
# Proceedings of the 3rd Conference of Eastern and Central European Botanic Gardens

## Botanic Gardens – delivering public goods and supporting society

9–11 October, 2017, Budapest, Hungary

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## Conference Themes

### Theme 1: *BGs – Knowledge Centres supporting society*

- BGs are research infrastructures – living collections on 1st place as well as specialist staff, furthermore buildings and equipment
- BGs provide knowledge for the society on wide scale – botany, ecology, agriculture/horticulture, sustainability, green infrastructure, green/smart city, etc.
- BGs support by their infrastructures and knowledge several fields of economy, agronomy, industry, etc.

### Theme 2: *Strategy – management – operation*

- BGs are living museums need strategic thinking, permanent development, professional management on every activities and daily operation as well
- BGs maintain and exhibit living collections and all the necessary (garden) infrastructure for all of their main linking activities: education, research, nature and built heritage conservation, ecotourism and recreation, cultural events
- BGs have different owners (e.g. state, municipality, private, etc.) and operational institutes (e.g. research, university, etc.) with different emphasises on main activities
- BGs have to optimize not only their own work but have to intend to harmonize it with external environmental, economic, social and other impacts and demands as well
- BGs have to intend to as sustainable operation as possible and display good (own) examples for the public
- Round table: Current challenges for BGs
- Saving functions of „classic" BGs in the 21st century
- BGs importance as national strategic wealth
- Expectations of the society from BGs
- Rational separation of strange and acceptable demands vs. social pressure
- Suggestions for the solutions of challenges
- New directions for braking out

### Theme 3: *Education*

- BGs provide diverse professional education programmes on nursery, elementary, secondary, high, graduate and post-graduate level as well as support teachers and educators in knowledge transfer about plant kingdom, biodiversity, ecology, sustainability, horticulture, etc.
- BGs ensure attractive environment rich in information and experiences for lifelong self- learning for the public from nursery aged children till elderly people
- BGs sensitize people for nature, make them more respectful for other living beings from small to big, from visible to invisible, etc. and by this to each other, raise people's environmental consciousness
- BGs help to understand operation, behaviour, etc. of living individuals and living systems on higher dimensions, complexity (e.g. community), etc.

### Theme 4: *Conservation*

- BGs are gene banks, biodiversity hotspots growing and saving high quantity of native and non-indigenous plant taxa
- BGs are key institutes of nature conservation mainly by their ex situ conservation and repatriation activities of endangered taxa
- A significant number of BGs themselves are protected area as nature conservation area and/or listed built heritage (e.g. historic garden)
- BGs have important role as scientific workshops in several research and results on positive (natural) and negative (e.g. invasion) processes

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## Esteemed Conference!

It was close to 250 years ago that Jakab Winterl, a professor at the first medical faculty in Hungary came to an important decision. As head of the chemistry department, he founded an educational botanical garden at the university – the first of its kind in Hungary. As is usually the case with innovative people with foresight, he initially also had to overcome a lot of difficulties. He needed funding for the upkeep of the university botanic park, gathering the funds required a lot of effort. However, Winterl did not give up. In one of his letters, he wrote that future doctors were not familiar enough with active ingredients and reasoned for maintaining the garden saying "… *botany needs to be considered more seriously*."

I do not need to prove to you – esteemed Ladies and Gentlemen – who are meeting in Budapest that the statement of Jakab Winterl about the significance of botany close to two and a half centuries ago has proven to be correct in many ways. The spread of special plant communities created according to unique considerations has also given a new impetus to numerous areas of research in our country. Species catalogues were compiled one after the other, making it possible to assess the characteristics and the chances of acclimatisation of different plants. It wasn't only the gardens that flourished but academia processing the knowledge related to them also blossomed. Furthermore, lay botany lovers could also enjoy this created beauty.

Later it became a practice of exacting land owners to think beyond considerations of image and comfort and to shape the natural environment with professional care. Hungary owes many of its best, still remaining valuable collections to such exemplary private initiatives (by former land owners and churches). The two objectives: research and the visual delight do not contradict each other. These dedicated places help to preserve rarities that have come close to extinction, while over the years it has also become possible to breed new strains that are capable of adapting to the changed climatic conditions. Arboretums and botanic gardens open to the public around Hungary are also extremely popular and draw huge audiences. By presenting the diversity of plant species they raise awareness about the importance of biodiversity and environment protection. Besides constituting a one-of-a-kind genetic bank for the conservation of species, they also play a huge educational and awareness raising role.

## Esteemed Ladies and Gentlemen,

Enjoying the legacy and dedication of Hungarian botanists, the Hungarian Association of Arboreta and Botanic Gardens Historic, which is celebrating its 25th anniversary this year is happy to welcome the delegates of the Eastern and Central European Botanic Gardens Conference. I hope that beyond the professional discussions, the participants of the conference will demonstrate again that these gardens and parks are representatives of the ecological approach. You are not guardians of unchanged museum artefacts, but values of living nature.

Natural values, with which humanity lives in a mutual dependency and has received much more from it so far than all the attention and responsibility than it returned. Therefore, I wish you a lot of success at your conference - carrying on the intellectual legacy of Jakab Winterl – in giving "serious consideration" to botany in the interest of all of us.

Budapest, October 2017

*János Áder*
President of the Republic of Hungary

# Speaking points for intervention by the European Commission Representation at the 3rd Conference of Eastern and Central European Botanic Gardens

by Liliána Zúgó
Budapest, 9–11 October 2017

- The Directorate-General for the Environment of the European Commission regrets not being able to send a representative to this conference but wishes to greet the participants and to share some thoughts with them.
- The EU Biodiversity Strategy to 2020 aims at halting the loss of biodiversity by 2020. It reflects the commitments taken by the EU in 2010 within the UN Convention on Biological Diversity (CBD).
- Article 9 of the CBD specifies measures for the establishment and maintenance of facilities for *ex situ* conservation of components of biological diversity. This article also points out the role such collections can play in the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions. Action A1.3.3 of the EU Biodiversity Strategy is the EU implementation of this article. It says: "*Identify and fill critical gaps in EU ex situ (zoo, botanic gardens, etc.) conservation programmes for wild species, in line with best practice, with appropriate cofinancing from European Commission and Member States*". This action is very relevant for the botanic gardens that you represent at this conference.
- In the course of the implementation of the Habitats Directive in the Member States, which is one of the key the targets of the EU Biodiversity Strategy, a number of projects with the support of the EU LIFE financial instruments carried out plant species reintroductions to their natural habitats with the cooperation of botanic gardens. In 2011 a publication summarized some of these projects, among which there were some successful projects on plant conservation carried out in Hungary, the host of this conference. (Pro Domo: http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/documents/reintroduction.pdf).
- Botanic gardens also play an important role in educating the public about plant conservation. There are many good examples of such activities.
- Also in the framework of the EU Biodiversity Strategy, the EU has adopted Regulation 1143/2014 on invasive alien species.
- Invasive alien species are one of the major threats to biodiversity. They cost the European economy at least 12 billion euro per year.
- The core of the Regulation is a list of invasive alien species of Union concern. There are currently 49 species on the list, among which 23 plants, mostly ornamental plants.
- Examples of terrestrial ornamental plants of Union concern are Giant Hogweed (*Heracleum mantegazzianum*), American skunk cabbage (*Lysichiton americanus*) and Crimson fountaingrass (*Pennisetum setaceus*).
- Examples of aquatic ornamental plants of Union concern are water hyacinth (*Eichhornia crassipes*), Fanwort (*Cabomba caroliniana*) and Water Primrose (*Ludwigia grandiflora*).
- Following the listing of species as invasive alien species of Union concern, restrictions to selling, cultivating, reproducing and releasing the species apply. Member States have the duty to rapidly eradicate newly establishing populations, and to manage widely spread species.
- Botanical gardens have a crucial role to play in educating the public on invasive alien species, the threats they pose and the actions to be taken, with special emphasis on invasive alien species of Union concern.
- The Commission is keen to cooperate with the botanical gardens, in order to address the problem of invasive alien species, and to stop the loss of biodiversity by 2020.
- We wish you a successful conference and we also look forward to seeing the outcomes of your discussions.


*3rd Conference of Eastern and Central European Botanic Gardens, Budapest, 2017*

## Dear Colleagues and Friends,

It is our honour to welcome you to the 3rd Conference of Eastern and Central European Botanic Gardens to be held in Budapest, Hungary from 9 to 11 October 2017 at the Buda Campus and Arboretum of Szent István University on the occasion that the organizer Hungarian Association of Arboreta and Botanic Gardens (HAABG) celebrates its 25th anniversary this year.

We appreciate and reckon EastCentGard as a valuable and important regional initiation, so our committed intention is to revitalize it. EastCentGard III to follow in line ECG I (Tartu, Estonia – 2003) and ECG II (Warsaw/Rogów, Poland – 2007) and it is going to address the classic features of botanic gardens and the challenges they are currently facing in the CEE region.

Focusing on the relations of botanic gardens and society, especially in terms of serving public goods, main topics cover the function of botanic gardens as knowledge centres, the triad of strategy- management-operation as well as social aspects of gardens' classic roles including conservation and education.

We do hope you will enjoy the oral and poster presentations about nice examples, successful projects, model cases, good practices and/or fruitful collaboration with strong BG activity and/or partnership, all of them are worthy for following/adaptation. Over the main themes, several botanic gardens and arboreta and/or their national network will be introduced in the poster section.

Although EastCentGard III is a region-focused conference, it is an open community which welcomes experts from any other part of Europe or other continents.

We are wishing you a fruitful conference in Budapest, Hungary! On behalf of the Scientific and Organizing Committees,

Géza KÓSA
President of HAABG
Co-chair of Scientific Committee

Vince ZSIGMOND
Secretary General of HAABG
Chair of Organizing Committee

*3rd Conference of Eastern and Central European Botanic Gardens, Budapest, 2017*

## The botanical gardens in Central and Eastern Europe. The current state of affairs and the new challenges and prospects for collaboration

Jerzy Puchalski[1], Paweł Kojs[1,2]

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It is possible to rank 22 countries among the area of Central and Eastern Europe. Among them are the countries being before 1990 the members of the Eastern Bloc of socialist countries, former republics of the Soviet Union and the republics of the former Yugoslavia, as well as, Albania. According to the BGCI's GardenSearch database 217 botanical gardens are located in this area of Europe. Among them 137 in classic meaning are botanical gardens with various plant collections, 50 arboretums or dendrological gardens holding mainly collections of woody plants and 31 gardens of other types: palm houses, gardens of medicinal plants or gardens of native flora. For the current state of affairs of botanical gardens located in Central and Eastern Europe very important is their managing body which is financing their activity. Until 1990 it was common to organize big botanical gardens or arboretums as the research units of the national academics of sciences, supported from the governmental funds. At present this type of botanical gardens remained only in a few countries. In total there are 15 botanical gardens as research units of the national academics of sciences or acting in the framework of the structure of academies research institutes. But the majority of botanical gardens, as much as 80, are the units of universities. 25 botanical gardens are municipal or regional institutions funded by city or region authorities. Also 20 arboretums or dendrological gardens belong to state forests or national parks. Only 4 botanical gardens are private. At present 11 countries from this region of Europe are members of the European Union, with total number of 149 botanical gardens. For the development of their activity very important was their membership in the European Botanic Gardens Consortium (since 2004) and the participation in various EU projects and programs, for example ENSCONET, ERASMUS or INTERREG.

