic, making 2022 the fourth round of grants. During this period, we have awarded in total 122 grants to 77 different recipient institutions in over 37 countries. However, we received three times this number of applications, and unfortunately, were not able to fund over 300 proposals. Many of these unfunded projects had great potential and would have made a real impact on the ground. There is a clear need for more funds to be made available to support small grants for plant conservation, education and sustainability projects.

The main factor in the decision on which projects to fund is the quality of the application. Has the applicant demonstrated that the pro-

ject is achievable in one year and within budget, have risks and means of evaluation been identified, are the objectives and plan put together well, is the project good value for money, and does the project meet the criteria of the grant? All project proposals are scored by at least two BGCI staff or funding partners and the projects are ranked. If we have more good projects than funds available (usually this is the case every year) we assess issues such as previous funding received by the institution and how well they previously delivered. We also consider the location of the project – is it in a region of the world with high plant biodiversity? We try to distribute the funding evenly across different countries and types of projects (for instance plant conservation, *ex situ*, *in situ*, education, sustainability etc.).

**There are a number of different grants all contributing to the Global Fund. Are these administered separately, or are you responsible for all the grant schemes?**

Yes we do have a number of different schemes that all contribute to the GBGF. These include the Minnesota Landscape Arboretum Grants that focus on general maintenance education and conservation in botanic gardens and arboreta. These are administered on behalf of the Minnesota Arboretum. And the BGCI/ArbNet Partnership Programme Grant, which we run jointly with the Morton Arboretum and focuses on tree conservation.

Then there is the Global Genome Initiative Gardens (GGI-Gardens) Awards Programme which is funded by the United States Botanic Garden, and jointly administered by BGCI and GGI-Gardens, focusing on collecting genome-quality plant tissues and depositing them into recognised biobanks.

So we have varying levels of involvement in the various schemes, but try to ensure that there is overall coordination across all the grants awarded.

**The grants are all quite small (a maximum of US\$2,500). Are these small grants sufficient to generate a real impact for the gardens who receive them?**

Yes, the grants are small, but we do aim to support as many gardens and their plant conservation activities as we can worldwide.

In some countries it can be very difficult to find even the small amounts of funding required for basic botanic garden maintenance, or for installing a new interpretation panel, or for travel to search for populations of rare and endangered species. We try to keep the application and the reporting processes as simple as possible to encourage smaller gardens with fewer resources to apply. I think if we increased the amounts provided, then the application and reporting would need to be more vigorous. Often the funds we provide complement other funding sources available to the garden or project, or help the garden apply for larger grants. Without our funding, some of these projects would never happen. The stories in this issue BGjournal highlight some of our successes.

**What is the biggest challenge you face as the overall administrator of the GBGF?**

The biggest challenge is keeping track of all the questions, extensions and special circumstances of all these projects. I am a team of one, and I am not only responsible for the GBGF, but also look after BGCI membership and accreditation amongst other things. Another difficulty we encounter relates to transfer the funds - it is so frustrating to see how part of the grants can be lost to unnecessary bureaucracy.

**In your role at BGCI, you must have contacts with botanic gardens all over the world. Have you had the chance to visit many of them, and of the ones you have visited, which is your favourite?**

Unfortunately not...I have a very busy family life with three young children. I do however travel through the computer, meeting people in Zoom and seeing all the wonderful project reports with videos and photos. So keep them coming! One day, when the kids leave home, I hope to be able to visit more of the projects in person.

To find out more about the GBGF, including the recipients of the 2022 awards, please visit: [BGCI Announces Global Botanic Garden Fund 2022 Recipients | Botanic Gardens Conservation International](#)



## **ARTICLES**

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**JAWAHARLAL NEHRU TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE AND THE GLOBAL GENOME INITIATIVE FOR GARDENS (GGI-GARDENS)**

**15 YEARS OF PLANT COLLECTING IN NORTHWESTERN LUZON, PHILIPPINES**



# REDISCOVERY AND CONSERVATION OF THE LOST EBONY *DIOSPYROS KETSENSIS* IN MADAGASCAR

Mature fruit of *Diospyros ketsensis* (Toky Ralainarina - MBG)

## Introduction

Originally described in 1926 by Perrier de la Bâthie, *Diospyros ketsensis* was previously only known from a single locality and a single herbarium specimen. It was collected in the Malagasy highlands, more precisely near Mahatsinjo to the North-West of Tampoketsa d'Ankazobe, with information indicating that its habitat was a recently burned fragment of forest. Locally endemic and listed as critically endangered under B2ab(ii,iii,iv,v) criteria, *Diospyros ketsensis* has never been knowingly seen by scientists since.

Given that the natural habitat of this species has been badly degraded due to the exploitation of timber, agriculture, charcoal manufacture and wild fires and that many forest fragments in the Tampoketsa have been lost over the past decades, it was thought likely that this species was now extinct in the wild. However, there was also a chance that it still survived in one of the remaining, albeit severely degraded, frag-

ment. Botanists had previously seen the ebony species, *Diospyros ketsensis*, only once, in 1926, when it was collected from a fire-threatened fragment of forest on the Malagasy Highlands. Through this project, our team has now been able to locate 4 small subpopulations of this species containing a total of 17 mature plants.

ments, and it is important for science to make an evidence-based decision regarding its conservation status and then implement informed conservation action. The purpose of this study was therefore to try to re-locate the species in its natural habitat and to obtain the demographic, ecological and cartographic data needed to update information on the IUCN Red List of threatened species.

## Description of the species

According to the information available on TROPICOS (<http://legacy.tropicos.org/Pro->

ject/Madagascar), in September 1926 H. Perrier de la Bâthie collected a species of *Diospyros* which he described as *Diospyros ketsensis* (collection number 17785). The associated geographical coordinates assigned post-facto were judged imprecise. The only useful data were the locality, the threat and the biological form of the species, described on the label of the herbarium specimen as follows: "Shrub or small tree. Center, Mahatsinjo, N-W of Ankazobe's Tampoketsa. Remains of burnt wood. Madagascar, Mahajanga, Betsiboka, Mahatsinjo, Tampoketsa d'Ankazobe."

The species belongs to the Ebenaceae family, considered to be a valuable wood in Madagascar. The following description was made in 1952 (de la Bâthie) : "Shrub or small evergreen tree, habit of a Boxwood; branches rigid: young stems and petiole pubescent. Leaves leathery, small, dull brown in herbarium; petiole 3-4 mm; blade elliptical or slightly obovate (15-36 X 8-23 mm)..... Female flower and fruit unknown. Ecologies and habitat: Woods on western slopes, around 1000 m altitude, on lateritic clays."

## Investigating the collection history and chronology

Studies in the TROPICOS database of the collections made by Perrier de la Bâthie from the same locality as the target species, before and after its collection (Nos. 17783, 17786 and 17788) revealed three associated species namely *Solanum sambiranense* D'Arcy & Rakot., *Phylloxylon xiphioclada* (Baker) Du Puy, Labat, *Eugenia viguieriana* H.Perrier. and therefore, searches were focused in areas where these species could be found. Expanding our analysis of Perrier de la Bâthie's more widely, we noted that he followed the axis of the National Road and therefore we focused our search on the fragments of forest located near this road.

## Area of intervention and mapping

Based on location information obtained from the label information of herbarium specimens, combined with the location of



Awareness-raising about *Diospyros ketsensis* in village close to one of the sub-populations (Toky Ralainarina - MBG)

remaining forest fragments we established a map showing the areas where we would seek the species. There maps were further refined using a digital elevation model (DEM) with search priority being given to areas with an elevation of between 800 and 1,400 m.

## Plant interviews

Within the identified search zones, our first step in the field was to visit local villages and meet with residents both from courtesy to inform them what we were doing in their landscape and seek plant and landscape knowledge from the local population. These village meetings are very important for the recognition and authorization of landowners in private properties but also to achieve the

objectives of the project by establishing an atmosphere of trust between the researchers and the local population. During the meetings, the objectives of the mission were stated and the photos of the type specimen were shown to everyone for informal and unstructured interviews. This method allowed several informants to participate in the interview and thus maximise the information collected on the target species. It also helped in the identification and recruitment of local guides who are deemed knowledgeable about the landscape and the natural world. Also, these meetings were used to derive information on local attitudes to nature and their perceptions of how remaining natural ecosystems in their landscape are threatened. In addition, information was sought during field work from guides, porters and cooks.

## Botanical inventory and systematic survey of habitats

Following the village meetings, and with the assent of the local population, we could begin work to relocate *Diospyros ketsensis*. This field work was guided by the maps we had created but also by local knowledge. The objective of this work was first to relocate the species, and then collect herbarium specimens to enable specialist confirmation, estimate the population size and presence of regeneration, and describe the habitat and threats. Also, we hoped to collect seed samples to enable the ex situ conservation of the species. Seed samples were to be propagated to the nearby Ankafobe Forest reserve, which supports a field gene bank.



Unprotected natural forest fragment habitat of *Diospyros ketsensis* at Antokonana – (Toky Ralainarina - MBG)

Location	Irindravato (2 Ha)	Belanitra (0,55 Ha)	Antokonana (2,21 Ha)	Andramala (0,88 Ha)	Total
Numbers of mature plants	4	3	7	3	17
Numbers of immature plants	9	18	25	2	54
Total	13	21	32	5	

Table 1: Number of individuals relocated by location

## Locating the species

After 27 field trips to the search area over 1.5 years field work, we were able to locate the target species in 4 forest fragments in Ankazobe District. Initially a few sterile plants were located that were thought likely to be *D. ketsensis*, but fertile materials (i.e. with flowers or fruits) were required to confirm our suspicions. These were only obtained after many months of monitoring. These specimens have now been confirmed as *D. ketsensis* by specialists. Among the specimens was the first ever specimen of *D. ketsensis* with female flowers and the first ever specimen in fruit (Perrier de Bathie's specimen was in flower). Table 1 summarizes the number of individuals inventoried.

## Habitat and ecology of the species

The habitat of the species is forest fragments within the mainly savannah landscape of the "Tampoketsa", at an altitude between 800 and 1400 meters above sea level. The topography is hilly and composed of thin soils, poor in nutrients and rich in iron, resting on a Precambrian granitic base. Water courses cross the landscape, and most of the forests where the species was encountered are riparian forests on granite bedrock. The average monthly minimum temperature on Tampoketsa ranges from 9.60°C (June) to 17.49°C (October), and the average monthly maximum temperature peaks at 22.27°C in August and 31.51°C in November. The average annual precipitation is 1,671 mm, almost all of which falls between November and March (Local data, 2021).

Although the survey area is in the sub-humid forest ecoregion of Madagascar, there is very little forest left on the Tampoketsa – making this biome one of Madagascar's most threatened. Tampoketsa has been

heavily altered since the colonisation by humans of this landscape around 1,000 years ago. Although the extent to which this area was originally forested remains a matter of debate, large tracts of forest have either been degraded for timber and charcoal production and then burnt or cleared entirely to grow rice, maize, cassava, beans and pineapples. The forest that remains today, including the four locations where *D. ketsensis* was located, is heavily degraded, fragmented into tiny areas, and much threatened. The most important current threats are the exploitation of wood for charcoal or timber (now acute since very little wood remains in this landscape) and frequent (almost annual) grassland fires can penetrate small degraded forest fragments.

Right: Male flowers of *Diospyros ketsensis* (Tahiry Rivoaharison - MBG)



Tahiry using SMART mobile for research and monitoring the target species (Toky Ralainaorina - MBG)



Stem of *Diospyros ketsensis* to be made into voucher herbarium specimen with Toky Ralainaorina and Tahiry Rivoaharison (Jeannie Raharimampionona - MBG)



Young plant of *Diospyros ketsensis* growing in a waterbox in the field genebank at Ankafobe Forest, Madagascar (Toky Ralainaorina - MBG)

### Ex situ conservation

Given these extreme threats to the wild populations of *D. ketsensis* we decided to collect some seeds for ex situ conservation and we are pleased to report that 8 individuals of this species are now growing in the field gene-bank associated with the Ankafobe Forest Protected Area.

### Conclusion

We are pleased to report that our team was able to re-locate *Diospyros ketsensis*. In total, 4 small subpopulations of this species were located containing a total of 17 mature plants. All the sub-populations were growing in tiny forest fragments that are threatened both by wildfires, that annually sweep over the surrounding savanna, and exploitation of woody plants by local people for timber and fuel.

