

Journal of Botanic Gardens Conservation International

BGjournal

Volume 19 • Number 2 • July 2022

**UNIVERSITY BOTANIC
GARDENS – CONTRIBUTING
TO PLANT CONSERVATION,
RESEARCH AND EDUCATION**



Celebrating 400 years
1621-2021
Oxford Botanic Garden
& Arboretum



**BOTANIC
GARDENS**
CONSERVATION
INTERNATIONAL

Editors:



Suzanne Sharrock
Director of Global
Programmes



Paul Smith
Secretary General

Design: John Morgan www.seascapedesign.co.uk

Cover image: The central fountain and Danby Arch of Oxford Botanic Garden (Oxford Botanic Garden and Arboretum)

BGJournal is published by **Botanic Gardens Conservation International (BGCI)**. It is published twice a year. Membership is open to all interested individuals, institutions and organisations that support the aims of BGCI.

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, 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
Internet: 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
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
- 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](https://www.skype.com/en/contacts/individual/bgci_kirsty),
Email: kirsty.shaw@bgci.org,
Internet: www.bgci.org

BGCI is a worldwide membership organisation established in 1987. Its mission is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. BGCI is an independent organisation registered in the United Kingdom as a charity (Charity Reg No 1098834) and a company limited by guarantee, No 4673175. BGCI is a tax-exempt 501(c)(3) non-profit organisation in the USA and is a registered non-profit organisation in Russia.

Opinions expressed in this publication do not necessarily reflect the views of the Boards or staff of BGCI or of its members.

EDITORIAL

03

University botanic gardens

FEATURES

05

NEWS FROM BGCI
Cuttings

07

PLANT HUNTING TALES
Croton rosarianus: A rare endemic species in the Puebla Cloud Forest
Allen J. Coombes et al.

09

FEATURED GARDENS
Britain's oldest botanic garden in the 21st century *Chris Thorogood*

Classic ideas and a modern stage for Leonid Rubtsov's Dendrarium
Olha Pokhylchenko and Yana Bobrova

17

INTERVIEW
Christopher Dunn

ARTICLES

20

The Botanical Garden of the University of Vienna – changes, challenges and success stories *Michael Kiehn*

24

Stellenbosch University Botanical Garden – academia supporting research, education and conservation outcomes
Donovan Kirkwood

28

Bonn University Botanic Gardens: A garden dedicated to (much more than) pure botany
Maximilian Weigend and Cornelia Löhne

33

The Botanical Garden of the City of Plottier (JBCP), a case of mixed university-municipal government governance in Argentina
Hernán Ariel López et al.

36

Padre Julio Marrero Botanic Garden: a university botanic garden in Ecuador
Santiago Bravo-Sánchez et al.

39

Education and research at the Ghent University Botanical Garden
Chantal Dugardin

42

A hundred years of nature and history: the Botanical Garden of the University of San Carlos de Guatemala
Carolina Rosales de Zea

45

The Botanical Garden of the University of Leipzig - bringing the global diversity of plants to Leipzig to explore, communicate and protect them *Rolf A. Engelman et al.*

CASE STUDIES

49

The Botanical Garden of the Adam Mickiewicz University in Poznań, Poland
Justyna Wiland-Szymańska

50

The Botanic Garden and the University of Castilla-La Mancha: a fruitful synergic relationship in the continental Mediterranean context
Guillermo García-Saúco Sánchez et al.

52

The Botanical Garden of the Faculty of Science of Masaryk University in Brno, Czech Republic *Magdaléna Chytrá*

53

Observatoire du Monde des Plantes, the botanical garden of Liege's University
Sophie Pittoors

55

Sofia University botanic gardens – History and present *Desislava Miteva*

UNIVERSITY BOTANIC GARDENS



Summer arch, The University of Oxford Botanic Garden

University botanic gardens are the focus of this issue of BGJournal. It is generally considered that the original physic gardens established by many Universities for teaching medicine during the 16th and 17th Centuries laid the foundation for today's botanic gardens. The oldest University gardens in Europe are those of Pisa and Padua (Padova) established in Italy in 1544 and 1545 respectively, with the Orto botanico di Padova still flourishing at the same site where it was originally founded. France's oldest botanical garden, the Jardin des plantes de Montpellier was established in 1593 inspired by the Orto botanico di Padova and in turn serving as a model for the Jardin des Plantes de Paris (1626). In the UK, the oldest botanic garden is that of the University of Oxford, which is celebrating its 400th anniversary this year, and is a featured garden in this issue.

These university gardens have witnessed the evolution of botany from a science originally applied to medicine, to an independent discipline with various branches. The mandate of university gardens has similarly expanded and evolved, and these gardens now play a central role in plant conservation, research and education around the world. This is excellently illustrated by The University of Oxford Botanic Garden which was first established as a 'physicke' garden for the cultivation of medicinal plants for teaching the University's medical students. Today, Oxford Botanic Garden and Arboretum hold

a collection of about 5,000 species, some of which are exceptionally rare or endangered in the wild; others are used in research to address the world's big challenges, for example those linked to climate change and nature-inspired technology (biomimetics).

In this issue, we highlight the work of University gardens from Europe, through Africa to the Americas. While ranging in age from 400 years to less than 2 years, these gardens all have a common focus on working with the students and academic staff of their parent institute to promote interest and research in plants in all their diversity.

Our interviewee, Christopher Dunn explores the relationship between Cornell Botanic Garden and Cornell University, highlighting the advantages his garden gains from being part of a larger institution. This is not only in terms of the administrative support the University provides, but also, through ready access to students and the opportunity to directly influence, in a positive way, the next generation of engaged young people.

The possibility to influence future decision-makers is also seen as important by Stellenbosch University Botanic Garden, the oldest in Africa. Stellenbosch University not only teaches future leaders of the region, but it is also the university of choice for many of the farming communities, the landowners, communities and families who determine the fate of much of the remaining threatened habitat of the Cape. If the botanic garden can positively influence their future attitudes and decision-making related to the threatened lowland floras, that could have tremendous impact.

While some university gardens have struggled to retain their relevance as the teaching of botany, as well as taxonomic research, has become more and more of a molecular enterprise, others have thrived. The examples and case studies in this issue

are perhaps evidence of a swing back to a more organismal and people-centred view of botany and plants in general.

As highlighted in the articles and case studies from European university botanic gardens, they are all clearly providing a wide range of services, not only to the universities they are associated with, but also to wider society and the international botanic garden community. They are actively engaged in scientific research, academic and public education, conservation, and horticulture. Moreover, as urban green spaces, these gardens are also important places for recreation and act as "windows" for the Universities' public outreach.

The situation is similar in South America, where university botanic gardens in Argentina, Ecuador and Guatemala are providing a focal point for university students and teachers across a range of disciplines, providing a valued open-air teaching space and promoting environmental values. As noted by the Botanical Garden of the University of San Carlos de Guatemala, which celebrates its centenary this year, without a doubt, the permanence of the Botanical Garden has been due to its association with the government University.

Finally, in recognition of the extremely challenging situation facing botanic gardens in Ukraine at this time, we have included a second featured garden in this issue. The Mykola Hryshko National Botanic Garden of the National Academy of Science of Ukraine is one of the gardens receiving support through BGCI's Disaster Relief Fund. In our article we highlight the huge importance of this garden to the local community and the on-going efforts to install an irrigation system in its arboretum, which was founded by Leonid Rubtsov over 70 years ago. To find out more about our 2022 Ukraine Botanic Garden Appeal, please visit: BGCI's Disaster Recovery Fund | Botanic Gardens Conservation International.

We hope you enjoy this issue of BGJournal, and as always, we welcome your comments and suggestions for future issues

Suzanne Sharrock

FEATURES

NEWS FROM BGCI
CUTTINGS

PLANT HUNTING TALES
***CROTON ROSARIANUS*: A RARE
ENDEMIC SPECIES IN THE PUEBLA
CLOUD FOREST**

FEATURED GARDENS
**BRITAIN'S OLDEST BOTANIC
GARDEN IN THE 21ST CENTURY**

**CLASSIC IDEAS AND A MODERN
STAGE FOR LEONID RUBTSOV'S
DENDRARIUM**

INTERVIEW
CHRISTOPHER DUNN

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

BGCI's Disaster Recovery Fund

Disasters strike communities around the world, and there is a growing realisation and evidence that their frequency and impact are becoming more prevalent globally. Botanic gardens have not been spared the calamitous effects of disasters. And botanic garden staff across the world are risking their health and safety to ensure that we do not lose the planet's incredible plant diversity – more than one third of which is held in botanic garden collections.

By establishing the Disaster Recovery Fund, BGCI will be working to support the botanic gardens impacted by disasters.

As part of the Disaster Recovery Fund, BGCI has launched the **Ukraine Botanic Garden Appeal**, in collaboration with Partnerships for Nature (Seattle, US) and leading gardens in Ukraine. The war in Ukraine has had a huge impact on the gardens there, causing shortages of staff and funding, loss of plant collections and infrastructure, forced closures for security reasons, and, in some cases, physical harm.

The donations will specifically support:

- Personnel costs;
- Collection recovery, maintenance and/or translocation as required;



- Facilitation of public engagement activities at botanic gardens to offer respite and sanctuary;
- Fostering collaboration among all botanic gardens in the country.

Funds raised will be disbursed to Ukrainian botanic gardens via a central coordination mechanism in close consultation with BGCI's governing body. Updates on how the funds have assisted those in need will be shared across BGCI's social media channels and website.

To support staff and sustain collections at botanic gardens in the Ukraine through this time of crisis, please visit: **SheepApp** (sheepcrm.com)

2022 Botanical Bridges Congress



We are pleased to announce registration and call for abstracts are now open for the 2022 Botanical Bridges Congress, to be held in Eleuthera, the Bahamas, from 14-18 November 2022.

Botanical Bridges Caribbean and Central America 2022 will bring together gardens from around the region to explore issues and exchange ideas about how botanical gardens play a leading role in plant conservation and taxonomy, sustainable development goals, and climate change adaptation and mitigation.

The network aims to foster collaboration 'bridges' among botanic gardens, botanic garden enthusiasts, and research centers interested in the Caribbean and Central American region. The congress promotes the exchange of experiences and innovations in conservation, education and research to solve common challenges faced by Caribbean and Central American botanic gardens and associated research institutions.

To find out more and register for the Congress, visit: **2022 BOTANICAL BRIDGES CONGRESS** (botanicalbridges2022.com)

BGCI Partners with the Society for Ecological Restoration

BGCI has entered a new five year partnership with the Society for Ecological Restoration (SER) to promote effective and high quality biodiversity outcomes from global restoration initiatives.

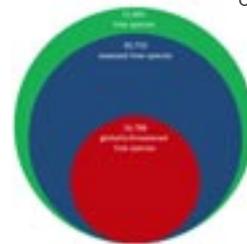
To ensure high biodiversity outcomes from global restoration efforts, SER will work with BGCI to:

- Promote and develop best practices guiding the use of threatened and endangered plant species in ecological restoration where appropriate;
- Create policy-position publications on what constitutes a native species;
- Develop joint training courses on restoration, including biodiverse forest restoration;
- Collaboratively promote and apply The Global Biodiversity Standard, which provides assurance that land management interventions such as tree planting, habitat restoration and agroforestry practices are protecting, safeguarding, and restoring biodiversity, rather than inadvertently causing harm.

BGCI members are invited to join SER to further advance knowledge-sharing and network-building world-wide. For more information, visit: <https://www.ser.org/page/Membership>

Threat assessments now available for nearly 80% of tree species

The latest update of the IUCN Red List of Threatened Species included 2,437 new tree species assessments. This brings the number of tree assessment available on the IUCN Red List to 37,411 assessments.



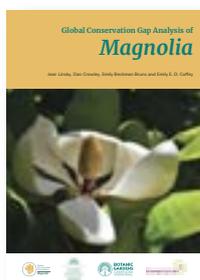
Using information on tree assessments from both the IUCN Red List and ThreatSearch database, we can account for assessments of 79% of the world's tree species. Our analysis also finds that at least 29% of all tree species are threatened with extinction globally.



Following the release of the State of the World's Trees in September 2021, the Global Tree Assessment is now in its second phase, focusing on publishing assessments from Threat Search and the National Red List on the IUCN Red List and updating assessments for trees published before 2010.

Find out more about progress with the Global Tree Assessment here: [IUCN 2022 Red List Update | Botanic Gardens Conservation International \(bgci.org\)](#)

The Global Conservation Gap Analysis of Magnolia



The recently published *Global Conservation Gap Analysis of Magnolia*, presents an in-depth review of the vulnerability, threats and ex situ and in situ conservation of 336 Magnolia species. Using data from global databases such as BGCI's

PlantSearch and a survey of the global botanic garden and conservation community, this publication reports, for the first time, accession-level information on Magnolia species in ex situ collections and applies conservation gap analysis methodologies to identify species of conservation concern. Recommendations on focal species and activities are made. This gap analysis also includes 28 species profiles of selected threatened Magnolia species that summarize in situ and ex situ status and needs. This analysis aims to provide information to organizations working on Magnolia conservation by identifying ongoing efforts and gaps in action and to guide next steps for collaborative conservation of the world's Magnolia species.

BGCI webinar series

The **Climate Toolkit** webinar introduced participants to the Toolkit, a new resource and collaborative opportunity for museums, gardens and zoos who want to learn how to proactively address climate change within their own organizations and inspire the communities they serve to follow their lead. To date, 52 institutions serving more than 42,882,000 annual visitors have joined the Toolkit.

The webinar includes an introduction to the Climate Toolkit by Phipps President and CEO Richard Piacentini, while staff members from Morton Arboretum and Hillwood Museum and Gardens — two institutions who joined the Toolkit early in its inception and are heavily involved — talk about their climate change journeys and how collaborative resources like the Toolkit have proven useful to them.

Plant Collection databases brought together representatives from four of the leading plant collection database management systems (BG-BASE, BRAHMS, HORTIS and IRIS BG). They introduced their latest database tools, described new features, and discussed options for gardens. Following the presentations on each database, members of the audience were able to ask questions to the presenters in order to better understand the features and facilities of each system.

Recordings of the webinars are available here: <https://www.bgci.org/our-work/sharing-knowledge-and-resources/bgci-webinars/>

New BGCI training course: Plant collecting policies

BGCI has launched a new training module on Plant Collection Policies. This course provides an introduction to plant collection policy for botanic garden professionals. It covers:

- Plant collection policies and purposes
- Using the policy to guide collection development;
- Plant acquisition and standards of information;
- Evaluating your collection in line with your collections policy.

This module forms part of the Botanic Garden Basics training modules and is based on BGCI's Manual on Planning, Developing and Managing Botanic Gardens.

The course is free to BGCI members and available on our Moodle platform.

BGCI's 2021 Annual Review

BGCI's new look 2021 Year in Review is now available. Replacing the Member's Review of the previous five years, and following feed-

back from members, the 2021 Review has a more user-friendly news-based format. The Review highlights our work to save plants, inspire people, share knowledge and resources, and address global challenges. A downloadable pdf document provides an overview of BGCI's key activities and success during 2021, with links providing access to longer, more detailed articles and additional information on the BGCI website.

To read the review and find out more, visit: [2021 Year in Review | Botanic Gardens Conservation International \(bgci.org\)](#)

Botanic Garden Accreditation updated

BGCI has redefined the targets required to achieve Botanic Garden Accreditation and improved the application and mentorship process. A revised version of the BGCI Botanic Garden Accreditation Standards has been produced and a new platform to make the process of applying easier for gardens and for BGCI.

Find out more: [BGCI Updates Botanic Garden Accreditation | Botanic Gardens Conservation International](#)

BGCI Accreditation



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

- Phipps Conservatory and botanical Gardens, United States
- The Dawes Arboretum, United States
- Maranoa Botanic Gardens, Australia
- Minnesota Landscape Arboretum, United States
- Huntsville Botanical Garden, United States
- Inala Jurassic Garden, Australia
- Queen Sirikit Botanic Garden, Thailand
- The Knowledge Garden at the Swedish University of Agricultural Sciences, Sweden



Croton rosarianus saplings 60 cm tall with fruit. (Qiliang Gan)



Croton rosarianus seeds. Top: eaten by insect larvae. Middle: an undeveloped seed. Above: apparently viable seeds.

PLANT HUNTING TALES

CROTON ROSARIANUS: A RARE ENDEMIC SPECIES IN THE PUEBLA CLOUD FOREST

Introduction

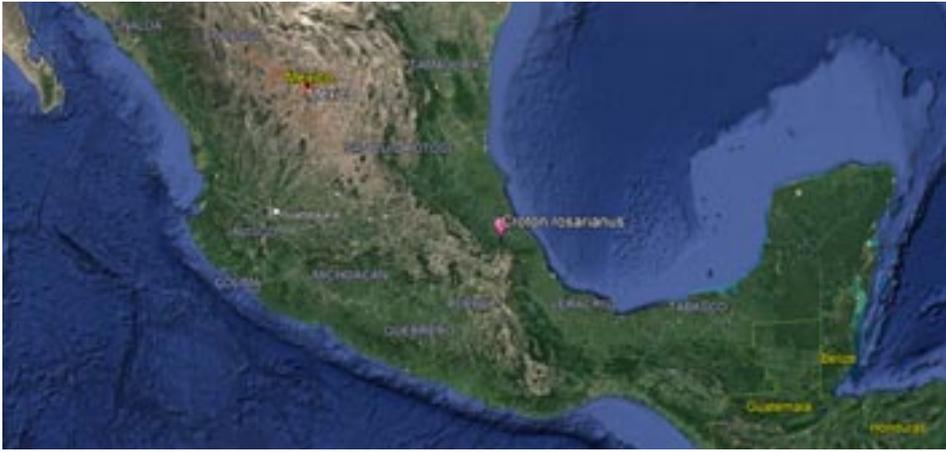
The IUCN Red List of Threatened Species (IUCN, 2021) tells us how rare any particular organism is and hence can highlight species that need conservation action. While many species have been assessed, many have not, and of those that have, relatively few are the subject of conservation activities. At the Puebla University Botanic Garden, when we were

looking for local species that we could help conserve, this is one of the publications we consulted. However, we also looked at other reports that could provide details of species not yet in the IUCN Red List but that could, potentially have a very limited distribution.

One of the species we selected was *Croton rosarianus*, a member of the Euphorbiaceae only described in 2002 but not included in The IUCN Red List. It is an evergreen tree,

growing to 8 m tall or more, with bristly shoots and small, white flowers, the males and females separate on the same inflorescence. On reading the original publication where it was described, we noticed that only one location was given, La Finca el Rosario near Cuetzalan, in the cloud forest of NE Puebla where it grows at about 823 m; this was obviously a species of potential interest to us (Map.1).

In order to investigate this little-known tree further, the Puebla University Botanic Garden (JBU-BUAP) and Botanic Gardens Conservation International (BGCI) started a three-year project under the Global Trees Campaign initiative to determine its current status and produce a recovery plan to guarantee the preservation of this unique population.



Map. 1. *Croton rosarianus* location in Mexico. The point indicates Finca el Rosario in Atepehua, Cuetzalan municipality, Puebla state, Mexico. Data SIO, NOAA, U.S. Navy, NGA, GEBCO. Data LDEO-Columbia, NSF, NOAA. Image Landsat/Copernicus

Over the course of 3 years we carried out 7 field trips to record the distribution, to document flowering and fruiting times and to look for any signs of regeneration. For propagation we collected seeds and cuttings. We also searched the literature and herbaria to determine whether other locations were known. Herbarium material collected during the project is deposited at the herbarium of the Puebla University Botanic Garden (HUAP).

Results

From our surveys in the area, it would appear that this species is, indeed, very rare. The entire population was found in an area of 71 m x 20 m in the Finca el Rosario and no other records were found either in the field or in our literature and herbarium surveys. 120 plants were found but no seedlings were seen, although some juvenile plants were present. One paper mentioned it as occurring in the state of Veracruz (Villaseñor, 2016), but this was found to be erroneous.

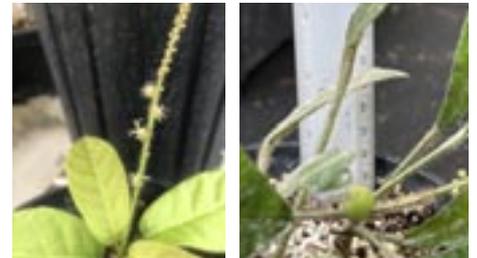
As a rare species described relatively recently we found no reports of its germination, propagation or reproductive biology in the literature and we had to devise our own techniques. We initially considered that propagation by seed would be the best method. However, over the course of our visits to the site we found that this tree produces fruit during much of the year and only a few mature fruits are present at any one time. In addition, we also found that many seeds appeared to have been eaten by insect larvae. During our field work we only managed to collect 19 fruits, from which we obtained 43 seed. However, many had not developed or had been eaten by larvae and only 5% were apparently viable. As yet we have not raised any plants from seed.

Vegetative propagation proved more successful and from 98 semi-ripe cuttings we raised 34 plants. Rooting of these was slow, taking 3 to 5 months and about 6 months to produce healthy plants of 15-20 cm. Warm, shaded and humid conditions were found to be essential for rooting. This propagation technique has been a big help in the detailed understanding of its flowers.