**Keywords:** botanical garden, Europe, EU projects, academy of sciences

## Building a global system for the conservation of all rare and threatened plant species. What can botanic gardens do to prevent plant species extinctions?

Paul Smith

*Botanic Gardens Conservation International*

Botanic gardens offer the opportunity to conserve and manage a wide range of plant diversity *ex situ*, and *in situ* in the broader landscape. The rationale that botanic gardens have a major role to play in preventing plant species extinctions through integrated plant conservation action is based on the following assumptions:

- There is no technical reason why any plant species should become extinct. Given the array of *ex situ* and *in situ* conservation techniques employed by the botanic garden community (seed banking, cultivation, tissue culture, assisted migration, species recovery, ecological restoration etc.) we should be able to avoid species extinctions.
- As a professional community, botanic gardens possess a unique set of skills that encompass finding, identifying, collecting, conserving and growing plant diversity across the entire taxonomic spectrum

Botanic Gardens Conservation International (BGCI) is a membership organization representing a network of 500 botanic gardens in 100 countries, and around 60,000 scientists, horticulturists and educators - the largest plant conservation network in the world. This network already conserves and manages more than 90% of plant families, 50% of genera and 30% of species in its living collections and seed banks. Following the example of the crop conservation community, BGCI's botanic garden-centered Global System for the conservation and management of plant diversity aims to collect, characterize and conserve all of the world's rare and threatened plants as an insurance policy against their extinction in the wild and as a source of plant material for human innovation, adaptation and resilience.

Using tree conservation as an example, the speaker will set out the approach, methodologies and milestones being employed by botanic Gardens and arboreta to ensure that no rare and threatened species becomes extinct.

# The Dendrological Trail at the Budakeszi Herbarium: Re-created native habitats from around the world demonstrate plants' genetic memory for cold hardiness

Zsolt Debreczy

*International Dendrological Foundation, Inc.*

The Budakeszi Herbarium*, the Hungarian laboratory of the International Dendrological Research Institute Inc. of Massachusetts, USA, is a repository for a quarter of a million-specimen herbarium and is surrounded by 2 hectares of inter-connected living collections along its Dendrological Trail and in their taxonomical plantations. The living plant collection along the Trail was created with the herbarium's supporting material in mind so that it is authentic and references well-recorded taxa. Both the Trail and herbarium are appropriate for education, serve as an *ex situ* gene reserve, are a resource for international plant-material exchange, and can even be used for conservation purposes. In addition, the collection is testament to our** studies of plants' genetic memory – cryptic properties – related to morphology and cold hardiness. We have special interest in the contradiction of the morphology of plants masked by their survival strategies in native habitats' harsh circumstances vs. the same (well documented) taxa in ideal to supreme conditions in arboreta. Leaf size, shape, and margins and even "more conservative" parts such as inflorescences are all subject to change in dramatically different conditions. Also in open air selection of seedlings grown in our experimental seedbeds has demonstrated that many supposedly tender taxa are perfectly hardy in our USDA zone 7 climate. Such a large scale of hidden cold hardiness can only be explained by the vegetation history of these studied taxa, that is, by the supposition that they formerly thrived in much colder areas than they inhabit today.

The Dendrological Trail and the plantations around and nearby the Budakeszi Herbarium have close to 1800 woody taxa, and the trail alone presents 650 wild-collected trees and shrubs introduced from their native habitats and planted in geographical synecology-type groupings. The European and Californian mediterranean sections are based on woody taxa which are, in general considered "not hardy" in our Central European climate. Mexican conifers, rare evergreen trees and shrubs complement the regional collections along the Trail and serve both experiments and educational purposes.

*International Dendrological Foundation

**Dendrological Atlas Project team

**Keywords:** Budakeszi Herbarium, dendroflora, hardiness, conservation, education

# Interpreting the Nature for its Visitors – Informal Education in the Botanic Garden "D. Brandza", University of Bucharest

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**Abstract:** It is generally accepted that most visitors to botanic gardens come here to relax and enjoy the plants' beauty. The botanic gardens do not only offer places for relaxation, they also play an increasingly important role in educating people to protect the nature and keep the environment healthy. To properly assume their role in education, botanic gardens have to share the secrets of the plants' world in a unique way, using the power of their collections and not only. Traditionally, this is done through formal education initiatives, such as seminars, workshops, conferences, panels and informative materials; it can also be conducted informally, through new original ways to discover the nature and to bring it closer to people. The nature can be interpreted from several points of view: scientific, aesthetic, cultural, ethical, as a resource that needs to be preserved. In the Botanic Garden "D. Brandza" all these aspects are transmitted through activities that combine plastic arts, photography, theatre, game, visitors' experiences, encouraging them to re-evaluate their attitude and their future actions towards the environment. Therefore, among the most important activities that we organise to educate visitors are: plastic art exhibitions, with the main theme being the vegetal world transposed with the colours on different supports (examples, Plant Art, Flowers for …Flowers); floral art exhibitions; photography exhibitions (examples, Romania's Wild orchids, Healers in the world of plants); fruits and seeds exhibitions; the creation of an original colouring book, especially for adults, representing images of medicinal and ornamental plants; creative workshops.

**Key words:** ecological education, exhibitions, arts, informing people.

Botanical Gardens represent for their visitors a special world within which they can relax, as well as study. Because plants cannot express themselves through words, they share their secrets with the help of scientists.

Botanical Gardens are assuming an ever more important role in helping the wider public to understand the global environmental changes, to recognise complex conservation issues and to reconsider their attitude / behaviour towards protecting their environment (Ryken 2009). Botanical Gardens have the potential to offer informal learning experiences (Mochnacký 2015). Studies show that, should the botanical gardens wish to introduce more educational activities, as visitors are rarely motivated to learn, they must thoroughly analyse the methods in which the activities are designed and promoted (Ballantyne *et al.* 2007). To efficiently accomplish this, they also require an interpretation well-conceived. The interpretation is a process of communication, an art (Tilden 1975), possibly as old as humanity although only defined in 1919. This notion appeared in the United States at the end of the 19th century with the declaration of the first national parks. Interpretation is a mean of educating the public without it being aware of the learning activity and should be suggestive enough to stimulate the individual to change his behaviour (Morales 1983).

It is often difficult to put scientific knowledge into a certain context understandable for the wider public. Therefore, using a great story and with the help of words, images, objects, and the imagination and emotions of visitors, the message we wish to portray must reach the target group as fast and as easy as possible. For this reason, botanical gardens are increasingly involved in highlighting the interpretation of nature in danger, with emphasis on the necessity for biodiversity conservation (Furse-Roberts 2009).

Interpretative programs in botanical gardens include exhibitions, displays, interpretative signage and guided or unguided tours, demonstrations, interactive screens (Honig 2000). Certain botanical gardens also provide booklets, books, guides, maps and brochures to complement self-guided visits.

Because it is aimed at a non-captive audience, interpretation must stimulate the interest and captivate the imagination of visitors, for them to be delighted and to want more (Honig 2000).

Over the last 20 years, Botanic Garden "D. Brandza" has made efforts to make the garden more accessible to its visitors. Thus, besides the informal educational activities within the School of Nature, a series of events including sensory activities, exhibitions, workshops have taken place. Like any botanic garden, Botanic Garden "D. Brandza" also provides interpretive signs and guided visits for visitors, and the information is constantly improved, and language adapted to make the information easier for the public.

We present some of our ways to interpret nature to bring it closer to the visitor, to communicate with people who did not come here to learn.

## Guided visits

A guided visit is one of the most commonly used method for interpretation in botanic gardens, as the guide can easily captivate the emotions and imagination of the audience. With it being an interactive means, the visitor is engaged in different sensory activities. They can opt for visits in the greenhouses, museum, exterior spaces or even a complete tour comprises all the before mentioned. As well, these guided tours can be themed, focusing, for example, on medicinal plants or plant adaptations.

## Interpretive Signs

Because interpretive signs are a practical option when there is insufficient staff available, being permanently accessible for the public, in Botanic Garden "D. Brandza", these signs are present in a fairly large number. interpretive indicators are providing information on the permanent collections both outside and inside greenhouses, as well as on outstanding individuals of certain outdoor tree species.

## Educational Theatre

For this, the message is transmitted through an interactive theatre piece, aiming to offer to the public different perspectives on a particular environmental issue. In some cases, these also include interactive parts, when visitors were encouraged to maintain punctual views and opinions on a particular environmental issue.

For example, in the play entitles "Nature's recyclers", the characters were trying to attribute themselves the most important role in natural material decomposition, and the visitors were encouraged to express their opinion on this issue.

## Colouring Books

Seen as a relaxation tool, the colouring book is an excellent way of educating an audience that does not particularly wish to learn about plants. The colouring book "The kingdom of plants", which is addressed to both adults and children, consists of 44 botanical boards designed by the artist Angiolina Santocono, created in the Botanic Garden „D. Brandza", and ink reproductions of these.

By including the scientific name as well as the common one and using as template the botanical plates with great detail on the plant morphology, it enables the person colouring the books to involuntarily get closer to the world of plants.

## Exhibitions

With the purpose of emphasising the beauty of plants and the value of biodiversity, our exhibitions stimulate visitors to discover the fascinating world of plants and to understand the necessity of preserving this treasure, one with such an important role in the life of humans.

Audience of all ages has the chance to admire unique works of art, the majority of which are made from ecologic materials, and interact with the artists during workshops specifically organized for this purpose. To have the opportunity to undergo a new artistic experience, to rediscover and filter through their souls and thoughts the show of colours, shapes and structures offered by the wonderful world of plants. These exhibitions are aimed at restructuring the mindset and feelings regarding nature's universe. Of these exhibitions, we may count: Plant Art, Patterns of Life, Ancestral periplus, Life of Bulbs, Flowers for …Flowers, Autumn colours.

"Plant Art" has represented an artistic manifest materialized into a series of visual art exhibitions which promotes the respect for nature, for a healthy, equilibrated lifestyle, in harmony with both the surrounding environment and ourselves. These exhibitions comprised of drawing studies, decorative compositions made from dried vegetal fragments, photographs and fabric prints, weaves, all having as a model natural structures collected from the Botanical Garden.

The "Patterns of Life" exhibition was, as well, an artistic valorification of the vegetal material offered by the Botanical Garden's Greenhouses. The students made use of plants in the making of various compositions in which the theme were lines and points, which symbolized seeds, leaves and branches.

Within the "Ancestral periplus" exhibition, the public could admire studies of drawings/colours and decorative compositions created on paper and fabric using both traditional and unconventional techniques, all inspired from rocks and fossils provided by the Faculty of Geology at University of Bucharest.

"Life of Bulbs" invited the public to rediscover the value and poetry of nature through a unique technique: full-scale representation of plants together with artistic representations of a philosophical elegance, created in

aquarelle, for which flowers at their real dimensions were used, as well as sketches from the scientific botanical literature. Among these works there were also representations of rare plants. The exhibition stirred afterthought on the road of life, with its transformations – from beauty to transcience.

"Flowers for …Flowers", an exhibition with 13 editions, held one week before Easter, attempts every time to bring nature closer through the art of floral arrangements, Ikebana. The significance of the arrangements' components (past, present and future or humans, sky and earth) invite the visitor once again to meditate on the link between man and nature.

Each year, the event "Autumns colours" transports the visitors in the micro and macroscopic world of fruits and seeds and talks about nature's chromatic with the aid of floral arrangements composed of flowers, branches and numerous vegetables. With the help of this event, the broad public, especially the children, discover the beauty and complexity of the world of plants and get familiarized with a series of information regarding the large variety of flowers, leaves, fruits and seeds that can be observed in nature.