Although the target species has been re-located, its current threat status seems amply justified: with few tiny and highly threatened sub-populations. The work also provided the first ever specimens of female flowers and fruit that will enable this species to be fully described for the first time.

The eight plants that are now growing in the field gene bank at Ankafobe are quite secure but additional measures to protect this mini-botanical garden from wildfires are recommended. It would also be desirable to collect and propagate more seeds to both reinforce the population in the field gene-bank and also to create a second safety-net ex situ population (perhaps at the Parc Botanique et Zoologique de Tsimbazaza) in the Malagasy capital Antananarivo. Further action is also required to conserve the tiny populations of this species in the wild. Certainly, the awareness-raising among the host community, which we have already begun, should continue, accompanied by a direct request for people not to exploit the forest for wood.

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This project was supported by a grant from the Anthony Hitchcock Species Recovery Fund, administered by BGCI.



Young fruits of *Diospyros ketsensis* (Tahiry Rivoaharison - MBG)



# EX SITU CONSERVATION OF THE ENDANGERED HOLOPARASITE, *DACTYLANTHUS TAYLORII* (PUA O TE RĒINGA)

*Dactylanthus taylorii* in its natural habitat

## Project background

**D**actylanthus taylorii (Pua o te Rēinga, woodrose) is New Zealand's only holoparasitic flowering plant and, as is the case with its pollinator, *Mystacina tuberculata* (short-tailed bat), is endemic to New Zealand. Based on pollen fossil records, *D. taylorii* was distributed over the entire length of both the North and South Islands but due to habitat destruction and impact from introduced pest species it is now restricted to < 5% of its former range. There is no question that the most effective conservation mechanism is habitat protection. However, ex situ collections can play a critical and fundamental role in combating extinction and for many species ex situ conservation via germplasm banking and living collections is essential to prevent extinction. The aim of this ex situ conservation project for *D. taylorii* was to establish a genetically diverse ex situ

collection through seed banking (conventional and cryopreservation) and living collections which could be used for research, seed production as well as reintroduction and population enhancement. The project also provided support for in situ conservation through population assessments, hand pollination and enhancing populations through seed plots. Conservation of *D. taylorii* is a collaborative project involving kaitiaki (guardians) rangers from Zealandia Ecosanctuary in Wellington, mana whenua, community conservation groups, Department of Conservation and Ōtari Native Botanic Garden.

## Project objectives

The aim of this project was to establish ex situ collections through germplasm banking and living collections. A brief overview of the specific objectives, including outcomes and challenges are discussed below.

## Seed germination and seedling establishment

There is currently limited information on the seed germination and seedling establishment requirements for *Dactylanthus taylorii*. Plants can take 5 – 10 years before appearing above ground and it is not known when germination starts and what triggers germination. Investigations into seed biology and seed germination for *D. taylorii* was conducted through:

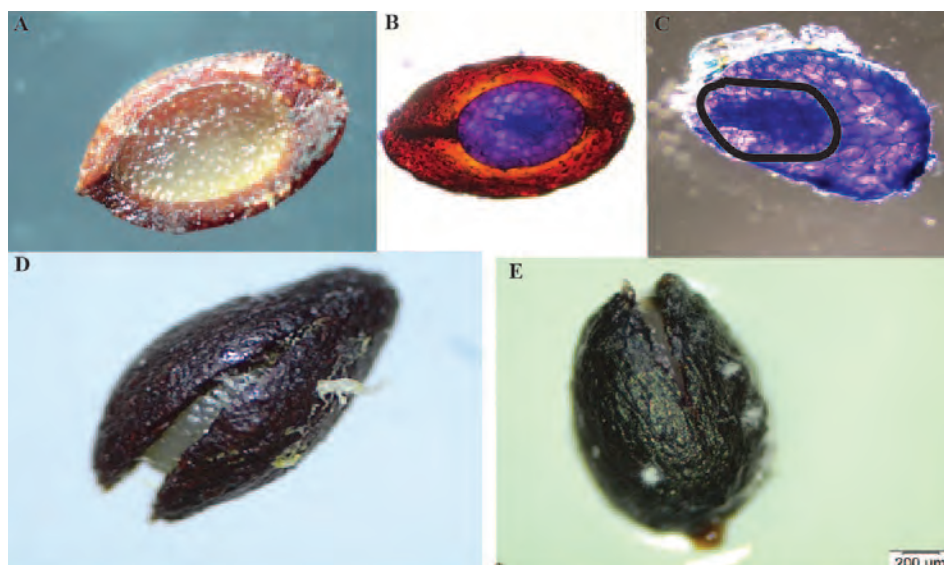
- Collecting small samples of seed throughout the seed development period (June to October). This provided insight into the timing of the onset of seed dormancy. For some species, including many orchids, seed is not dormant before or at natural maturity, but becomes dormant if environmental conditions at the time are not suitable.

- Seed germination trials using different media combinations including a) agar only, b) agar supplemented with gibberellic acid and c) agar with soil collected from natural populations/forest areas at Ōtari.
- Investigating the role of low temperature stratification and germination temperature on seed germination.

The research found that at time of natural seed dispersal (October), the embryo is underdeveloped and takes approximately 10 months to reach maturity (Fig. 1A-C). Once the embryo is fully developed, the seed coat splits indicating the first stage of germination (Fig. 1D & E). Preliminary data indicate that the seed will split irrespective of temperature, germination media or the presence of a host root. The embryo development followed by seed splitting has taken more than 12 months and the next step in the seed research includes introducing split seed to host roots or host seedlings to stimulate the production of a radicle.

### Seed banking

Seed banking options investigated for *D. taylorii* included storage at 5°C (fridge), -18°C (freezer) and -196°C (liquid nitrogen). However, a challenge for effective seed storage is the verification of seed viability. *Dactylanthus taylorii* seed will take more than 12 months to split open, which could be used as one criterion for seed viability.



**Figure 1:** *Dactylanthus taylorii* seed consists of an endosperm and hard seed coat (A) which becomes clearer when stained (B) to reveal the embryo (circled in black) which develops after 12 months (C). Once the embryo is fully developed, the seed coat splits indicating the first stage of germination (D & E).

### Karakia - Te Pua o Te Reinga (Māori incantation/prayer for *Dactylanthus taylorii*)

Ka tipu  
Ka tipu  
Ki roto i ngā pō  
Ki te ao awatea  
Mai ngā ngahere nui o Te Waonui – a – Tane

Ka hora  
Ka hora  
Hei kai mā ngā pekapeka  
Hei kai mā ngā manu

Ko Te Pua o te rēinga ka puawai mai te  
rangi ki te whenua  
He kākāno whakatipu no Ranginui e tu iho nei  
He kākāno whakatipu ki roto ia Pāpātuanuku  
e takoto nei  
He waewae atua, he karu o te whēnua

Kia hau mai  
Kia hau atu  
Kia hauhake  
Ki ngā kura o te wananga nui a te kore

Tane toko te rangi  
Tane te wananga  
Tane te whiwhia  
Hine wairau ngahere  
Hine wai-te-rere  
Ki te whaiao  
Ki te Ao Marama  
Tuturu whakamoua kia tina! Tina!  
Te Pua o te rēinga, Waewae atua,  
Hakarimata hui e! Taiki e!

The seed of light  
The seed of light  
The living of night  
The living of dawn  
In the lifestyle of the great forest of Tane  
Spreading the seedlings  
Planting and putting crops to settle to grow

A food nest for bats  
A food nest for the birds and the nature of the forest

I am the *Dactylanthus* that attracts the energy from  
the skies to the land  
I am the seed of life of sky father that stands above  
me

I am the seed of life of earth mother that lays below  
me

He waewae atua, he karu o te whēnua  
I have many names that i can relate to that are  
used outside the regions

Using the winds within  
Using the winds outwards  
Before we harvest and share to re-plant  
To the school of knowledge that is bring's  
life of well-being

Tane that fought to the skies  
Tane of knowledge  
Tane that recieves  
Hine the rainforest  
Hine the water of life  
To the world of light  
To the world of the physical world  
From good wisdom to share light  
To the mouri of this generation of our anseters to life

Seed treated to various storage conditions have been plated for germination, but seeds were not showing signs of survival (splitting) at the time of writing. Tetrazolium chloride staining methods tested were inconclusive

as the limited or lack of embryo development complicates the interpretation of the staining pattern.

### Pollen collection and storage

Understanding pollen viability has been highlighted as a critical component in the overall conservation of *D. taylorii*. This was emphasized in March 2020 when conservationists had to travel for 5 hours to Pureora Forest the day before nationwide lockdown in New Zealand to collect pollen for hand pollination. Initial work on pollen collection and storage was conducted using five male flowers collected from Puroera Forest in March 2021. *Dactylanthus taylorii* produces copious amounts of pollen which needs to be removed from the flowers as soon as possible to prevent fungal contamination (Fig. 2A). Pollen storage trials were established by storing non-desiccated and desiccated (dried over lithium chloride to reach a relative humidity of 15%) at 5°C, -18°C and -196°C (Fig. 2B). Next steps during the 2022 flowering season will be to optimise pollen germination protocols (media and temperature) and quantify viability and vigour of fresh and stored pollen.

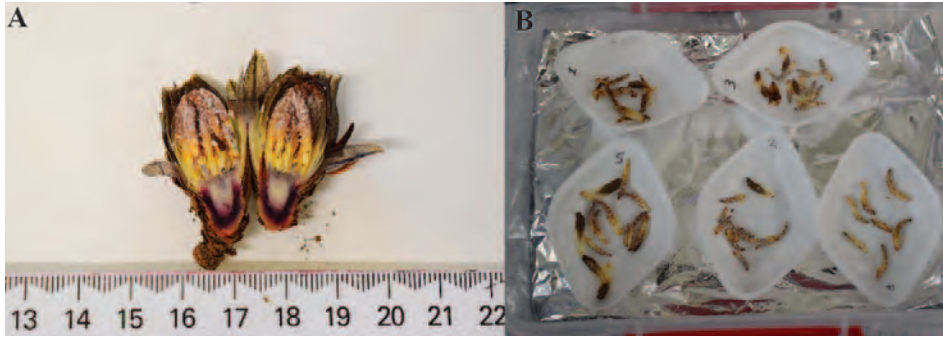


Figure 2: *Dactylanthus taylorii* flowers showing copious amounts of white pollen grains (A). The spadices containing the anthers were collected for each flower and desiccated using lithium chloride chambers generating 15% relative humidity (B) before storing the pollen at 5°C, -18°C and -196°C.

### Project outcomes and evaluation

#### Site visits to Pureora forest and Patitapu

The closest known population of *D. taylorii* to Ōtari is located at Patitapu Reserve, approximately 150 km northeast of Wellington. Site visits were conducted in September 2020 and April 2021. The surveys found that the *D. taylorii* population at Patitapu is no longer viable due to old age, lack of recruitment (no flowering and fruiting) and trampling of tubers by deer and cattle. Although the site might be suitable for future relocations, immediate actions have been recommended to the land managers which include possum control (introduced pest that destroys the flowers), establishment of a deer-proof fence and removal of deer and cattle within the forest patch. Pureora Forest Park was visited in October 2020 as part of the seed collection trip (discussed below).

#### Seed collection from at least one population

A seed collection trip was undertaken in October 2020 to Pureora Forest Park in central North Island. The forest park contains the largest known population of *D. taylorii* with several thousand plants confined to approximately 2 hectares. The trip became the first in the history of plant conservation in New Zealand which saw representatives from all six iwi in the Wellington Region (Taranaki Whānui, Ngāti Toa Rangatira, Rangitāne o Wairarapa, Ngāti Kahungunu ki Wairarapa, Ātiawa ki Whakarongotai, Ngā Hapū o Ōtaki), three independent conservation organisations (Ōtari Native Botanic Garden, Department of Conservation, Zealandia Ecosanctuary) and private conservationists (David and Bethely Mudge) collaborating to collect and sow the seed. The collection trip included a formal pōwhiri (Māori welcoming ceremony) before entering

the forest for seed collection (Fig. 3A). As per permit conditions, ten seed heads were collected, seed processed and divided into parcels and transported back to Wellington by iwi nominated kaitiaki (guardian) of Pua o te Rēinga, Gemma Wright (Fig. 3B). The collected seed was earmarked for sowing in 12 plots at Ōtari and Zealandia, and research at the Lions Ōtari Plant Conservation Laboratory.