Conclusions

Our surveys indicate that this is a very rare tree that warrants conservation action. It grows in a very small location in a specific habitat where it is shaded, warm and humid. Our initial results show that very often, little viable seed is produced. These factors seem to be the main threats to its survival. We believe that more work needs to be done in order to make a good assessment of its conservation status according to IUCN criteria. We are planning to continue work on propagation to enable the establishment of conservation collections and to eventually be able to replant it in its natural habitat.

The involvement of the Finca el Rosario's landowner, workers and local communities continues to be essential to the success of the project. They are important stakeholders who will support the development of the Recovery Plan to secure the survival of this tree. At the beginning of the project *Croton rosarianus* was unknown to local people and lacked a common name. In order to assist with its recognition, we are proposing that it is referred to as 'Arbol del Rosario' (Rosario Tree). We are still hoping to find more individuals of the species in another area and maybe we will find its local name.



Croton rosarianus inflorescences - top.; male flower - middle; female flowers and insertion of fruit - above.

Acknowledgements

The authors would like to thank Mr. Jose Luis Flores Hernandez, the owner of Finca el Rosario, who supported this research project on his property. We also give thanks to his Finca caretaker Mr. Dionicio Juarez Cabrera, who helped in the long walks in search of this species.

References

- IUCN. 2021. The IUCN Red List of Threatened Species. Version 2021-3. <https://www.iucnredlist.org>. Accessed on 10 May 2022.
- Villaseñor, J.L. 2016. Checklist of the native vascular plants of Mexico. *Revista Mexicana de Biodiversidad* 87: 559–902.

Allen J. Coombes, Michelle Xicotencatl-Lozano, Lucio Caamaño Onofre, Maricela Rodríguez.
Puebla University Botanic Garden (JBU-BUAP), Puebla, Mexico

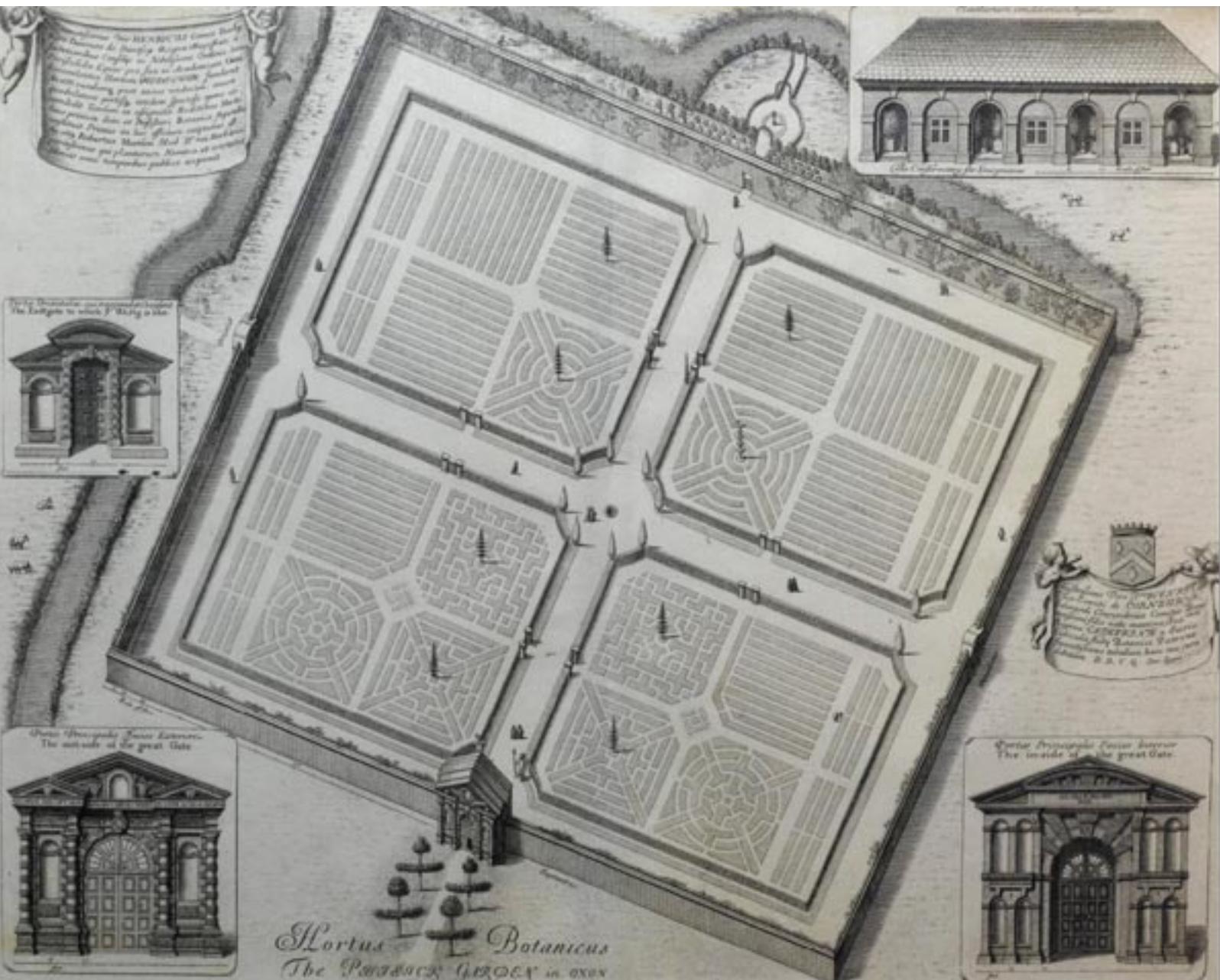
FEATURED GARDEN

BRITAIN'S OLDEST BOTANIC GARDEN IN THE 21ST CENTURY

The University of Oxford Botanic Garden, founded in 1621, occupies a unique place in history as the birthplace of botanical science in the UK.



Path down to the Professors House (1871)



Hortus Botanicus, or the Phisick Garden (Botanic Garden), from 'Oxonia illustrata' (1675)

Introduction

The University of Oxford Botanic Garden is the oldest botanic garden in the UK. It was first established as a physicke garden for the cultivation of medicinal plants for teaching the University's medical students. Today, Oxford Botanic Garden and Arboretum (OBGA), hold a collection of about 5,000 species; some are exceptionally rare or endangered in the wild and hold international conservation value; others are used in research to address the world's big challenges, for example those linked to climate change and nature-inspired technology (biomimetics). The collections are also used to engage people with the wonder of plants at a time when this has never been more urgent.

The history of Britain's oldest botanic garden

The historic Walled Garden was built between 1621 and 1639 and planted in the 1640s by the Garden's first keeper. When the Garden was first established as a physicke garden in 1621, many of the plants were classified according to their medicinal properties. Later, in the mid-1800s, they were rearranged by geographical origin as more specimens became available from overseas. Today the Taxonomic Beds house thousands of plants organised by their genetic relatedness and are an important



Danby Arch and River Path pictured 1913



Glasshouses

resource for teaching and research. The Garden's trees are the longest-standing living features of its ever-changing landscape. The oldest of these is an English yew (*Taxus baccata*) planted in 1645. The sole remaining tree is one of many yews that were planted, most of which were removed by Charles Daubeny, the Sherardian Professor of Botany, in the 1800s. The tree was damaged severely by Storm Ciara in February 2020, but it lives on, and may see another four centuries still (Thorogood, 2021).

Research in a changing world

Today OBGA runs a diverse portfolio of collections-based research projects. At a time of great need to step up efforts to conserve the world's flora, the Botanic Garden is placing focus on plants which have historically evaded conservation focus. Parasitic plants for example, are often neglected by botanic gardens owing to their perceived intractability to cultivation. Over 1% of flowering plants are parasitic, and extract their food from other plants - their so-called hosts. They include the world's largest flowers (*Rafflesia*), economically important pests (e.g. *Striga*), and ecosystem engineers (e.g. *Rhinanthus*). All parasitic plants possess a special organ called a haustorium, which attaches to the host, penetrates its tissues and draws food and water from it, forming a living physiological bridge between the two plants. Many have abandoned photosynthesis (holoparasites), and these are now completely dependent on other plants for their existence. The evolutionary origins of parasitic plants were unclear until the advent of DNA sequencing technologies. This was because the shift to parasitism was associated with a degeneration of features traditionally used in plant classification, such as well-developed leaves. At OBGA we are interested in the processes by which these parasitic plants form new species. Our research shows that shifting hosts may be a driver of the formation of new species of parasitic plants. Linked to this research, we are now developing a unique research collection of parasitic plants at the Botanic Garden which includes species that are absent in cultivation elsewhere (Thorogood et al., 2022).

A specific research focus is on a genus of parasitic plants called 'Desert hyacinths' (genus *Cistanche*). Some are traded widely for herbal medicine or have historical local importance as food. But despite their impor-



Top: *Glossostemon bruguieri* which features in herbal medicine in Iraq.

Illustration by Chris Thorogood

Above: *Cistanche deserticola*. Illustration by Chris Thorogood

tance, little or nothing is known about the biology of most species and their taxonomy remains confused, hindering identification. Together with scientists at the University of Reading, Royal Botanic Gardens Kew, and other institutions in China and the Middle East, our work seeks to unravel taxonomic complexity in this overlooked but important group of plants. Recently we highlighted the potential of *Cistanche* as a future global crop in a changing climate. A growing body of research into the cultivation of pharmacologically well-characterised *Cistanche* taxa in China has enabled a regional supply of traditional herbal medicine at low-level cost and intervention. In the context of a global desertification crisis, there is now significant potential to expand cultivation of the plant beyond China, as an ancillary crop alongside belts of trees installed to halt land degradation.

To realise this potential, and to monitor trade to control unsustainable harvesting of threatened wild populations, a robust taxonomy informed by both morphological and molecular data is needed. We are using a combined approach examining the ecology (host range), morphology and DNA sequence data to develop a robust taxonomic framework for *Cistanche* that can inform trade, agriculture and conservation (Thorogood et al., 2021).

Biomimetics: plants and technology

We work in collaboration with physicists and mathematicians at the University of Manchester and University of North Carolina, and at the Mathematical Institute of the University of Oxford to examine the functional and structural properties of plants. Oxford Botanic Garden cultivates an extensive research collection of carnivorous *Nepenthes* pitcher plants under glass. Our work explores the functionality of the slippery surfaces of the *Nepenthes* pitcher, and its potential technological applications. Inspired by the plant, we have created artificial surfaces to explore the capability of trapping, retaining and directing the travel of liquid droplets. Our findings revealed a potential mechanism for developing systems in which the transport of droplets is controlled by 'energy railings'. These railings could provide a biomimetic means of transporting and sorting droplets in droplet-based fluidic devices and could enable the efficient mass transport of liquids along pre-determined pathways. This work also offers insight into the evolution of pitcher plants, showing that capillary action pins droplets to the parallel, water-infused grooves, and directs their transport in a controlled way. This indicates that the 'pitfall' trapping mechanism of *Nepenthes* is enhanced by the water-infused grooves on the slippery rim, driving prey into the trap in a way that is more tightly controlled than considered previously, by avoiding arbitrary slippage (Box et al., 2019).

Recently we extended this work to examine the structure of giant Amazonian waterlilies (*Victoria*). The famously large leaves can grow 40cm a day, reaching nearly 3m in diameter – ten times larger than any other species of waterlily – and carry the weight of a small child. In collaboration with physicists, we found recently that the distinctive pattern on

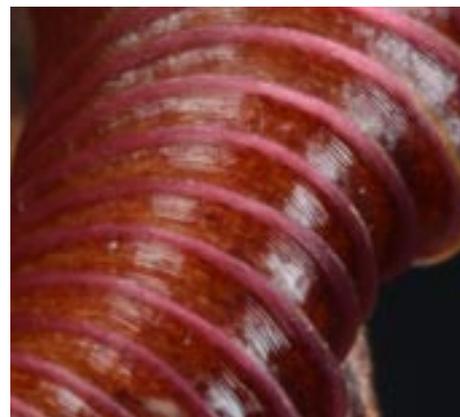


The carnivorous *Nepenthes* trap

the underside of the gargantuan leaves is the secret to the success of this great floating enigma. A framework of veins on the underside makes up the vascular structure of the leaf, supporting its large surface area and keeping it afloat. We compared the high-sided giant Amazonian waterlily leaf which has thick veins to *Nymphaea* – a smaller relative with disc-like leaves and a less prominent vascular system. Using *in situ* experiments and mathematical modelling, we found that the giant Amazonian waterlily leaves had a greater rigidity for a given volume of plant matter. Leaf size is usually restricted mechanically by the expense of maintenance. A larger surface area for photosynthesis uses more of the plant's energy to maintain. But the efficient structure and load-bearing properties of the giant Amazonian waterlily give it a competitive edge: high strength at low cost. Remarkable structures in nature such as this can help us to unlock design challenges in engineering. For example, the form of these waterlilies could inspire giant floating platforms, such as solar panels in the ocean (Box et al., 2022).

Plants, people and planet

Biodiversity is being lost locally, regionally and globally, at an alarming rate. New species of plants are still being named and described each year, whilst others shift towards extinction, losing the battle against



The energy railings (grooves) of the *Nepenthes* peristome



The underside of the giant Amazonian waterlily

the threats they face amid an increasing human population. So there is a growing urgency for botanic gardens to inform and inspire people with the scientific wonder of plants, and foster a greater awareness of their importance and the need for their conservation. Yet unlike animals, plants often go unnoticed, a phenomenon that has been described metaphorically as 'plant blindness'. Botanic gardens' collections are visited by millions of people every year so the opportunities for engaging people with the importance of plants and plant conservation are immense. An approach we have explored at Oxford Botanic Garden, is to astonish people with plants, changing their perceptions that plants are inanimate compared with animals. For example carnivorous plants, those that attract and trap animal prey to obtain nutrients – have inspired generations of scientists since Charles Darwin. They can challenge conventional concepts of plant behaviour, and are a powerful engagement mechanic. Online communication can also be used to show plants that cannot be seen in cultivation. Parasitic plants – many of which are rarely seen by people – can challenge people's perception of plants.



Parasitic plants (Orobanche) in cultivation at Oxford Botanic Garden

Articles on such plants such as those published in the 'Flora Obscura' series in the journal *Plants People Planet*, which are accompanied by visually engaging digital media, have achieved significant online activity and engagement with audiences worldwide. Some of these species happen to be of extreme conservation concern. Promoting awareness of them and the need for their conservation beyond a conventional academic readership, may also be a catalyst for conservation action (Thorogood, 2020).

"First conceived as gardens of medicine centuries ago, today botanic gardens are not only refuges for plants; they are sanctuaries for human healing."

It is not just plants that we are losing: people's knowledge of plants in traditional herbal medicine is also at risk. Herbal medicine plays a vital role in healthcare in Middle Eastern countries such as Iraq. Here, some local communities depend entirely upon traditional herbal medicine for the treatment of illnesses. Despite the importance of herbalists in the community, their work is often undocumented, and the rich ethnobotanical heritage of traditional herbal medicine is at risk of being lost. During periods of war and political turmoil, when communities were reliant on plants for healthcare, the herbalists have documented the country's flora and its uses in ethnobotanical medicine. OBGA recently produced a herbal flora, published with Kew, inspired by an Iraq herbalist Jaleel Ibrahim Quragheely, who dispensed herbal medicines to communities for when they

were most in need. The aim of this project is to help safeguard the continuation of traditional Islamic medicine and its profound importance in the treatment of disease in areas where, due to war, the knowledge of generations is at risk of being lost (Ghazanfar and Thorogood, 2022).

Combining conservation with community engagement can be a powerful approach to bringing about positive change. OBGA works in collaboration with local partners to examine and document the flora of the Canary Islands, and identify opportunities for conservation work in a region under growing pressure from anthropogenic change. Together with local ecologists, we work with communities to 'rewild' brownfield sites around the city of Arrecife using plants propagated from natural populations around the island. This approach to conservation using native species creates green spaces that require little or no long-term intervention, and benefit the mental health and wellbeing of local communities. Together with the local residents, we have helped create urban restoration gardens of native species.

"At a time of unprecedented extinction, there is an urgent need to foster a greater awareness of the bewildering plant diversity that exists on our planet."

Concluding Remarks

The solutions to many of our biggest challenges will be unlocked through research into plants – from renewable energy technology and climate change to food security. The



Community-led conservation work in Arrecife

c. 400,000 vascular plants that exist on our planet represent a living library for scientists to explore. Finally, besides their importance in conservation, research and engagement, botanic gardens which are often situated in cities, are green oases which are beneficial to people's mental health and wellbeing. Urban greenness has been shown to reduce the public health burden of mental disorders. First conceived as gardens of medicine centuries ago, today botanic gardens are not only refuges for plants; they are sanctuaries for human healing.

References

- Box, F., Erlich, A., Guan, J.H. & Thorogood C.J. 2022. Gigantic floating leaves occupy a large surface area at an economical material cost. *Science Advances*. 8(6):eabg3790. doi: 10.1126/sciadv.abg3790
- Box, F., Thorogood, C.J. & Guan, J.H. 2019. Guided droplet transport on synthetic slippery surfaces inspired by a pitcher plant. *J R Soc Interface*. 16(158):20190323. doi: 10.1098/rsif.2019.0323
- Ghazanfar, S.A. & Thorogood, C.J. 2022. A herbal of Iraq. Kew Publishing, London.
- Thorogood, C.J. Astonishing Plants. 2020. *Trends in Plant Sciences*. 9:833–836. doi: 10.1016/j.tplants.2020.06.007
- Thorogood, C.J. 2021. The University of Oxford Botanic Garden: sharing the scientific wonder and importance of plants with the world. *Curtis's Botanical Magazine*. 38: 438–450. <https://doi.org/10.1111/curt.12419>
- Thorogood, C.J., Witono, J.R., Mursidawati, S. & Fleischmann, A. 2022. Parasitic plant cultivation: examples, lessons learned and future directions. *Sibbaldia: The International Journal of Botanic Garden Horticulture*, (21). <https://doi.org/10.24823/Sibbaldia.2022.1892>
- Thorogood, C.J., Leon, C.J., Lei, D., Aldughayman, M., Huang, L-f. & Hawkins, J.A. 2021. Desert hyacinths: An obscure solution to a global problem? *Plants, People, Planet*. 3: 302– 307. <https://doi.org/10.1002/ppp3.10215>



Horse chestnuts with tree peonies (Olha Pokhylchenko)

FEATURED GARDEN

CLASSIC IDEAS AND A MODERN STAGE FOR LEONID RUBTSOV'S DENDRARIUM

More than 70 years since its creation, the social and scientific value of this arboretum remains the same as originally intended – it is a green laboratory, an education center, an example of garden art, and a place for people to relax.



Leonid Rubtsov

Introduction

Rubtsov's Dendrarium (Arboretum) is part of the Mykola Hryshko National Botanic Garden of the National Academy of Science of Ukraine. Spread over 30 ha the arboretum is named after landscape architect and Doctor of Biology, Leonid Rubtsov, who created a number of projects for this and other garden's areas. Rubtsov supervised the collection of specimens, land preparation and planting on this area as well as the first stocktaking in 1967.

Rubtsov used a terraced slop of the high bank of Dnipro River in Kyiv to provide suitable

conditions for plants requiring different ecologies. This long-inhabited area includes more than twenty ancient and veteran trees, such as oaks, mulberries, elms, and horse chestnuts and the composition of the Arboretum's landscape is magnificently emphasized by the churches of Vydubecky monastery and Kyiv-Pechersk Lavra.

Leonid Rubtsov wrote in his publication "The Dendrarium and its collections" in 1971: "the arboretum aims to be a living laboratory, containing the type-specimens for species identification and providing a base for the reproduction of future plants, as well as being an education center for city gardening specialists, an example of garden art and a place for relaxation".

Developing the collection

In creating the arboretum, the efforts of garden staff were focused on collecting plants and seeds from other botanical gardens, as well as carrying out scientific expeditions to natural stands. The Garden's botanists visited places of temperate climate across the whole USSR looking for potentially interesting flora – these included the Far East, Caucasus, Central Asia, Crimea, and the Carpathians.



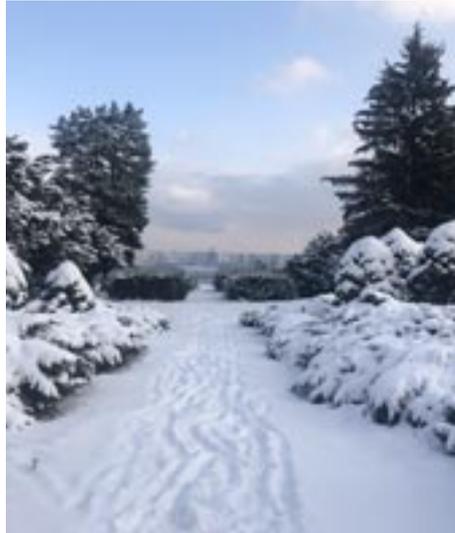
Magnolia Garden (Olha Pokhylchenko)

The collected seeds and plants became a basis for the Arboretum. In 1946, Leonid Rubtsov with other scientists visited Germany to select and buy plants from local nurseries. Receipts for purchasing the plants from different nurseries are kept in the garden's archive. These papers provide confirmation of the origin of the collected plants. Nowadays, the German plants are the oldest in the arboretum collection.

During the Arboretum project creation in 1947, the plants were placed by genera according to Engler's system. A species, its varieties and forms became the collection's basic unit. Specific differences between similar species were underlined through their close alignment. After stocktaking in 1967, the arboretum collections comprised 754 species with 257 varieties and forms.