## Workshops

Workshops are means of engaging visitors, especially children, in memorable experiences which they would extend as long as possible.

For children, these workshops are numerous and havethe following themes: plant-based soft beverages preparing, medicinal plants and their preservation (drying), figurines made of vegetables, floral arrangements making – workshops both for children and adults, painting and the design of flowers out of leaves, creation of designs for dresses out of leaves.

For adults, these workshops have as main topics floral art, botanical art and plant care.

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# Recent developments in the Arboretum of Szarvas: matters of protected values, public relations and fostering education

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## Introduction

With a 82-ha living collection, the Arboretum of Szarvas is the largest arboretum of Hungary. Ever since its founding, the Arboretum faces continuous challenges. In the beginning, the founders had to deal with harsh natural conditions, and later the world wars and the change of political systems had all caused difficulties. Nowadays, securing funds to cpver costs of maintenance is the main challenge and provide a lot of tasks. In spite of these, both the founders and the later keepers have continuously developed the Arboretum, which is now a multifunctional area. It acts as a botanical collection, as a gene bank, as a community relaxation space, as a tourist attraction, and a science and education workshop.

## History

The area of the Arboretum was owned by the Bolza family from the year 1798. The Arboretum is bordered on one side by the river Körös, and the river was one of the reasons why the development of the plant collection was very slow at the beginning. Every year in spring time the river flooded the area of Arboretum. This problem was solved in 1888 when the Körös was drained. After that count Pál Bolza was the one who started introducing plants from around the world. Pál Bolza desinged the garden in a landscape garden style (Gardenesque) which means that he planted valuable plants in a free style without any geometrical positioning. Count Pál Bolza offered his garden to the Hungarian state in 1943, when it was immediately declared a nature conservation area.

Now the Arboretum consists of 5 parts. The Kitchen garden and the Pepi-garden are the oldest parts of the living collection; these two parts were offered originally by Pál Bolza. The next tree parts were added to the area in two phases: the Mitrovszky-garden in 1955, the Tree nursery and the Park forest at the same time in 1961. These five parts altogether occupy 82 hectars. Now the keeper of this state-owned Arboretum is the Szent István University.

## Recent works and developments

The last 20 years the financial self-sufficiency of the garden has become more and more important and it is a great challenge for the Arboretum. Tourism is one of the main opportunity to increase our income. So we organise a number of programs in the Arboretum, closely cooperating with local NGOs. At the same time it is equally important to decrease the overall costs as well. During the last 10 years we have successfully applied for EU grants.

## Conservation and restoration of the botanic garden and the protected historical gardens

The EU financed KEOP tender had two phases (KEOP-3.1.3/2F/09-2010-0004; KEOP-3.1.3/2F/09-11-2011-0005). The first step included historical researches of the Arboretum and than geodetic and plant stock surveys. Based on these researches and surveys was created a new database and a development plan for the garden. The main results of this project were the construction of an irrigation system on 17 hectares, renovation of the drainage system to prevent inland water along 700 m, reconstruction of river bank protection line along 800 m, reconstruction of greenhouses, renovation of fences (4 km long) and the installation of a new entrance gate (Figure 1).


**Figure 1.** The new gate at the entrance of the Szarvas Arboretum

## PRO-PLANTS project

It was a joint project between Hungary and Romania (HURO/1101/119/1.3.1). In the frame of this project we were able to open the „Park forest" area of the Arboretum to the visitors, to create an educational base, a botanical museum and an educational package. Educational package means 8 test booklets for elementary school students plus one test booklet for adult ages. These booklets were designed to help training people for greater levels of environmental consciousness.

## New methods for the green future project

This KEOP project (KEOP-6.1.0/C11-2012-0022) was a national campaign for the green future. We invited 20 other arboretums and botanic gardens to participate in this project. This program provided kids and adults with large amounts of new information about plants, horticulture, nature conservation and sustainability. The campaign has reached tens of thousands of people.

## Results

The number of visitors is an important indicator for botanical gardens. Figure 2 shows how the number of visitors has increased in the last 10 years thanks to recent developments. The number of visitors decreased in the first 5 years but started to increase from the beginning of 2013. The reason of decreasing was the worldwide economical crisis in 2008; on the other side many new attractions near the Arboretum have been established. The competition for visitors is always increasing. When seeing the bad trends we started to put in increasing efforts to get back the lost visitors.

It has to be stated that we wouldn't have been able to achieve these results without an enthusiastic team, in particular that our group consists of only 20 people. As the Arboretum director (1) I wish to express my thanks to all my colleagues for the every-day hard work.

*Funding acknowledgements* – The authors would like to thank the European Union and the Hungarian Goverment for supporting all above mentioned projects.

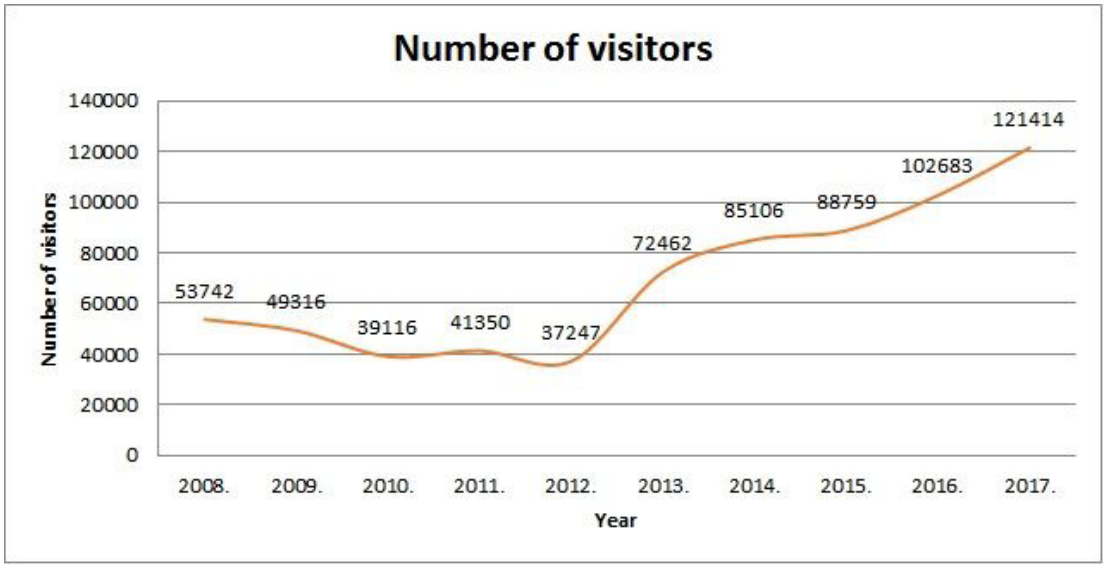


**Figure 2.** The change in the number of visitors of the Szarvas Arboretum

# Botanic Garden of Delft University of Technology, Netherlands

Bert van der Meijden

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Every year the Garden welcomes 36.000 visitors, many from abroad. The garden has a surface area of 2.8 hectares. It is at a walking distance from the centre of Delft, a city with 100.000 inhabitants. The university population is 27.000 (Fig. 1). The Garden shelters 16 plant families and 1 genus which are part of SNP, National Plant Collection Foundation, an alliance of Dutch botanical gardens for the allocation and preservation of the national botanical heritage.

A cross section of the Delft plant collection has the label 'technical'. Its origin is linked to the specific character of the Garden which from its beginning in 1917 has focused on economically useful plants and on how to process them. The scope is much wider now implying e.g. biomimetics.

These "technical" plants, rubber, fibres, coffee, tea, colorants, medicine and others, are a heritage of an era when the Netherlands, a colonizer nation, has had the focus on Indonesia. When the latter country became independent after WW II the Garden's reason for existence faded away and institutional reorganization and austerity measures followed.

At the beginning the new millennium winds have changed and new and promising pathways for science and technology, teaching, community education, protection of biodiversity and art have opened. Research at the Garden received new directions such as electrostatic extraction of secondary metabolites from plants; converting ultraviolet light into safe blue light; LED technology usage "glasshouse horticulture"; interception of rain by trees; restoring mangrove ecosystems; catching fine dust by living plants in vertical architectural structures.

One of the important researches referred to particulate matter and ultra-fine particulate matter reduction. The core of this technology is giving a positive load to negatively charged particles of fine dust and let them precipitate on a mesh with negative polarity. This system has been successfully implemented in tunnels, garages, cattle farms and street cleaning vehicles. The trigger was an observation by Mr. Bob Ursem, the Garden's scientific director, of natural fine dust blown in from the sea and hovering over Hippophae rhamnoides bush. A parallel research topic deals with the fine dust absorption by plant integrated architecture.

Various conventional ways in which the Garden communicates with the general public include signs, tours for different types of groups, children programs, seasonal classes for older kids, popular events, lectures, exhibitions, symposia and conferences.

**Figure 1.** View of the Botanic of Delft University of Technology

This summer the Garden and its twenty-four fellow institutes under the umbrella of the Dutch Association of Botanical Gardens launched 'Chatting with plants', an interactive app for tablets and mobile phones containing each collection's Crown Jewels. This project and more could be realized thanks to a generous gift of Postcode Loterij, a national lottery organization. Waag Society, institute for art, science and technology provided technical support. Tight bonds between the various gardens and staff are a valuable contribution to the efforts of the five year development period.

In the Netherlands there are about 1500 wild plant species, of which 530 are on the Dutch Red List. After 2005 we see a slight shift from threatened to not threatened categories. The general condition of our environment has been improving, but still not good enough to guarantee sustainability. In 2008 the Garden has started gathering a collection of the Dutch Red List species. At present the collection contains 110 of such plants.

## Vilnius University Botanical Garden: To improve the quality of plant collections

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Located in Vilnius City at two sites the Botanical Garden of Vilnius University currently holds almost 199 hectares of land. The main part of the garden (191.5 ha) is located on the north-eastern outskirts of the city (Kairėnai), while the historic part of the garden (7.35 ha, est. 1919) remains in downtown Vilnius. Today, in these two plots of land 10,956 taxa are cultivated (represented by 12031 accessions of living plants). The collections contain a wide array of thematic groups, which today may be divided into 3 larger and 14 smaller groups. This complexity has led to the accumulation of a fair amount of information both historical and cultural, and the development of collections that require specifically formulated management. In order to bring all management requirements for the various collections under controll, an entire system of measures have been introduced to ensure high quality standards for the garden. To this end we 1) created a single database of plants and launched it online (http://botsodas.lt/indexplantarum); 2) unified the plant labeling system that includes the use of QR codes; 3) established a policy development of plant collections; 4) begun mapping the garden plants (using both aerial photographs and GIS software system) to create a common, interactive garden map linked to the garden Plant Database.

**Keywords**: plants, quality, collections

## The International Plant Exchange Network (IPEN): a botanic gardens´ approach to cope with the Nagoya Protocol of the Convention on Biodiversity

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The International Plant Exchange Network (IPEN) was launched in 1998 as a Botanic Gardens´ strategy aiming at: (1) complying with CBD requirements, especially those related to Access and Benefit Sharing issues; (2) developing and implementing material transfer systems for non-commercial purposes for Botanic Gardens which are transparent and trustworthy to providers of plant genetic resources; (3) securing the sharing of benefits with providers; (4) creating confidence in the work of Botanic Gardens worldwide and thus facilitate access to genetic resources; (5) mitigating negative effects of administration potentially caused by new legally binding material transfer or documentation regulations. (6) creating unique identifiers for plant material exchanged between Botanic Gardens. Today IPEN has 189 members from 32 countries.