#### Establishing seeding plots of *Dactylanthus taylorii*

Seeds collected in Pureora Forest were divided into 14 batches, each containing approximately 600 seeds. Twelve batches were used for planting at Ōtari and Zealandia while the two remaining batches were used for research into the seed biology and germination. On the 16th of October 2020 seeds were sowed in twelve plots, six at Ōtari and the other six at Zealandia (Fig. 4). The seed collection and sowing event generated a lot of interest from local media (1News, Stuff, Radio NZ), politicians and conservation authorities, highlighting the importance of integrating western science and traditional cultural knowledge systems (mātauranga Māori).

#### Establishing key partnerships

Key partnerships identified for this project included multiple mana whenua entities (local tribes of indigenous people), Department of Conservation and Zealandia Ecosanctuary. Although these key partnerships were established, this project has since become a model for all plant conservation work in New Zealand.



Figure 3: *Dactylanthus taylorii* seed head in the forest at Pureora (A). Cleaned seed from ten *D. taylorii* seed heads prior to dividing into batches for planting and research (B).





Figure 4: *Dactylanthus taylorii* seed was placed in a petri dish with clean river sand (A) before evenly spreading the sand and seed in a 50 cm x 50 cm plot using a steel grid for reference (B). The steel grid was then removed and seed covered with leaf litter. The four corners of each plot were identified by permanent markers.

As the first plant translocation which integrated western science and mātauranga Māori (Māori knowledge), we continue to collaborate and during a wānanaga (meeting to discuss, deliberate and consider) held in August 2021 we strengthened the partnerships and worked on next steps in the conservation of *Dactylanthus taylorii*.

#### Public awareness – Presentations and publications

Prior to this project, the public awareness of the conservation needs for *D. taylorii* was very limited. However, the excitement of a 22 multicultural person collection trip stimulated people's interest in *Dactylanthus*/Pua o te Reinga. In addition to the publication of information through popular media, an article was compiled for the Wellington Botanical Society entitled: "Ex situ conservation of *Dactylanthus taylorii*". A booklet is currently being developed on Pua o te Reinga and the relocation event. Presentations included the following:

- David Mudge, Avi Holzapfel, Karin van der Walt. Conservation of *Dactylanthus*. Ōtari Trust Seminar. March 2021.
- Karin van der Walt. Ex situ conservation of *Dactylanthus taylorii*. Nga Manu Winter Series. May 2021.

- Avi Holzapfel, David Mudge, Karin van der Walt. Getting to know Pua o Te Reinga seed. Wananga. August 2021.

#### Conclusion

The GBGF fund contributed to the expenses associated with the project "Ex situ conservation of *Dactylanthus taylorii*". With significant financial challenges for local governmental agencies following lockdowns due to Covid-19, the funding meant that work was able to continue as costs associated with the project were covered. The project has also established a solid foundation for plant conservation in New Zealand as the first reintroduction effort which combined western science with mātauranga Māori. Research into seed germination, pollen storage and seed banking will continue for *Dactylanthus taylorii* with another seed collection trip scheduled for November 2021.

#### Acknowledgements

Many people contributed to this project. I would like to acknowledge Ná Kurt Smith-Komene for composing the karakia for Te pua o Te Reinga. Terese McLeod and Aaria Ripeka Dobson-Waitere (Bicultural Engagement team at Zealandia Te Māra a Tāne) who elevated this project by bringing together all six iwi from the Wellington Region. The plight

for *Dactylanthus* was brought to our attention by David and Bethely Mudge who dedicated their lives to the plight of this special species, without them, this would never have happened. Thank you also to Dr Avi Holzapfel (Department of Conservation) who unconditionally and enthusiastically shared, and continues to share, his extensive knowledge on all things *Dactylanthus*. To Rhys Mills at Ngā Manu Nature Reserve, we are really grateful for your willingness to share seed and flowers from your plants, this provided essential material which helped us to understand seed development and pollen biology. Last, but certainly not least, money always provides opportunities and we acknowledge the GBGF fund as well as the Wellington Zoo Local Conservation Grant, for providing the financial support that enabled seed collection trips, planting and research into the ex situ conservation of *Dactylanthus taylorii*.

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**Dr Karin van der Walt**  
**Ōtari Native Botanic Garden and**  
**Wilton's Bush Reserve**  
**Wellington City Council**  
**160 Wilton Road**  
**Wellington. 6012**

# COMMUNITY BOTANIC GARDENS FOR COVID-19 RECOVERY: A CASE STUDY AT THE JARDIN ETHNOBOTANIQUE DU KIVU IN THE EAST OF THE DEMOCRATIC REPUBLIC OF THE CONGO



Local school children with the Youth Pandemic Team kits

The implementation of the Youth Pandemic Teams (YPT) approach by the Jardin Ethnobotanique du Kivu (JEBK) has contributed to the visibility and resilience of the botanic garden in a pandemic context in a fragile environment.

## Introduction

### The COVID-19 pandemic and resilience in botanic gardens

Worldwide, the outbreak of the COVID-19 pandemic disrupted, if not paralyzed, businesses, livelihoods, and biodiversity conservation. The global lockdown to limit the impacts of the pandemic highlighted the need to rethink the ways in which botanic gardens could still fulfil their community mission during an ecological crisis. While botanic gardens were among the first to reopen after the lockdown

(Hodor et al., 2021), continuing restrictions meant that the majority of botanic gardens still encountered difficulties in fulfilling their mission of physically connecting people with plants (Glover, 2022). As a result, many of their activities temporarily shifted from physical to online contact and most of the well-resourced gardens adopted specific measures to minimise physical contact with visitors.

### Botanic gardens in the context of a pandemic: environmental and social benefits

Despite the numerous adverse impacts of COVID-19, some environmental benefits have been observed for city dwellers. For example, the lockdown provided an opportunity for cities to revisit the ecosystem services provided by green spaces (Sepe, 2021). Studies suggest that the COVID-19 pandemic increased the reliance on green spaces, contributing to an improved quality and flexibility of such spaces, and a recognition of the recreational, psychological and physical health benefits they provide (Sepe, 2021).

### DRC: ex situ conservation in the face of multiple health emergencies

In the mega-diverse Democratic Republic of Congo (DRC), four historical botanic gardens (Kisantu, Kinshasa, Eyala, and Kisangani) contribute to the ex situ conservation of plant diversity. Together with nature reserves, they contribute to about 215,000 km<sup>2</sup> of conservation areas in the DRC, most of which were created during the colonial period. The Congolese botanical gardens manage several endemic threatened plant species of huge social, economic, and medicinal importance for the local community, particularly for the poorest (Latham, 2014). However, growing poverty levels combined with a lack of social support during the pandemic increased food insecurity and the reliance on plant resources for food and anti-COVID-19 medicine (Modeawi et al., 2020, De Meyer et al., 2022).

In DRC, 10,630 confirmed cases of COVID-19 and 272 deaths were recorded as of September 2020 (Juma et al., 2020). The particular context in the country was characterized by the presence of COVID-19 alongside existing diseases such as Ebola, cholera, etc (Nachega et al., 2020).

The fragile healthcare system, combined with the massive displacement of people from the conflict zones of the east of the country, complicated the implementation of COVID safety regulations. In addition to the economic crisis associated with the pandemic in rural areas, the implementation of health safety plans has been hampered by cultural beliefs and poor livelihood options (Juma et al., 2020).

During the COVID crisis, the community-centred Jardin Ethnobotanique du Kivu (JEBK) explored the challenges and opportunities for sustaining ongoing plant conservation activities, including maintaining traditional knowledge among local people. In terms of expertise on infectious diseases, many rural areas are still underserved. However, in a pandemic context, health management and conservation can be achieved by combining basic safety measures and local knowledge with environmental education. Drawing on a case study in JEBK in South Kivu, we highlight some of the results achieved through a community-based approach to addressing the challenges in a pandemic context.

#### **Jardin Ethnobotanique Kivu : Context and location**

The case study was conducted at the Jardin Ethnobotanique du Kivu (JEBK) in the village of Kadjuchu from October 2020 to December 2021. The village of Kadjuchu is a peninsula located in lake Kivu, in the province of South Kivu in the east of the Democratic Republic of the Congo (Fundiko, 2020). Kadjuchu covers an area of 73.8 km<sup>2</sup> and is subdivided into 29 sub-villages. Given its geographical position, the village is accessible by road, air, and lake, and is open to both the provinces of South Kivu and North Kivu. Due to its proximity next to the Kahuzi-Biega National Park, the soil fertility, mild temperature, and easy access, the Kadjuchu peninsula is home to the ethnic groups of the Bashi, Bahavu, and indigenous Batwa (Pygmies), etc. Local livelihoods mainly depend on traditional agriculture (90%), traditional fishing, and small livestock farming. Major threats to the landscape are overpopulation, urbanization, deforestation, degradation of natural habitats, and the persistence of diseases such as cholera, dysentery, typhus, and malaria. In addition, frequent unpredictable natural hazards (such as volcanic eruptions and landslides) have significantly affected the

topography. About 20 primary and secondary schools are located in Kadjuchu, most of them around the JEBK. In Kadjuchu village, the JEBK covers 2ha and focuses on the ex situ conservation of threatened plant species, education, participatory research, and the dissemination of traditional botanical knowledge in the community around the protected areas.

### **Methodological Approach**

#### **The Youth Pandemic Team approach (YPT)**

In order to reinforce inclusive local infectious disease expertise in the village, the JEBK project used the Youth Pandemic Team approach (YPT)<sup>1</sup>. Relying on focus groups, local team experts were selected in schools, churches, and the local medical centre to build YPTs. The strategy aimed to strengthen the participation of school youth, indigenous women, and environmental experts in the training and dissemination of COVID-19 safety measures. A YPT unit included 3 schoolchildren, 1 teacher, 1 village leader, and 1 indigenous person. A COVID-19 kit<sup>2</sup> was designed for use by the YPTs.

#### **Selection of the participating schools**

Under the leadership of the traditional chief and school leaders, 5 schools were selected as a pilot. Each YPT was trained and equipped with a COVID-19 kit and the members were multilingual. The YPT school members mobilized other schools and the community. Schools lacking infrastructure such as drinking water facilities were prioritized. Five indigenous pygmy women participated in the project and provided their traditional knowledge about the selection and importance of some priority tree species in the botanic garden.

#### **Selection of content of the YPT training**

After the selection process, the YPTs received training on COVID safety measures,



**Dioscorea (yam) tubers are important for food security**

and a list of the 10 most endangered useful tree species was compiled. School teachers and the indigenous pygmy women participated in a “walk-in-the-wood” (Alexiades, 1996) activity at JEBK to identify and document the most important tree species. A detailed list of species will be published in a school guide for environmental education purposes (Fundiko, work in progress). The data collected so far include traditional plant names, local use of the species, and their conservation status as well. The species identification was confirmed by the taxonomist of the Flore d’Afrique Centrale (FAC) at the Herbarium Lwiro of the Centre of Research in Natural Sciences of Lwiro in South-Kivu, DRC.

#### **The YPT approach: a path for benefit-sharing, inclusion, and social utility**

To enable benefit sharing and increase the social utility of the JEBK living collection, the YPT strategy drew on the expertise of indigenous women and local community members. The main purpose of including indigenous people was the necessity to link plant conservation to their livelihoods (Mongera & Tsioumani, 2010) and to align the project with the Kew Declaration on Reforestation for biodiversity, carbon capture<sup>3</sup>, and livelihoods beyond the COVID-19 context. The expertise of pygmy women provided insight into the motives and focus of future seed selection for domestication (Schroeder, 2009). In return, these women and their children were supported with a YPT kit, school supplies, and clothing for women.



**Indigenous women with their children benefitted from school supplies and clothing**

## Results and Achievement

### The Youth COVID-19 Teams

In total, 10 YPTs were established of which 5 school teams were trained and equipped with COVID-19 kits. A kit was deposited at the traditional chiefdom, a public space visited daily by the population. About 500 face masks were distributed. In order to reach the community level, the project supported 1 local church and a small medical centre with the COVID-19 kit. Furthermore, one COVID-19 kit was offered to an indigenous pygmy women's group in Tchofi village in the territory of Kalehe. This contributed to strengthening the relationship between the Shi ethnic and the Havu Twa group in the Kalehe territory.