Colour combinations

Rubtsov's principle of color concentration was implemented in stands of plants with seasonally alternate blooming times. The first April flowering starts in the Magnolia Garden. Next come Forsythias, which were planted together with contrasting Muscaries. During early May, the apple garden is in its heyday and in Rubtsov's time, the apple-trees were planted together with huge numbers of tulips on a lawn surrounded by trees. May is also the time of flowering for 1,500 lilac bushes and tree peonies that grow side-by-side. Plants of 22 species and 132 cultivars of lilac grow in the Syringaryi, which covers 2.4 hectares. The view from the Lilac Garden toward the Dnipro and



Crimea perspective (Olha Pokhylchenko)

Vydubetsky monastery is the most famous picture of Kyiv. Deutzias and mock-oranges succeed lilacs from late May to June.

After more than 70 years of the Arboretum's existence, we can see how talented and far-sighted Leonid Rubtsov was – the trees have grown up, but all the author's conceptions are recognizable and spectacular. People who took part in creating these collections drew planting schemes and filled cards for each specimen, leaving detailed reports in the garden's archive. All these papers are a basis for documenting the modern collection.

The collection today

Today the Arboretum's collections comprise 1,062 species, varieties, and cultivars. All the plants have grown into trees and shrubs and it is now time to restrict the introduction of new species. According to the current collection policy, Rubtsov's Dendrarium is enriched only with plants from natural stands, with a focus on species from Ukraine, threatened species, and fully represented genera, such as spruce, pine, juniper, ephedra, linden, lilac, mock-orange, deutzia, and willow. Cultivars of Ukrainian selection are on the wish-list too. The social and scientific value of this place remains the same as it was intended by Leonid Rubtsov – it is a green laboratory, an education center, an example of garden art, and a place for people to relax.



Syringarium (Olha Pokhylchenko)



Lilacs with tree peonies (Olha Pokhylchenko)



Volunteers helping to build the irrigation system (Valentyna Sliusar)

These artificial stands provide an ideal opportunity to identify problems and understand how to create new optimal ecological models. More and more trees are dying every year for different reasons, including allelopathic interaction, decreasing precipitation and increasing pest and disease burdens. Trees that can live up to 300 years in optimal conditions (spruces, larches, or pines) typically last only 70-80 years in our circumstances.

Building an irrigation system

Optimised watering and mulching can revitalise the soil and improve the growing conditions for the trees. Therefore, building an irrigation system became the next stage in the Rubtsov's Dendrium story. However, as the garden's budget didn't allow such a massive project to be implemented in a short time, this activity was only affordable with external assistance.

The challenge was taken up by Yana Bobrova, Executive Director and co-founder of "Peli can live" charity foundation¹: "Starting the 'Water for botanic garden project' was a real challenge as we had never created an irrigation system before".

After investigating the problem, it became clear that the only way to save and develop the unique collection of Rubtsov's Dendrium was a sustainable watering solution. Unfortunately, the old irrigation system built at the time of foundation of the Botanic Garden, failed in the early '90s and could

not be restored. Thus, the only available decision was to start the construction of a new watering system.

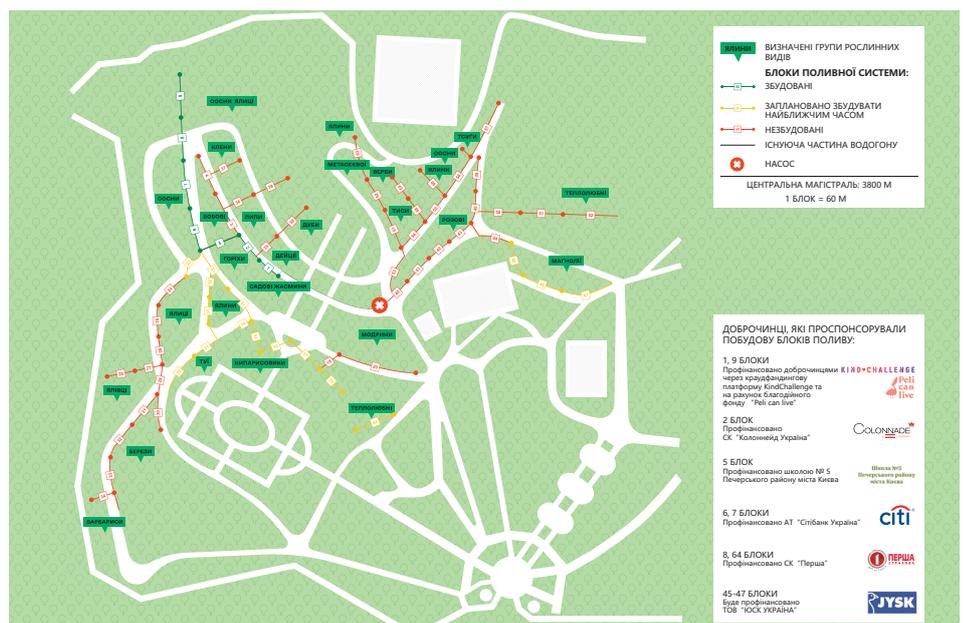
A project group was created in Autumn 2020, consisting of the Garden's and charity foundation's management, to develop the technical plans for the irrigation system and to be able to make any required amendments quickly. Being a charity foundation, our financial resources are limited and we had to solve the problem within strict budget limits. After long discussions, we decided against the option of drip irrigation and decided to develop a more conservative system - a network of pipes and wells. In

the future, when the Botanic Garden has more financial opportunities, it will be possible to add the drip irrigation on top of the existing watering system. Another important decision made was to divide the Arboretum into 64 blocks and build the system gradually based on available financing. This approach allows us to provide water to areas of the Garden as soon as the corresponding irrigation block is constructed, rather than waiting for the entire irrigation system to be finalized. Moreover, we also have a chance to show our donors the results achieved and initiate fundraising for new blocks.

In summer of 2021 we built the first three blocks of the irrigation system. These covered the Jasmine Garden, ash trees and hickory trees. We also installed the pipeline to cover plateau areas of the Arboretum.

Fundraising

The donations we received came from very different sources. We organized fundraising through a crowdfunding platform "Kind Challenge" and we received funds from the secondary school № 5 located near the Garden, that held a charity fair to raise the money. A significant part of financing was obtained from an insurance company with Canadian roots "Colonnade Ukraine". Work by volunteers also helped to save money related to digging the trenches (423 meters) and wells (15) as well as creating a friendly atmosphere around this project.



Map of the watering system



Friends of the Botanic Garden (Andrii Gorb)

To raise further funds for the new blocks of our irrigation system, in addition to the crowd-funding and financing from the corporate donors we introduced a “Plant Your Tree” project. This allows individuals and companies to choose a tree (from the list of plants grown and provided to us by the Botanic Garden) and plant it in honor of their family or company. These trees are supported by the agreed charitable contribution to our Foundation. The names of donors are indicated on the signs next to the planted trees.

“We even participated in a marathon to raise funds for the garden”.

Thanks to financing by the EU through ISAR Ednannia in the framework of the EU4Civil Society Sustainability in Ukraine project, we created the Friends of Botanic Garden community, for whom we organized several thematic excursions (including one devoted to the birds that live in the Botanic Garden) and worked on a special photo project #waterforbotanic garden. As well as attracting several new corporate donors to this project, others have also made positive decisions to finance it. Our initial plan was to start the construction of the new blocks of irrigation in April 2022, and we started to make the necessary preparations. The last portion of required equipment was purchased on 23rd of February, 2022.

Recent challenges

The Russian invasion of Ukraine has changed our plans. We could not start the construction works as we planned, we postponed the opening of our photo exhibition and we have lost some of our committed donors as they have lost their assets due to the war. The

Botanic Garden was closed to visitors, as well as other parks and forests located in the territories suffering from the war. However, during the last weekend of May 2022, the Botanic Garden reopened its doors for the visitors, and we decided not to waste valuable time but to continue our construction.

Four new blocks of irrigation system are already working, 5 more will be opened in August this year. This is thanks to our new corporate donors: the JSC “Citibank Ukraine” and Insurance Company “Persha” as well as the other financing mentioned above and many private individuals who love the Botanic Garden and supported this project during this summer fundraising campaign. We have also received confirmation from JUSK UKRAINE of financing for the Magnolia blocks.

Today this project means much more for the volunteers of the botanic garden: it is their time to believe in a future peaceful life. And it is uniting people. Some of our volunteers arrived in Kyiv from the territories occupied by Russian invaders, some people lost their friends or the members of their families. The joint work in the botanic garden is a treatment for their’s and our souls.

Now we need help telling our story to the visitors/communities of other gardens, hoping they would like to support our fundraising campaign. Perhaps, some people/companies would like us to plant their own tree in the Mykola Hryshko National Botanic Garden of National Academy of Science of Ukraine, in the heart of Kyiv, capital of Ukraine.

Olha Pokhylchenko
M.M. Hryshko National Botanic
Garden of National Academy of
science of Ukraine
Ukraine 01014, Tymiryazevska
str., 1. NBG NANU

Yana Bobrova
Peli can live, charity foundation
pelicanlive.com

ENDNOTE

1. Charity foundation “Peli can live” was created in 2017 to implement nature protection projects. The mission of the foundation is: “Empowering force of nature for the harmonic development”. The foundation builds pelican nesting islands and insect hotels, helps preserve forests and natural ecosystems, and restores forest belts.



Opening to visitors (Yana Bobrova)

INTERVIEW

CHRISTOPHER DUNN, EXECUTIVE DIRECTOR CORNELL BOTANIC GARDENS, CORNELL UNIVERSITY, USA

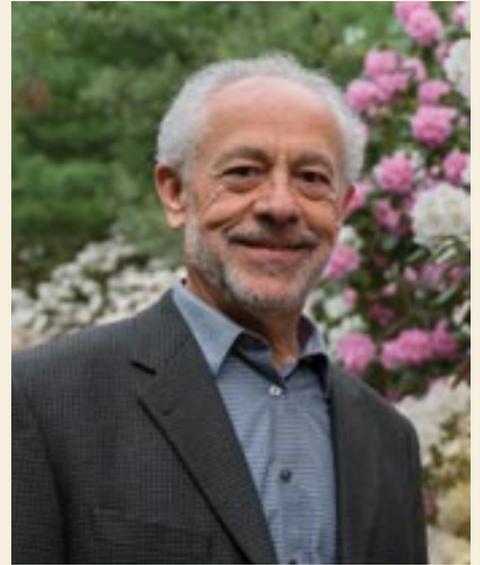
You are Director of a large botanic garden located on the campus of a university. Are the programmes of the garden influenced by the interests of the university, or do you set your own priorities?

It is both. The interests of Cornell University relate primarily to supporting the academic enterprise and to engaging our community. We not only support faculty and student research/teaching, but we also contribute to the academic enterprise by teaching several formal courses. Our interests at the gardens, and which we largely develop on our own, deal with increasing awareness, broadly, of the essential interdependence between plant diversity and human cultural diversity. It is not enough, for instance, to conserve species for their own sake. We need to do so also for the sake of local and Indigenous communities whose livelihoods and traditions depend on that diversity.

Certainly, our interests and those of the university overlap considerably. In fact, our focus on biocultural diversity and conservation, which we will discuss a bit later, is one area that brings together faculty in natural sciences, humanities, and the arts. We are increasingly being appreciated as a hub where multidisciplinary work can be nurtured.

Do the visiting public see the garden as a part of the university?

That is a good and important question. I think most visitors see us that way. Because the university is a non-profit educational institution, it does not pay taxes to the local governments. However, in lieu of taxes, the university supports a number of community organizations, the local bus system, etc. The botanic garden is also listed as one of the university's contributions to the community. Thus, we are appreciated by the community



(and especially so during the COVID-19 pandemic, as we continued to be open to all). On the other hand, most community members assume that we receive full funding from the university. In actuality, we receive very little support.

One interesting aspect to this is that, until a few years ago, we had a very different name (Cornell Plantations). When I took over as Executive Director in 2014, my staff and I made a concerted effort to see if there was support for a new name or if the current name had strong support. A new name won the day. With that new name came a lot more awareness of who we are, what we do, and our place within the university structure.

Is the garden used by university students in their research projects?

Yes, very much so. We actively encourage this and make every effort to engage students. And the students are not only in the plant sciences. We have had physics and engineering students studying the architecture and structure of trees, others looking at identifying species by their spectral signatures. Students in art, literature, and music have been studying the relationship between human creativity and nature. And others examining the emotional, psychological, and physical benefits of spending time in nature. Clearly, we are not just a pretty place!



Aerial shot of garden (Jay Potter)



Staff member engaged in academic enterprise (Cornell University Photography)

You have a particular interest in biocultural conservation. Is this something that is also reflected across the University's programmes?

Yes, I am very interested in biocultural conservation, as we talked about earlier. I came to Cornell University from Hawai'i where the relationships among land, nature, culture, and language are profound. Developing biocultural programs at a botanic garden in the Pacific is not much of a challenge. In fact, it would be strange if that were NOT the case. On the east coast of the United States, however, linking plants' stories (their ecological, evolutionary, economic significance) to those of various cultures is not such an easy concept to sell. However, because we have a very thoughtful and forward-thinking staff, as well as a resurgence of the Native American communities and culture in our region, we were able to readily develop both the support for, and content of, biocultural programs that are authentic to our place. As soon as we changed our name to Cornell Botanic Gardens, we prepared new mission and vision statements that explicitly refer to the interdependence between plant and cultural diversity.

Cornell University supports an American Indian and Indigenous Studies Program which includes faculty from various disciplines and an Africana Studies and Research Center, allowing us the opportunity to expand the scope of the communities and faculty with whom we work. As we continue along this path, we are finding so many more faculty and students with strong interests in this

topic. So much so, that our goal to develop a biocultural hub at the university has a strong chance of coming to be. In fact, in collaboration with a faculty member in the natural sciences, we hosted a hybrid international conference on biocultural conservation with a focus on how climate change is impacting local pastoralist communities in the Pamir Mountains of Central Asia.

To give you an idea of university support for this initiative, the Provost of the university facilitated the in-person participation of members of those communities and provided some welcoming remarks that spoke passionately about Cornell's commitment to providing a space for the Indigenous voice.

I will say that all botanic gardens should embrace biocultural diversity and conservation. It must be an integral component of the work we do. It is both an opportunity and an obligation, as I have written about extensively.

Do you think it is an advantage for a botanic garden to be associated with a University?

Yes, it is a great advantage. We receive support in a number of administrative areas that we would otherwise have to pay for ourselves, such as IT, human resources, insurance and retirement plans. And, we do not have to support our own research programs. Some visitors and professional colleagues have asked me about our research staff. I point to the university campus and say, "THAT is our research program." On the

other hand, there are some drawbacks to being affiliated with a "parent organization." It means we are not as nimble when it comes to staffing, hiring, getting grants (the university takes a large cut), among other things. We need to ask permission for some activities or processes that we would otherwise consider and develop internally.

That said, having access to students means that we can directly influence, in a positive way, the next generation of engaged civic-minded young people. Having students wanting to work with us and eagerly being involved as student leaders in our new Learning by Leading program is immensely gratifying.

In some countries there is a trend away from the teaching of botany at universities, in favour of more biotechnological options. Do you see this in your university and more broadly across the USA?

Yes, this has been a concern for many years. In fact, even in the 1980s, many universities were abandoning organismal science in favour of molecular research. Taxonomy, too, has become a molecular enterprise and less of a field-based one. Accompanying these changes has been the tendency to combine botany and zoology departments into biology ones, often to the detriment of the botanical sciences. However, at Cornell all the botany-related academic departments (and this includes horticulture) have been assembled into a single School of Integrated Plant Sciences. Although any reorganization will meet some resistance, I think this new School elevates the plant sciences to a level not otherwise possible. Another interesting development (and this is not unique to Cornell) is the increasing appreciation of the many values of nature, greater awareness of environmental justice, and greater interest in ethnobotany and ethnomedicine. I am hopeful that we are beginning to see things swing back to a more organismal and people-centered view of botany and plants in general.

Further reading:

Dunn, C.P. 2017. Biological and cultural diversity in the context of botanic garden conservation strategies. *Plant Diversity* 39: 396-401. <https://doi.org/10.1016/j.pld.2017.10.003>

ARTICLES

THE BOTANICAL GARDEN OF THE UNIVERSITY OF VIENNA – CHANGES, CHALLENGES AND SUCCESS STORIES

STELLENBOSCH UNIVERSITY BOTANICAL GARDEN – ACADEMIA SUPPORTING RESEARCH, EDUCATION AND CONSERVATION OUTCOMES

BONN UNIVERSITY BOTANIC GARDENS: A GARDEN DEDICATED TO (MUCH MORE THAN) PURE BOTANY

THE BOTANICAL GARDEN OF THE CITY OF PLOTTIER (JBCP), A CASE OF MIXED UNIVERSITY-MUNICIPAL GOVERNMENT GOVERNANCE IN ARGENTINA

PADRE JULIO MARRERO BOTANIC GARDEN: A UNIVERSITY BOTANIC GARDEN IN ECUADOR

EDUCATION AND RESEARCH AT THE GHENT UNIVERSITY BOTANICAL GARDEN

A HUNDRED YEARS OF NATURE AND HISTORY: THE BOTANICAL GARDEN OF THE UNIVERSITY OF SAN CARLOS DE GUATEMALA

THE BOTANICAL GARDEN OF THE UNIVERSITY OF LEIPZIG - BRINGING THE GLOBAL DIVERSITY OF PLANTS TO LEIPZIG FOR EXPLORATION, COMMUNICATION AND PROTECTION

CASE STUDIES

THE BOTANICAL GARDEN OF THE ADAM MICKIEWICZ UNIVERSITY IN POZNAŃ, POLAND

THE BOTANIC GARDEN AND THE UNIVERSITY OF CASTILLA-LA MANCHA: A FRUITFUL SYNERGIC RELATIONSHIP IN THE CONTINENTAL MEDITERRANEAN CONTEXT

THE BOTANICAL GARDEN OF THE FACULTY OF SCIENCE OF MASARYK UNIVERSITY IN BRNO, CZECH REPUBLIC

OBSERVATOIRE DU MONDE DES PLANTES, THE BOTANICAL GARDEN OF LIEGE'S UNIVERSITY

SOFIA UNIVERSITY BOTANIC GARDENS – HISTORY AND PRESENT

THE BOTANICAL GARDEN OF THE UNIVERSITY OF VIENNA – CHANGES, CHALLENGES AND SUCCESS STORIES



Main alley of the Botanical Garden. (R. Hromniak)

Since its establishment in 1754, the Hortus Botanicus Vindobonensis (HBV) has been actively engaged in scientific research, academic and public education, conservation, and horticulture. As a green space in the city centre, the garden is also an important place for recreation. Acting as a “window” for the University’s public outreach, the garden has always tried to trigger curiosity and encourage contact with nature.

Introduction

Today, the HBV covers an area of c. 8 ha and is visited by up to 200,000 people each year. The plant collections of the garden comprise more than 11,500 species from all over the world. A large number of these plants are used in the research, teaching and public outreach pro-

grams of the University. Almost 5,000 species are growing outdoors and are publicly accessible. Display groups are, e.g., devoted to plant systematics, useful plants, plant morphology, plant geography, or to the *ex situ* conservation of rare and endangered species of the Austrian flora. The greenhouses harbour more than 6,500 species on c. 1,500m². As most of these plants are used for research purposes

only and are not accessible to the public, a small greenhouse and several display cabinets inform about the special collections cultivated indoors (Kiehn & Knickmann 2019).

Connecting history with modern science: the new “Systematic display”

Many maps, planting lists and seed catalogues document changes in layout and plant collections of the HBV since its foundation. Thus, it is possible to analyse and use this historical legacy for future developments. This approach was applied in the recent rearrangement of the systematic division at the HBV according to the most recent state of science, a topic of major importance for a university garden. Covering about a quarter of the garden’s area, the “systematic” arrangement of species, genera, families and orders has a long and well documented history, reflecting changes in views about systematic concepts of flowering plants.

"The diversity of functions as well as the knowledge about historical developments and achievements can be successfully used to cope with new challenges and changing tasks"

Using the publicity of the 650th anniversary of the University of Vienna for the realization of this project, at first a trail ("Endlicher-Fenzl-Kerner-trail") leading through the display groups was established. It is named after the three garden directors Stephan Endlicher, Eduard Fenzl, and Anton Kerner von Marilaun, who were very influential botanists at their time. Along this trail interpretative boards help to understand the history and changes of plant systematic concepts reflected in the garden layout with special focus on ideas developed at the University of Vienna. The trail is embedded into the new arrangement for all flowering plant beds in the systematic division (with now more than 2,000 taxa) according to the most recent classification, the Angiosperm Phylogeny Group IV system. It needs to be emphasised, that without the skills of the greatly involved head gardener, the division could not have been reorganized in this way. Information panels explain the different plant groups as well as the changing views about their circumscription and relationships for different target audiences (Knickmann et al., 2020). The new "system" is well perceived by the garden visitors. It is the subject of many guided garden tours and is also used in university teaching.