Since Oct. 12, 2014, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in accord with the Convention of Biological Diversity" (NP) has come into force. This has serious consequences for scientific institutions (including Botanic Gardens) when trying to acquire new material for research, conservation or public outreach. IPEN and its coordination group have reacted to these challenges by informing Botanic Gardens about the NP and its potential implications for BGs and adjusting IPEN to cope with the NP, especially by developing a new Code of Conduct taking the NP into account. The new IPEN is now open for new members.

The talk will present the new elements of IPEN and hopefully will encourage a vivid discussion.

**Keywords**: International Plant Exchange Network, IPEN, Nagoya Protocol, CBD

## The European Native Seed Conservation Network (ENSCONET) Consortium

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As a follow-up to the EU-funded project ENSCONET (running 2004–2009), 31 organizations from 17 European countries decided to continue their seed conservation related activities and, in 2010, established the ENSCONET Consortium coordinated by the Millennium Seed Bank, RBG Kew.

At its last general meeting at the 6th Global Botanic Gardens Conference in Geneva (June, 2017), the wo rk of the Consortium for the near future was prioritized as follows:

1) contributing to targets 8 and 9 of the GSPC in Europe by encouraging the upload of data about seeds stored in European seedbanks to the ENSCObase system and by using this data for national and regional gap analyses and collection plans;

2) strengthening communication and links within the network and with other conservation and plant biology related institutions and stakeholders;

3) promoting seed research activities and the exchange of seed conservation related knowledge, best practices and experiences; thus ensuring that seed collections are suitable and available for conservation projects including seed-based restoration activities;

4) seeking funding opportunities, especially on national and regional levels, to enable the Consortium to carry out these tasks.

**Keywords**: GSPC targets 8 and 9; conservation; seed collection, storage and curation; ENSCObase; seed research; ENSCONET Consortium

## Current management directions in the O. V. Fomin Botanical Garden

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The Management plan for the Botanical Garden was first developed in 2016. Work on the project consisted of two stages: inventory and planning. Its materials include the analytical part and the management block. In the latter, the justification and proposals for further garden management are given: Development of measures for the protection of nature complexes and objects; Restoration of disturbed territories; Organization of environmental education, scientific and training work; Environmental and economic measures; A list of necessary managerial decisions, scientific, design, survey work, justification of financing from the state and local budgets; Monetary assessment of the main activities of the project.

Priorities of the management for the next 10 years include: Creation of new collections (now the creation of groups of introductory populations is being implemented); Construction of new heating facilit y; Struggle with erosion processes. Strategic management priorities include: development and preservation of a garden plant collection; Reconstruction of existing plantations and greenhouse buildings; Improvement of the staff schedule; Development of ecological-educational and recreational infrastructure of the garden.

The management objectives in dendrology include: publication of a special catalogue of garden collections until 2019; Continuation of coniferous and evergreen deciduous introduction; Design of seasonal floral areas using a new assortment of plants; Regular sanitary care for plants; Replacement of old trees and shrubs.

Thus, in the O.V. Fomin Botanical Garden for more than 175 years of history plant collections of temperate, tropical and subtropical zones of the planet of over 9,000 species and intraspecific taxa have been created. The project will allow implementing operational measures of management and planning of longer -term strategic measures, which besides the main tasks of the garden will contribute to the greening of the Kyiv urban agglomeration.

**Keywords**: botanical garden, management, plant collections development

## Croatian botanical gardens and arboreta within the UNESCO's International Year of Sustainable Tourism for Development (2017)

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Increasingly attractive tourist destination, Croatia is famous for its warm Adriatic Sea, with beautiful coastline and many islands. However, besides its famous natural, historic and cultural merits, Croatia has lots of potential in the various combinations of these, with botanic gardens and arboreta being just one part of it and in accordance to the UNESCO's International Year of Sustainable Tourism (2017).

In Croatia 8 botanic gardens and 3 arboreta are officially registered, managed by various institutions, such as Faculties, Public Institutions, Museums and Schools. Most of them are statutorily protected as Monuments of park architecture or/and Monuments of culture. There are 4 University botanic gardens (in Zagreb, Split and Dubrovnik) and 2 mountain botanic gardens (the Velebit Mt and the Biokovo Mt) managed by the County Public Institutions; with 1 Museum (Rijeka) and 1 School (Kaštela) botanic garden recognized as nationally important. Three arboreta – Trsteno, Opeka and Lisičine – managed by the Croatian Academy of Arts & Sciences, Public Institution and Forestry Department, respectively, are also subjected to diverse laws of protection at the state level.

National botanic gardens and arboreta, together with many other botanical collections in the country, are joined within the Croatian Botanical Society as members of the Section of botanic and school gardens, arboreta and botanical collections. For the first time this season (2017), Croatian botanical gardens step forward to propose joint touristic offers for the foreign market, within the "Croatian Nature & Heritage Tours" programme.

What is that Croatian botanic gardens and arboreta have to offer, and what perspective does this potentially sustainable type of touristic offer have in the future, it is yet to be seen.

**Keywords**: Croatia, botanical gardens, sustainable tourism.

## Protection vs. development? Sustainable development of the 1021 years old Benedictine Monastery of Pannonhalma

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The World Heritage Site in Pannonhalma is affected by many different land-use methods. The most important roles must be considered in all plans, strategies and cultivation schemes, whilst minor functions can help the site to develop as a living entity.

The habitat structure of the World Heritage Site is very complex. In the interest of understanding this complicated structure, it was not enough to make environmental surveys, but was also important to anal yze the historical land-use methods and spatial structures of the area. The results provided by these historical studies give us clear answers to many of the questions presented by the current habitat and land -use structures that sit side by side.

To understand and develop the site in a sustainable way it is absolutely necessary to have a firm knowledge about the past. In the last 1000 years it was the Monastery's farming system which dominated the façade of the surrounding lands – this is why we made the complex survey of the natural environment.

The fact, that some parts of the Pannonhalma Landscape Protection Area were under intense cultivation 50–60 years before, proves that it is possible to make decisions on the development of protected areas in this t ime period as well. From an environmental aspect the conditions, which originated from the abandonment and disuse of rural areas, can be expressly useful: lots of lost natural riches can be rediscovered.

The results proved that even 100% human-made habitats can play an extremely important role for local flora and fauna. In a well constructed and accurately sustained land-use system, the uses and protection processes are not antagonists, but strengthen each other.

**Keywords**: Pannonhalma, protection, development, world heritage

## Information handling related to plant materials in botanic gardens

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Botanic gardens are defined as institutions holding documented plant collections. However, the ways and methods of documenting changed immensely over the last decades. Also, since the Convention on Biological Diversity (CBD) entered into force the responsibility of botanic gardens has grown greatly. The information related to plants has more important role within the collection and in plant exchanges, communication between institutions either. To serve that role there have been several solutions developed for data handling. From the simple spreadsheets to so called 'collection management' software are in use. The data collected at garden level, or extracts of it may build up a local, national or regional database or network fulfilling the related action points of the Global Strategy for Plant Conservation (GSPC). Most of them are available on-line. Adaptation of the CBD and its proceeding regulations has also brought new tasks in plant related documentation, the documentation of the exchange of genetic materials. The International Plant Exchange Network (IPEN) and its system are constructed to support this process. This voluntarily joined network reached a good number of gardens across Europe and can be detected in the seed lists of those gardens. It provides a good method to track back the original source of plant materials being exchanged.

The voluntarily applied documentation of exchanges is to be extended or replaced to a more regulated form, which is according to the Nagoya Protocol. Its implementation and practical use is being worked out and will be in place in the not too far future.

**Keywords**: data base, plant exchange, CBD

## BGCI's databases, tools to support plant conservation prioritisation and practice

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Botanic Gardens Conservation International (BGCI) has developed a suite of databases to support conservation planning and practice by botanic gardens and the wider conservation community. The GardenSearch database is the only global source of information on the world's botanical institutions. In addition to over 2,700 botanic gardens and arboreta, GardenSearch also includes gene and seed banks, network organizations, and zoos. The databse can be searched by country, institution or by a wide range of other fields related to facilties and expertise. PlantSearch is a database of the plant collections (both living and seed) maintained by botanic gardens around the world. Linked to a range of other databses, PlantSearch allows threatened species in *ex situ* collections to be identified. To further support the prioritisation of conservation action, BGCI recently launched a new database – ThreatSearch. This is the most comprehensive database of conservation assessments of plants listing global, regional and national red list assessments. It includes conservation assessments from a variety of sources. Finally, and as a resource to support the Global Tree Assessment (an intiative to red list all the world's tree species by 2020), BGCI has developed GlobalTreeSearch, the most comprehensive list of tree species and their country-level distributions. All four of BGCI's databases are freely available for public consultation on the BGCI website, with enhanced search facilities provided to BGCI's members through a members' only area of the website. This presentation will introduce the databases and provide examples of how they can be used to support plant conservation in botanic gardens.

**Keywords**: databases, plant conservation, prioritisation, botanic gardens, *ex situ*

# Development of botanic gardens of Estonia in the period between the EastCentGard 1 – 3 (2003-2016)

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The number of accessions of the Tallinn Botanic Garden (TBG) in 2003 – 8 088, and in 2016 – 8 780; in the Botanical Garden of the University of Tartu (BGUT) accordingly 6 500 and 10 000. Environmental education was carried out intensively by means of exhibitions, thematic days, and guided tours. In 2006, TBG launched programs for children to match the school curriculum. The number of visitors in TBG increased from 37 383 in 2003 to 56 039 in 2016; in BGUT the increase was from 5 000 to 17 500. TBG takes part in two research programs in biodiversity conservation and in environmental studies. For storing the data about the plant collections, TBG uses an Excel based database, and BGUT uses ArcGis. There are also special databases about the herbarium in TBG (80 000 records) and about rare and valuable ornamental plants in BGUT (550 records). Conservation programs are going on according to GSPC Targets VII, VIII, and IX. The budget of TBG was in 2003 593 000 EUR, in 2016 – 1 108 300 EUR, and the BGUT one was 112 900 EUR and 400 000 EUR respectively. The total number of employees in TBG in 2003 was 51, and it has not changed. BGUT raised the number of employees from 11 to 16.

All greenhouses of both botanic gardens have been renovated. In 2007, a new experimental and reproduction garden (0,5 ha) was opened in BGUT. Many new displays were opened in both gardens, such as the permanent exhibition of lichens, mosses and fungi, the garden of senses in TBG, and the gardens of peonies, of *Clematis*, of medicinal plants, of mosses in BGUT. The territory of TBG diminished from 123 ha in 2003 to 46 ha in 2016; of BGUT – from 7,5 ha to 4 ha. Both botanic gardens started to use more environmentally friendly fuels in their heating centres. The Estonian botanic gardens are members of the Botanic Gardens Conservation International, the EU Botanic Gardens Consortium, and the Association of the Baltic Botanic Gardens.

**Keywords**: botanic gardens, Estonia

# The experience of the introduction of ornamental woody plants in Abkhazia, flowering in autumn, winter and early spring

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**Abstract:** The article presents an overview of the types of ornamental plants blossoming in the period of autumn, winter and early spring. A total of 74 taxa are mentioned, indicating their life form and flowering time. Plants are recommended for use in different types of planting.