*Focusing on traditional knowledge of threatened plants and local participation, the YPT approach has facilitated the ongoing seed collection, maintenance, and ex situ conservation despite the pandemic crisis.*

### The YPT approach as a path to benefit-sharing and integration of indigenous knowledge

Among other opportunities offered by the lockdown in the rural areas, was ongoing seed selection in the natural habitats as well as in the local markets using indigenous experts. Priority trees with associated



Engaging school children in the project



YPT Kit at the traditional chiefdom in the village of Kadjuchu

indigenous knowledge were collected and nurseries were managed. A recent study suggests that indigenous pygmies evicted from the park still rely on wild plants collected in the protected areas. Mixed communities, such as those around the JEBK, provided opportunities for the project to document traditional knowledge and contribute to raising awareness of neglected endemic plant species. The walk-in-the-wood field trip with the indigenous women and the YPT enabled us to inventory the top 10 tree species. Most tree species are used for food and medicinal purposes in times of pandemic. However, their uses as medicinal native products were not restricted to the COVID-pandemic but extended beyond. Among the top 10 priority species selected *Prunus africana*, *Prunus salasii*, *Afrocarpus usambarensis*, *Jacaranda mimosifolia*, *Musanga leo-errerae*, *Lebrunia bushaie*, *Coffea arabica*, *Coffea kivuensis*, and *Myrianthus holstii* were mentioned.

## Conclusion

The COVID-19 lockdown has been challenging for most botanic gardens including the JEBK in eastern DRC. Yet, the lockdown somehow generated several opportunities. While restrictive measures were amplified in urban areas, in rural areas large public spaces including churches, schools, and markets remained open and visited. Several city dwellers temporarily moved to (sub) rural

zones in search of space and agricultural products to solve food insecurity. The COVID-19 recovery approach at JEBK prioritized school youth to build the YPTs given their expertise and the opportunities in terms of environmental skills and quick knowledge transfer among generations in the community (from child to household). Furthermore, the traditional authority (custodian of cultural traditions) was more cooperative with local schools. Such a collaboration facilitated the application of a minimum COVID safety plan in the village, to support the local infectious disease expertise. The walk-in-the-wood activity to identify the priority species with indigenous women contributed to increasing their social integration, and the appreciation of the social value of the living plant collection. In this way, the project funding contributed to benefit sharing while linking plant conservation with the livelihoods of the indigenous women.

## Acknowledgment

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### In Memorium

While writing this manuscript, with deep sorrow we learned of the passing of our programme manager **Emmanuel Machara CIRIMWAMI** on 13 November 2022 due to a car accident. He will be

remembered for his sterling work and dedication to our mission.

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**Marie-Cakupewa Fundiko**  
**Jardin Ethnobotanique du Kivu (JEBK), South-Kivu, Democratic Republic of the Congo**  
**Department of Environment, Faculty of Sciences, Université du Cinquanteenaire de Lwiro, South-Kivu, Democratic Republic of the Congo**

All images credited to Norbert Mugisho & Bijou Kitumaini, JEBK DRC/South-Kivu, 2020-2021.

### ENDNOTES

<sup>1</sup> The project approach was initially designed as Youth COVID-19 Teams (YCT) given the context of the COVID-19 pandemic

<sup>2</sup> A COVID-19 kit includes a plastic container with a capacity of 200 litres, a tap, disinfecting products and face masks.

<sup>3</sup> The Declaration Drafting Committee, 2022



JEBK Volunteering Team

# ENHANCING THE *EX SITU* CONSERVATION OF CRITICALLY ENDANGERED EUROPEAN PLANTS CONFINED TO GREECE: EXPEDITION HIGHLIGHTS OF CRITICAL.GR PROJECT



Figure 1 (above and right): Individuals of *Saponaria jagelii* on Elafonisi Island

## Introduction

The project CRITICAL.GR was supported by the Global Botanic Garden Fund (GBGF Project 2020/45096) to bring a conservation focus on extremely rare, single-country or single-island Greek endemic plants, assessed as Critically Endangered (CR) globally and/or nationally.

Three priority plant groups of CR taxa (species or subspecies) were outlined on the basis of extant ex situ conservation sites according to the BGCI's PlantSearch database as follows:

- Priority Group I (PG-I): No ex situ conservation;
- Priority Group II (PG-II): Ex situ conservation in a single country (or institution);
- Priority Group III (PG-III): Ex situ conservation in more than a couple of institutions/countries.

The botanical expeditions of CRITICAL.GR aimed to collect propagation material of different targeted CR taxa for ex situ conservation at the Balkan Botanic Garden of Kroussia (BBGK):



## Elafonisi and Kythira Islands - PG I targets

The tiny *Saponaria jagelii* Phitos & Greuter (Caryophyllaceae) occurs only in a single seaside sand dune of Elafonisi island (South Peloponnese) from which seeds of at least 10 individuals were collected (GR-1-BBGK-21,51; GR-1-BBGK-21,52; GR-1-BBGK-21,53; GR-1-BBGK-21,54; GR-1-BBGK-21,51; Fig. 1)

*Polygala helenae* Greuter (Polygalaceae) is a rare local endemic of Kythira Island which is rarely encountered by people to date. Luckily, softwood cuttings were collected for further propagation (GR-1-BBGK-21,28; Fig. 2).

### Evia Island - PG-I and PG-II targets

*Minuartia dirphyia* Trigas & Iatroú (Caryophyllaceae, PG-I) is only found on schist rock formations on the upper northwestern part of Mt. Dirphy in Evia Island. Among 50 individuals counted, a couple of plants at risk of being destroyed by beekeeping activities were uprooted and potted for subsequent propagation (GR-1-BBGK-21,157; GR-1-BBGK-21,209; Fig. 3).

*Allium runemarkii* Trigas & Tzanoud. (Alliaceae, PG-II) is a local endemic species growing only in two spots near Karystos town, south Evia Island. Propagation material (seeds and bulbs) was successfully collected (GR-1-BBGK-21,357; GR-1-BBGK-21,358; Fig. 4) in its type locality. The area hosts half of its population and has become a famous destination for swimming and therefore needs urgent protection from expanding urbanisation.

### Samos Island - PG-I target

*Dactylorhiza pythagorae* Gözl & H. R. Reinhard (Orchidaceae) is a local endemic of the island of Samos. It grows along some streams in the pine and mixed forests of Mt. Ambelos. Among 30 individuals that were spotted, two were potted with their original soil for further study and propagation (GR-1-BBGK-21,146; Fig. 5).

### Cephalonia Island - PG-II and PG-III targets

*Viola cephalonica* Bornm. (Violaceae, PG-II) is a perennial endemic taxon occurring at the highest elevations of Mt. Ainos and is under very high pressure due to goat grazing. The only known population is now confined within a small, fenced area close to cell towers. An individual plant was found and some seeds were collected.



Figure 2: *Polygala helenae* flowering on Kythira Island

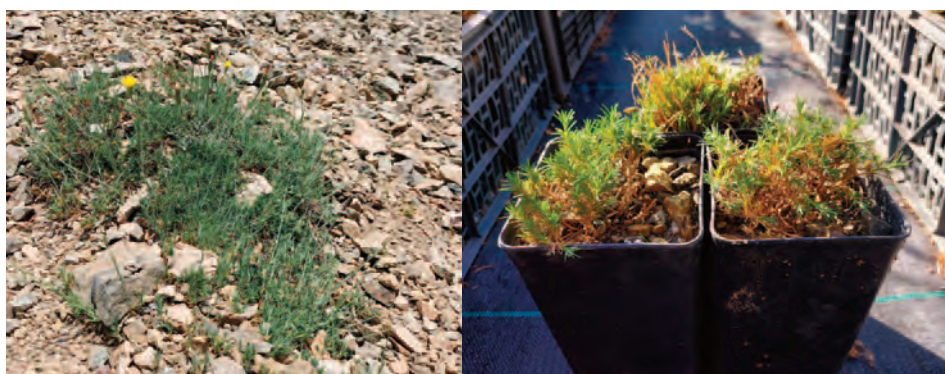


Figure 3: *Minuartia dirphyia* on Mt. Dirphy's schist screes potted for ex situ conservation



Figure 4: Collected seed and bulbs of *Allium runemarkii* in Evia Island



Figure 5: *Dactylorhiza pythagorae* individual potted for ex situ conservation from its original habitat in Samos Island

*Silene cephalenia* Heldr. subsp. *cephallenia* (Caryophyllaceae, PG-III) is a local chasmo-phytic endemic of Poros gorge with a few hundred individuals found in vertical crevices. Some dozens of cuttings were taken from different individuals for further rooting (GR-1-BBGK-21,362; GR-1-BBGK-21,363; seeds: GR-1-BBGK-09,5321; Fig. 7).

### Crete - PG-I, PG-II, and PG-III targets

Each *Horstrissea dolinicola* Greuter (monotypic genus of Apiaceae, PG-I) plant has a big tap root that helps store water throughout the long dormant season. The leaves become apparent in spring and wither by early summer. During late summer, the plants flower just above the rocky ground on Mt. Skinakas of the Psiloreitis mountain range, which is perhaps the heaviest goat grazing ground in Crete. Since its original description (1990s), only a few dozen of individuals have been recorded to date, mostly in a small, fenced area (about 100 m<sup>2</sup>). Seeds from only one individual were collected (GR-1-BBGK-20,477; Fig. 8).

*Dianthus juniperinus* subsp. *kavusicus* Turland (Caryophyllaceae, PG-I) is a shrubby pink of Koudoumi gorge, in north-eastern Crete. The expedition recorded only three individuals but were able to access only one for propagation material (Fig. 9). The cuttings managed to root later at the grounds of BBGK. Due to limited access in high and steep gorge walls, only around 50 individuals are known to occur.



Figure 6: Fenced *Viola cephalonica* population in Mt Aenos summit and potted individual for ex situ conservation (GR-1-BBGK-21,361) supported by stored seeds (GR-1-BBGK-06,3379; GR-1-BBGK-08,4944)

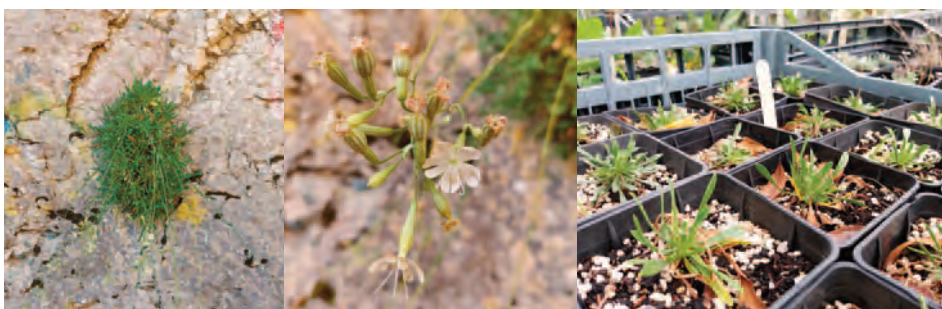


Figure 7: *Silene cephalenia* subsp. *cephallenia* in its habitat, in flower and under ex situ conservation



Figure 8: Petrodolakia fenced microreserve of *Horstrissea dolinicola* on Mt Skinakas from which seeds were collected for ex situ conservation

Figure 9: Steep Koudoumi gorge in eastern Crete with an accessible individual of *Dianthus juniperinus* subsp. *kavusicus* reached to obtain propagation material (GR-1-BBGK-21,95)





*Convolvulus argyrothamnos* Greuter (Convolvaceae, PG-II) is big shrubby chasmophyte, with impressive white flowers and silver leaves. The known locations for this species in Crete are two gorges and most of the plants hanging on the gorge walls are inaccessible. Only one individual was reached to obtain a few seeds (Fig. 10).

*Bupleurum kakiskalae* Greuter (Apiaceae, PG-III) is known to occur only in the famous Cretan Samaria gorge (Mt. Gigilos). The pressure of heavy grazing on its wild populations has left only a few hundreds of plants occupying inaccessible places for humans and goats. Luckily, a few years ago, a neopopulation was established in a small, fenced area of the local National Park where the plants are freely reproducing to date (Fig. 11).