Collections suited for 21st century research and conservation

The HBV is still an indispensable tool for university research and teaching; it provides up to 10,000 plants or parts of plants of around 400 species from its collections every year. However, the foci of the collections have been changed in line with the garden's changing tasks in research, teaching and public outreach. Modern collection management requires: a proper documentation of the accessions; a forward-looking collection policy; and mid- and long-term on-site planning for content and design incorporating historical aspects if appropriate. Today, well planned additions to the collections of the HBV are made by research trips in accord with the requirements of nature protection and international conventions like the CBD or CITES, and also through seed and plant exchanges with botanical institutions worldwide. Garden staff members actively participate in national and international networks like the European Consortium of Botanical Gardens, BGCI or IABG. They are involved in the implementation of international regulations regarding access and benefit sharing, e.g., by fostering the International Plant Exchange Network (IPEN) or by negotiating MoUs with biodiversity-rich countries. Thus, unique research collections with a special focus on species conservation and protection have been developed in the greenhouses and outdoors, representing, e.g., the orchid genus *Bulbophyllum* (c. 700



New systematic display group with information board (B. Knickmann)

species cultivated indoors), or the Pannonian flora (c. 160 species of different dry vegetation types from Eastern Austria). The "Pannonian Group", developed since 1991 in an open area of the garden, represents an ex situ gene pool for several highly endangered species. Current research activities, e.g., focus on the links between ex situ and in situ species conservation (Schumacher et al., 2013, Kodym et al., 2018). At the same time, the displays aim to improve the public interest in conserving endangered Austrian dry locations and the associated species. As a consequence of the described collection policy, many cultivated species are of high scientific value or occur only rarely in nature. As they all are legally acquired, national and international cooperation projects have been set up to share expertise about their cultivation requirements and to pass on such plants (in particular duplicates) to other gardens. This means that not only their chance of survival in cultivation is increased; it is also more likely that plant material of the species in question will be available for future research and conservation purposes.

Linking history and climate change: the amended plant geographical groups

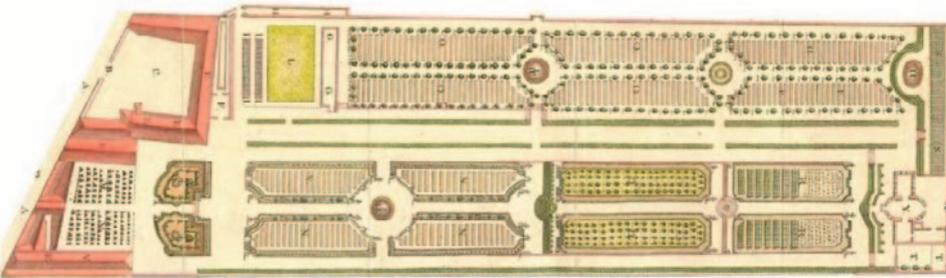
Many historical traits of botanical sciences are mirrored in the layout of the HBV, thus providing a valuable background for a major task of a university garden: to explain and present developments and challenges in botanical research. This relates, e.g., to the "plant geographical groups". These were established in 1879 by Anton Kerner von Marilaun and seem to be the first divisions in a botanic garden worldwide explicitly dedicated to plant geography. In 1889 they comprised c. 25 well documented geographical areas with typical elements of their vegetation zones. After more than a century, a new concept



Pannonian display group (R. Hromniak)



Children at the Botanical Garden (R. Hromniak)



Map of the HBV in 1770

for a revitalization of this part of the HBV was initiated. It is based on the historical evidence and plantings, but adds a new element to the topic: potential effects of climate change (Knickmann & Kiehn, 2022). As vegetation zones and climate are closely related to each other, hardiness is taken into account for the selection of new taxa. Especially species reported “just not to be hardy in the Viennese climate” are tested. Thus, the new approach builds on the historical plant geographical framework, but, in addition, is likely to provide long-term information about the climate tolerance of the selected species.

Training university students and public outreach: the “Green School Program”

Situated in the city centre, the HBV provides an attractive environment to create and support curiosity about nature for visitors of all ages and social backgrounds. Thus, science communication, especially of topics studied at the University of Vienna, is a rewarding challenge. The corresponding public out-

reach (“Green School”) program at the HBV was started more than 30 years ago. It was developed in parallel to the need for courses for science education for biologists and future biology teachers. Thus, it was created with the intention to combine the potentials,

options and needs of university education with the demands for education activities at the garden. Over time, the different courses and programs, as well as the interactions with the target groups, have been subject of evaluation and research. University courses with their applied elements in the garden have become part of the curricula. As a side effect of the research projects on science education topics, new ways and tools to increase curiosity about nature in different audiences have been developed, e.g. to counteract “plant blindness” (Pany & Heidinger, 2017) or to understand effects of climate change. A remarkable indicator for the recognition of this program is the recent establishment of a new building for the Green School at the garden, realized in the context of the 650th anniversary of the University of Vienna in 2015 (Kiehn et al., 2020).

Concluding remarks

Some of the structures and tasks of the HBV have remained nearly unchanged since 1754. Some others have been altered considerably, and some have been added to the portfolio of the garden. The present paper has highlighted examples for each of these fields. They all contribute to the current state of the HBV as a well-recognized Core Facility of the Faculty of Life Sciences at the University of Vienna, as a highly esteemed green space and learning environment for the general public, and also as an important player in the national and international botanic garden and scientific communities.



Botanicum building (K. Ranger)

Acknowledgements

The author is grateful to his colleagues Barbara Knickmann, Frank Schumacher and David Bröderbauer for sharing their ideas about different topics featured in this paper.

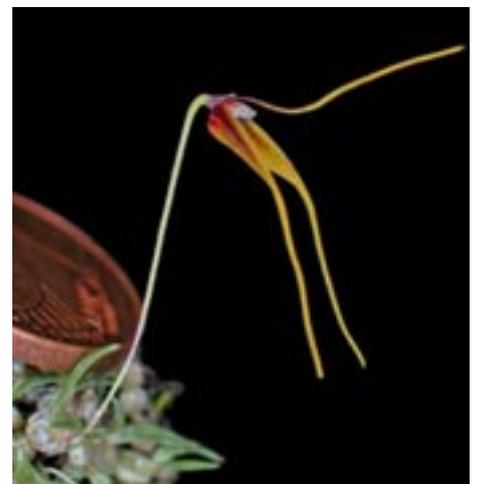
References

- Kiehn, M., Bröderbauer, D., Rose, M., Schumacher, F., Rauchberger, N. & Schlag-Edler, B. 2020: The Botanicum: New options for science education and public outreach at the Botanical Garden of the University of Vienna. pp. 139-144 in Espírito-Santo, M. D., Soares, A. L. & Veloso, M. (eds.): Botanic Gardens, People and Plants for a Sustainable World: following the 8th Eurogard Congress held in Lisboa, May 7th-11th 2018. Lisbon: IsaPress.
- Kiehn, M. & Knickmann, B. (eds.), 2019: Der Botanische Garten. 2nd edition, Wien. 94 p.
- Knickmann, B., Kiehn, M., Schumacher, F. & Petz-Grabenbauer, M., 2020: Connecting heritage with modern science: the new systematic division at the Botanical Garden of the University of Vienna. pp. 212-216 in Espírito-Santo, M. D., Soares, A. L. & Veloso, M. (eds.): Botanic Gardens, People and Plants for a Sustainable World: following the 8th Eurogard Congress held in Lisboa, May 7th-11th 2018. Lisbon: Isa-Press.



Alpine plant display (R. Hromniak)

- Knickmann, B. & Kiehn, M., 2022: Revitalization of the historical Plant Geographical Group at the Botanical Garden of the University of Vienna. pp. 77-84 in Espírito Santo, M. D. (ed.): Proceedings 1st International Congress of Historic Botanical Gardens. Lisbon: IsaPress.
- Kodym, A., Senula, A., Tensch, E., Hood-Novotny, R., Schumacher, F., Sekurova, O., Zotchev, S. & Kiehn, M., 2018: Micropropagation and cryoconservation of the endangered plant species *Artemisia laciniata* (Asteraceae). *CryoLetters*. 39: 177-189.
- Pany, P. & Heidinger, C., 2017: Useful plants as potential flagship species to counteract plant blindness. pp. 127-140



Bulbophyllum lakatoense (R. Hromniak)

in Hahl, K., Juuti, K., Lampiselkä, J., Uitto, A. & Lavonen, J. (eds.): Cognitive and Affective Aspects in Science Education Research: Selected Papers from the ESERA 2015 Conference. Cham: Springer.

- Schumacher, F., Grünweis, F., Knickmann, B., Maier, R., Prehler, D., Tod, F. & Kiehn, M., 2013: Projekte und Initiativen des Botanischen Gartens der Universität Wien (HBV) zur Erhaltung von Steppenpflanzen am Beispiel von *Artemisia paniculata* und *Dracocephalum austriacum*. pp. 385-394 in Baumbach, H. & Pfützenreuter, S. (eds.): Steppenlebensräume Europas - Gefährdung, Erhaltungsmaßnahmen und Schutz. Erfurt.



Pannonian display. (R. Hromniak)

Michael Kiehn
Head, Core Facility Botanical
Garden
University of Vienna
Rennweg 14, 1030 Vienna
Austria

STELLENBOSCH UNIVERSITY BOTANICAL GARDEN – ACADEMIA SUPPORTING RESEARCH, EDUCATION AND CONSERVATION OUTCOMES

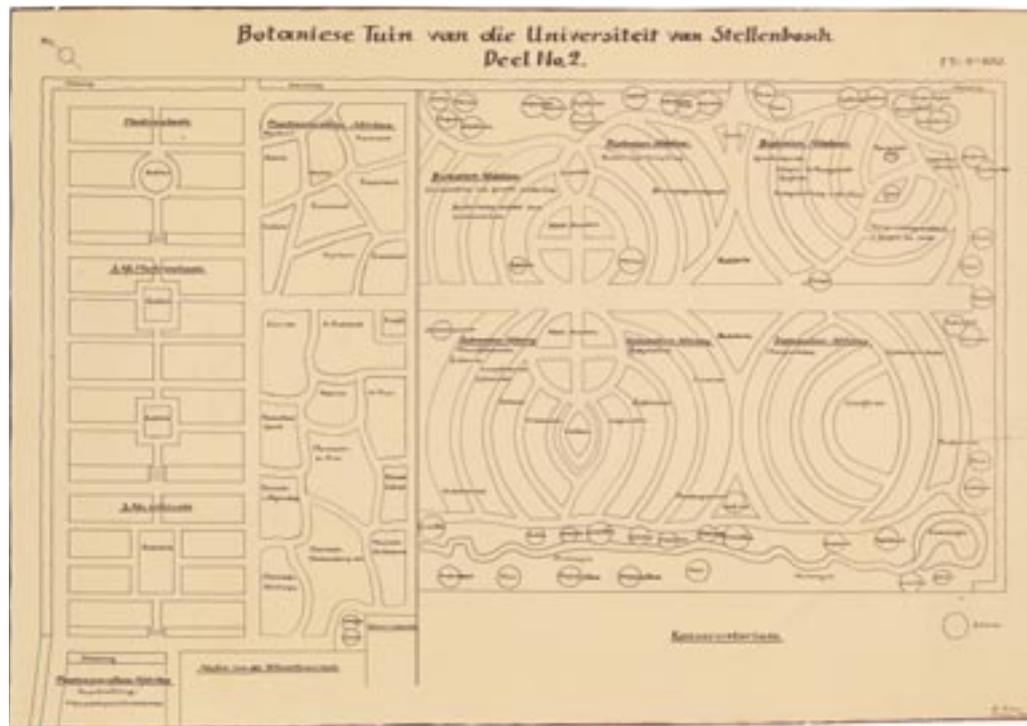
1922 – a teaching garden is established

The beginning of Stellenbosch University Botanical Garden (SUBG) was in 1902 when lecturer Dr Augusta Vera Duthie started growing plants for research and teaching next to the main botany building on campus. By 1921 this small start was of enough value that professor of Botany, Dr Gert C. Nel, convinced University Council to allocate the current small ~1.5 hectare (~4 acre) university property for the Botanical Garden, and work started in 1922. In 1925 the first curator, Dr Hans Herre was appointed, joined by horticulturist Mr Helmut Meyer in 1930. This makes Stellenbosch University Botanical Garden the oldest university botanic garden in Africa.

The new institution rapidly gained international recognition with a strong focus on academic botany. Many species and genera were discovered and described by Herre and Meyer, and more named after them, including *Meyerophytum meyeri*, *Herreanthus meyeri* and *Cyrtanthus herrei*. The garden layout was inspired by classical European teaching botanical gardens. Our 4 existing public glasshouses were replaced over the original glasshouse footprints, even retaining a *Welwitschia* sown in 1926 from seed sent by Marloth, probably one of the oldest in cultivation. The garden map from 1948 shows beds laid out by region and major habitat types, or taxon to support foundational South African botany teaching and education.

Attack of the clones

After the initial purely academic start, the garden prioritised aesthetic and visitor appeal for six decades. From 1962 until he retired in 1999, curator and landscape architect Mr Wim Tijmens, regularly led overseas



Layout of the "upper garden" from 1948

Surrounded by the world's richest non-tropical flora, and close to the most diverse desert flora, the Stellenbosch University Botanical Garden is the only university botanic garden within the heart of the Cape Flora - a region that is a conservation super-hotspot.

tours to European and Asian gardens with a focus on horticultural landscaping and botanical curiosities. However, specific academic collections, such as the greenhouse succulents, did continue to be grown. Later, the globally exceptional South African *Pelargonium* collection created and curated by botany academics was planted out haphazardly across the garden. We know from records in Botany that nearly all of that *Pelargonium* collection is now lost at our

garden. Only historical labels and older records retained information continuity. Google Street View images of the garden from 2014 still reflect large areas of mature landscaping planted with common horticultural plants.

A new hope

Of course there was still some academic involvement throughout and the garden was an ongoing source of teaching material.

Notably in 1998, our important *Oxalis* research reference collection was established at the SUBG, but with all the care done by Prof. Dreyer and her associates at the Botany and Zoology Department. Mr Martin Smit started as curator in 2012, and started the mammoth task of updating the collections, working from labels and available records, mapping specimens, and identifying unlabelled specimens and accessioning into the IrisBG collections database we still use. By the time he left in early 2018, the database reflected 2,500 accession items representing 1,540 species. Mr Smit added a number of interesting global and South African plant species, spearheaded the construction and planting of an upgraded Tropical Greenhouse and improved many displays. Academic collaboration started getting off the ground again. In particular Mr. Smit worked with the Dr Paul Hills at the Stellenbosch University Institute for Biotechnology to start a conservation project with the increasingly endangered geophyte *Haemanthus pumilio*



Seven of our interns with staff horticulturist Mbali Mkhize on a recent local fieldwork outing

(Amaryllidaceae) that occurs on a local university property. This was a fruitful partnership that is now expanding to other taxa, supporting conservation, research and teaching. Local restoration ecologist Dr Stuart Hall stood in as a temporary manager for a few months in 2018. Apart from being a prodigious collector in local threatened habitats, he achieved the important milestone of registering SUBG as a BGCI Conservation Practitioner Garden.

So when I (Don Kirkwood) started in late 2018, a lot of the important groundwork for growing the conservation and academic revival of the garden was in place. Critically, the appointment of Curator was jointly overseen by representatives from Botany and the SUNCOM Commercial Services division that directly manages the garden, with a clear mandate to expand academic and conservation value. But there was a huge amount to do. Staff morale was low and operational and upgrade resources were non-existent. There was no garden vision, policy framework, strategy or business plan in place. This is where our academic context made all the difference. As a stand-alone institution, going from a permanent staff of five and 3 raw interns, with no infrastructure or project budget, to where we are four years later, would have been impossible. Stellenbosch University, already one of the top five universities in Africa, put an ambitious and progressive 2019-2024 Strategic Framework in place that aligns perfectly with the role of a modern conservation botanical garden.

Collaborative activities

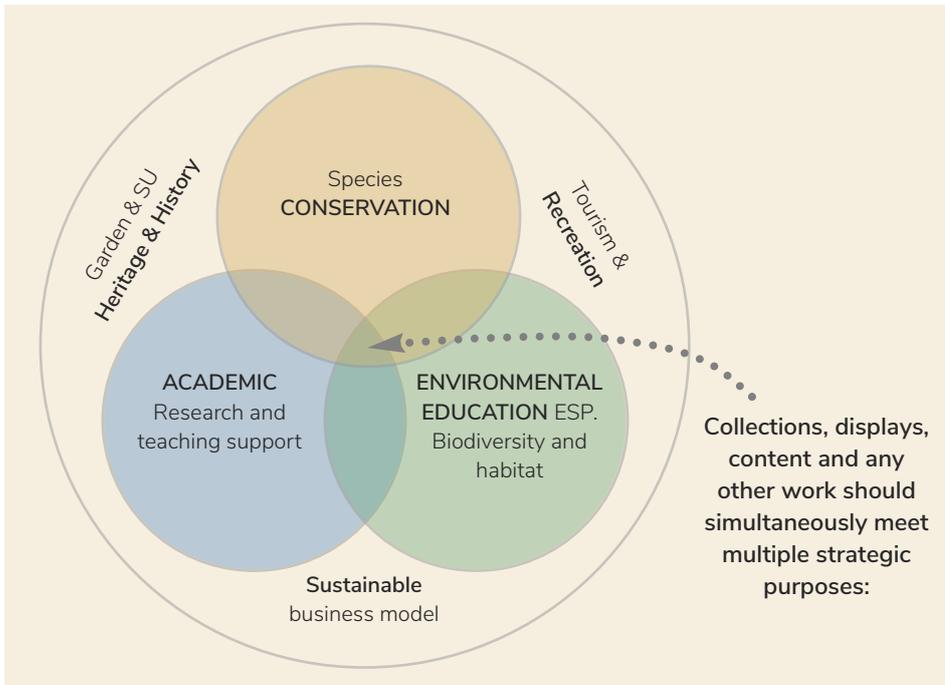
Apart from demonstrable commitment to transformation and being an employer of choice, the university vision has collaboration

at its core. With a small investment in time, even existing collaborations have greatly expanded in scope. These provide us with valuable resources, communication content and reach, and potential interns. In turn we can contribute teaching and research services and growing support. Reaching out to new academic partners has been fruitful. Even within Life Sciences there were many academics only barely aware we existed, or not considering us as a source of support or workspace, or a showcase for their research. Earth Sciences were delighted to move some first-year practical teaching to our garden, advising us on construction of rock walled raised beds that also demonstrate regional geological materials, bedding structures and unconformities. Geomatics Honours students come into the garden every year and improve and update our digital map while learning how to use high precision GPS, survey equipment and undertake real-world, client-focused Geographical Information System projects.

And of course, having a massive, well-resourced support machine – Finance administration, HR, Legal, Facilities and Infrastructure management, IT, Health, and even Security - means we can focus on our own core work. Our income and operational budgets were decimated by the impacts of Covid, but we didn't have to worry about core salaries. Although not intuitive, being managed as part of SUNCOM, the Commercial Services division, rather than Botany, just makes sense. SUNCOM manage leases, shops, business and residences on campus, and houses an innovation and business start-up hub – so we have full support to manage our lease and other income streams, support a long-term investment in growth, and we are free to obsess about plants!



Stellenbosch University core strategic themes directly support revitalisation of our Botanical Garden



SUBG collection strategy

A desirable workplace

We are still a small garden, but in mid-2022 this is more of a strength than a challenge. As a team we have tremendous freedom to re-imagine our strategy and work, as long as we are creating value. Staff positions have been expanded and re-arranged to improve strategic skills and team resilience, and a massive increase in intern placements, from three to eight Honours and Masters level graduates provides enormous value. Being within a university provides a legitimate base for tapping into South Africa's job creation interning programmes. We get to advertise and select highly motivated and diverse graduates looking for their first work experience, with more than half of their stipend covered externally. Interns get to work in a safe, stimulating and diverse environment, with pipelines into the workplace or continued education. For some it's a place to figure out exactly what they want to do and their next steps. We throw them into work that would probably be far more senior at other conservation institutions globally – communication and signage content; accession database updating; plant propagation and care, including critically rare collections; input into new display design and layout; and for some, project management. For most graduates from botany, conservation ecology and science, hands on plant care and having to learn global plant diversity are exciting and useful new skills. Even horticulture graduates quickly learn how much more is out there in the vast range of plant propa-

gation and care needs. Freshly graduated interns have unexpected benefits. Apart from a palpable improvement in team dynamics, I suspect that the visible presence of a diverse, young and energetic team of interns in the garden is substantially responsible for the massive improvement in visitor diversity we've seen in the last year. For the first time in our history there are more people of colour visiting the garden than white. This is massively meaningful in an institution that was segregated with white only access for most of our history. However, there is still a long way to go, and huge challenges remain to integrate and expand the Eurocentric frameworks of academic botany in a country that actively discounted and exterminated rich traditional local knowledge.

Conservation focus

All of this new energy still needs to be carefully focused to make a meaningful difference for our exceptional flora. We have specifically chosen to make Target 8 of the 2020 Global Strategy for Plant Conservation a core mandate¹. The Cape flora and South Africa as a whole have so many species at extreme risk of extinction in the wild, and as far as I am aware, no other institution in the Cape is explicitly tracking living collection genetic diversity or aiming to meet global best practise in genetic representivity in conservation collections. Because we have limited propagation and bench space, we also specifically target taxa that allow us to grow many plants in a small space. Most obviously this means

a focus on Cape bulbs and other geophytes, where one can hold hundreds to thousands of individuals in a few large pots. In the last four years we have collected 51 accessions from species we consider Critical Conservation Accessions. We identified a further 33 accessions from the existing collections as of similar high value. These are collections with full provenance and useful genetic diversity of taxa at high risk of extinction in the wild in the next 10 years, or populations at immediate risk of extinction, where either only a few populations remain, or the global population of the taxon is estimated at fewer than a thousand individuals. In the Cape, Red List status and criteria are a supporting guide, but with so many very localised and tiny plant populations, even Vulnerable species with a stable population trend over the last 3 generations, can be at risk of outright extinction if any further loss happens. Many are not yet held in any ex situ collection at all.