**Key words:** woody plants, flowering periods, evolution of life forms

The botanical garden (BG) at Sukhum of the Institute of Botany (IB) of the Abkhazian Academy of Sciences, (AAS), is among the oldest in Eastern Europe and offers a rich collection of woody plants. The research conducted here has provided important data relevant to the practical implementation of their research results. Over the past ten years, the IB's Department of Plant Introduction and Department of Dendrology has been creating a new inventory based on thorough research of its woody plant collection.

The preliminary inventory shows that the collection of BG currently includes over 800 taxa and the collection of IB's Dendropark – 600 taxa are woody. There are about 1200–1300 woody plant taxa in Abkhazia. Research (Ayba *et al*. 1984; Bebiya 2003, 2008; Gulanyan and Bebiya, 1984; Karpun 2009; Kholyavko *et al*. 1976; Turchinskaya 1974) indicates that many of the introduced woody plants show promise for green belt development of the Black Sea coastal region as well as the foothills of the Caucasus (BSC).

For the subtropical zone of Abkhazia, the focus is on taxa in which the flowering period is in the winter half-year, that is, from autumn to spring. More than 100 such species and cultivars have so far been found in cultivation in the BSC. Most of them are introduced from other parts of the world, however, 8 of these are native in the coastal area: *Alnus barbata* C.A. Mey.; *Arbutus andrachne* L.; *Cornus mas* L.; *Corylus avellana* L.; *Erica arborea* L.; *Hedera caucasigena* Pojark.; *Hedera colchica* K. Koch; *Hedera helix* L. These represent different life forms, such as deciduous or evergreen, trees, shrubs, or lianas. The flowering period of these taxa lasts mainly from September through April, and in horticultural use these types of plants complement the rich profusion of flowers in the warmer seasons and provide floral beauty year-round, which is an extremely important feature for both private plantings and for urban greenery worldwide.

The study of such plants also shows that they have scientific as well as ornamental value and reveals certain rules pertaining to the evolution of life forms in connection with autumn, winter and early spring flowering times.

It is characteristic of Abkhazia's weather patterns that the arrival times of the typical temperate zone seasons are quite variable; autumn may arrive in late September but more often in mid-October. Such variability in different years may influence both flowering and fruiting time considerably.

The present work aims to familiarize dendrologists, landscapers, gardeners and gardening enthusiasts, as well as "green building" specialists with the wide assortment of woody plants that are recommended for use in the subtropical climate of Abkhazia.

The time and duration of flowering in woody plants are the most important indicators of their ornamental value, and these depend on numerous factors: the region's climate, the age and vigor of the plants, and the use of proper horticultural techniques and care.

The BSC, including Abkhazia, enjoys a long, moderately moist and warm autumn. In this zone, September is the time when the flower buds of many subtropical woody plants begin to develop, inflorescences are forming and the flowering period is imminent. Flowering continues until the onset of cold weather in December; and in mild winters, it extends until January. Such plants can be classified as autumn-blooming plants. In this category, mass flowering occurs after the shoots are completely mature. In some species, flowering begins at the end of the calendar summer and continues until the end of autumn (*Clerodendrum bungei* Steud.; *Hibiscus syriacus* L.).

Even in the subtropical region of Abkhazia, the number of woody species with mass flowering during winter is quite limited (*Colletia cruciata* Gill. et Hook.; *Hamamelis virginiana* L.; *Mahonia gracilis* (Benth.) Fedde; *Sarcococca humilis* Stapf; *Tetrapanax papyrifer* (Hook.) R. Koch).

In mild to warm winters, other decorative woody plants with a flowering period beginning in January and February include *Daphne odora* Thunb. 'Aureo-marginata'; *Lonicera fragrantissima* Lindl. et Paxton; *Loropetalum chinense* (R. Brown) Oliv.; *Pieris japonica* (Thunb.) D. Don. The flowering period then lasts until March, merging with the wide range of plants having their main flowering period in early spring.

Due to the instability of winter weather conditions, the flowering period in many plants may extend from one and a half to four months. When the temperature falls below 0°C, the flowering period is interrupted; when the temperature increases to above +10°C, the flowering period begins again. Typically, in most decidu-

ous plants having flowering periods under short daylight conditions, the foliage appears only after the flowering period is over (e.g., *Chaenomeles × superba* (Frahm.) Rehd.).

From a biomorphological perspective, it is typical in winter-blooming species that the generative shoots are short, leafless (dwarf) shoots.

The focus here is on the autumn-, winter- and early spring- (collectively, "winter"-) flowering woody plants growing within Abkhazia, mainly in the IB's living collections at the Abkhaz Research Forest Experimental Station and the parks in Sinop, Agudzer, but also in several urban plantings as well.

The study does not include those woody plants that flower again in the autumn, such as *Magnolia liliiflora* Desr.; *Rhaphiolepis umbellata* (Thunb.) Makino; *Rhododendron luteum* Sweet, etc., in which the morphological, ecological and decorative features may be different.

In the table below, the winter-flowering plants are listed with an indication of their flowering periods.

As the table indicates, the longest flowering period was observed in *Camellia japonica* L. due to the presence of a large number of varieties (more than 40 cultivars in Abkhazia), each blooming in different periods from December to May (and rarely extending into June). Another species with a long blooming period is *Gordonia axillaris* (Roxb.) Endl. (November–May).

**Table 1.** Timing of flowering of ornamental woody plants.

| | Name of plants | Life form | Flowering time | Flowering | | |
|---|---|---|---|---|---|---|
| | | | | autumn | winter | early-spring |
| 1 | *Abelia × grandiflora* (Rovelli ex Andre) Rhed. | s-e.g./sh. | VII–XII | + | | |
| 2 | *A. chinensis* R. Br. | s-e.g./sh. | VIII–XII | + | | |
| 3 | *Alnus barbata* C.A. Mey. | d./tr. | I–II | | + | |
| 4 | *Arbutus andrachne* L | e.g./tr. | XII–III | | + | |
| 5 | *Arbutus unedo* L. | e.g./tr. | IX–XII | + | | |
| 6 | *Buxus balearica* Lam. | e.g./tr. | I–V | | | + |
| 7 | *Camellia japonica* L | e.g./tr. | XII–V | | | + |
| 8 | *C. olifera* Abel | e.g./sh. | IX–XI | + | | |
| 9 | *C. sasanqua* Thunb. | e.g./sh. | IX–XII | + | | |
| 10 | *C. sasanqua* Thunb. 'Semi-Roseopetaloides' | e.g./sh. | IX–II | + | | |
| 11 | *Camellia sinensis* (L.) Kuntze | e.g./sh. | X–I | + | | |
| 12 | *Chaenomeles x superba* (Frahm.)Rehd. | d./sh. | I–III | + | | |
| 13 | *Chimonanthus praecox* (L.) Link. | d./sh. | XII–III | + | | |
| 14 | *Ch. p.* (L.) Link. 'Luteo-grandiflorus' | d./sh. | XII–III | + | | |
| 15 | *Chimonanthus yunnanensis* W.W. Smith | d./sh. | XII–III | + | | |
| 16 | *Choisya ternate* N.B.K. | e.g./sh. | XI–II | | + | |
| 17 | *Clerodendrum bungei* Steud. | d./sh. | VIII–XI | + | | |
| 18 | *C. trichotomum* Thunb. | d./tr. | VIII–XI | + | | |
| 19 | *Colletia infausta* N. E. Br. | e.g./sh. | I–III | | | + |
| 20 | *C. kruciata* Gill. et Hook. | e.g./sh. | XII–II | | + | |
| 21 | *Cornus mas* L. | d./tr. | I–III | | | + |
| 22 | *Corylus avellana* L. | d./sh. | I–III | | + | |
| 23 | *Daphne odora* Thunb. | e.g./sh. | I–IV | | + | |
| 24 | *D. o.* 'Aureo-marginata' | e.g./sh. | I–IV | | + | |
| 25 | *Elaeagnus pungens* Thunb. | e.g./sh. | X–I | + | | |
| 26 | *E. p.* 'Maculata' | e.g./sh. | X–I | + | | |
| 27 | *Erica arborea* L. | e.g./sh. | II–III | | | + |
| 28 | *Eriobotrya deflexa* (Hemsl.) Nakai | e.g./tr. | II–IV | + | | |
| 29 | *Eriobotrya japonica* Lindl. | e.g./tr. | XI–II | + | + | |
| 30 | *Eucalyptus cinerea* F. Muell. | e.g./tr. | XI–I | + | | |
| 31 | *Eupatorium ligustrinum* DC. | в.з./к.?? | IX–I | + | | |
| 32 | × *Fatshedera lisei* (Cocher) Guillaum. | e.g./sh. | X–XI | + | | |

| | Name of plants | Life form | Flowering time | Flowering | | |
|---|---|---|---|---|---|---|
| | | | | autumn | winter | early-spring |
| 33 | *F. japonica* (Thunb.) Decne. et Planch. | e.g./sh. | XI–XII | + | | |
| 34 | *Fatsia polycarpa* Hayata | e.g./sh. | XII | | + | |
| 35 | *Freylinia lanceolata* (L.f.) D.Don | e.g./sh. | X–XI | + | | |
| 36 | *Gordonia axillaris* (Roxb.) Dietr. | e.g./sh. | XI–V | + | | |
| 37 | *Hamamelis japonica* Siebold et Zucc. var. *flavor-purpureascens* (Mak.) Rehd. | d./sh. | XII- I | + | | |
| 38 | *H. virginiana* L. | d./sh. | XII–I | | + | |
| 39 | *Hebe x andersonii* (Lindl. et Paxt.) Cockayne | e.g./sh. | IX–I | + | | |
| 40 | *Hedera caucasigena* Pojark. | e.g./l. | IX–XI | + | | |
| 41 | *Hedera colchica* K. Koch | e.g./l. | IX–X | + | | |
| 42 | *Hedera helix* L. | e.g./l. | IX–XI | + | | |
| 43 | *Hibiscus x hybridus* hort. | g.d./sh. | IX–XII | + | | |
| 44 | *H. lasiocarpus* Cavar. | g.d./sh. | IX–XII | + | | |
| 45 | *H. mutabilis* L. | g.d./sh. | IX–XII | + | | |
| 46 | *H. syriacus* L. | d./sh. | VIII–X | + | | |
| 47 | *Jasminum nudiflorum* Lindl. | d./sh . | XII–IV | | | + |
| 48 | *Koelreuteria integrifolia* Franch. | d./tr. | IX–X | + | | |
| 49 | *Lantana x hybrida* hort. | d./sh. | VIII–XII | + | | |
| 50 | *Lippia citriodora* (Ortega) Kunth. | d./sh. | VIII–I | + | | |
| 51 | *Lonicera fragrantissima* Lindl. et Paxt | d./sh. | I–III | + | | |
| 52 | *L. x purpusii* Rehd. | d./sh. | XII–IV | | + | |
| 53 | *L. standishii* Jacq. | s-e.g./sh. | XII–III | | + | |
| 54 | *Loropetalum chinense* (R. Brown) Oliv. | e.g./sh. | II–IV | + | | |
| 55 | *L. ch.* var. *rubrum* Yieh, Zhong Guo Yuan Yi Zhuan Kan | e.g./sh. | II–IV | + | | |
| 56 | *Mahonia bealei* (Fort.) Carr. | e.g./sh. | I–II | | + | |
| 57 | *M. gracilis* (Benth.) Fedde. | e.g./sh. | XII–II | | + | |
| 58 | *M. oiwakensis* Hayata | e.g./sh. | XII–I | | + | |
| 59 | *M. pinnata* (Lag.) Fedde | e.g./sh. | XII–I | | + | |
| 60 | *Osmanthus fragrans* (Thunb.) Lour. | e.g./tr. | IX–II | + | | |
| 61 | O. fragrans (Thunb.) Lour. 'Aurantiacus' | e.g./tr. | IX–I | + | | |
| 62 | *O. heterophyllus* (G. Don) P.S. Green | e.g./tr. | IX–II | + | | |
| 63 | *O. heterophyllus* 'Variegatus' | e.g./tr. | IX–II | + | | |
| 64 | *O. × fortunei* Carriere | e.g./tr. | XI–II | | + | |
| 65 | *O. × f.* 'Integrifolia' | e.g./tr. | XI–II | | + | |
| 66 | *Pasania shinsuiensis* (Hayata et Kanehira) Nakai | e.g./tr. | XII–II | + | | |
| 67 | *Persea americana* Mill. | e.g./tr. | X–III | + | | |
| 68 | *Peumus boldo* Molina | e.g./tr. | XII–I | | + | |
| 69 | *Pieris japonica* (Thunb.)D. Don | e.g./sh. | II–III | | | + |
| 70 | *Rosmarinus officinalis* L. | e.g./sh. | IX–IV | + | | |
| 71 | *Sarcococca humilis* Stapf | e.g./sh. | I–III | | + | |
| 72 | *Sycopsis sinensis* Oliv. | e.g./tr. | I–III | | + | |
| 73 | *Tetrapanax papyriferus* (Hook.) K. Koch | e.g./sh. | XII | + | | |
| 74 | *Viburnum tinus* L. | e.g./sh. | IX – II | | | + |