### Central Greece - PG-I and PG-III targets

*Veronica oetaea* L.-Å. Gustavsson (Veronicaaceae, PG-I) is a tiny annual plant of vernal pools formed after snow-melting on high elevations of Mt. Oeta. We collected seeds in some of them which have been marked by local authorities with trunks to deter 4WD trucks visiting this area regularly (Fig. 12).

*Centaurea heldreichii* Halácsy (Asteraceae, PG-I) is a chasmophytic species with two populations on limestone rocks at lower elevations of Mt. Varasova. As the mountain drops into the sea rendering the two populations inaccessible, one has to drive all around the mountain massif to reach the second population. The latter is situated on a popular climbing ground, and obviously any climber may damage seedlings or suitable cracks on the limestone surface without knowing it. Cuttings from several individuals from both populations were taken for further propagation (GR-1-BBGK-20,39; GR-1-BBGK-07,4397; Fig. 13).

Figure 12: Collecting seeds of *Veronica oetaea* in Mt. Oeta (GR-1-BBGK-21,225; GR-1-BBGK-21,226)



Figure 10: Vertical Roka gorge habitat and individual of *Convolvulus argyrothamnos* in flower and seeds collected (GR-1-BBGK-20,413)



Figure 11: Established neopopulation of *Bupleurum kakiskalae* at the premises of the Samaria National Park in Omalos plateau, Chania and ex situ conservation material (GR-1-BBGK-21,101; GR-1-BBGK-19,1102)



Figure 13: Individuals of *Centaurea heldreichii* variable in leaf shape and serration (first population) and vertical rocky climbing ground (second population) in Mt. Varasova



Figure 14: The peak of Mt. Taygetus (Profitis Elias or 'Pyramid') with inaccessible rock crevices inhabited by *Jurinea taygetea*

### Mt Taygetus (Peloponnese) - PG-I target

*Jurinea taygetea* Halácsy (Asteraceae, PG-I) is a local endemic to the alpine zone of Mt. Taygetus, the highest mountain of the Peloponnese. Its populations naturally thrive only in the highest summit (Profitis Elias, Fig. 14). With no roads to reach the summit, a whole day hiking is required to climb 1,400 m from the lowland mountain refuge. Due to the small-size and widely scattered populations, a thorough search of the area was performed to record some 300 individuals.

After nine botanical expeditions performed in different parts of Greece in the framework of the CRITICAL.GR project, the ex situ conservation of the following CR taxa has been enhanced with new accessions stored and/or cultivated to date:

- 9 CR taxa (16 accessions) of PG-I conserved ex situ for the first time:
  - *Centaurea charrelii* Halácsy & Dörf.,
  - *Dactylorhiza pythagorae*,
  - *Dianthus juniperinus* subsp. *kavusicus*,
  - *Jurinea taygetea*,
  - *Horstrissea dolinicola* (also in the Mediterranean Agronomic Institute of Chania, MAICh),
  - *Minuartia dirphyia*,
  - *Polygala helenae*,
  - *Saponaria jagelii*,
  - *Veronica oetaea* (also in the National and Kapodistrian University of Athens).



Figure 15: Deep-rooted individuals of *Jurinea taygetea* collected for propagation and recovery during ex situ cultivation after one month (GR-1-BBGK-21,359 and GR-1-BBGK-21,360)

However, *Campanula papillosa* Halácsy, *Consolida samia* P. H. Davis and *Centaurea carystea* Trigas & Constantin. still lack ex situ conservation to date and should be prioritized.

- 3 CR taxa (5 accessions) of PG-II have enhanced ex situ conservation:
  - Established for the first time at the grounds of BBGK:
    - *Allium runemarkii*,
    - *Convolvulus argyrothamnos* (also in MAICh),
    - *Viola cephalonica*
  - Seeds of *Aethionema retsina* Phitos & Snogerup are stored in NKUA and *Allium platakisii* Tzanoud. Kypr. and *Anthemis glaberrima* (Rech. f.) Greuter in MAICh.

- 3 CR taxa of PG-III (6 accessions) have enhanced ex situ conservation, i.e., *Bupleurum kakiskalae* (also in MAICh), *Centaurea heldreichii* are established for the first time at the grounds of BBGK, while ex situ conservation of *Silene cephalenia* subsp. *cephallenia* has been enriched with new accessions.

**Nikos Krigas**  
**Balkan Botanic Garden of Kroussia (BBGK),**  
**Institute of Plant Breeding and Genetic Resources (IPB&GR),**  
**Hellenic Agricultural Organization (HAO) Demeter**  
**Thessaloniki**  
**Greece**

Botanical gardens and arboreta are well-poised to use their resources, audiences, expertise, facilities, and collections to implement science-based conservation practices, both *in situ* and *ex situ*, to prevent biodiversity loss.<sup>1</sup>



NUEBG Partnership Programme groupshot

## TYPHOONS, TREES AND TEAMWORK: A CASE STUDY FROM THE BGCI/ARBNET PARTNERSHIP PROGRAMME

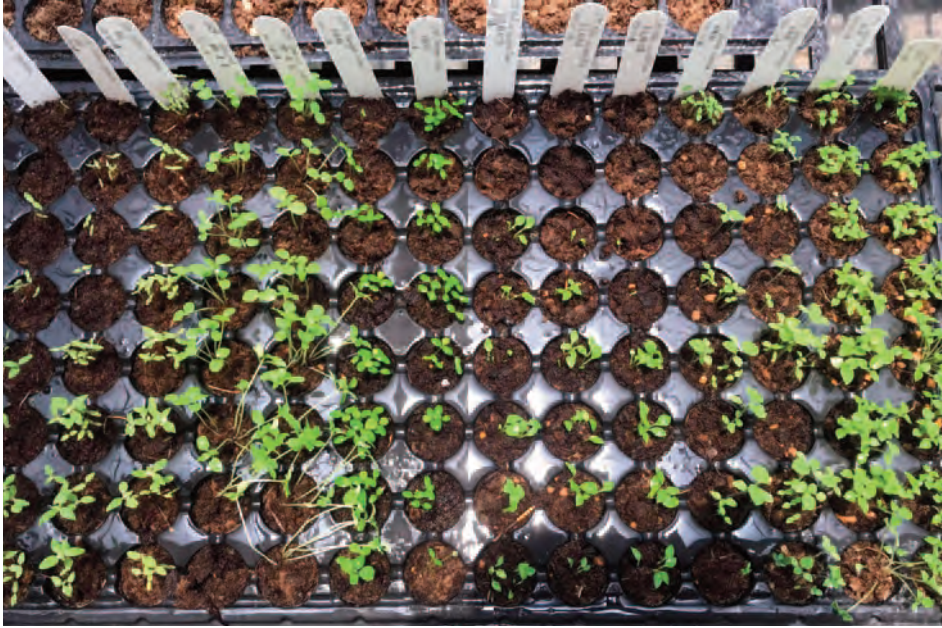
### Introduction to the Partnership Programme

**T**rees, the backbone of most terrestrial ecosystems, provide critical benefits to people and the planet. Despite their importance, canopy loss is occurring worldwide and many tree species are threatened with extinction. Furthering these challenges, given their size and long-life span, this unique life form requires specific curatorial and horticultural care. They are also under-researched and under-conserved.

Increasing the number and professionalism of tree-focused botanical gardens can support a healthier planet during this sixth mass extinction. These opportunities underscore the importance that:

- trees are essential for life on this planet;
- people need access to trees and tree-focused gardens to receive the benefits that trees provide; and
- tree-focused gardens need professional support and networking to research, conserve and care for trees.

To support these needs, in 2011, The Morton Arboretum, with the endorsement and cooperation of Botanic Gardens Conservation International (BGCI) and the American Public Gardens Association (APGA), established ArbNet. This esteemed and award-winning program identifies arboreta through the Morton Register; defines industry standards through the ArbNet Arboretum Accreditation Program; raises professionalism; supports tree planting and proper care; facilitates collaborations; and advances tree research and conservation.



Seedlings for NUEBG KBCC Partnership Program. Some of the trees that successfully germinated are *Cassia* (Fabaceae), *Flueggea*, *Dolichandrone* (Bignoniaceae) and *Antidesma* (Phyllanthaceae)

Over the past decade, ArbNet has fostered meaningful partnerships for long-lasting impact with not only tree-focused gardens, but also garden associations. The BGCI and ArbNet teams work closely with each other, as they recognize the importance of the botanical garden community as a way to support plant conservation at a regional, national, and international level. Through this mutual support, these networks are collaborating to help gardens meet the targets of the Global Strategy for Plant Conservation as well as key aims identified in the ArbNet and BGCI accreditation programmes.

As a way to support international collaboration between tree-focused botanic gardens and arboreta, in 2017, BGCI and ArbNet developed the BGCI/ArbNet Partnership Programme. This funding opportunity supports the exchange of skills, resources, and expertise between gardens of different sizes in different countries to advance tree conservation efforts. Administered through the [BGCI Global Botanic Garden Fund](#), the Partnership Programme provides funding (usually up to \$2,500) for collaborative tree conservation projects, with priority given to projects that target biodiversity hotspots and/or capacity building in developing countries. Grant applications must satisfy the following conditions:

- Focus on tree conservation;
- Involve an international partnership between two botanical institutions;
- Both partners are [BGCI members](#) (botanic gardens that are not BGCI members may apply, but a membership fee must be paid prior to the application deadline);
- At least one of the two partners is an ArbNet accredited arboretum ([accreditation applications](#) may be submitted by the closing date of the Global Botanic Garden Fund).

Over the years, there have been many beneficial partnerships. These include The Tasmanian Arboretum (Tasmania) partnering with the Vilnius University (Latvia) on a project to “Develop a social media program to promote the Plant Conservation role of botanical institutions” or the Tropical Rainforest Conservation & Research Centre (Malaysia) and The Blue Mountains Botanic Garden Mount Tomah (Australia) project “Developing various Dipterocarpaceae propagation techniques”.

One particular partnership that has been incredibly fruitful is the 2019 project between the Northwestern University Ecological Park, & Botanic Gardens (NUEBG), Philippines and Dr. Cecilia Koo Botanic Conservation Center (KBCC), Taiwan.

## A model of international collaboration for tree conservation:

The NUEBG is among the many facilities of the Northwestern University Inc., a private non-government academic institution in the Northwest Luzon, Philippines started in 2007. The goal of this garden is to conserve the endemic species (species found only in one country or location) of the Northwest Luzon, which is regularly battered by annual typhoons and the alarming degradation or loss of its natural forests.

The KBCC is a non-governmental organization for tropical plant conservation in Taiwan. It aims to be the largest shelter of tropical plants on earth by 2027. It will do this through ex situ conservation of 40,000 different taxa with the ultimate goal of participating in, and leading, in situ conservation.

The Philippines is a megadiverse country with many endemic species. One of the reasons it is so diverse is because of the number of unique ecosystems that can be found, including coastal tidal flats, upper montane tropical rainforests, ultramafic forest over limestone, and seasonal dry forests. However, the Philippines and Taiwan are visited by at least 20 strong typhoons annually that destroy vegetation and communities along their path.



KBCC seedling



KBCC seedlings. Each plant is coded with accession numbers according to the KBCC records

As with many biodiversity hotspots that experience disturbance, both human and environmental, urgent work is needed to document species, and understand their current conservation status. Therefore, *ex situ* plant conservation is urgently needed as a means to protect critical flora.

The NUEBG in the Philippines and the KBCC in Taiwan were awarded a BGCI/ArbNet Partnership Programme grant for a project called "Mega diverse flora in peril threatened by annual super typhoons." This partnership project aimed to:

- document the local flora in priority sites;
- assess the conservation status of the documented plants;
- study seed germination and plant propagation of priority threatened tree species;
- understand how species respond and recover from natural disturbances; and
- collect herbarium vouchers and specimens of the flora to be held in the living collections at NUEBG and KBCC.

These *ex situ* collections will be used for future cultivation at the conservatories, as well as research, education, and future ecological restoration.

### Project outcomes and achievements

The team identified priority sites that had narrow endemic species in Key Biodiversity Areas and critical habitat, with the goal of finding a predetermined list of prioritized species. Sites were identified, visited, and explored from 2020 to 2021. When possible, herbarium vouchers and seeds were collected. The team was able to find 99 species out of the 105 prioritized species. Some of the trees that were found are rare endemic species that can only be found in Northwest Luzon. Three species could not be located, meaning they are likely extinct in the wild, and another three species were not able to

be accessed in the provenance or their locality where they were first documented.