But a tight ex situ conservation focus isn't enough in our context, we also need to influence regional behaviour and appreciation of the value of our plants. Stellenbosch University provides a unique opportunity for us. Not only do we teach the future leaders of our region. This is the university of choice for many of the farming communities, the landowners, communities and families who determine the fate of much of the remaining threatened habitat. If we can attract them into the garden and create communication and displays that positively influence their future attitude and decisions around our threatened lowland floras, that could have tremendous impact. We are also engaged with current landscape managers and have an opportunity to suggest research projects or taxa to our academics and students that they might not have considered. So to be as effective as possible, new collections and displays need to achieve all of three goals – hold valuable ex situ collections, provide general teaching and education opportunities, AND support and engage our academic researchers. Some incredible, established displays remain from the early days, such as an Eastern Cape Thicket bed with massive old Euphorbias, but in other areas planting is mixed with no clear display intent. As much as possible we are reorganising interesting and useful specimens into displays clearly grouped by habitat or region, or by family or taxon, going back the garden's roots.

Cape Threatened Lowland Habitat displays

Our most threatened nearby habitats are inaccessible to most people, small remnants surrounded by private property – farmland or new urban development. As a result, they are poorly known, even by environmental decision makers. Many look scrappy and uninviting from a distance, but they contain spectacular floral diversity. Our aim is to showcase the plants and beauty of a range of specific local sites, to build an emotional connection to these remnants. And of course, to try and make the staggering turnover and diversity of our landscape tangible. The Table Mountain Fund supported this vision and we started with 6 raised beds representing a diversity of local threatened habitats. Each is constructed of the stone that underpins their unique soils and plant communities.

But this is also an opportunity to meet all our other strategic focuses. The sites are carefully selected where multiple ex situ conservation collections would be of high value, and the beds themselves can hold meaningful populations. Only a single local area is sampled, so even Least Concern species serve as research material or restoration motherstock.

The first of these is already planted with search and rescue material and site soil from a Critically Endangered Shale Fynbos habitat 24km (15mi) away and illustrates the potential of such displays. Two small beds include 9 threatened plant species from the site and show that fynbos can include short shrub and grass dominated habitats, with truly spectacular spring geophyte displays. The habitat



Critically Endangered Shale Fynbos habitat beds from nearby Gordon's Bay showcase low, seasonally wet and grassy ecosystems, with a large geophyte component.



Pelargonium fergusoniae is both a Critical Conservation collection and a key display element in another lowland bed that will display Overberg Renosterveld habitat from near Swellendam. Previously only known from five subpopulation with two recently lost to agricultural development, there is ongoing decline of this species' habitat. This elegant geophytic species is fortunately easy to hand pollinate and multiply from seed, and matures rapidly. We already have mature plants ready for display two years after original collection.

lost was valuable enough that we also colonised 150m² of campus beds outside the Life Sciences building to plant with the same search and rescue material. The raised beds bring plant detail closer to eye level and are located right at our main entrance for maximum impact.



Further information

- SUBG website: <http://www.sun.ac.za/english/entities/botanical-garden>
- Our collections online: <https://sun.garden-explorer.org/>
- Our Instagram feed: [Instagram.com/subotgarden](https://www.instagram.com/subotgarden)
- South African Red List statistics: <http://redlist.sanbi.org/stats.php>

Dr. Donovan Kirkwood
Stellenbosch University Botanical Garden
Stellenbosch, Western Cape 7602
South Africa

ENDNOTE

1. Target 8: At least 75 per cent of threatened plant species in ex situ collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes.

BONN UNIVERSITY BOTANIC GARDENS: A GARDEN DEDICATED TO (MUCH MORE THAN) PURE BOTANY



View of the glasshouses over the waterlily pond and the borders with hybrid roses (*Rosa* “Montana”). The entire ensemble was created during the reconstruction after WWII (Volker Lannert).

Bonn University Botanic Gardens today provides a wide range of services to university, society and the international botanic garden community. Activities in outreach and conservation and at the science-policy interface keep the gardens relevant and visible at the beginning of their third century.

Introduction

Bonn University Botanic Gardens holds a collection of over 10,000 plant species in ca. 13,000 accessions of wild and cultivated plants from across the globe on an overall area of ca. 14 ha at three sites. It is one of the largest university botanic gardens in Germany and was founded in 1818 simultaneously with Bonn University. The development of the garden has been inti-

mately linked to the university’s history, responding to the development of the discipline of biology and its precursors and subdisciplines over the past 200 years. Today, the “Botanische Gärten der Universität Bonn” is a central unit of Bonn University and its collections are extensively used in teaching across three faculties and in botanical research, but also in studies on organic chemistry, plant physiology and other disciplines. Although research and teaching are the core

missions, public engagement, tourism, conservation and activities at the science-policy interface play an ever-increasing role.

“A garden dedicated to pure botany”

The founding director Nees von Esenbeck was a plant systematist and taxonomist. He worked on a wide-range of plant families such as the Poaceae, Lauraceae (Nees von Esenbeck, 1836) and Asteraceae, publishing over 400 new genera and over 7,500 new species. His vision was to create “a garden dedicated to pure botany” (Nees von Esenbeck & Goldfuß 1819, own translation). The crucial role of the garden for the medical faculty was reflected in the fact that early in its existence it was often referred to as *hortus medicus*. Accordingly, the pharmaceutical botanist Theodor F. L. Nees von Esenbeck became the first curator.

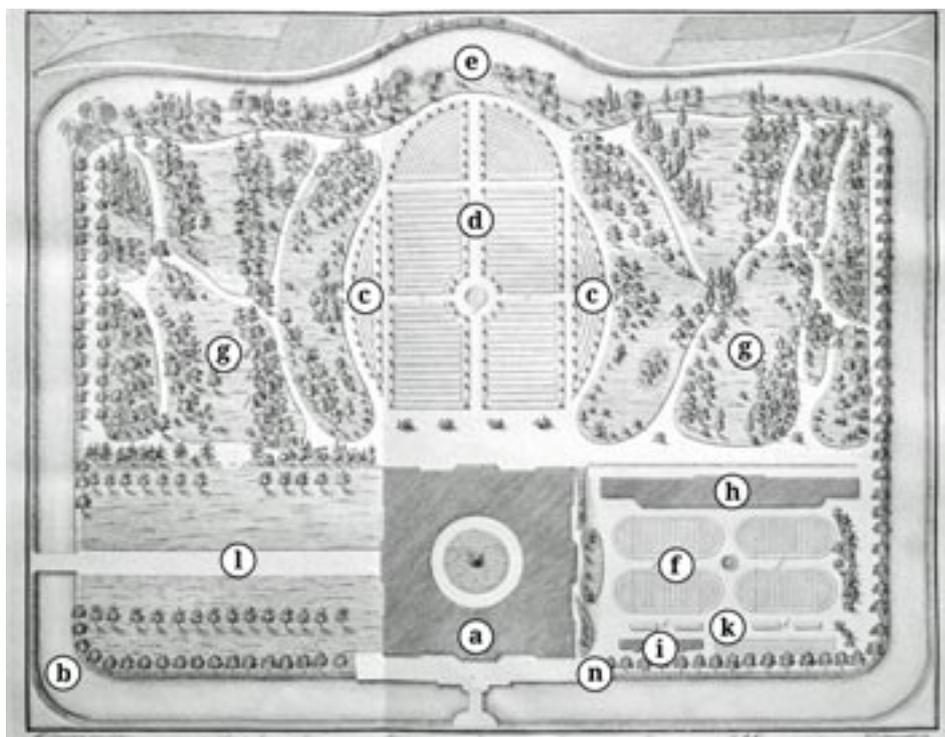
Pharmaceutical botany in research and teaching were of particular importance for the botanic garden in the 19th century, but other disciplines, especially physiology and cell biology as emerging fields, played in an increasing role in the second half of the 19th and the first half of the 20th century.

In the early period, the botanic garden was considered as an exclusive university resource and access was more or less restricted to members and students of the university. The Nees brothers explained: "The doors are open to scholars and the dear colleagues, they are closed to the idle and insolent rabble of promenaders" (Nees von Esenbeck & Nees von Esenbeck 1823, own translation).

Towards the end of the 19th century, Eduard Strasburger took over the direction of the botanic garden. His garden inspector, Ludwig Beissner, was a keen dendrologist (Beissner et al., 1903, Beissner, 1909), who planted many of today's most prominent trees, especially in the newly added southern portion of the Schlossgarten. The early 20th century saw the addition of some thematic areas, such as the first phytogeographical section as a terraced border along the castle façade. During WWI, much of the greenhouse collection was lost and although



Sinningia helleri Nees, type species of the genus *Sinningia* (Gesneriaceae) named after the curator Wilhelm Sinning by the founding director Nees von Esenbeck in 1825. Raised from seeds received from Würzburg Botanical Gardens and described from cultivation in Bonn Botanic Gardens (M. Weigend).



Layout of the garden in 1823 (W. Sinning in Nees & Nees, *De Cinnamomo Disputatio*, 1823) a) museum building = palace (aedes musei), b) moat (fossa), c to f) areas for various groups of plants, g) arboreta, h) large greenhouse (hibernacula maiora), i) small greenhouse (caldarium minus), k) heating beds (vaporaria), l) uncultivated area in front of the museum building, m) main gate, to be built later, n) other garden gate.

the interwar period brought a short respite, WWII led to wholesale destruction. During this period, the systematics section was dedicated to growing potatoes and in winter 1944/45 the castle and the greenhouses were largely destroyed by shelling.

In view of these extensive destructions, the post-war period started with a discussion to move the botanic garden to a new site and the development of a property in the Melb valley, about 4 km from the current site, was initiated. However, this plan was soon abandoned and development continued at the original site, but the property Melgarten remained with the botanic garden. The historical areas of the Schlossgarten – glasshouses, arboreta and the systematics section – were restored, but several additional sections were added, e.g., flower- and fruit-ecology sections, a rockery as well as extensive ornamental plantings. As ever, the bulk of the new garden areas were clearly directed towards familiarizing students with different aspects of plant biology. The medicinal plant collection in the botanic garden however, lost its importance after WWII, since a new pharmaceutical-botanic garden with its own greenhouses was created as a part of the Institute of Pharmaceutical Biology.

The economic-botanic garden (Nutzpflanzengarten)

Independently, but adjacent to the botanic garden around Poppelsdorf Palace, an experimental garden with a radically different mission was founded by the new Higher Agricultural College at Poppelsdorf in 1847 (Gura, 2012). The economic-botanic garden rapidly developed into an extensive research and display facility for economic botany, presenting some 600 plant varieties for teaching and experimentation, including a mulberry plantation for raising silkworms. Extensive breeding work was carried out, especially on pulse crops and cereals. Its extensive teaching collection of living and dried plants and seeds continued to be of considerable importance for the students of agriculture when the agricultural academy was incorporated into the university in 1934. Its collections were considerably increased during the 1960's to 80's, but it gradually lost its importance towards the end of the 20th century. The living collection was ultimately saved by inclusion in the central unit (see below). Today, Bonn holds of over 2,000 useful plants, including tropical fruit and spices, but also local and near-extinct heirloom varieties of beans, lettuce and other vegetables.

Consolidation

Wilhelm Barthlott took over the directorship of the botanic garden in 1985. Barthlott initially studied the systematics and taxonomy of Cactaceae, carnivorous plants and orchids, which led to a massive build-up of these collections. The main focus was on developing the greenhouse collections, but other parts of the garden were also extensively remodelled. A most prominent achievement is the large display of 'Ecosystems of the Rhineland', presenting both typical and rare species of the region in a more natural setting, covering all major habitat types of the region and reflecting an increasing involvement in plant conservation. The display of endangered plants in a near-natural setting was a huge didactic step forward from the presentation of rare plants in a kind of cabinet of curiosities. The 'Ecosystems of the Rhineland' and the neighbouring systematics section are the didactic core of the garden. Both are extensively used in teaching and guided tours to this day.

Barthlott made extensive use of the living collection for a whole range of scientific studies. He was amongst the first botanists to systematically employ Scanning Electron Microscopy to study plant microstructures (Barthlott & Ehler 1977). His observations in the garden collections led to the discovery of



Soybean variety "Schwarze Poppelsdorfer". One of the countless varieties of useful plant bred in Bonn over the past 200 years, now on the "red list of endangered cultivated plants". This is one of a number of heirloom varieties which are maintained in cultivation at the Bonn University Botanic Gardens (M. Weigend).



Large bald cypresses (*Taxodium distichum* (L.) Rich.) planted in the early 20th century by director Strasburger and his curator Beissner, on the banks of the Melbweiher, raised from seeds brought from South Carolina (M. Weigend)

the 'Lotus effect', i.e. superhydrophobic surfaces (Barthlott & Neinhuis 1997). The study of living plants in the garden thus became seminal for biomimetic research, and further discoveries followed (e.g., the 'Salvinia effect', Barthlott et al., 2010). Barthlott's research also comprised extensive forays into macroecology and global biodiversity maps, which ended up becoming a universal tool of biodiversity communication (Barthlott et al., 2005). Even more importantly, during Barthlott's tenure, the attitude towards the public changed profoundly: The garden was increasingly opened to the public, with



Sacred Lotus (*Nelumbo nucifera*) in cultivation at Bonn. Wilhelm Barthlott discovered the eponymous "Lotus effect" on plants growing at the botanical garden, the starting point of a prolific working group in biomimetics (C. Löhne).

extended opening times and events that actively invited civic society. The creation of the Association of Friends as a "booster club" in 1989 was a crucial step, playing a critical role in raising funds for garden projects. Nowadays, it is of particular importance - outside the original remit of science and teaching - in creating and maintaining visitor infrastructure, outreach and education programs. A major shift of paradigm had taken place: From an elitist university garden, the botanic garden had - while remaining a hub of science and teaching - become one of the most popular local recreation spots, offering a range of information and social events for the interested public. This inevitably led to some conflicts of interests, especially since the university persisted in viewing the gardens as a resource of, and for, the university.

Bonn University Botanic Gardens as a Central Unit:

The status of the botanic garden as part of the faculty of natural sciences was no longer tenable when the mission was diversified during the 1990's to include outreach and education as well as conservation. Consequently, the Schlossgarten and the, at that time, orphaned economic-botanic garden were united in 2002 as a 'Central Unit' of the university. Under the new name 'Bonn University Botanic Gardens' (Botanische Gärten der Universität Bonn) the organization is led by the garden management, consisting of the Director (who is also professor at the Nees Institute of Plant Biodiversity), a Vice-Director from the Agricultural Faculty, the Curator and the Technical Manager.

The Director reports to an advisory board led by the Dean of Science and the Dean of Agriculture and includes external representatives from the city of Bonn, the Association of Friends, and other research collections. During the tenure of Director Barthlott, the garden thus developed into a unit independent of the faculties and became a highly visible public institution, while expanding its role in both science and teaching. These developments were followed up as the directorship passed to Maximilian Weigend in 2011. An action plan was developed for the run-up to the garden's 200th anniversary in 2018 (Masterplan 2011-2018), systematically integrating the diversified missions of the Central Unit. The three sites with their different histories and collections, namely the Schlossgarten as the historical core, the Nutzpflanzengarten with its economic botany collection, and the Melbgarten as a hitherto poorly developed third site, were assigned complementary specializations. In 2014, the botanic gardens re-absorbed the collections and staff of the pharmaceutical-botanic garden, that had led an independent life for the previous 50 years.

The revised charter of 2014 finally acknowledged the expansion of the garden missions: "The botanic gardens serve science and teaching. Additionally, they contribute to the conservation of species and biodiversity. The botanic gardens particularly facilitate teaching material to the botanical and pharmaceutical institutes of the Faculty of Natural Sciences and the institutes of the Agricultural Faculty and they provide services for the fulfilment of the missions of the Rheinische Friedrich-Wilhelms-University Bonn according to § 3 HG. The botanic gardens serve as space for teaching and learning for the members of Bonn university and – beyond that – as a place of instruction for the general public" (own translation, Charter of 27.08.2014, University of Bonn 2014). From the wording it is immediately clear that conservation is at long last recognized in its importance, but also that public outreach remains an afterthought.

Where we stand today

University botanic gardens develop in a university ecosystem. Bonn University Botanic Gardens are a special case, representing the largest genuine university botanic garden in Germany (as opposed to state botanic

gardens only administered nowadays by universities such as those of Berlin or Munich). Bonn University Botanic Gardens also have a unique mixed heritage with a strong history in pharmacology and classical botany (systematics, taxonomy, morphology, ecology), but also economic botany. The make-up of today's collection is reflected in this legacy, with an extensive useful plant collection of over 2,000 accessions, in addition to the 11,000 accessions of the main collection. Providing plant material for research and teaching remains the core mission: each year the gardens provide several thousand plants and plant parts for classes across 20 institutes in the faculties of Natural Sciences, Agriculture and Medicine. The collections of the gardens remain central to research carried out in the biological institutes – first and foremost the Nees Institute for Plant Biodiversity, but also in, e.g., pharmacology, organic chemistry, plant physiology and palaeontology.

The living collections in Bonn were started by an exchange with other botanic gardens and this exchange remains a mainstay of garden activities: In a typical year, Bonn University Botanic Gardens sends out over 3,000 seed lots to over 200 institutions worldwide. Additionally, the garden maintains an *ex situ* conservation programme of regionally endangered species in close col-

laboration with conservation agencies, propagating material for reintroduction into the wild. Garden collections are increasingly integrated into national germplasm collections, *inter alia* under the umbrella of the Federal Ministry of Agriculture, with the *Magnolia* collection as the first collection formally recognized in 2022.

The gardens also continue to be a focus of public interest – they are open 6 days a week, welcoming over 170,000 "idle and insolent perambulators" each year. The infrastructure was adjusted accordingly: A new main entrance from the *avant-cour* was finally opened in 2018 (it was planned in 1823). Visitor infrastructure and information have been continuously expanded and an up-to-date website went online in 2021. The recent addition of another 2ha plot to the Melbgarten provides extra space for the planned expansion of the conservation of heirloom varieties, especially of traditional fruit trees of the Rhineland.



Current layout of the Botanical Garden (Palace Garden and Useful Plants). After 200 years, a representative main entrance was created from the "avant court".

This reflects a tremendous public interest in the topic, underscored by federal initiatives for the preservation of heirloom varieties. It represents a logical extension of the economic botany collection.

Conclusion:

Just like any botanic garden, Bonn University Botanic Gardens operates in a specific institutional environment. Mission and governance of the gardens are spelt out by the charter, vividly illustrating the expectations of the university. There has been a focus – consistently along our entire history – on providing the best possible service in research and teaching. Other engagements – outreach, conservation, public engagement – have to take second place. This concerns the varied expectations of a range of external stakeholders: the municipality, the general public, the media, political parties, government agencies and national and international non-governmental organizations. An expansion of visitor infrastructure, extended opening times, public events, an education programme, press releases, information systems and the participation in discussions on biodiversity loss and climate change are all directed towards at least tentatively meeting these expectations. The “booster club” is of particular importance in this context, since it provides additional resources – both volunteers and financial means. The specific

situation of university botanic gardens, which usually have a strong emphasis on science and teaching, distinguishes them from botanical gardens under different supporting organizations such as cities, private foundations or federal institutions.

Despite the limitations imposed by this specific situation, Bonn University Botanic Gardens have been able to experience a fruitful interaction of science and teaching in a unique horticultural setting under the umbrella of Bonn University for the past 200 years. Against some systemic resistance and with patience and dedication, Bonn University Botanic Gardens have maintained a dynamic development over the past decades, providing a widening range of services to university, society and the international botanic garden community. It has been possible to develop activities in outreach and conservation and at the science-policy interface, keeping the gardens relevant and visible at the beginning of their third century. Diverging from the founding director’s dictum, it is now dedicated to much more than pure botany.

References:

• Barthlott, W. & Ehler, N. 1977. Raster-Elektronenmikroskopie der Epidermis-Oberflächen von Spermatophyten. Stuttgart: F. Steiner. 105 pp.

- Barthlott, W., Mutke, J., Rafiqpoor, M.D., Kier, G. & Kreft, H. 2005. Global centres of vascular plant diversity. *Nova Acta Leopoldina* 92: 61-83.
- Barthlott, W. & Neinhuis, C. 1997. Purity of the sacred lotus, or escape from contamination in biological surfaces. *Planta* 202: 1–8.
- Barthlott, W., Schimmel, T., Wirsch, S., Koch, K., Brede, M., Barczewski, M., Walheim, S., Weis, A., Kaltenmaier, A., Leder, A. & Bohn, H.F. 2010. The *Salvinia* paradox: Superhydrophobic surfaces with hydrophilic pins for air-retention under water. *Adv. Mater.* 22: 2325-2328.
- Beissner, L. 1909: *Handbuch der Nadelholzkunde*. 2nd Edition. Berlin: Parey. 742 pp.
- Beissner, L., Schelle, E. & Zabel, H. 1903. *Handbuch der Laubholz-Benennung*. Berlin: Parey. 625 pp.
- Gura, S. 2012. Der Nutzpflanzengarten der Botanischen Gärten Bonn. *Rheinische Heimatpflege* 49: 101-112.
- Nees von Esenbeck, C.G.D 1836. *Systema laurinarum*. Berolini: Sumptibus Veitii et Sociorum. 726 pp.
- Nees von Esenbeck, C.G.D. & Goldfuß, G.A. 1819. Etwas über die naturwissenschaftlichen Anstalten zu Poppelsdorf. *Jahrb. Preuß. Rhein-Universität* 1: 45–57.
- Nees von Esenbeck, C.G.D. & Nees von Esenbeck, T.L.F. 1823. *De cinnamomo disputatio*. Bonn. 74 pp.
- University of Bonn. 2014. *Amtliche Bekanntmachungen* 44. Jahrgang, Nr. 25. 7 pp. Available at: <https://hdl.handle.net/20.500.11811/297>.