Note: L/f – the life form; s-e.g./sh. – semi-evergreen shrub; e.g./sh. – evergreen shrub; d./sh. – deciduous shrub; g.d./sh. – grassy deciduous shrub; e.g./tr. – evergreen tree; d./tr. – deciduous tree; e.g./l. – evergreen liana; e.g./sh.l. – evergreen shrub – liana.

In addition to the results of our own observations, we also used literature sources for this study (Kholyavko and Globa-Mikhaylenko 1976; Turchinskaya 1976; Vasiliev 1955–1959).

Surveys of ornamental plantings of Abkhazia, have clearly shown that these highly decorative plants are rarely found among either private or public plantings.

With the exception of *Lantana* × *hybrida*, which is of tropical origin, it is noteworthy that all the autumn-winter-early-spring blooming woody plants discussed here are of subtropical or temperate climate zones. During their evolution, however, these plants gained some resistance to cold effects; in Abkhazia, even when the branches are damaged by cold, in the spring these plants are able to recover from the lower sections of their crown or from below ground, and if they recover, flowers may appear that same season.

The peculiar flowering time of these plants in our climate is clearly a reflection of their tropical origin – tropical plants may bloom and bear fruit at any time of the year. During the late Tertiary, the climate became cooler in the lead up to the subsequent glaciations. In response to climate change, the tropical species adapted to lower temperatures to the point that they were increasingly able to resist the effects of prolonged cold. Two elements of the adaptations that resulted in the development of warm temperate (subtropical) woody plants were the winter cessation of growth and the development of flowering periods in the winter months. However, these plants retained certain growth features and development patterns that can be traced back to their tropical climate origins. Such characters include having several periods of growth, remontancy, that is, repeated flowering in the same year, as well as retaining their dry autumn leaves until the new leaves appear in the spring.

Other species preserved special features during this process of evolution in the subtropical climate, e.g., autumn-winter flowering, with characteristic bioecological features which must be taken into account when introducing and caring for them. For example, Mountain camellia, *Camellia sasanqua* Thunb., grows naturally mainly in the monsoon-affected subtropics of East and South-East Asia. It grows on mountain slopes and on the banks of rivers and ponds forming a lower tree or shrub layer in the evergreen broad-leaved or mixed deciduous-broad-leaved forests. In the process of evolution, summer-wet and winter-dry conditions in these climates were favorable for the development of generative organs during the sunnier and drier winter half-year, that is, in the autumn-to-spring period. These characters have been preserved in cultivation, and horticultural experience reveals that they continue flowering in wintertime in areas where the winter is mild enough to support short-daylight flowering, which is typical for the BSC. This observation is extremely important both from theoretical and practical aspects.

As discussed in the literature and also observed by us here in Abkhazia, all the plant taxa we researched can rather easily be propagated by seed or from scions (both from cuttings and by layering) and, typically, by all these methods simultaneously. We encountered no problems with their reproduction and with obtaining the right propagation material, thus, there is a good chance that these plant taxa will be more widely cultivated in our environment, resulting in colorful plantings in which morphology, biology, phenology and ecology are all taken into account.

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## In vitro screening of antibacterial activities of various Ficus species cultivated in greenhouse conditions at botanical gardens of Ukraine

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**Abstract:** The prospects of use of medicinal plants and plant-derived natural products for the treatment of bacterial induced diseases are at present actively studied as antibiotic resistance has become a global concern. In order to contribute to this issue, the mega-diverse genus *Ficus* (Moraceae), one of the most species-rich and ecologically important plant genera, was chosen for evaluation in antimicrobial activity. The primary aim of this study was in vitro antibacterial assay of leaf extracts in more than 70 species of *Ficus* genus cultivated under glasshouse conditions. Among these species there are many widespread in botanical gardens, in particular *Ficus carica* L., *F. erecta* Thunb., *F. pumila* L., *F. sycamorus* L., *F. religiosa* L., *F. benghalensis* L., *F. benjamina* L., *F. binnendijkii* (Miq.) Miq., *F. elastica* Roxb., *F. lyrata* Warb. However, there are also many species that are rare in the collections: *F. johannis* Boiss., *F. cyathistipula* Warb., *F. palmata* Forssk., *F. deltoidea* Jack, *F. formosana* Maxim., *F. sarmentosa* Buch.-Ham. ex. J.E. Sm., *F. hederacea* Roxb., *F. sagittata* J. Koenig ex Vahl, *F. villosa* Blume, *F. montana* Burm. f., *F. ulmifolia* Lam., *F. virgata* Reinw. ex Blume, *F. mucuso* Ficalho, *F. sur* Forssk., *F. auriculata* Lour., *F. septica* Burm. f., *F. callosa* Willd., *F. crocata* (Miq.) Miq., *F. petiolaris* Kunth, *F. lacor* Buch.-Ham., *F. virens* Aiton, *F. altissima* Blume, *F. platypoda* (Miq.) A. Cunn. ex Miq., *F. vasta* Forssk., *F. natalensis* Hochst. subsp. *natalensis*.

The current investigations were undertaken in the frame of a cooperation program between the Institute of Biology and Environmental Protection, Pomeranian University in Slupsk (Poland) and two botanical gardens of Ukraine, directed to the assessment of medicinal properties of tropical plants. The whole collection of tropical and subtropical plants at both botanical gardens have the status of a National Heritage Collections of Ukraine. Antimicrobial activities of crude ethanolic extracts of the plant samples were evaluated by the paper disc diffusion method.

Our results showed that ethanolic leaf extracts of *Ficus* species have potent antimicrobial properties against both Gram-positive (*Staphylococcus aureus*, methicillin-resistant *S. aureus* and *Streptococcus pneumoniae*) and Gram-negative bacterial strains (*Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, metallo-beta-lactamase producing *P. aeruginosa* and *Escherichia coli*), as well as against fungi (*Candida albicans*, *C. krusei*). The results of our studies suggest that *Ficus* species are potentially rich in antimicrobial compounds and can be used in treating diseases caused by tested bacterial organisms.

Our findings provide a clear demonstration of the generally overlooked importance of the collection of tropical plants accumulated at the Botanical Gardens as an important sources of new chemical substances with potential therapeutic effects, including antimicrobial activity.

**Keywords**: medicinal properties, tropical plant collection

## Botanic gardens – promoters of ecotourism

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The Botanic Garden of the University of Ljubljana has long tradition of collaboration with Central European botanists. Foreign botanists frequently visited Slovenia, joining the local people during excursions, sometimes even for longer periods. Valvasor, who published his famous iconotheca of Carniolan flora in the 17th century, mentioned already that he had published his work with the aim to present this flora and fauna to the wider public of Europe. Foreign botanists came to Ljubljana to study botany even before the Botanic Garden was established. In 1810, when the Botanic Garden was founded, such visits became more frequent. Throughout the history of the Garden, all garden leaders, as well as horticulturers and gardeners, collaborated fruitfully with Central-European botanists, gardeners, as well as plant enthusiasts at that time.

In more recent times, specially in the last twenty years the Garden has promoted various forms of ecotourism. First, we organized for the visiting specialists trips to different natural sites of Slovenia. We also offered our services and botanical knowledge to local groups in the frame of excursions to different European countries, where the topic of the trip was about plants and gardens. In the last decades we focused on the native

flora, which we presented to different groups of people coming to Slovenia from various parts of Europe. For this purpose, we organised thematic festivals of common snowdrops, where we attempted to attract as many visitors as possible with our own and foreign lecturers, to present the Slovenian flora during the snowdrop blooming season. Students have also expressed their great interest for the Garden. In the last seven years they were visiting our Garden through various Erasmus exchanges and internships. During this time, we have organised two summer schools for foreign students, where they discovered plants, get acquintained with their ecology and habitat types. We organised guided excursions on Slovenian flora for our colleagues from other botanic gardens, led excursions for renowned British gardening societies. This year, we did this for the World's Rose Society. We guided numerous enthusiasts and experts from throughout the world at the regional convention in Ljubljana. The purpose of our activities is presenting to the general public the diverse flora of Slovenia. Because four phytogeographic regions interfere – the sub-Pannonic, sub-Mediterranean, Alpine, and Dinaric – the Slovenian flora is extremely diverse. Our experience so far with different foreign groups, are very positive. Guided tours also prevent illegal picking of plants. Visitors discover the local flora and its peculiarities, while we provide comparisons to flora of other countries. They in turn spread the knowledge of plants throughout the wider region, which is a tradition in this country.

**Keywords:** botanical excursions, summer school, ecotourism.

## Introduction

Botanical gardens are some of the most visited institutions across the world. Many are true tourist attractions due to their cultural or botanical heritage (Cheney *et al.* 2000, Monem 2007, Oldfield 2010). Some gardens have additional offers linked to various themes in ecotourism. Special themes are emphasised and offered, for example, by the Australian National Botanic Gardens (https://www.ecotourism.org.au/eco-experiences/green-travel-guide/australian-national-botanic-gardens), Singapore Botanical Gardens (https://www.nparks.gov.sg/gardens-parks-and-nature/singapore-botanic-gardens), gardens in South Africa, Cuba and Belize (http://www.bgci.org/barcelona04/abstracts/pdf_abstracts/Sutherland_ecotourism.pdf). In general, botanic gardens have become very popular tourist attractions in the last decades, thus opening up an opportunity for ecotourism (Sutherland 2012, 2013).

The current territory of Slovenia was always popular for the visitors and for the researchers, as it lies in a region where roads from the Adriatic Sea and the Alps cross. That is why the flora has always been the subject of study in this region. Some researchers came here for interesting plants, while others were attracted because former famous botanists who visited the area made interesting descriptions conducting studies here. The first known reports on Slovenian plant names originate from 1415, "*Liber de simplicibus Benedicti Rinii*". The first naturalist who studied the flora of the Slovenian territory was Pietro Andrea Mattioli (1501–1577), who wrote the first notes on plants in Slovenia in his *Commentarii in libros sex Pedacii Dioscoridis Anazarbei de materia medica*. Later Carolus Clusius (1526–1609) published his *Stirpium Nomenclator Pannonicus* including species also from the Slovenian flora (Petkovšek 1967, Gosar & Petkovšek 1982).