An exciting discovery of these trips was the re-collection of *Syzygium ilocanum* and *Guioa parvifoliola*. Both of these species were thought to be extinct in the wild. While they were no longer found in their type locality, the team was able to locate new populations in a nearby forest. The team also found *Syzygium subsessililimbium*, which is rare to find as a mature tree in the wild.

After collection, with proper documentation and transport permits, seeds were sent to the KBCC for germination testing, and for cultivation *ex situ*. Successfully germinated seeds were selected and planted for scientific research, as well as for exhibits at KBCC. This research will help inform conservation action for species that are difficult to propagate. Some of the tree genera that successfully germinated as a result of this partnership are *Cassia* (Fabaceae), *Flueggea*, *Dolichandrone* (Bignoniaceae) and *Antidesma* (Phyllanthaceae). These plants are of high ornamental value, as they have showy flowers and attractive fruits. NUEBG has successfully conserved 48% of the target 105 species while another 34% are currently being monitored in the nursery. However, 13% will need to be collected again due to unsuccessful recovery in the garden nursery.



Matured collections are now ready for translocation into the botanic gardens. The University president graced the launching of the conservatory during the foundation anniversary of the school.



The University president visited the newly established ArbNet Collections in January 2022.

## Real world impact

The NUEBG received ArbNet arboretum accreditation at Level II in 2020, with less than 400 tree species in its collection. With much effort and perseverance they are now at Level IV, after just a year of being engaged in this project. The latest tree inventory at the NUEBG shows more than 500 tree species documented in their living collections. These species are both endemic to the Philippines and from around the world: including 38 species of Gymnosperms in the family Cycadaceae, Pinaceae, Araucariaceae, Cupressaceae, Podocarpaceae and Gnetaceae; approximately 26 species of the Basal Angiosperms consisting mostly of Annonaceae, Magnoliaceae and Myristicaceae; 6 species of woody monocots consisting *Beucarnea*, woody *Dracaena* and *Cordyline australis*; and 417 Dicotyledonae species ranging from 64 families. A total of 517 species of trees are safeguarded in the gardens at NUEBG. The BGCI/ArbNet Partnership Programme grant also enabled NUEBG to expand its research, collecting, and ex situ conservation programs, all of which are required for level IV accreditation.

The growing collection at the KBCC now has representation of the flora of Luzon, Philippines. The ex situ efforts will increase the

capacity to propagate critical plant species, and will create additional stocks for reintroduction in the future. It also provides a safeguard for mature trees that cannot produce seeds due to harsh climatic conditions and severe weather disturbances. KBCC will serve as one of the emergency conservatories for NUEBG in case of climatic catastrophe, volcanic eruptions, disease outbreak, or human disturbance in the future. It ensures that critical plants in peril will not be lost even when their natural habitat is destroyed completely.

In addition to the increase in the NUEBG's living collections, the Herbarium of the Northwestern Luzon (HNUL) has reached its target of 20,000 specimens at the end of 2020, after a series of expeditions in the wild. Some of these herbarium vouchers are of species which have not been collected for almost a century. The NUEBG is a repository of biological specimens in the Northwestern Luzon, Philippines. It is now extensively utilized for research purposes.

Both NUEBG & KBCC are private botanical institutions, each having their own unique conservation strategies, knowledge, capacity, and skill sets. As a result of this important partnership grant, the institutions formed a tighter collaboration to foster tree conser-

vation in the region. The NUEBG-KBCC partnership plans to extend the species collection until 2025, to meet an ambitious goal to ensure that no tree species goes extinct in Northwestern Luzon, Philippines, covering the northern and western Cordilleras and the Zambales Mountain Range in the south. This collaborative effort created the The ArbNet Conservatory of Exceptional Philippine Trees as a way to conserve rare trees in North Luzon and Taiwan, which both experience severe weather disturbances.

The partnership grant was a great catalyst that supported collaboration and will surely be sustained for years to come.

A Memorandum of Understanding has been forged to strengthen the partnership and scientific cooperation, and this partnership serves as a model for international plant conservation.

## Grant applications

The call for applications for the BGCI/ArbNet Partnership Programme usually opens around April or May each year, so be on the lookout via the ArbNet and BGCI website or ArbNet newsletter ([sign up here](#)) for when the call for applications opens for 2023. To learn more about the types of projects that have been previously funded recently, [check out the tree conservation projects funded in 2021](#). If you are not already an ArbNet accredited institution you have plenty of time to [submit your application](#) in order to qualify for this programme.

[Sue Paist, ArbNet Coordinator,](#)

[Michael Agbayani Calaramo  
\(Director/Curator - NUEBG\)](#)

[Dr. Jessica Turner-Skoff  
\(The Morton Arboretum\).](#)

### END NOTES

<sup>1</sup> Botanic garden solutions to the plant extinction crisis - Westwood - 2021 - PLANTS, PEOPLE, PLANET - Wiley Online Library



## THE GLOBAL GENOME INITIATIVE FOR GARDENS PARTNER AWARD PROGRAM

Liquid nitrogen storage tanks at the National Museum of Natural History's biorepository in Washington DC (Donald E. Hurlbert)



**BOTANIC  
GARDENS**  
CONSERVATION  
INTERNATIONAL



**UNITED STATES  
BOTANIC GARDEN**

On September 22, 2020, Botanic Gardens Conservation International, the United States Botanic Garden, and GGI-Gardens launched the inaugural GGI-Gardens Partner Award program as a collaborative funding opportunity supported by these three institutions.

These awards were intended to support GGI-Gardens collection activities throughout the 2021 calendar year. A total of 27 applications were received, 16 of which were funded after review by a panel comprising staff from BGCI, USBG, and the GGI-Gardens Advisory Committee. Although

final reports were due by 31 December 2021 for these awards, delays due to the COVID-19 pandemic resulted in six-month extensions for more than half of the funded awards. Final reports from all except for three partner awardees were received by June 30, 2022.

From just 13 of the 16 total awarded projects, the 2020/2021 GGI-Gardens Partner Award program supported collection of preserved scientific voucher specimens for plant genomics research from **7,478 total vouchers; nearly 10% of the genera (1,482) and 50% of the families (213) of**

**all vascular plants on Earth.** These scientific voucher collections represent high priorities for collection in the global genomics community and among them 853 genera and 19 families were not previously represented in any Global Genome Biodiversity Network (GGBN) biobank. Furthermore, 615 genera and 14 families that were collected through this award program were neither represented in GGBN biobanks nor had any sequence data been generated and deposited in Genbank. These collections represent high value targets for conservation, genomics, and general botanical research interest.

Thanks to this award, data from these collections will be added to updated, publicly searchable databases (e.g., BGCI's Plant Search and the GGBN Web Portal) to facilitate international research and conservation projects and expanded collaboration among gardens, policymakers, conservation practitioners, and researchers worldwide. These data will support plant conservation, genomics research, and the ability of each awardee to better fulfill its mission in service to demonstrating the importance of plants to humankind.

The accomplishments made through this award program are directly the result of the partnership between the United States Botanic Garden, Botanic Gardens Conservation International, and GGI-Gardens.



A GGI-Gardens collecting team at the U.S. Botanic Garden. L to R: Morgan Gostel, Asia Hill, and Vicki Funk. (U.S. Botanic Garden)

Institution	Country	Award Amount	Genera new to GGBN
Tooro Botanical Gardens	Uganda	\$4,458	0
Universiti Brunei Darussalem	Brunei	\$4,407	21*
Jawaharlal Nehru Tropical Botanic Garden	India	\$4,496	24
Kunming Botanical Garden	China	\$4,500	47
NUEBG	Philippines	\$4,498.25	127
Royal Botanic Garden Jordan	Jordan	\$4,500	19
Australian National Botanic Garden	Australia	\$5,000	63
Inala Jurassic Garden	Australia	\$4,171.13	31
Core Facility Botanic Garden, University of Vienna	Austria	\$3,492.5	127
Huntington Botanical Garden	USA (California)	\$4,475	67
Atlanta Botanical Garden USA	(Georgia)	\$4,489	70
Desert Botanical Garden USA	(Arizona)	\$4,752	33
Lyon Arboretum, University of Hawai'i	USA (Hawai'i)	\$4,449	11
Montgomery Botanical Center	USA (Florida)	\$3,755.49	55
San Diego Botanic Garden	USA (California)	\$5,645	56
Jardim Botânico do Rio de Janeiro	Brazil	\$4,500	121

\*Indicates gardens that have not yet submitted their Final Reports due to COVID-19 delays and/or a late project start date.



-80C freezers at the National Museum of Natural History's biorepository in Washington DC (Donald E. Hurlbert)



GGI-Gardens founder, Vicki Funk, collecting with interns at the U.S. Botanic Garden. L to R: Sara Gabler, Vicki Funk and Asia Hill. (U.S. Botanic Garden)



# JAWAHARLAL NEHRU TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE AND THE GLOBAL GENOME INITIATIVE FOR GARDENS (GGI-GARDENS)

*Exacum atropurpureum* Bedd. (Gentianaceae), a species endemic to the Western Ghats, India, listed as Vulnerable. Leaf tissues of this gentian species were sampled and are being preserved in our tissue collection. (Deepu Sivadas)

## Introduction

Established in 1979 after the first United Nations Conference on the Human Environment, held in Stockholm, Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) is one of the largest conservatory botanic gardens in India for tropical plant resources and undertakes research programmes for the sustainable utilization of these resources. Established in the foothills of the Western Ghats, a UNESCO World Heritage site and Biodiversity Hotspot, spread across 300 acres, it also falls within the Agasthyamala Biosphere Reserve.

The story of JNTBGRI and its establishment as a conservatory botanic garden for the perpetuation of the declining tropical plant diversity of India follows that of a visionary botanist, Professor A. Abraham, who was also the founder Director (Prakashkumar, 2019). Conservation and research programmes go hand in hand and the Institute

With the establishment of a genome-quality tissue sample collection and recognition as a Biorepository through GGBN, we intend to support collaborative research on the genomics of the plants found in this part of the tropics.

is recognised as a Centre of Excellence. The layout of the garden has been prepared with the technical guidance of the Royal Botanic Gardens, Kew. The Botanical Garden has the largest tropical collection composed of the Arboretum, Ornamentals and several Thematic Collections viz., Medicinal and Aromatic plants, Orchids, Bamboos, Palms, Cacti and Succulents, Zingibers, *Ficus*, Cycads, Ferns, Wild Fruit plants, Aquatic plants, Bromeliads, Balsams, Jasmines, Piper, Andaman plants, *Musa*, Mango, threatened plants, etc. The collection consists of ca. 50,000 accessions, with ca. 4,000 taxa, a majority of which are native to this part of the tropics, including endemics to the Western Ghats, as well as conservation

collections of threatened species. Multiple accessions of most species are available from different localities to be a storehouse for the genetic diversity of the species.

The key areas in which the Institute's activities are aligned, apart from being a conservation garden, are to:

- introduce, cultivate and culture plants of India/other countries with comparable climatic conditions for the economic benefit of the country;
- carry out botanical, horticultural and chemical research for plant improvement, bioprospecting and utilization;

- chemically screen plants of potential medicinal importance;
- offer facilities for the improvement of ornamental plants and propagate them in the larger context of the establishment of the nursery and flower trade;
- engage in activities conducive to helping botanical teaching and creating public understanding of the value of plant research in general, and the need for preserving our plant wealth;
- act as a model production centre for translating the fruits of research to public advantage leading to plant-based industrial ventures;
- serve as a source of supply of improved plants not readily available from other agencies.



*Palaquium bourdillonii*, a species endemic to the southern Western Ghats, India, listed as Vulnerable (Deepu Sivadas)

## The GGI award

In 2020, JNTBGRI received a BGCI GGI-Gardens Partnership Award and, with it, began a new genome-quality tissue sample collection, the “INTBGB”. Before this, there were no Biorepositories in India as part of the Global Genome Initiative, and through this programme, JNTBGRI became part of the Global Genome Biodiversity Network (GGBN). Through this award, we intended to develop a biorepository of taxa not present in other biorepositories, with a priority on plants which are endemic to the Western Ghats, India, and are not well represented in the conservatories. By the end of this program, we were able to voucher and preserve genome-quality leaf tissues from 58 taxa (57 species) belonging to 47 genera under

28 families. All those taxa were new to the GGBN portal. The collection holds significance as it includes 41 endemic and 14 threatened species, of which two species are point endemics. The collection and preservation of samples followed the methods outlined by Funk et al. (2017).