View over the oldest part of the “economic botanic garden” in 2010. Display of herbs, vegetables and cereals in the foreground and one of the greenhouses in the background (Thomas Niemtzt)

THE BOTANICAL GARDEN OF THE CITY OF PLOTTIER (JBCP), A CASE OF MIXED UNIVERSITY-MUNICIPAL GOVERNMENT GOVERNANCE IN ARGENTINA

The Botanical Garden of the City of Plottier (JBCP) is a recent institution, active for 18 months, whose governance scheme follows the mixed system between a university and a municipal government, as described in BGCI's botanic garden manual. (Gratzfield, 2016)



Inflorescences of *Buddleja globosa* Hope (Scrophulariaceae) a species native to the province of Neuquén (Argentina), part of the living collection of the Botanical Garden.

Introduction

The JBCP has the mission to represent the native flora of the province of Neuquén, which is located in the north of the Argentine Patagonia. The botanical garden has an educational, recreational, conservation and research function. In the provincial region of Neuquén there are 1,322 species of vascular plants, of which 35 are exclusively endemic species. It is an aim of the garden to cultivate and carry out *ex situ* conservation of these endemic species. Currently the living collection of the botanical garden is made up of 100 species, the number of which is continually increasing.

The botanical garden was established in 2020, coinciding with the start of the Covid pandemic. In Argentina, a rigorous quarantine was implemented and the botanical garden was initially developed in circumstances which required permits for the movement of workers and visits to the site. After its opening during a quarantine period, it was one of the few botanical gardens in Argentina to be open under such difficult circumstances.

Governance is through a coordinating committee made up of a representative of the municipal government and a member of the university institution. The coordinating committee acts symbiotically, with both members supporting each other and benefiting through the development of the botanical garden.

The role of the University

During the design period, the University of Flores formed an interdisciplinary team made up of architects, ecologists and botanists that carried out pre-operational tasks such as preparing the botanical garden management plan, the design of primary and secondary trails, main access signage and thematic areas, as well as identifying species and the botanical proposal of the living collection. In a later stage, through new agreements, the university institution offers the service of curatorship in the administration of the garden.

The tasks of the curator include generating management policies and establishing the guidelines for the organization of the thematic areas of the garden. Additionally, the curator offers technical advice and provides guidance to the staff of the municipality who perform maintenance tasks and train tourism personnel in order to promote the site. The Curator also offers scientific, botanical and design support, manages the database of the living collection, administers a germplasm bank, offers extension talks about the native flora, conducts guided visits to support institutional educational activities, as well as generating links with the Argentine Network of Botanic Gardens (RAJB), the South American Network of Botanic Gardens (RSJB), the Native Plant Nursery Network (REVINA) and with BGCI, of which the garden is a member. It is hoped soon to be able to participate in the International Plant Sentinel Network



Planting of new species carried out jointly with the community



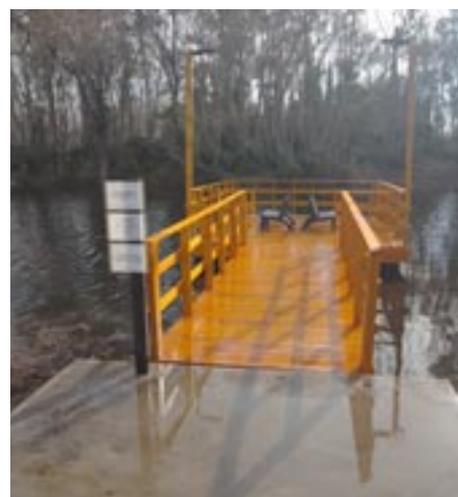
Access gate, originally designed by members of the University of Flores (LEB Laboratory). This visit to the Botanical Garden was made during the Covid period. Guided by Marcos García (EDEP) and Hernán López (UFLO)

(IPSN), organized by BGCI for the purpose of reporting the behavior of pests and diseases of certain plant species.

Additionally, the university institution has presented the development and activity of the botanical garden at national and international scientific congresses and meetings and has applied to various sources of financing to strengthen the activities implemented by the garden, some of which have been granted and others are under evaluation.

One of the tasks of the botanical garden has been the transfer of botanical knowledge to the community, this has been done with the assistance of the NGO Semana del Arbol, participating in webinars on the following topics:

- “Biological aspects of a native Willow, restoration of the species” (López, 2020), which deals with the biological aspects of *Salix humboldtiana*, a species that is conserved *in situ* by the botanical garden;
- “Native orchids of the province of Neuquén” (López 2021a), where knowledge is given of the 19 species of native terrestrial orchids that are found in the province of Neuquén and that are expected to be cultivated and conserved *ex situ* in the garden;
- “Discovering the species of *Bougainvillea* (Nyctaginaceae)” (López, 2021b), which deals with the worldwide recognized species of this genus of Nyctaginaceae of which some species are cultivated and conserved *in situ* by the garden;
- “Contribution to the knowledge of Neuquén endemic species” (López, 2021c). which deals with the exclusively endemic species of the province, their



Floating platform for bird watching on the "Elena" lagoon. Originally designed by members of Universidad de Flores. (LEB, laboratory)

characteristics and their distribution, useful information to start *ex situ* conservation tasks in the institution; and

- “Recognizing the families of Neuquén vascular flora” (López, 2022), which aims to highlight the diversity of vascular plants present in the region in order to help with their recognition.

Furthermore, the JBCP has participated in Fascination of Plants Day, an international initiative, where the observation of plant diversity has been promoted with the community.

The University of Flores carries out scientific studies on the wetland that is located within the garden, making observations on the level of the water table and seasonal studies of the presence of bird species. 83 species of birds have been registered throughout the year at this site and it is a site of interest for bird watching in the province of Neuquén.



Inflorescences of *Berberis darwinii* Hook. (Berberidaceae) a species native to the province of Neuquén (Argentina), part of the living collection of the Botanical Garden.

The role of the Municipality

The Municipality provided the political will for the development of the botanical garden and, through the activities of the Economic Development Entity of the City of Plottier (EDEP), supports the activities of the Garden, providing personnel to carry out periodic cleaning and maintenance of the garden. They have also made identification signs for the plants, constructed the access gateway and provided the floating bird viewpoint in the Lagoon that borders the botanical garden. Benches have recently been placed along the 2000 meters of the main path of the garden. Periodic activities carried out in the botanical garden are shared with the community to build a sense of it belonging to all. Here the members of the EDEP assist participants or organize the groups of Botanical Garden volunteers.

Building the profile of the garden

The botanical garden has a Google maps page, where photographs, comments and news from both the administration and the visitors themselves are posted. This medium helps to encourage visitors to the garden. According to analysis of this page, it can be seen that the place is visited by an average of 23,000 people each month. Their photos show numerous visualizations, indicating that they are visiting several localities in the region and some come from distant places, integrating the garden among their tourist options.

Once permission was given for educational organizations to re-start outings after the lifting of Covid restrictions, the botanical garden was visited by around 50 school groups, with about 2,000 students being able to take guided tours and have contact with nature again. They were able to appreciate the flora and fauna of the place on their first community outings after a long period of isolation.

The botanical garden has now become a relevant green infrastructure, with its position within an urban space in continuous development, providing various ecosystem services to the community. It has become a place for tourists and educational visits, and it played a significant role in the well-being of the community during the Covid pandemic.

Conclusions

The botanical garden is in continuous development; the support of both institutions that make up this mixed governance scheme will certainly help strengthen its progress as it works to achieve its objectives and mission. The future plans and activities of the garden are focused on continuing to develop the living collections; enclosing the property; consolidating the main path; and generating the infrastructure and facilities to support the actions required to apply for BGCI Botanic Garden Accreditations.

It is our hope that the Botanical Garden of the City of Plottier can continue its development, supported by different government efforts, so that this green infrastructure is preserved for the city, and allowing biodiversity to be known, appreciated and conserved by the community.

References

- Gratzfeld, J. (Ed). 2016. From Idea to Realisation- BGCI's Manual on Planning, Developing and Managing Botanic Gardens. Botanical Garden Conservation International. Richmond. United Kingdom.
- Lopez, H. A. 2020. Biological aspects of a native Willow, restoration of the species. On line Source: https://www.youtube.com/watch?v=o61QGYpMJhE&ab_channel=SemanadelArbol.
- López H. A. 2021a. Native orchids of the province of Neuquén. On line source: https://www.youtube.com/watch?v=FIZ8yjKufBM&ab_channel=SemanadelArbol.
- López H. A. 2021b. Discovering the species of Bougainvillea (Nyctaginaceae). On line source: https://www.youtube.com/watch?v=FIZ8yjKufBM&ab_channel=SemanadelArbol.
- López H. A. 2021c. Contribution to the knowledge of Neuquén endemic species. On line source: https://www.youtube.com/watch?v=aHHycC2m_Fw&ab_channel=SemanadelArbol.
- López H. A. 2022. Recognizing the families of Neuquén vascular flora. On line source: https://www.youtube.com/watch?v=XiKpwiXiq7A&ab_channel=SemanadelArbol.

Hernán Ariel López
Taller Multidisciplinario de Plantas Vasculares (TMPV) and Curador del Jardín Botánico de la ciudad de Plottier (JBCP).
Laboratorio de Ecología de Bordes (LEB),
Universidad de Flores Sede Comahue (UFLO).



The Botanic Garden is the setting for educational projects that integrate different degrees. Students from Tourism, Social Communication and Nursing participated in this activity.

PADRE JULIO MARRERO BOTANIC GARDEN: A UNIVERSITY BOTANIC GARDEN IN ECUADOR

The Padre Julio Marrero Botanic Garden provides a focal point for university students and teachers across a range of disciplines, providing a valued open-air teaching space and promoting environmental values.



Introduction

The conservation of biodiversity is a fundamental objective of botanic gardens around the world, and a task in which they are playing a key role. This wide-ranging mission involves not only halting and reversing the loss of species, but also includes limiting the loss of plant genetic diversity and preventing the degradation of natural ecosystems. Achieving this goal

requires a wide range of actions that go far beyond biological research and involves all types of institutions.

The importance of education

Conservation, as a long-term goal, cannot be achieved without giving particular attention to education. Botanic gardens have made significant progress in environmental education, being pioneers in innovative pro-

grams that aim to reach wide audiences through different types of activities. As a result, they have played a prominent role in spreading messages such as the importance of plants in underpinning ecosystems and supporting human well-being, the relevance and role of biological diversity in the systemic balance of our planet, and the need for a restructuring of our societies on the basis of environmental, economic and social sustainability.

Modern botanic gardens have their origins in the medicinal plant gardens associated with the medical faculties of European universities in the Middle Ages and the Renaissance. Today, while the main objective of the modern botanic gardens is conservation, the implicit links to education have strengthened their bonds with universities.

The Botanic Garden

The Padre Julio Marrero Botanic Garden was created in 1999 through the initiative of the Bishopric of Santo Domingo in Ecuador. It has since become part of the Pontifical Catholic University of Ecuador, Santo Domingo Campus. It is located in the north of the Ecuadorian Coast region, close to the Andean slopes. This area belongs to the biogeographical Chocó region, a biodiversity hotspot, though threatened by deforestation. In fact, Santo Domingo de los Tsáchilas is one of the areas with the highest population growth in the country, and the city is today the fourth largest in the country by population, with around half a million inhabitants. In addition, tropical rainforests have been replaced by pastures and croplands, as the region's agricultural productivity has led to the expansion of the agricultural frontier.

Linkages with the University

From the beginning, the Padre Julio Marrero Botanic Garden has maintained a close link with the rest of the Pontifical Catholic University of Ecuador, Santo Domingo Campus. Although this university does not offer degrees in the field of natural sciences, and despite not being located close to the main campus, a number of different academic activities have developed. Indeed, the Botanic Garden has provided a valuable space for the university community for the development of all kinds of activities. This includes practical lessons or activities in the context of many different subjects from different courses, ranging from tourism to graphic design. For example, one of the latest environmental education projects, aimed at 12-year-old students, has brought together students from the subjects of Ecology and Education, Didactics of Language and Literature, and Body Expression. Those students, who study the Basic Education degree, have been in charge of designing and developing the workshops.



A panoramic view in the Botanic Garden

The possibility of carrying out activities developed under non-traditional pedagogical criteria, as well as being able to practice outside the classroom, has been valued very positively by both students and teachers. For example, in the case of the Basic Education degree, the possibility of carrying out environmental education activities with kids has allowed students to establish contacts and develop their skills beyond the educational institutions in which they carry out their internships.

Throughout its history, the Padre Julio Marrero Botanic Garden has played an important role in research, especially the training elements, of the Pontifical Catholic University of Ecuador, Santo Domingo Campus. It has provided the context for

degree theses of different subjects, and the Botanic Garden has benefited from this. For example, it obtained its own corporate image (logo) designed as part of a Graphic Design dissertation, has been involved in the development of environmental education programs, and developed strategies related to the communication or the management of visitors, among others.

The botanic garden has also been a meeting place for other educational institutions. In addition to the frequent visits of primary and secondary school students, with whom different environmental education programs have been developed, it has also collaborated with other universities from the city of Santo Domingo, or even from other cities in the country.



A student of the Basic Education degree carrying out an activity with school students



One of the environmental educators of the Botanic Garden giving an explanation about botany.

In that sense, the Padre Julio Marrero Botanic Garden has coordinated and participated in the development of research projects, pre-professional practices or other types of internships, usually in the context of courses in the area of natural sciences. For example, the Pontifical Catholic University of Ecuador Santo Domingo Campus has collaborated with the Quito and Ibarra campuses, as well as with the Technical Particular University of Loja in research projects about *Bixa orellana* or the *Geonoma* genus.

Overcoming challenges

The work of the Botanic Garden has not always been easy. The lack of courses related to biodiversity conservation has made it difficult to generate and implement initiatives focused on that issue. And although the Botanic Garden owes its exist-

ence to the University, it is true that the circumstances of this one have had repercussions in our Botanic Garden. Thus, the needs of the Botanic Garden have not always been at the forefront, and its objectives have had to be reoriented according to circumstances. Likewise, not all the people who make up the University, including teachers and students, have understood the importance and mission of the Botanic Garden, or even the overall concept of botanical gardens.

“the general lack of institutional support for Ecuadorian botanic gardens correlates with a lack of awareness of their relevance amongst the general public”

However, in such circumstances, universities are one of the few forms of survival for botanical gardens. And belonging to organ-

isations such as BGCI or the South American Network of Botanical Gardens is an important endorsement for the Padre Julio Marrero Botanic Garden, not only with regard to the University, but also with local society.

Conclusion

In short, the Padre Julio Marrero Botanic Garden, has been a meeting place for the different faculties of the University to which it belongs, facilitating the integration of multidisciplinary knowledge and involving students and future professionals in a journey with a strong socio-environmental commitment. Although the path is not without difficulties, the development of new projects and joint work with other universities and international institutions will allow the scope of its actions to expand, with the aim of achieving its mission as a botanic garden.



Santiago Bravo-Sánchez
Padre Julio Marrero Botanic Garden,
Pontifical Catholic University of Ecuador

View of the Padre Julio Marrero Botanic Garden

EDUCATION AND RESEARCH AT THE GHENT UNIVERSITY BOTANICAL GARDEN

A DAY IN THE LIFE OF A UNIVERSITY BOTANICAL GARDEN

Introduction

15 May 2022: a nice sunny day and the garden is buzzing with young voices. On this typical spring morning groups of scholars are following a guide towards the workshop room while others are swarming around trying to locate specific plants. Students in white laboratory coats are performing limnology experiments and all seem to be very focused and enthusiastic. Even though the Ghent University Botanic Garden, in Belgium, celebrates its 225th birthday this year, it has not lost its attraction to plant-loving youngsters.

A bit of history

The garden was founded at the end of the 18th century (1797), predating Ghent University by 20 years. Being part of a central school, which also featured a library and a laboratory, the new botanical garden organized lessons in botany and horticulture and supported the rise of the golden age of horticulture in Ghent. It raised many famous horticulturalists and nurserymen who settled in the area during the 19th and 20th century.

Although the botanical garden nowadays mostly focuses on wild plants, the link with the local horticultural community and horticultural research institutions has been maintained and the garden takes part in the celebration of the Ghent Floralties every four years. In the most recent edition (May 2022) the garden showcased the current developments in horticultural research (breeding, climate change, biological pest control, urban greenery) as well as the relationship of humans with nature.



High school scholars searching for water organisms (Chantal Dugardin)

Collections as a backbone

As in any typical university garden, space is rather scarce. The garden is situated on the edge of a public park and the complete area is no more than 2.75 ha. Still, it features 4,000 m² of greenhouses and houses living collections of around 10,000 well-documented taxa. Each year, approximately 1,500 university and college students perform practical exercises and follow courses in the garden as part of their university curriculum. Today, a class of future biologists learns about plant morphology, phylogeny and ecology, while a bit further away, future horticultural architects get acquainted with the best plants to survive the changing climatic conditions in a garden. Some students are wandering about, using the living plants for self-study, preparing for their final tests at the end of the academic semester.

In the basement of the main building, no less than 300,000 herbarium specimens offer the opportunity for students to use this collection for their exercises and bachelor and master theses. The herbarium collections are steadily growing due to specimens and DNA-samples collected on numerous field trips. The herbarium room has recently been renovated and a special consulting room has been created, to facilitate future research.

Not only are biologists or archeologists intrigued by the preserved specimens. In a recent heritage project, IT-specialists, botanists and historians joined forces, enabling us to digitize historical herbarium books dating from the nineteenth century. The project provided us with an insight into the evolution of regional biodiversity over the last 200 years and has led to further historical research into the reasons for the steep decline of the regional flora.

Training to become a botanist or a horticulturalist

Leonard, a German trainee, and Bart, his Belgian counterpart, are working side by side in the arboretum. The botanical garden has a history of offering traineeships to students of different levels. Bachelor students (studying green management or plant management) are especially welcomed to spend up to four months in the garden. They assist the staff with the care of living

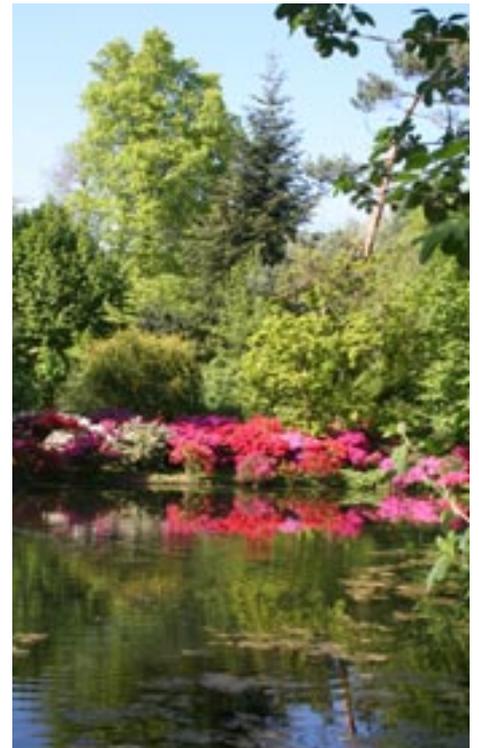
collections and learn how to maintain healthy plants, using diverse horticultural techniques and understand biological pest control. International Erasmus+ trainees and PhD students are also welcomed to get an insight in the management of a botanical collection or are trained to perform molecular work in the laboratory.

Molecular research – a joint effort

In the molecular lab, Kate is performing the final tests on *Magnolia* samples. She hopes to finish her master's thesis script in the summer. The garden benefits from its proximity to the molecular laboratory and scientists in order to perform DNA-studies. The laboratory was set up more than 10 years ago as a joint venture with different research groups. In order to learn basic molecular techniques, bachelor students perform small tests to identify 'mystery plants' in the garden. Those plants, of which the labels or origin got lost in time, are used as examples to determine the plant family or genus.

Thanks to the financial support of the Franklina Foundation, the botanical garden is able to participate in this molecular work and share the equipment and knowledge on how to address genetic questions supporting *in situ* plant conservation projects. The scientific research in the garden currently focuses on two plant groups: *Magnolia* (Magnoliaceae) and *Boswellia* (Burseraceae).

The molecular research on *Magnolia* species of Central America helps to unravel the relationships in this group and supports local conservation of threatened species. The



View of the big pond with the Rhododendron collection and arboretum (Chantal Dugardin)

knowledge, protocols and guidelines obtained from the research are then shared with local organizations or students who translate them into concrete actions in the field. For this research, the Botanical Garden cooperates with the Instituto de Ecología (A.C., Mexico). Prof. Dr. Marie-Stéphanie Samain (Instituto de Ecología, A.C. and guest professor at the Ghent University) takes part in the Global Conservation Consortia Conservation Genetics Working Group and the Global Conservation Consortium for *Magnolia*.