Undoubtedly the greatest comprehensive work was the publication by Janez Vajkard Valvasor, entitled *Slava vojvodine Kranjske* (The Glory of the Duchy of Carniola), a polyhistoric work examining the territory of current Slovenia (https://www.slovenska-biografija.si/oseba/sbi759993/). A special volume on this topic is the book *Iconoteca Valvasoriana*, which presents the plants and animals of Carniola (Valvasor 1685). In his work, Valvasor shows a very modern way of thinking, and stated that the plants and animals of this region must be presented to Central Europe, because too little is known about them. Valvasor's work could be assessed as a significant scientific work at the time. Valvasor was admitted to the Royal Society in London because of his discussion on the intermittent Cerknica Lake (https://www.slovenska-biografija.si/oseba/sbi759993 ).

Between 1722 and 1725, G. G. Zanichelli, a Venetian apothecary, often visited Slovenian Istria and surveyed many plant species (Wraber 1990). In the second half of the 18th century, the pinnacle of such activities and studies is certainly Joannes Antonius Scopoli (1723–1788), who came to Idrija in 1754 as the first physician of the mercury mines, and worked here until 1769. In addition to treating the miners of Idrija, he also studied the flora and fauna, as well as the nature in general. He did not study only the vicinity of Idrija, but travelled in most parts of the historical Carniola. In 1760, he published the first, Latin edition of *Flora Carniolica* in Vienna, which presented 1000 species of higher and lower plants (Scopoli 1760, Petkovšek 1960, 1977). This first publication was followed in 1772 by the second, largest edition included in two books, which already used the Linnean binomial nomenclature. In this work, he described 1277 higher plants and ferns (Scopoli 1772, Petkovšek 1960) from this region. Between 1760 and 1775, Scopoli had quite an extensive correspondence with the famous Swedish botanist Carl Linné. Scopoli sent to him plants and their seeds (Soban 1995, 2004). Franc Ksaver Wulfen (1728–1805) worked on the territory of Slovenia from 1755 to 1761. During this time, he visited a significant part of the current western Slovenia (Praprotnik & Wraber 1998). He collaborated with Scopoli,

but later he has published his own works also (Praprotnik 1988). Balthasar Hacquet (1739 or 1740–1815) came to Idrija in 1766 because of Scopoli's fame. Between 1773 and 1787 he worked in Ljubljana. Being a versatile scientist he studied and collected plants for his herbarium, and published *Plantae alpinae carniolicae*. On the western slopes of the Triglav, he discovered a new scabious plant species, *Scabiosa trenta* Hacq. Later this plant species attracted other botanists and mountaineers to these mountains, like Tommasini and Kugy, as it was reported by Praprotnik, (2001, 2003*a*). In 1809 and 1810, Franc Hladnik, the founder of the botanic garden in Ljubljana, initiated detailed studies on the flora of Carniola of the time. With his student, Andrej Fleischmann (1804–1867), he made trips across Carniola. In addition to the local flora (*Flora bochinensis*), he described the flora of Carniola (*Flora carniolica*) mentioning 2,492 plant species (Praprotnik 1993, 1994, 2010, 2012, Bavcon *et al.* 2017). Like Scopoli, Hladnik had also a lot of foreign correspondence and was sending plant materials to other botanists in Central Europe. Among others, he sent plant materials to Koch's *Synopsis florae germanicae et helveticae* (1835–1837, 1838, 1843–1845), to Reichenbach for the *Flora Germanica excursoria* (1830–1832) and for the collection *Flora Germanica exsiccata* (1830–1845). Much information has been sent to Host, primarily for his works on *Salix* and the *Flora austriaca*. He also collaborated with Tommasini (Voss 1884, 1885, Praprotnik 1994, 2010, 2012).

The plants growing in the territory of Slovenia drew the attention of Frederick Augustus II, the Elector of Saxony, who on the 14th May 1838 surprised the owner of the manor, Count Blagay. He arrived to visit the famous habitat of *Daphne blagayana* Freyer, which was discovered just one year before in its traditional habitat the Polhov Gradec Mountain. He also visited the habitat of *Pedicularis acaulis* Scop in Črnuče along the River Sava (near Ljubljana) and the habitat of the Carniolan primrose (*Primula carniolica* Jacq.) by the Wild Lake in Idrija. In the same year Blagay, to commemorate this visit and these famous plant species, erected an obelisk that still stands today (Wraber 1990).

Later in 1844, Hladnik's student, Fleischmann, published *Pregled kranjske flore – Übersicht der Flora Krains* (Overview of Carniolan Flora), listing the plant species of this region. Hladnik had another student besides Fleischmann – Žiga Graf (1801–1838), who collaborated with many botanists, with: Koch in Erlangen, Reichenbach in Dresden, De Candolle in Geneva, Hoppe in Regensburg, Schlechtendal in Halle, Jacquin in Vienna, Agardh in Lund, Zuccarini in Munich, Unger in Graz, and Biasoletto in Triest. During this time, Henrik Freyer, a student of Hladnik and the first custodian of the Estate Museum of Carniola, was also preparing his collection of flora. He discovered and described several new species, among them the above mentioned *Daphne blagayana*, which was presented in 1838 at the floral exhibition in Dresden as a new and horticulturally extremely interesting species of the Carniolan flora (Wraber 2002, Praprotnik 2003 b, 2004). We must also point out further three botanists who collected and studies plants in this region between 1853 and 1883: Jurij Dolliner (1794–1872), Valentin Plemel (1820–1875) (Praprotnik 2015), and Karel Deschmann (1821–1889) (Praprotnik 2001). In 1864 Anton Kerner visited Carniola (Voss 1884,1885). After 1886, Alfonz Paulin (1853–1942), the head of the Botanic Garden in Ljubljana at the time, started intensive study on the flora of Carniola. His work was published between 1901 and 1936. In addition to his publications (Wraber 2008), he did the herbarium collection of the Carniolan flora, *Flora exsiccata carniolica*, comprising 20 sheets of 100 specimens, with 2,000 numbers. In this publication, he described many different species and subspecies (Wraber 1966). In addition he collaborated with Kerner in the *Flora exsiccata Austro-Hungarica*, contributed to Hayak's *Flora stiriaca exsiccata*, *Flora der Sanntaler Alpen* (Hayek & Paulin 1907), and to Hegi's *Illustrierte Flora von Mitteleropa*. He wrote around twenty discussions between 1895 and 1917, publishing new information on newly discovered and rare species from the Carniolan flora. He wrote monographs on *Lycopodinae*, *Equisitinae*, on ferns (*Filicinae*), on lady's mantle (*Alchemilla*), spurge (*Euphorbia*) and some others (Petkovšek 1934).

Glowacki's identification key, *Flora slovenskih dežel* (Flora of Slovenian Countries) was published in 1912. The next identification key for spermatophytes and ferns by Dr Angela Piskernik was published in 1941, and was followed by reprints. In 1952, Ernest Mayer, in his *Seznam praprotnic in cvetnic slovenskega ozemlja* (List of Ferns and Flowering Plants in the Slovenian Territory), listed all species and subspecies from the territory of Slovenia known at that time. The first edition of *Mala flora Slovenije* (Little Flora of Slovenia) was first published in 1969, with updated editions in 1984, 1999, and the final one in 2007. During this time, two more works were published: *Register flore Slovenije* (Register of Slovenian Flora) (Trpin & Vreš 1995) and *Gradivo za Atlas flore Slovenije* (Material for the Atlas of Slovenian Flora) (Jogan *et al.* 2001). In addition to these large publications, many articles were published by different authors on specific species and specific local areas of Slovenia.

Soldiers and officers often showed interest for plants. Even from the time that was not the most conducive for such activities, during the I. World War, we can find interesting records, like those from the Isonzo Front. It is a diary in which one of the soldiers describes how he has found *Auricolla carniolica* (today *Primula carniolica*) at the Čaven Hill on 17 April 1915, while he and his engineer colleagues were planning the defence line in Cerkljansko (western part of Slovenia) (http://www.rtvslo.si/prva-svetovna-vojna).

During the II. World War, the head of the botanic garden at that time, Gabrijel Tomažič (1899–1977), made studies on the Slovenian flora. He was both a phytocoenologist and a florist. After the II. World War, another

important person in this field is certainly Maks Wraber (1905–1972), who studied phytocoenology and botany. He partitioned Slovenia into four main phytogeographic regions – Alpine, Dinaric, sub-Pannonian, and sub-Mediterranean – and two transitional regions – pre-Dinaric and pre-Alpine. Another important contribution to the knowledge of the Slovenian flora was made by Viktor Petkovšek, who published articles from the Slovenian flora in different scientific and popular scientific journals. Ernest Mayer, a professor in systematic botany and later a regular member of the Slovenian Academy of Sciences and Arts (1920–2009), published articles on specific species of the Slovenian flora and extensively studied the flora of the Balkans. Vinko Strgar (1928–1992) was head of the Botanic Garden from 1967 to 1992. He wrote many articles including new species of the Slovenian flora, and also started an overview on horticultural usage and cultivation of plants. Ljerka Godicl (1930–2006) studied the flora of Eastern Slovenia and the flora of the steppes. Tone Wraber (1938–2010) was certainly among those researchers who wrote many articles about the Slovenian flora in various scientific and popular-scientific journals. He was a botanical custodian at the Slovenian Natural History Museum, and later became professor in systematic botany at the University of Ljubljana. He wrote a few popular books on the flora of Slovenia.

Even in recent time, the flora of Slovenia is interesting for many botanical enthusiasts. In the Botanic Garden of the University of Ljubljana, we thus recently hosted and hold botanical tours across Slovenia and Europe for well-known horticultural experts. Jelena de Belder brought her guests to Slovenia several times. Our garden collaborated in these visits. Horticultural experts, such as Noel Kingsbury, Piet Oudolf, Henk Gerritsen, Rosi Attkins and many others, were visited Slovenia to discover our flora. We also organized several excursions for our colleagues from other Slovenian botanic gardens. All this led to different themes for excursions, which are offered today by the Botanic Garden of the University of Ljubljana as part of the ecotourism programme.

Slovenia is a wind-swept country, where many different influences converge. The north-western and central northern parts belong to the Alps, the south-western part reaches to the sub-Mediterranean, the north-eastern and eastern parts to the sub-Pannonic region, while the south-western and central southern parts belong to the Dinaric world. All this gives Slovenia the foundation for an exceptionally rich plant diversity. According to the data from the 2017 edition of *Mala Flora Slovenije*, 3,452 species and subspecies, of which 3,119 are autochthonous and naturalised, grow in this relatively small area of 20,256 $m^2$ (Martinčič *et al.* 2007). In addition to the diversity of species and subspecies, there is equal diversity within individual species. This exceptional intraspecies diversity is reported in numerous works by horticultural experts from abroad, who mention Slovenia as exceptionally diverse (Grey-Wilson 2002, Gerritsen 2008). This intraspecies diversity makes Slovenian flora even richer than it seems.

## Material and methods

On the occasion of the visits of horticultural experts from Europe and during our group excursions, we invented some themes for the shorter and longer excursions in different seasons. We have considered several criteria in our selection:

Accessibility and difficulty of the terrain, depending on the physical conditions of the participants. Some tours are therefore easier, suitable for older participants, some are of medium difficulty, and some are demanding, and only accessible for participants in good physical condition.