Among the INTBGB specimens new to GGBN, *Nothopegia aureo-fulva* Bedd. ex Hook.f. (Anacardiaceae) is critically endangered, *Symplocos macrophylla* ssp. *rosea* (Bedd.) Noot. (Symplocaceae), *Cinnamomum chemungianum* M. Mohanan & Henry (Lauraceae), and *Tabernaemontana gamblei* Subram. & Henry (Apocynaceae) are endangered. Nine species fall under the vulnerable

category viz. *Belosynopsis vivipara* (Dalz.) C.E.C. Fisch. (Commelinaceae), *Exacum atropurpureum* Bedd. (Gentianaceae), *Gluta travancorica* Bedd. (Anacardiaceae), *Hedyotis pruinosa* Wight & Arn. (Rubiaceae), *Kunstleria keralensis* C.N. Mohanan & N.C. Nair (Fabaceae), *Lasianthus jackianus* Wight (Rubiaceae), *Palaquium bourdillonii* Brandis (Sapotaceae), *Phaeanthus malabaricus* Bedd. (Annonaceae), and *Sonerila versicolor* var. *axillaris* (Wight) Gamble (Melastomataceae). Twenty-eight species have narrow distribution found only in the southern Western Ghats. Three species in this collection are point endemics—*Cinnamomum mohananii* Gangapr., S.P. Mathew & Jagad. (Lauraceae), *Thottea ponmudiana* (Gamble) Ding Hou (Aristolochiaceae) and *Silentvalleya nairii* V.J.Nair, Sreek., Vajr. & Bhargavan (Poaceae). The collections under INTBGB can be accessed at the GGBN data portal ([https://www.ggbn.org/ggbn\\_portal/search/result?institution=JNTBGRI%2C+Kerala](https://www.ggbn.org/ggbn_portal/search/result?institution=JNTBGRI%2C+Kerala)).



*Adenoon indicum*, a peninsular India endemic herb species (Deepu Sivadas)



*Rhynchospora pandurangani*, a species endemic to the southern Western Ghats (Deepu Sivadas)

Through the BGCI-GGI Award, we aimed to store sustainably-collected genomic-quality leaf tissues for use in collaborative genomic research. All the samples collected as part of the award are from targeted expeditions to the localities where these species are found, and special care was employed to make non-destructive collections, as most of them were restrictedly represented in their localities. Along with the tissue samples, which are stored silica-dried, herbarium voucher specimens of each taxon are deposited in the JNTBGRI herbarium—TBGT.



*Thottea pomudiana* an endemic shrub species found in evergreen forests in the southern Western Ghats (Deepu Sivadas)



*Ancistrocladus heyneanus*, a climber found in South India and Sri Lanka (Deepu Sivadas)



*Arundna graminifolia* a rare Orchid species (Deepu Sivadas)

## Future focus

To continue contributing to the GGI initiative, we prepared a list of nearly 100 plants as priorities which are currently not represented in any biorepositories, with emphasis on species which are threatened or endemic to the Western Ghats. Also, multiple accessions of the same species from different locations will be added to the collection. Alongside this, samples from species already present in the JNTBGRI live collections, and not represented in biorepositories, will also be added from time to time. Collections in the form of herbarium and genetic tissue

samples highly benefit the scientific community. With the establishment of this facility and recognition as a biorepository through GGBN, we intend to enrich the biorepository with collections in a way that will support collaborative research on the genomics of the plants found in this part of the tropics.

We believe that establishing this kind of genetic tissue biorepository holds great significance as presently there are restrictions in most countries on the movement of plant genetic resources out of the country. The availability of a database with informa-

tion on the genetic samples available in different organisations will help to facilitate meaningful associations and work on next-generation sequencing and metagenomics, and will be especially helpful for those who have limited resources to travel to another place and make collections.

The need for tissue biorepositories has grown relative to the changing needs of projects and strengthening this will help to foster inclusive access to data and information on biodiversity. The expansion of regional biorepository collections holds significance as they can act as a storehouses of the diversity in their region of operation.



*Silentvalleya nairii*, an endemic species with restricted distribution in the Western Ghats, India (Deepu Sivadas)

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Deepu Sivadas  
JNTBGRI  
Thiruvananthapuram  
Kerala 695562  
India

# 15 YEARS OF PLANT COLLECTING IN NORTHWESTERN LUZON, PHILIPPINES



Expedition in Northwest Luzon

As a recipient of a GGI-Gardens Partner Award in 2021, Northwestern University launched a project to document important species not yet represented in any GGBN Biobank.

## Introduction

The Philippines is one of the most biodiverse countries in the world and occupies a region of significant conservation concern as one of the hottest biodiversity hotspots (Myers et al., 2000). The archipelago that the Philippines comprises is also home to a high number of island endemic species.

The northwestern part of the largest island in the Philippines (Luzon) features astounding ecological formations, that represent both Key Biodiversity Areas (KBA) and Important Bird Areas (IBA). Several legislated national parks and protected areas (PA) are located in this region and help conserve part of its rich biodiversity.

Unfortunately super typhoons are increasing in frequency and destroying vegetation in their path. Severe climatic conditions such as the northeasterly monsoon and the southwest monsoon have brought devastating torrential rains. In 2016 and 2018 Luzon was severely impacted by Super Typhoons Lawin and Ompong, respectively. The confluence of a changing climate and habitat destruction for rural development projects aggravates the degradation of various ecological landscapes in the region. The conversion of pristine beach forests to tourism developments and the expansion of upland farms has contributed to the loss of critical ecosystems.

The Northwestern University Biological Diversity Research Unit launched its wild collection expeditions program in 2007 and has documented 11 major vegetation types including arid coastal intertidal ecosystems; upper montane coniferous; and mafic landscapes, among others. This program has helped reveal the ecological diversity of Luzon and has been responsible for numerous new records for the Philippines and new plant species to science. (see Arriola et al., 2015; Calarmo et al., 2022; and Gronemeyer et al., 2016). It is very alarming that the flora and fauna of the region is threatened both by natural and manmade activities. COVID-19 has also driven a plant craze, which has resulted in exploitation of wild populations driven by high demand on the internet (Howey, 2022). These challenges in the conservation sector have bewildered experts in the Philippines and there is an urgent need for international collaborative intervention to protect critical flora and fauna especially among narrowly endemic plant species.

As a recipient of a GGI-Gardens Partner Award in 2021, Northwestern University launched a project to document important species not yet represented in any GGBN Biobank and also re-collect plant species that

were lost from the NUEBG living collection due to Super Typhoons Lawin and Ompong. This project also aimed to document and preserve biological diversity through ex situ living plant collections and the establishment of a genomic collection stored in its herbarium – the Herbarium of the Northwestern Luzon (HNUL) and biobank.

### A quest to the 18th century collection of Father Manuel Blanco in Ilocos Norte.

The Northwestern University botanical exploration program began in 2007 and has propelled its plant conservation initiative. As a result, several endemic species were collected and brought into the gardens, including rare species that were documented by previous botanists. Other 19th century collections from Merrill were also rediscovered in the wild by revisiting their type localities. Curiously, Father Manuel Blanco's discovery of *Nepenthes alata*, a carnivorous plant described from "Vintar en Ylocos Norte, 1873" is still enigmatic. This pitcher plant was the first species of *Nepenthes* documented in the country, and despite long Northwesterniana expeditions from 2007-2017, this species was never

encountered from this locality. Blanco's discovery is also quite problematic as there were no herbarium specimens according to Merrill's Species Blancoanae (1918), and upon verification of possible depository at Real Jardín Botánico, Madrid Spain, no herbarium specimen was deposited by Blanco (Cheek & Jebb, 2013).

After a decade of botanical exploration in the Northwestern Luzon, a much-anticipated mission was again organized in 2021 just after the worst of the COVID-19 pandemic and border shutdowns. A search for the 'Hairy Pitcher Plant' was then arranged by the expedition team in the municipality of Vintar.

The team began digging through archives to draw any hint to the 18th century collection site of Blanco. The team consulted some technical specialists who uncovered an electronic copy of *Biblioteca Historica Filipina* by Jose Gutierrez de Vega (1892-1893) and found a few inscriptions mentioning Ilocos Norte, including "Mount Quebrada", as well as the "Mapa de una parte de China, las Islas Filipinas, las Islas de la Sonda, las Molucas, las Papúas, by Pieter Mortier (1661-1711). These include coastal localities in northwest Luzon and therefore an image of ancient Ilocos came to life. The ecology and vegetation during Spanish colonization started to form, piece by piece, as the words were translated from Spanish to English. The team constructed a map by tagging all the places mentioned in archives to show the routes of early exploration and the habitation of early settlers. It unveiled some descriptions of trees and useful plants, and river ways. The locality of Blanco's specimen started to be revealed.

Thanks to the GGI-Gardens Partner Award, our team was able to search for Blanco's lost pitcher plant. A reconnaissance team was formed to complete the exploration before the rainy season in June. The high-elevation mountains that comprise the rediscovered localities were challenging and susceptible to flash floods, and obstacles included river crossings and large rock formations. The thick, humid forest here is dense with *Pandanus* and *Calamus*, which makes it very hard to traverse. The climax forest fragments of Vintar are also cold, mossy and often enveloped by clouds.



*Nepenthes alata*



Pollen and tissue processing

In 2013 Cheek & Jebb (2013) assigned a neotype to *N. alata*, a male flowered specimen (Fenix BS 26726) in the municipality of Burgos Ilocos Norte; however, unfortunately our team has not been able to locate the population. Fortunately, our team was able to find a population of this species in Pasuquin, a town adjacent to Burgos.

Thanks to this discovery and the support we received from the GGI-Gardens Partner Award, the first photograph of Blanco's Pitcher plant was made. The plants are variously pigmented, depending upon their position in relation to the sun. Some individuals are bright red, while those that are shaded are green. A voucher specimen was deposited at the HNUL herbarium and preserved genomic tissue vouchers were deposited in our biobank.

The discovery of additional populations of Blanco's pitcher plant will be published later.

### The only known surviving *Psychotria ilocana* Merr. in existence at the NUEBG ex situ collections

Another noteworthy achievement of the NUEBG Biological Diversity Research Unit that was facilitated by the GGI-Gardens Partner Award was the recollection of *Psychotria ilocana*, a species that was thought to be extinct in the wild. Yearly small grants – such as the GGI-Gardens Partner Award that supported this work – are received by the botanic garden for expeditions, and bulk of collections are brought into the gardens. This will supplement the living collections devastated by super typhoons that ravaged the province every year.

Despite numerous attempts by botanists at NUEBG to discover wild populations of *Psychotria ilocana* our team has been unable to

find this species. Indeed, this species was declared as “possibly extinct” by Sohmer & Davis (2007). Numerous field expeditions have been undertaken, but the team has never located the plant. Our team took a creative approach to searching for this species by scanning field photographs to check if any individuals were ever captured near its original collection locality (Bangui). Incredibly, we were surprised to find a similar plant in a photograph, but it was never collected because it was sterile. Compared to all species of *Psychotria* from this province, *P. ilocana* is notable for its broad-oblong leaves.

Our team set out to recollect this individual in 2020 and transported living material to the garden at NUEBG. In 2021, during our GGI-Gardens Partner Award collections this sample – growing in our living collection – finally flowered and we were able to confirm that the identify of this individual was indeed the long-lost species, *Psychotria ilocana*. Unfortunately, the locality where this individual was collected has been cleared for road construction and a solar farm. This collection, which survives in the living collections at NUEBG, is the only known surviving plant as it has never been recollected and the type locality is no longer forested. Our team hopes that a natural population still exists elsewhere with the same ecology and climate within the type locality and NUEBG therefore has prioritized this tree species for conservation. To date, this species is documented to have a very poor seed viability and dispersal.

### Collecting samples not yet represented in the GGBN web portal: a challenging work amidst the pandemic and inclement weathers.