Trainees and PhD students at 'Biodiversity Day 2022' (Chantal Dugardin)



Future horticultural architects following a guided tour (Chantal Dugardin)

Dr. Kay Van Damme coordinates a project for the conservation of endemic and threatened frankincense trees (*Boswellia*) on the Socotra Archipelago (Yemen). The project runs in cooperation with the Mendel University (Brno, Czech Republic) (main coordinator), Botanical Garden of Rome, La Sapienza University (Italy), the Royal Botanic Garden of Edinburgh (United Kingdom), Wageningen University & Research (the Netherlands), Oman Botanic Garden (Yemen) and local organizations and families. Local people on Socotra lead this project on the ground, protecting frankincense trees in nature and replanting the trees themselves.

Biodiversity experiments

Apart from the in-depth studies, the garden also provides the perfect setting for all kinds of biodiversity experiments. Research groups or individual researchers find their way into the garden to perform experiments involving the living collections or using the infrastructure. For example, Arno has just finished a



Students performing limnology experiments (Chantal Dugardin)

test on tree pollen, which supposedly contains a lot of nitrogen, while Lydia has started a new experiment on the occurrence of bumble bees in the garden. A limnology class is performing a one-week traineeship using the garden ponds; the water in the ponds is known to be very clear and contains a lot of life. Students are setting up their makeshift laboratory at the garden entrance and are taking water samples for further investigation. It was through studies such as this that two years ago, two new parasitic nematodes were found in the garden soil.

Special programmes for high school scholars

A group of high school scholars who are waiting to start their own guided tour are attracting attention. Being part of a university, the garden focuses its educational programme mainly on 15–18-year-olds. Once you get their attention these pupils are very motivated. The garden programme fills in the gaps in the school curriculum, with teachers being offered activities which are related to the school curriculum but are difficult to tackle within the confines of a classroom.

Today's group is acting as 'biological warriors' trying to combine the knowledge of plants, pests and their natural enemies. They are searching for pests which they can match later-on with the correct natural enemies using an identification key and a microscope.

Stack of bones

Some visitors are staring up at the stack of bones which has been drawn on the garden wall. It is an impressive mural by the street artist ROA, which marks the entrance to the GUM (Ghent University Museum). The GUM,

which opened its doors onto the garden site two years ago, currently coordinates the educational programme of both museum and botanical garden. The museum themes (chaos, model, creativity, etc.) are chosen to help visitors get an insight into the mind of a scientist. They show how science is carried out and help people to understand how science evolves over time. The big glass windows on the museum's first floor open onto the systematic section in the botanical garden, combining the theme 'chaos and classification' of the museum with the 'classification of plants according to APG' outdoors. The museum combines art with science and is especially appealing to a younger public (18-25).

Supporting plant conservation activities through the Botanical Garden Fund

Through the help of a private investor, the botanical garden was able to establish the Botanical Garden Fund Gabriëlle De Waele, in order to support conservation research on endangered taxa and to enhance public awareness of the richness, opportunities and threats to botanical biodiversity. The fund also allows us to communicate the results of scientific research to the public. In this way we hope to improve the well-being of humans and plants alike.

Together with the GUM (Ghent University Museum) and the University Archive the Botanical Garden forms a central department in the Ghent University. The mission of the Ghent University Botanical Garden is to provide a place of education, scientific research, recreation and beauty. The garden provides healthy, well-maintained and well-documented living plant collections. It holds an accreditation as a botanic garden and conservation practitioner (BGCI) as well as an accreditation of ArbNet (Level IV). It is a member of the Belgian Botanic Gardens Association (VBTA) and BGCI and is an official Flemish heritage museum (Belgium).

Chantal Dugardin
Ghent University Botanical Garden
K.L. Ledeganckstraat 35,
B-9000 Gent, Belgium



Architectural art in the botanical garden (Ixchel Maldonado)

A HUNDRED YEARS OF NATURE AND HISTORY: THE BOTANICAL GARDEN OF THE UNIVERSITY OF SAN CARLOS DE GUATEMALA

Introduction

The Botanical Garden of the University of San Carlos of Guatemala (USCG) celebrates its centenary this year. It opened its doors for the first time on December 27, 1922, in honor of the centenary of the birth of Louis Pasteur. There had been several previous attempts to establish the garden and it was finally achieved thanks to the efforts of the authorities of the Faculties of Medicine and Chemical Sciences and Pharmacy of the University.

The site of the garden was previously occupied by a school for boys destined to learn technical and manual jobs. Following its destruction by the earthquakes of 1917 and 1918, the president of the Republic of Guatemala, Dr. Carlos Herrera, decided not

to rebuild the school and instead donated the land to the only government university, the University of San Carlos de Guatemala, for the construction of the garden.

100 years ago, this garden was located in the suburbs of what was once a small Guatemalan city. Now it provides one of the few green areas accessible to the public in the commercial and hotel zone of the city. Surrounded by private properties, there are no possibilities to expand its size (1.7 hectares).

The early years

In the first years after its foundation, the administration of the Garden was mainly the responsibility of various University departments, but also with some external input. However, responsibility was definitively trans-

ferred to the Faculty of Chemical Sciences and Pharmacy in 1958 and since 1981 it has been incorporated as a unit of the Center for Conservation Studies of the same faculty, which also manages 7 protected areas of the Guatemalan national system.



Pouteria sapota, a tropical fruit in the collection (Albina López)



Squirrels in the botanical garden (Jorge Maldonado)

The Botanical Garden flourished under the University administration, thanks to the dedication of its first directors, who were eminent scientists and visionaries, and who were devoted to the Garden and the University. The main avenues of the Botanical Garden are named after three directors in recognition of their important contributions: Ulises Rojas Bendfeldt, Elfriede Pöll and Mario Dary Rivera.

Ulises Rojas Bendfeldt (1881-1959) was the first director of the Garden and was considered one of the country's most renowned

scientists of the 20th century. He was in charge for 34 years and selected many of the species that still make up the collection. Due to his efforts, *Ceiba pentandra* (L.) Gaertn was declared the national tree, and the Guatemalan five-cent coins bear the image of this tree. Ulises received an honorary degree from the University of San Carlos and received the highest honorary distinction awarded by the Guatemalan government, the Order of the Quetzal.

The Austrian botanist Elfriede Pöll (1922-2021) managed the herbarium and the Index Seminum from 1967 until the mid-1980s. She designed and built, with the gardening staff, at least half of the alleys and plant beds and made numerous expeditions to enrich the collections. She was distinguished by the Guatemalan government with the Science and Technology medal for her contributions to research and was also honored with the Order of the Quetzal.

The pharmacist and entomologist Mario Dary Rivera (1928-1981) was the Garden's director until 1981. As a great visionary, administrator and politician, he successfully established the University's system of protected areas, as well as the Center for

Ceiba pentandra – the national tree of Guatemala (Albina López)

Conservation Studies, the administrator of protected areas. Through his efforts, in 1971, the discipline of biology, previously unavailable in Guatemala, was established in two universities, (one governmental and one private). He also created a research office and a scientific research fund at the University of San Carlos.

On June 16, 1981, during a period of civil unrest, Mario Dary Rivera was elected Rector of the University of San Carlos de Guatemala, leaving the Botanical Garden administration. Unfortunately, shortly afterwards, the political persecution suffered by university students and professors reached him, and he was assassinated on December 15, 1981. In his honor, the day of the Guatemalan biologist is celebrated on his birthday, February 21.

Recent developments

The country's civil war deeply affected the University and there was a marked slowdown in the development of the Garden in the years that followed. However, despite some difficulties, with the start of the new century, we are now advancing and developing our activities as part of the government University - research, teaching and community service.

Research at the Garden is directed, prioritized, and represented in the USCG herbarium. The herbarium was created in 1923 and currently has 47,900 specimens, including some important historical collections such as those of Ulises Rojas Bendfeldt and Rafael Tejada Aguirre.

The herbarium also has valuable collections such as those of macro fungi and Guatemalan oaks that are the result of the last fifteen years of work of its research team. Changes in the composition of species of macro fungi over time reflect changes in land use and habitat loss and can also be used as indicators of climate change in different ecosystems of the country.

Regarding the oaks, studies have been carried out on their diversity and distribution, uses, cultural value, their state of conservation and vulnerability, as well as the associated vegetation and fungi.



A break in the middle of the city (Jorge Maldonado)

New research projects

The Botanical Garden is now resuming some of the activities that had been discontinued, such as research on native fruits and seeds. In 2011, a reference carpological collection was established with research materials collected in recent years in the San Carlos protected areas. The collection now has 2,800 accessions of seeds and 114 fruits.

This year, with support from BGCI, we have a project in the cloud forest protected area "Mario Dary Rivera University biotope". We are studying the phenology of trees that are used as food by the Quetzal, our national bird, with the aim of propagating this species for restoration.

Being able to reach research objectives represents a great challenge, in a country where the investment in science and research represents 0.035% of GDP. Even so, the Garden annually develops one to three research projects financed mainly by the University, which allows it to generate botanical and ecological information from the university's own protected areas.

Outreach activities

In teaching, we usually work with undergraduate students from different disciplines. These are mainly students of biology, agronomy, architecture, graphic design, systems engineering and communication sciences.

Many of the students learn by working as assistants in our studies and several are mentored in their final graduation projects.

As part of our work with the community, we are carrying out an educational project on the classification of household waste with residents of a neighborhood located one hour from Guatemala City. It is aimed at children and their families and is supported by the Ludwig Maximilian University of Munich and the Center for International Health.

In addition, we have an education program for visitors that takes place from Monday to Friday through which we reach students of

all educational levels and admit visitors from all over the country. We have the support of a team of twelve committed and faithful volunteers who have been collaborating with us for between five and fifteen years. At the moment this program is closed due to the Covid pandemic.

The average number of annual visitors before the pandemic was 16,500 people a year, mainly children from educational institutions between the ages of 7 and 15. Over the past ten years we have also developed environmental education activities aimed at families, to encourage love of the biological diversity of this megadiverse country and to promote the science carried out by Guatemalan biologists.

Several of our activities are now replicated by other institutions, which encourages us to create new ideas and spaces to disseminate and popularize science.

Without a doubt, the permanence of the Botanical Garden for a century has been due to its association with the government University. Although its budget is low, it continues to be the only public botanical garden in the country; it is an institution with stable operations, which generates quality scientific information and that trains students of all educational levels in the country.

Carolina Rosales de Zea
Jardín Botánico de la Universidad de San Carlos de Guatemala
Guatemala



Walking trails in the botanical garden (Ixchel Maldonado)



Children on a discovery journey in the tropical greenhouses in the Botanical Garden Leipzig (@feinesbild.de)

THE BOTANICAL GARDEN OF THE UNIVERSITY OF LEIPZIG - BRINGING THE GLOBAL DIVERSITY OF PLANTS TO LEIPZIG FOR EXPLORATION, COMMUNICATION AND PROTECTION

The Leipzig Botanical Garden has maintained its importance over centuries. Today it is valued for its role in teaching, research and knowledge transfer across the entire university, while the university has always been the basis of existence for the Botanical Garden.

Introduction

The Botanical Garden of the University of Leipzig is considered the oldest botanical garden associated with a university in Germany. Its origins date back to 1542, when the Dominican monastery of St. Paul with the associated medicinal garden, was transferred to the newly

founded University of Leipzig. As early as 1580, the garden was integrated into the university's teaching and research activities with the employment of Moritz Steinmetz as the Garden's first prefect. Over the centuries, the location of the Botanical Garden was moved several times and it has now been at its current location for almost 150 years. The Botanical Garden looks back on

a varied history and has become part of the scientific and cultural identity of the University of Leipzig and the city of Leipzig during the 480 years of its existence.

Today the Botanical Garden, with its living collection of about 6,500 species, has an outstanding scientific importance in teaching and research. Within the University, the Botanical Garden is integrated into the teaching of the Faculties of Life Sciences, Physics & Earth Sciences, Medicine and Veterinary Medicine. In teaching, the garden's collections are used in a total of nine modules. The stock accessions serve as demonstration material in lectures, as material for measurements of plant traits (Functional Biodiversity of Plants) and phenology, and diverse courses use the Garden through guided tours or for self-study.

Furthermore, plant accessions are provided for identification courses (systematic botany and plant ecology) and for greenhouse experiments of ecological courses (introduction to ecology, biodiversity and ecosystem functions, tropical botany).

A Garden of Diversity

Its branding as a "garden of diversity" is due to the maintenance of a plant collection that primarily serves a range of research and teaching purposes. With the basic renovation of the greenhouses from 1998-2001 and a strengthening of the biosciences at the University of Leipzig, the importance of the Botanical Garden has grown in recent times. The construction of the Medicinal Garden in 2001 in an adjacent park focused on building knowledge of medical herbs for students of the university.



View to the greenhouses in spring, Botanical Garden Leipzig (Botanical Garden Leipzig).

The Botanical Garden played a key role in the acquisition and establishment of the renowned German Centre for Biodiversity Research Halle-Jena-Leipzig (iDiv) in 2012. In combination with new challenges for a modern infrastructure, the construction of a new research greenhouse was necessary. This research greenhouse, completed as a pilot project in energy efficiency, is also located in the grounds of the Botanical Garden and provides the facilities for state-of-the-art scientific experiments.

Further main collaborations exist with the City of Leipzig in the operation of the Fragrance and Touch Garden as well as with the iDiv within the research platforms ARBOfun (Research Arboretum Großpösna) and the Leipzig Canopy Crane Facility.

Biodiversity research

In addition to the above-mentioned projects and the maintenance of the plant collection, the Botanical Garden also carries out its

own research projects thanks to its affiliation with the University of Leipzig and our scientific staff. In accordance with the branding of the Botanical Garden, the focus lies in plant diversity, but for some applications also including the diversity of all known organisms. It is our goal to make the species richness of our planet visible and thus tangible not only for scientists but ultimately for all people. In recent years, the curator of the Botanical Garden, Martin Freiberg, and colleagues have put a lot of work into the publication of the Leipzig Catalogue of Vascular Plants (LCVP). This reference list contains 1,315,562 scientific names of all globally described vascular plant species. The current version of the *Leipzig Catalogue of Vascular Plants* (version 1.0.3) contains 351,180 accepted species names (plus 6,160 natural hybrids) within 13,460 genera, 564 families and 84 orders (Freiberg et al., 2020).

Based on this catalogue, the idea arose to represent not only plants, but all organisms of our planet in a single phylogenetic map. Consequently, the idea for the LifeGate project (www.lifegate.idiv.de) was born. LifeGate is a digital interactive two-dimensional phylogenetic map with the arrangement of all known species (2.6 million) in an interactive zoomable user interface. LifeGate has been integrated into the PlantHub project which aims at making all of iDiv's plant-related data searchable and accessible.



Lavender blossom in the Medicinal Garden (Wolfgang Teschner).



View over the Eurasian steppe to the Inspector's House in May in the Botanical Garden Leipzig (Botanical Garden Leipzig).

In addition to the research projects concentrated in the Leipzig Botanical Garden, we are also very interested in joint projects with other botanical gardens and partners. For example, we have been working for several years in the PhenObs network. The aims of this project are linking phenology and functional trait ecology of plants and understanding how biotic and abiotic changes influence shifts in herbaceous species phenology (Nordt et al., 2021).

Knowledge transfer

Over the centuries, the Botanical Garden of the University of Leipzig, as a publicly accessible research facility, has always been a showcase of the University and a place of knowledge transfer. Today, this transfer is of even greater importance and is supported by the university management. The new Transfer Department, founded in 2021 within the Botanical Garden, focuses on exhibitions with partners and third party funded projects with citizen scientists, such as "Pflanze KlimaKultur!" (engl. Plant, ClimateCulture!). Building on the PhenObs project, we are currently working together in a network of four botanical gardens including the cities of Berlin, Halle, Jena and

Leipzig. In over 200 climate beds distributed in the four cities, each with the same set of eleven plant species, scientists and citizen scientists jointly collect and analyse phenological data. In addition, we are using citizen dialogues to improve conscious experience of nature, climate and the natural processes of vegetation development. In joint projects with citizens, scientists, non-governmental organizations and city representatives, we as the Botanical Garden want to jointly

develop important, locally implementable approaches to nature conservation and climate adaptation for urban green spaces.

Science meets Society

The project "LifeGate Leipzig" jointly developed with the Natural History Museum of Leipzig is another important transfer project, funded in a pilot phase within the university's "Science meets Society" program.



Overlooking the new iDiv research greenhouse in the Botanical Garden Leipzig (Wolfgang Teschner).



Pupils learn in the Botany School of the Botanical Garden Leipzig (@feinesbild.de)

The vision of this project is to compile the regional biodiversity of a city like Leipzig - whether occurring in nature, in a garden, the zoo or a park, or preserved in museums or collections or even offered in supermarkets - as comprehensively as possible and to compare it worldwide in a global context. In this first pilot phase, we are collecting all digitally available species lists from local stakeholders and linking them to the global species dataset in LifeGate to show the immense regional biodiversity. In a next phase of the project, we plan to develop ways to close possible gaps in the digitization of collections e.g. of museums, to incorporate the extensive knowledge about species and their occurrences from the grey literature and to bring poorly studied groups of organisms into the focus of scientific interest. Ultimately, we want to demonstrate the comprehensive dependence of local society

on global biodiversity, i.e. the entanglement of nature and culture, by developing a suitable exhibition concept.

The Botany School of the Leipzig Botanical Garden also contributes to the knowledge transfer task. Here, teachers paid by the federal state of Saxony use the Botanical Garden as an extracurricular place of learning and thus make our plant collections accessible to Leipzig pupils of all school types. Botanical and ecological topics can thus be taught directly with living organisms. Coordinated by the Botanic Garden's Transfer Team, the Botany School creates lasting experiences within the world of plants for young people.

There are also learning opportunities in the Botanical Garden for even younger kids that show how knowledge transfer in the Botanic

Garden works even with the youngest in society. Within the *kindergarten*-project, children from a partner day-care centre (pre-school age 5-6 years) come to the Botanical Garden on a weekly basis and use a permanent refuge in our grounds for all gardening activities that occur in a botanical garden during the year. This is accompanied by a gardener from our team and regularly presented as a model project during excursions, e.g. within the training of future educators.

Volunteer support

Finally, we would like to take this opportunity to acknowledge the work and effort of the Friends of our Botanical Garden. Without the extensive voluntary commitment of many people who love the Botanical Garden of the University of Leipzig, many of our education activities, especially in the past, would not have been implemented to the extent achieved. The work of the Friends of the Botanical Garden also generates considerable additional financial resources that benefit the work of the Botanic Garden in all fields of activity.

References

- Freiberg, M., Winter, M., Gentile, A., Zizka, A., Muellner-Riehl, A. N., Weigelt, A., & Wirth, C. 2020. LCVP , The Leipzig catalogue of vascular plants , a new taxonomic reference list for all known vascular plants. *Scientific Data* 7, 416.
- Nordt, B., Hensen, I., Bucher, S. F., Freiberg, M., Primack, R. B., Stevens, A. D., Bonn, A., Wirth, C., Jakubka, D., Plos, C., Sporbert, M., & Römermann, C. 2021. The PhenObs initiative: A standardised protocol for monitoring phenological responses to climate change using herbaceous plant species in botanical gardens. *Functional Ecology*, 35(4), 821-834.

Rolf A. Engelmann
 Botanical Garden, Leipzig University
 Linnéstraße 1
 04103 Leipzig, Germany

THE BOTANICAL GARDEN OF THE ADAM MICKIEWICZ UNIVERSITY IN POZNAŃ, POLAND



The Botanical Garden in Poznań, Poland was established in 1925 as an educational school garden. At present, it is a 21ha unit belonging to the Adam Mickiewicz University in Poznań and is open free-of-charge to all visitors throughout the year. It is a popular place for leisure and cultural events for the inhabitants of the city and the entire region. The collection of plants, grouped in 10 thematic sections, comes from six continents, with over 300 species of endangered or legally protected plants in Poland, and 580 CITES-listed species.

The garden is a multidimensional teaching base for students. Since 1956, about 250 diploma theses of various types have been carried out in connection with the Garden. Polish and foreign students also attend internships, which allow them to expand their knowledge in the field of biodiversity, species protection and plant cultivation. Specimens of plants or their parts are made available for the purposes of conducting laboratory classes and for research. Experimental work is also carried out in the Garden as part of university research grants. Garden employees actively participate in collecting research material and monitoring experiments, often as co-authors in papers.

The garden staff, together with employees of the AMU Faculty of Biology participate in programs for the reintroduction and strengthening of the populations of rare and protected species. Joining international conferences provides the opportunity to exchange scientific and practical knowledge, e.g: *Ex situ conservation of plants. Problems and solutions*. Similarly, the exchange of experiences and participation in joint projects are possible thanks to membership in international groups of scientists. An example of such cooperation is the brochure on European CITES species published in 2022 as part of



the COST Action 18201. Thanks to being part of the University, Garden staff benefit from exchanges within the Erasmus+ program and projects e.g. "Botanical garden: A green world for everyone! Educational activities for visitors with special needs in green space". We are also a host or a sightseeing place for employees from other universities coming to the AMU.

Cooperation with universities, both Polish and foreign, results in the organization of thematic exhibitions, presented in the Garden. In addition to strictly scientific activities, the AMU BG employees conduct educational activities all year round and participate in actions promoting the protection of biodiversity, the development of urban greenery and pro-ecological behavior. They also provide consultations and opinions on the selection of plants and plant care.

In summary, the AMU Botanical Garden is not only a showcase of the University and its gift to the inhabitants of the city of Poznań, but also an important center of education at all levels. In addition, it is a unit that cooperates in the implementation of research tasks, both in the field of basic and applied sciences, as well as artistic projects. While being a cultural monument, it is also an important historical, natural and recreational facility, implementing the principles of the University's openness to society and broadly understood cooperation with society.

Justyna Wiland-Szymańska
The Botanical Garden
Adam Mickiewicz University
Poznań, Poland

THE BOTANIC GARDEN AND THE UNIVERSITY OF CASTILLA-LA MANCHA: A FRUITFUL SYNERGIC RELATIONSHIP IN THE CONTINENTAL MEDITERRANEAN CONTEXT



The Botanic Garden of Castilla-La Mancha (BGCLM) is located in the outskirts of the city of Albacete, in south-eastern Spain. In this 7-hectare environment, more than 28,000 plants of 2,100 taxa from all over the world help this botanic garden spread love and interest in plants.

The BGCLM is focused on the native, continental Mediterranean flora of this inland region in the Iberian Peninsula. Samples of such an interesting Mediterranean vegetation have been arranged in recreations of about 40 natural habitats, representative of the autonomous community of Castilla-La Mancha, all of them protected by regional and European laws. Overall, regional habitat examples in the BGCLM comprise around 800 native species, many of them endangered. They have all been planted and established successfully, often under species-specific cultivation techniques.

Another significant part of the botanic garden is devoted to collections of plants from all over the world, also appealing to visitors. This huge display of plant diversity is managed according to strict biological

procedures (according to EU legal regulations), which has allowed the BGCLM to be formally certified as of “ecological excellence” (the only one in Spain and Portugal). The environmentally-friendly management has allowed a wide variety of animal species to thrive in the botanic garden, particularly

birds and invertebrates, which promotes a very interesting lesson around biodiversity components and their relationships.

The BGCLM is supported by the Albacete city council, the Albacete provincial council and the University of Castilla-La Mancha (UCLM) through a non-profit foundation.

Research

The UCLM has a research centre in the Botanic Garden - the Botanical Institute (Instituto Botánico). There, a number of university professors and collaborators carry out their research on diverse scientific disciplines related to botany: plant ecology, conservation biology of plants, molecular biology, phytochemistry, systematics, ethnobotany... The Botanical Institute of the UCLM offers laboratories, offices and material to the researchers and some Botanic Garden staff members participate as research collaborators. This helps achieve a “symbiotic” relationship between the institutions and contributes to BGCLM achieving its the research aims.



Cistus creticus - rockrose (Botanic Garden of Castilla-La Mancha)

Other researchers, although not necessarily linked to the Botanical Institute, also participate in national and international research projects along with the staff members of the Botanic Garden. Recent studies have shown how the BGCLM is as an important urban biodiversity hotspot for birds and insects such as hoverflies and dragonflies. Scientific papers produced in the Botanical Institute are displayed in the Botanic Garden's hall, so that visitors can learn about the science that is taking place.

The UCLM and the BGCLM are currently involved in a research network analysing the effect of climate change on urban lawns in an international study along with other Spanish and Portuguese universities.

Education and scientific dissemination

The Botanic Garden functions as an open classroom and practice field for students from different University programmes and degrees, including pharmacy, biotechnology, agricultural and forest engineering, education... The students get to understand the role of botanic gardens in the world, with respect to plant species conservation and as scientific research centres. This way, the UCLM promotes and disseminates information about our Botanic Garden among future professionals. The UCLM also organises different academic and scientific activities such



as symposia, conferences and seminars which help promote the value of botanic gardens for research and conservation

Conservation

The University of Castilla-La Mancha, through the Botanical Institute, offers infrastructure support to the seed bank of the Botanic Garden, whose origin dates back to 2007. Here, more than 1 million seeds are kept long-term in controlled conditions, as an *ex situ* means of conservation for endangered or vulnerable wild native plant species. These seeds can be germinated after long periods

if needed to recover plant populations which have suffered loss in the wild. Through this line of conservation line, many researchers have studied the germination ecology of a number of endangered plant species.

Qualified members of staff

Some BGCLM staff members work at the UCLM. They contribute to the design, management and programme execution in the Botanic Garden. The Director and the Scientific Director are UCLM professors specialised in ecology and botanical systematics. The curator received his Doctorate through the UCLM programme, and his studies were centred on morphophysiological seed dormancy types of relict populations of threatened plant species in the Iberian Mediterranean region.

The Botanic Garden of Castilla-La Mancha is determined to continue its collaboration with the University of Castilla-La Mancha. This synergistic connection has proven to be extremely beneficial for both institutions and, thanks to this alliance, many people are becoming more connected to the plant world – something that is essential for society in the light of the current global change.

Guillermo García-Saúco Sánchez
Departamento de Divulgación y Promoción
Jardín Botánico de Castilla-La Mancha, Albacete, Spain



UrbanFun Experiment (Botanic Garden of Castilla-La Mancha)

THE BOTANICAL GARDEN OF THE FACULTY OF SCIENCE OF MASARYK UNIVERSITY IN BRNO, CZECH REPUBLIC



Around 30,000 visitors visit the garden annually and about 15,000 visit the greenhouses. Approximately 2,500 pupils and students participate in professional excursions through the greenhouses. Usually, there are four professional exhibitions of plants or animals per year, and there are also exhibitions with ecological themes, art exhibitions, concerts and other events for the public.

Since 1989, when the Czech Republic became a democratic country, the university has broadened its approach. The garden staff have repeatedly completed internships abroad with the support of Erasmus. In 2005, the Professional Union of Botanical Gardens of the Czech Republic was established, with our garden as a founding member. In 1996, the Association of Friends of the Botanical Garden, a community of experts and amateurs, visitors and lovers of our garden, was founded.

The Botanical Garden of the Faculty of Science of Masaryk University in Brno, Czech Republic, was founded in 1922 by Professor Podpěra, who also founded the Institute of Botany. The garden remains in its original location, in the middle of the city; it is a classic university botanical garden with living collections of plants according to the original arrangement. It serves students and the public, scientists and schools of all levels.

Since the 1960s, due to political and financial pressures, the botanic garden has been an independent workplace without a connection to the Institute of Botany, and there is no place for science. The garden has become mainly a place for education and public awareness. Open daily, it is a showcase for the University.

Magdaléna Chytrá
Masarykova Univerzita
Kotlářská 267/2 , 611 37 Brno
Czech Republic

Outdoor collections, on 1,5 ha, include systematic flower beds with 85 families and more than 1,500 plant taxa. There are also examples of vegetation from South Moravia, the Carpathians and species from the temperate zones of Asia and America. There are collections of woody plants and a geopark of the Institute of Geological Sciences in the Faculty on an area of 3 ha.

The greenhouses (1,100 m²) house a diverse group of tropical and subtropical plants including collections of ferns, cycads, bromeliads and succulents. Subtropical and tropical greenhouses are focused on useful plants and pride-of-place is given to the water lily (*Victoria cruziana*) pond.



OBSERVATOIRE DU MONDE DES PLANTES, THE BOTANICAL GARDEN OF LIEGE'S UNIVERSITY



The desert greenhouse (Patrick Motte)



Mangrove swamp area in the tropical greenhouse (Sophie Pittoors)

The « Observatoire du Monde des Plantes » (OMP) is the botanical garden of Liège's university. Opened in 1996, it is located on the University's estate of the Sart-Tilman (Liège, Belgium). It is one of the main university's facilities dedicated to science outreach and is integrated in the university museum and culture group.

This botanical garden is composed of a large greenhouse of 2,300 m² providing areas/zones with different climatic profiles, recreating 3 of our planet's biomes- "tropical evergreen forests", "Mediterranean evergreen forests" and "arid deserts". The displays illustrate varying themes, including the evolution of land plants and the beginning of life on earth; the co-evolution between plants and animals; some exceptional species, environments or biological mechanisms; and various fragile and threatened ecosystems, such as mangrove swamps or cloud forests.

The OMP possesses a rich and varied plant heritage containing some remarkable botanical collections and subjects: the unique collection in Belgium of Bryophytes, a set of Namaqualand and Madagascar plant species as well as an important collection of Bromeliaeae, are among the most notable elements.

The missions of the OMP are numerous. One of these is the conservation of plant species through the maintenance and enrichment of a botanical collection that already includes some 3,000 taxa, some of which have become extremely endangered or extinct in their natural habitat. In order to carry out this task, the OMP has joined various networks such as BGCI, the "Association des Jardins Botaniques et Arboreta de Belgique" (VBTA-Vereniging Botanische Tuinen en Arboreta) as well as the JBFPP ("Jardins Botaniques de France et des Pays Francophones"). These networks have a common focus on enhancing relationships and building competency/skills, as well as supporting the exchange of plant material (seeds, plants) between botanical gardens, in line with the provisions of the Convention on Biological Diversity, to support the conservation of plant species and their threatened habitats.



The tropical greenhouse (Sophie Pittoors)



Macaronesian area in the desert greenhouse (Sophie Pittoors)

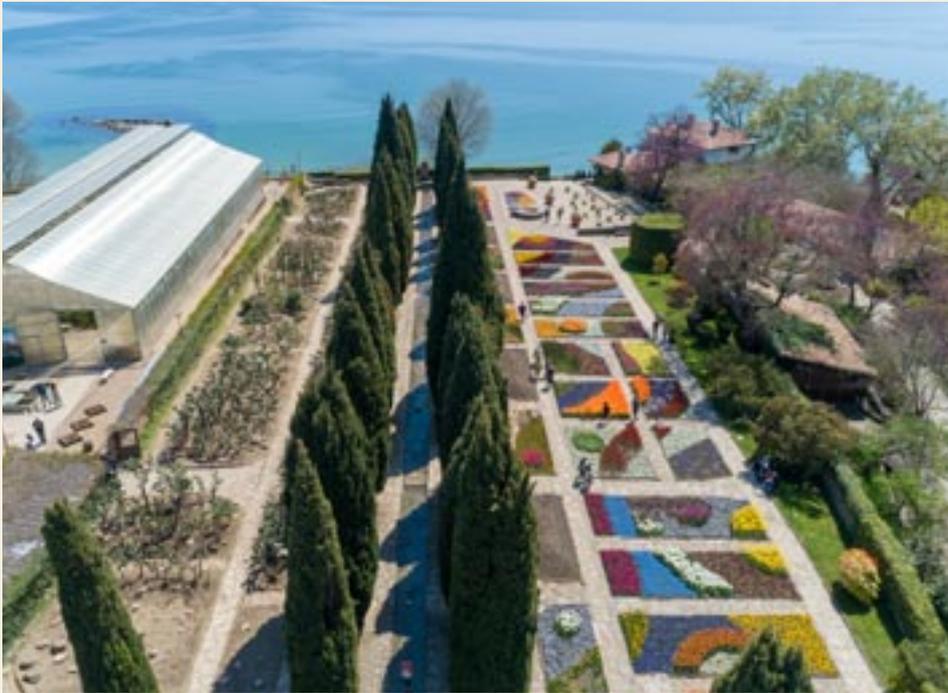
Public education about biology and ecology and raising awareness about biodiversity and its conservation are among the crucial duties of OMP. So, for example, a new database of the plants in the collection allows plants to be labelled with their conservation status according to IUCN. Various educational approaches, as well as guided visits inform visitors about the importance of environmental protection and of the dramatic consequences of human activities. A wide audience, encompassing students from various education levels, researchers and the general public is reached by these various approaches and science diffusion is wide.

Beyond its essential role in biodiversity conservation, as a university botanical garden, the OMP has a close relationship with the university students and its research environment. Through its collections, the OMP contributes not only to the illustration of various courses, such as taxonomy and plant systematics, ecology, plant physiology, evolutionary biology, conservation and even pharmacognosy and biogeography. It also provides botanical materials for the practical work of students, doctoral students and researchers. The OMP regularly hosts students as part of their internships and also for final-year dissertations on a range of topics. Likewise it participates in research on fundamental and applied scientific studies, such as biomimicry or active biomolecules with interesting pharmacological properties.

To summarize, as a botanical garden bound to a university, the OMP, apart from its more 'classical' missions linked to public awareness and plant conservation, is a substantial educational asset for students as well as providing support, in various ways, for research carried out at the University of Liège.

Sophie Pittoors
Espaces Botaniques Universitaires
de Liège
Chemin de la ferme, 1
4000 Liège, Belgium

SOFIA UNIVERSITY BOTANIC GARDENS – HISTORY AND PRESENT



The University Botanic Garden in Balchik

The University Botanic Gardens at Sofia University „St. Kliment Ohridski“ (Bulgaria), is made up of gardens in three locations – the cities of Sofia, Varna and Balchik. They were established at different times and each one has its unique development and characteristics. The University Botanic Garden in Sofia already boasts a 130-year history.

The oldest university in Bulgaria (Sofia University “St. Kliment Ohridski”) was founded on 1st October 1888. Just four years later, in 1892, under the leadership of the first Bulgarian Professor of Botany Dr. Stefan Georgiev (1859 – 1900), Sofia Botanic Garden started to welcome students and academics.

The opening ceremony was attended by the Bulgarian King Ferdinand, who had a certain interest in botany. Then, an oak tree (*Quercus robur* L.) was planted, which still grows in the center of the garden. Additionally, to enrich the developing collection, a greenhouse was built and a set of exotic plants –

orchids, cacti and poinsettias were ordered from Erfurt, Germany. Later, the garden was developed by Karl Neff, the son of the famous Swiss gardener Daniel Neff.



University Botanic Garden, Sophia

Nowadays, there are several distinct zones in the park – rock gardens, water pond with lilies, wetland with moisture-loving plants and a perennial garden. The plants in the greenhouses are mainly cultivated for scientific and education purposes and include well-documented collections of subtropical, tropical species and succulents. Up-to-date, the University Botanic Garden Sofia grows and preserves more than 1,500 plant species.

Sixty-three years after the foundation of the garden in Sofia, a new branch on the Bulgarian Black Sea Coast was established. In 1955, the University Botanic Garden in Balchik opened its doors for year-round public visits. Under the guidance of the world-famous botanist Prof. Daki Jordanov, the park territory of the former summer residence of Romanian Queen Marie Alexandra Victoria of Edinburgh was transformed into a breathtaking botanical oasis on the edge of the sea.

Nowadays, the Botanic Garden in Balchik spreads over 19.4 ha on the cliffs of a limestone plateau from the sea level up to an altitude of 35 m. Since 2005, it is in the list of protected areas in Bulgaria. The unique combination between the microclimate in the garden and a set of different habitats on a small territory allows an exhibition of exclusive and rare plant assemblages.



University Botanic Garden "Eco-Park" Varna

The garden is famous for its rich cactus and other succulent plant collection of about 4,000 species. Every spring, the Botanic Garden Balchik becomes a home of a splendid tulip pageant (more than 50 000 tulip bulbs), an incredible parade of floristic beauty.

As an institution, which aims to unite science, education and social activities, the University Botanic Garden Balchik participates in national and international education and social projects and hosts different green schools and exhibitions.

In 2005, a new extra zone ('Nursery Garden' – 0,7 ha) in the garden was created to welcome the guests with limited abilities. This

zone was designed as a minimalist model of different gardens in the whole park complex, allowing disabled visitors to enjoy most of the plant expositions. In addition, a corner for visually impaired people was established, where plant biodiversity could be felt and explored through the tactile and olfactory senses.

Last but not least, The Botanic Garden Balchik functions as a rescue center for rare and endangered plant species in Bulgaria, being part of the international CITIES framework.

University Botanic Garden "Eco-Park" Varna was established in 1977 on the site of an existing nursery. Since 2002, this garden has been opened for visitors as the first Ecological Park in Bulgaria.

It has been designed as a typical arboretum comprising over 330 species of native and introduced trees and shrubs. It is a tourist site of regional significance and during its 20-year development Ecopark Varna launched many eco-attractions of cultural, scientific-educational, sport and entertainment nature. In its joint work with local organizations and educational institutions, the garden organizes "green school" environmental camps that direct the attention of the pupils towards environmental conservation and strengthen their sense of responsibility towards nature. The guided walks and botanical consultations showcase the natural and man-made ecosystems in the park, increasing the visitors' knowledge about the significance of the biological diversity in the area. The celebrations of national and folk holidays, the designation of recreation zones, the rides in a traditional decorated Bulgarian carriage and the organization of folk wedding ceremonies in the park area help the visitors get closer to the traditional Bulgarian family values.

University Botanical Gardens are members of the World Botanical Gardens Council, the European Botanical Gardens Consortium, the Botanical Gardens Environmental Education Network and participate with their collections in the *Index Seminum* seed and plant exchange with botanical gardens around the world.

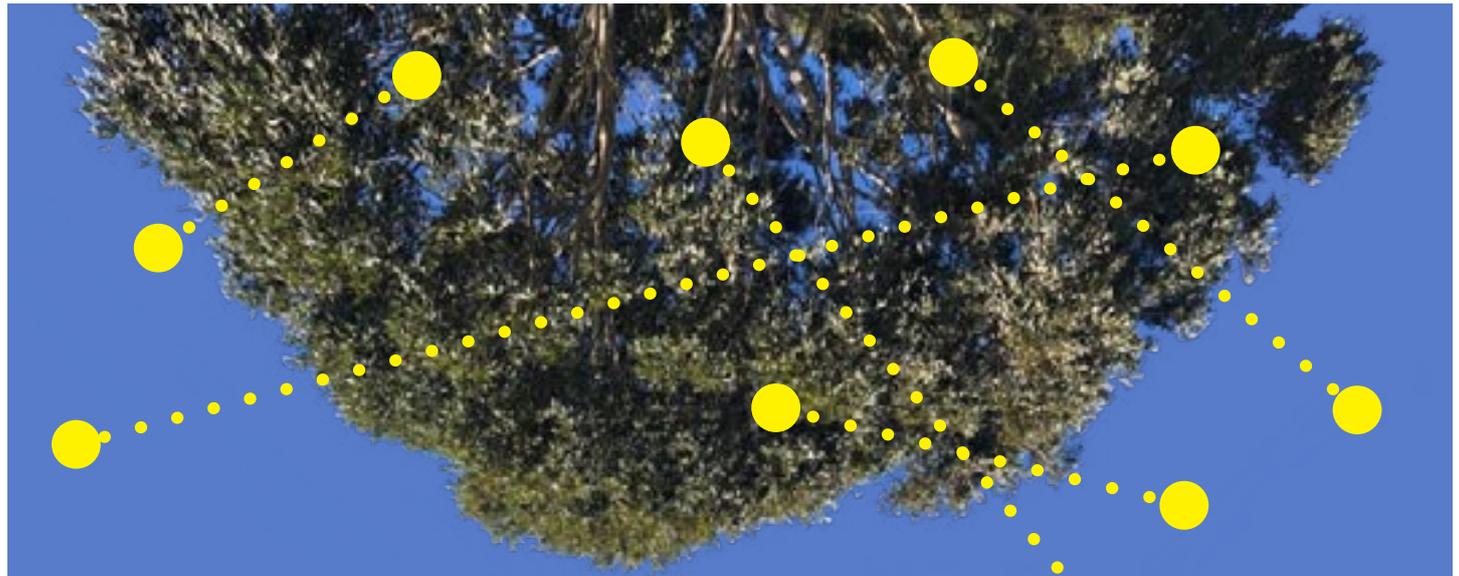
Desislava Miteva
University Botanic Garden Varna
Bulgaria



**BOTANIC
GARDENS**
CONSERVATION
INTERNATIONAL

Descanso House, 199 Kew Road,
Richmond, Surrey, TW9 3BW, U.K.
Tel: +44 (0)20 8332 5953
E-mail: info@bgci.org
Internet: www.bgci.org
https://twitter.com/bgci

BGjournal Volume 19 • Number 2 • July 2022 ISSN 1811-8712



INFLUENCE & ACTION

Botanic Gardens as Agents of Change

**7th Global Botanic
Gardens Congress**

**25–29 September 2022
Melbourne Australia**

Join us for the 7th Global Botanic Gardens Congress (7GBGC) which will be held in Melbourne Australia from Sunday 25 – Thursday 29 September 2022.

It is an ideal time to bring our community together and experience real people, real connections and real gardens. *Influence and Action: Botanic Gardens as Agents of Change* will explore how botanic

gardens can play a greater role in shaping our future. With accelerated loss of biodiversity across the globe, increased urbanisation, population growth and climate change, our need to work together to find new solutions for the future has never been greater.

Join inspiring speakers, fascinating workshops, panel discussions, and symposia over the Congress days and be

part of the global discussion. You'll have the opportunity to participate in a designated Education and Engagement Day, field visits and a post-Congress tour visiting the spectacular Wildflowers of Western Victoria. Explore Royal Botanic Gardens Victoria's stunning and contrasting landmark gardens at Melbourne and Cranbourne or immerse yourself in natural areas of coastal heathland or towering hardwood forest,

or regional botanic gardens. And whilst in Melbourne, you can experience the vibrant contemporary creative and food scenes for which the city is globally renowned for.

Visit the Congress website to view the program and for information on registration and join us in Melbourne in September 2022.



Royal
Botanic
Gardens
Victoria



**BOTANIC
GARDENS**
CONSERVATION
INTERNATIONAL



For further information visit
7GBGC.ORG