The NUEBG living collection is home to enormous diversity, including ca. 205 families and 2,300 species of land plants. Among these, 161 genera were not repre-

sented in any GGBN biobank and ca. 180 genera did not have any DNA barcode sequence data available.

As a result of the 2021 GGI-Gardens Partner Award to NUEBG, we were able to collect herbarium and genomic vouchers from 158 genera (including 249 species) of the 161 genera that were targeted. These collections include herbarium vouchers and silica-dried tissue samples deposited in our herbarium and biobank (HNUL).

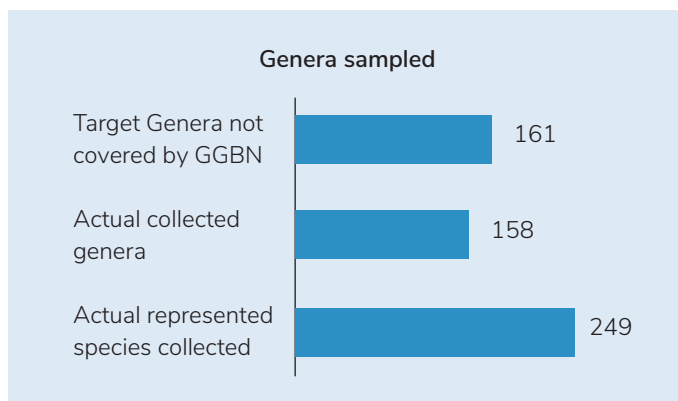
Also, pollen and other interesting plant parts are gathered and deposited at the herbarium. Additionally, tissue and pollen are also subjected to cool drying and preserved in a -36° C freezer for future use. Seeds that are recalcitrant and cannot be conserved using traditional seed banking methods are germinated for growth in the botanic gardens, while orthodox seeds are air dried to 14% RH and stored at -32 ° C.

More target species are underway to be collected but the pandemic has curtailed some of the scheduled fieldwork. Other priorities include the translocation of some important species into the garden greenhouses to augment the botanical collections and create stable populations of endemic species.



Herbarium processing

Family	GGBN	GeneBank
Anthocerotaceae	No	Yes
Bryaceae	No	Yes
Spiridentaceae	No	No
Sphagnaceae	Yes	No
Conocephalaceae	No	No
Xanthorrhoeaceae	No	No
Taccaceae	No	Yes
Basellaceae	Yes	No
Dipteridaceae	Yes	No



While there were living plant collections that are conserved *ex situ* in NUEBG, fresh specimens were recollected from the wild to replace specimens lost from super typhoons in 2016 and 2018, for GGBN tissue specimen deposit, and because many living collections cannot be sacrificed for herbarium specimen and tissue samples.

Six of the families grown at NUEBG remain unsampled (genomic and herbarium vouchers) and sequence data from 5 families in our garden are not yet present in Genbank. We will prioritize these for future collection.

The NUEBG has recovered its devastated collection from the 2016 & 2018 super typhoons. It now houses 209 families of the kingdom Plantae with more than 2,200 species of living collection.



Collecting samples in the field

## Processing and organising collections

After arduous fieldwork to collect target species in the wild, specimens are processed following Funk et al. (2017) and Gostel et al. (2016) to ensure viable materials are collected for storage and for future research. Tissue samples are meticulously gathered and stored in teabags, labeled and stored in boxes with desiccant to dry naturally without heat during collection, they are then carried in larger transport boxes and transported to the laboratory. They are cool dried with the desiccant, while their associated herbarium voucher is pressed and put in the drier for 2 days.

Associated herbarium specimens were also accessioned and stored at the Herbarium of the Northwestern Luzon (HNUL). The genomic tissue sample storage room comprises stackable plastic crates that are temporarily stored in the NUEBG Function Hall as the herbarium building was devastated by the super typhoons in 2016 and 2018. More than 20,000 accessioned specimens have been collected during the course of the past 15 years of field expedition.

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**Michael Calaramo**  
Northwestern University Ecological  
Park and Botanic Gardens  
Laoag City, Ilocos Norte  
2900 Philippines



# Plant Germplasm Conservation in Australia:

## *Strategies and guidelines for developing, managing and utilising ex situ collections (Third edition)*

Amelia J. Martyn Yenson, Catherine A. Offord, Patricia F. Meagher, Tony D. Auld, David Bush, David J. Coates, Lucy E. Commander, Lydia K. Guja, Sally L. Norton, R.O. (Bob) Makinson, Rebecca Stanley, Neville Walsh, Damian Wrigley, Linda Broadhurst (Eds.) (2021)

**Germplasm is living tissue - such as seeds, cuttings or spores - from which new plants can be grown.**

### Sharing our knowledge

The new edition of *Plant Germplasm Conservation in Australia* shares knowledge about ex situ plant conservation, such as seed storage, which helps safeguard plant diversity for future use in restoration, translocation, horticulture and research.

A video series and webinar recordings, both based on the guideline's chapters, support this release and are available on our YouTube channel.

### In the Guidelines

These 'Germplasm Guidelines' are practical, technical and evidence-based, providing a workflow to address each step of acquiring, maintaining and utilising genetically representative collections (right).

Decades of research and experience from 78 contributors actively conserving Australian plants in seed banks, botanic gardens and conservation nurseries has been brought together in these best-practice guidelines.

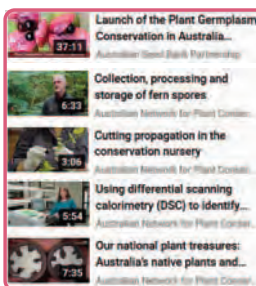
Readers are taken through the genetics and practice of acquiring collections and the processes of seed banking, tissue culture, cryopreservation, and living collections maintenance, with 50 case studies to highlight the application of research and theory.

While tailored to Australian species and our unique environment, these guidelines draw on the international plant conservation literature. In many cases, the techniques and technologies are transferrable to flora of other countries. Decision support tools and planning frameworks (right) can provide a template for other countries wishing to conserve germplasm.

The Guidelines include information on common plant families, including those known to be difficult to store and germinate. We address the need to collect, store and grow plants with 'special' life history stages or growing requirements (terrestrial orchids with mycorrhizal associations, carnivorous and parasitic plants) and 'special' types of germplasm (material from ferns, mosses, and liverworts).

### Who can use the Guidelines

Conservation agencies, scientists, botanic gardens and nursery staff, students, volunteers, and anyone interested in applied plant biology will all benefit from reading the guidelines.



**VIDEOS**

For more resources visit the ANPC YouTube channel and browse our playlist Plant Germplasm Conservation in Australia.

You'll find our webinar series 'Plant treasures - in conversation', technique specific videos and more!

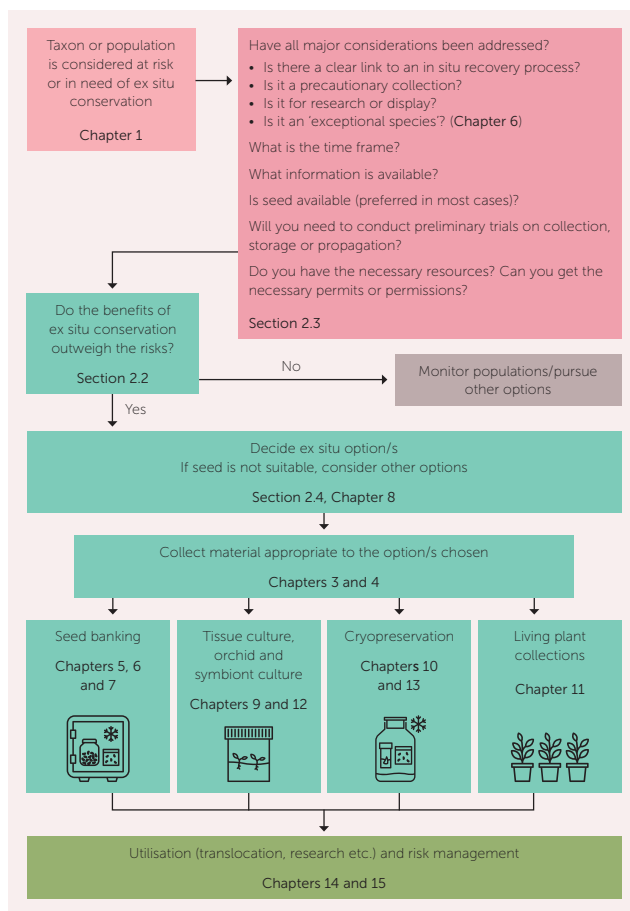
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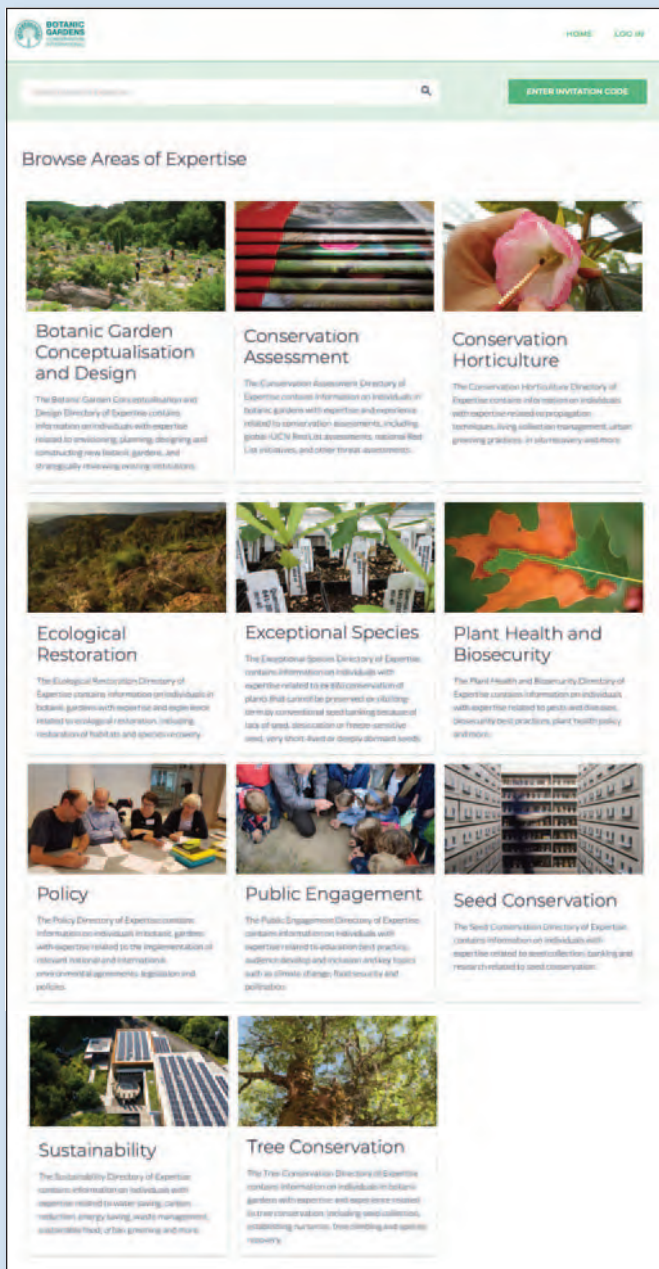
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Revised by the ANPC in collaboration with the Australian Seed Bank Partnership, funded by The Ian Potter Foundation.







## BGCI INVITES EXPERTS TO JOIN DIRECTORY OF EXPERTISE

**BGCI's Directory of Expertise is designed to enable experts within botanic gardens to let other people know about their own skills and knowledge and, if possible, help them to solve a problem or challenge related to botanic gardens or plant conservation.**

**As a membership benefit exclusively for BGCI Institutional Members, staff associated with these institutions can apply to be listed in the Directory.**

BGCI's purpose in creating this Directory is twofold: firstly, to share the knowledge and skills in the botanic garden community with broader society to solve problems or save plant species, and secondly to give staff of BGCI Institutional Members opportunities to broaden their experience and make a contribution that might not come their way in day to day work.

Experts in the Directory do not commit to provide their expertise wherever it is required, but agree to be contacted to ask for help, whether that be through partnership or paid for services. Those experts included in the Directory agree to adhere to BGCI's Code of Conduct. All applications are reviewed by BGCI's own experts. We also reserve the right to reject applications.

For more information and to apply

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