Habitat sensibility: Endangered habitats are not included in our excursions.

Phytogeographic diversity: This is usually an important criteria considered in each excursions that last a few days, allowing participants to visit different phytogeographic regions.

Season: Excursions are suitably prepared for sightseeing of plant species that are in the optimal vegetative stadium in a particular season.

Diversity and variety of the habitats: For excursions, we choose locations with high species diversity, which are interesting both for regular visitors and experts.

The goal of all excursions is to present the flora and habitat diversity of Slovenia. Of course, each programme is adapted to the season and to the accessibility of plant environment. We do not organise excursions for such large groups that might overstress the habitat and its natural environment. Furthermore, in national and landscape parks, we proceed according to the principles and rules established.

## Results

Since 1995, the Botanic Garden of the University of Ljubljana collaborated, organised or led various excursions of very diverse levels of difficulty. Excursions were organised for the general public of various age, expertise both from Slovenia and abroad. Initially, we organised tours in the nature only for Slovenians. Before the start of the trips we often organised introductory presentations in the Botanic Garden of the University of Ljubljana.

The tours were initially organized for various social groups, for school teachers or members of the mountain watch. The tours usually last several hours, and most of them took a full day. We visited different parts of Slovenia like Porezen and Cerkljansko in the pre-Alpine region. Since 1998, we organised excursions to Nanos, Čaven, Križna gora in the Dinaric region, Vojsko, Rodne police, Snežnik, etc. Most of these locations are situated in the Dinaric Alps or the Dinaric pre-Alpine transitional region. Since 2005, we organise regular botanic excursion to Kopa, which is the final part of the Porezen mountain chain in the pre-Alpine region.

The first contact in preparing and leading excursions for foreign visitors was Mrs Jelena de Belder from Slovenia, who together with her husband designed the Kalmthout Arboretum in Belgium. She invited first guests from abroad to Slovenia, and we guided them on excursion to discover the nature in Slovenia. Their enthusiasm for our flora increased our interest to further promote Slovenian biodiversity. Simultaneously, Jelena de Belder propagandized in many foreign botanic gardens Slovenia. Tourist agencies started to include garden visits in their offers and we provided the experts to lead the excursions. The excursions usually lasted two to four days, while longer ones lasted seven to eight days. We usually visited two or three gardens in one day including botanical gardens, arboretums, private gardens and even famous public parks. Throughout the years, we visited also many countries, in the neighbouring Italy the gardens of Rome and Tuscany. Programmes included Austria, Great Britain (gardens of southern England, London and surrounding areas), Scotland, Ireland, Belgium, The Netherlands, Germany, France (several times Provence, the Loire region), Portugal, and Madeira. Special excursions included large gardening events, such as the Floriade, IGA, Buga, Chelsea Flower Show and annual gardening fairs.

Since 1996, we receive smaller groups of foreign visitors curious for plants. Among them are several famous people from the field of horticulture; Noel Kingsbury, Piet Ouldolf, Henk Gerritsen, Rosie Atkins, always accompanied by their associates. We showed them different parts of Slovenia: Slovenian Istria, Karst (sub-Mediterranean phytogeographic region); Snežnik (Alpine solitary mountain with intertwined Alpine and Balkan Dinaric flora); Savinja Alps (Alpine phytogeographic region); Nanos, Čaven, Sinji vrh (Dinaric phytogeographic region); Kozjansko, Prekmurje, Karavanke, Peca, Uršlja gora, Julian Alps, Gorenjska, Pokljuka, Bled, Bohinj, Vogel, Vršič, Sleme, Soča Valley; Idrijca Valley (pre-Alpine region); Kočevska and Kolpa Valley (Dinaric region), etc. For excursions that lasted several days, we organized a programme that included visits to at least two to three phytogeographic regions. We focused on presenting our endemic species, plants with traditional habitats in Slovenia, and on Alpine and Dinaric flora. The targets of the excursion were oftentimes colourful meadows, letting us to involve even larger groups like tourist groups. Based on first experiences, we started to prepare programmes also for scholars, both for Slovenian and foreign groups.

Since 2012, the Erasmus and Internship programmes aloud regular visits by students and the trips became more frequent. We guided shorter or longer excursions across Slovenia. In the last few years, we also initiated a detailed summer school programme for foreign students. We have organised three, six-to-eight-day summer schools for Taiwanese students from the Sun Yat Sen University. Furthermore, we guided excursions for friends of botanic gardens from neighbouring and other countries, in collaboration with our colleagues from abroad. We also organize and led excursions for horticultural societies from Europe. In 2016, we initiated a tour for the oldest gardening society from England – The Worshipful Company of Gardeners. In 2018, we organised one-day excursion to Porezen for members of Perenne, the society of perennial plant cultivators. In that year we organised also a presentation and photo exhibition on the colourful flora of the Slovenian meadows at the very popular gardening fair in Freising (Bavcon & Ravnjak 2018).

In late summer, we spent 14 days collecting plant seeds in different phytogeographic regions of Slovenia in collaboration with colleagues from the Royal Botanic Garden Edinburgh.

In 2009 on the 30th World Travel Market in London we presented the wealth of the Slovenian flora and on this occasion we announced the 200th anniversary of our Botanic Garden, which was in 2010.

The common snowdrop (*Galanthus nivalis*) turned out to be a very good target for tourism (Bavcon 2008). That is why, since 2016 we are regularly organising a three-day festival of common snowdrops, which includes lectures on the subject of common snowdrops and excursions to their habitats. Since 2011, we have presented Slovenian common snowdrops in Belgium (2011), at the Galanthus Galla in England (Tavistock College in 2012), and in Ireland (2016). In 2016, when Ljubljana was the European Green Capital, a permanent exhibition of 1,200 specimens of Slovenian autochthonous plants were exposed on a green wall of the Information Point in the centre of Ljubljana.

## Discussion

Botanic gardens are old institutions that were generally attached to universities. The gardens at Pisa and Padua are two of the oldest in Europe (Cappelletti 1994, Cheney *et al.* 2000, Monem 2007, Oldfield 2010). Some gardens are also world heritage sites designated by UNESCO (Cheney *et al.* 2000, Monem 2007, Oldfield 2010).

Many gardens are true treasures of the cultural heritage because of their age (Young 1987, Wyse Jackson & Sutherland 2000, Monem 2007, Oldfield 2010). The Botanic Garden of the University of Ljubljana has also a famous history (Freyer 1829, Voss 1884, 1885, Paulin 1912, Lazar 1960, Strgar 1973, Bavcon 2000, 2010, Bavcon & Ravnjak 2015). In 1991, has become protected as a monument of local importance (OG RS 1991), and as a monument of national importance in 2008 (OG RS, no. 16/08). Since its very beginning, the Botanic Garden of the University of Ljubljana showcased the plant species of the native flora (Bavcon 2000), similar to the garden of Austrian flora that was designed by Host in Vienna in the time of the Habsburg Monarchy (Petz-Grabenbauer 2017). Due to their complexity and because linking science to the general public, botanic gardens play important role in tourist attractions. Both in Europe and across the world, botanic gardens welcome a great numbers of visitors each year (Young 1987, Cheney *et al.* 2000, Monem 2007, Oldfield 2010, Standler 2013).

Botanic gardens hold a wide tourism potential because of their great diversity in activities and collections, thus contributing greatly to local tourism and public garden development (Bramwell & Aquilella 2004). National parks also offer numerous products that support ecotourism (Sutherland 1999).

Today, the Botanic Garden of the University of Ljubljana is very popular among tourists, even though much had been said about a potential relocation throughout its history (Voss 1884, Paulin 1912, Lazar 1960, Strgar 1973, Bavcon 2000, 2010). Nowadays, it can be reached by boat, by a train for tourists, or by walking along the banks of River Ljubljanica. It takes only 15-minute walk away from the city centre. A pathway on the bank leads directly to the garden across Hladnik's bridge, which is named after the garden's founder. Today, the Botanic Garden of the University of Ljubljana has collections also in other locations in Ljubljana. Since 2009, it is managing the plant nursery in the main city park, Tivoli. In 2000, the garden arranged the plantation of the Japanese cherry trees by the Department of Biology of the Biotechnical Faculty. In 2004, a plant nursery for Mediterranean plants and sunflowers was built at the same location (Bavcon 2010), which was followed by another plant nursery in 2015. In 2000, the garden also leased the dry meadow on the edge of Ljubljana for purposes of *in situ* preservation (Bavcon & Marinček 2004, Bavcon 2010, 2013, Bavcon & Ravnjak 2016*a*,*b*, Bavcon & Ravnjak 2017). The meadow has exceptional diversity, and includes also some species from the Red List of Threatened Species. The meadow is ideal for a quick introductory presentation of species' richness of Slovenia. Usually, we show to visitors this meadow before starting longer excursions. If longer excursions in nature are not possible, we guide visitors to this meadow, so that they get a quick view on the plant diversity. Each of the additional locations of the Botanic Garden can by itself represent a tourist attraction. However, since 1995 the Botanic Garden of the University of Ljubljana organises and leads field trips, as well as excursions to other gardens in Slovenia and Europe. This is just a part of the strategy included in the action plan of the botanic gardens (Cheney *et al.* 2000). Some of the young gardens abroad are extremely popular tourist attractions, such as the Eden Project (Smith 2001), Kew, Glasnevin, Berlin, Uppsala, etc. Ultimately, botanic gardens as part of research expeditions, are sending people across the world to collect new plant species (Don & King 1998, Musgrave *et al.* 2000). This is true even today. We collaborated with the Millennium Seed Bank in 2013 (Ravnjak & Bavcon 2014, Bavcon & Ravnjak 2014), and in 2018 with the Royal Botanic Garden Edinburgh, working together with the researchers, collecting seeds from different phytogeographic regions of Slovenia.

With our guided excursions in nature, we focus on presenting the plant word and always educate participants, indicating them what are the main principles to protect nature. We only let them to do photographs of plants but we do not visit ecologically sensitive areas. We show the diversity of habitats, warning participants about the vulnerability of specific environments and draw the attention on the right management of the preservation (Bavcon & Ravnjak 2016). Various tourist agencies have already realised that tourists have become much more demanding and want to receive more comprehensive technical information. Therefore, tourist agencies often ask us to provide guides for trips in the nature (Bavcon 2013, Ravnjak & Bavcon 2017, Bavcon & Ravnjak 2017, Bavcon *et al.* 2018, Praprotnik *et al.* 2018). This expertise on the knowledge of nature and the flora can be a good tool for all botanic gardens in the future, because this is the only way to save nature from mass tourism, Ecotourism, with participation of experts, can represent an important commercial sector, particularly in those countries that still have well-preserved natural sites. Thus, natural treasures can act as an export product, if we know how to protect and properly present them.

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## The Folly Arboretum and Winery

Réka Folly

*Folly Arboretum and Winery, Badacsonyörs, Hungary*

Our botanical garden is not simply an arboretum of many. It's not only a unique collection of cedars and cypresses, but a family history of four generations, a result of dedicated work and perseverance with the help of God. This story begins hundred and twelve years ago in 1905 with Gyula Folly MD, who planted the first conifers to the stoniest and steepest part of the Kisörs Hill, which is in Western Hungary, on the North shore of the Lake Balaton. The whole estate is ten hectares, half of it is vineyards, the other half is the botanical garden. We have cedars, junipers, and an outstanding collection of cypresses that is about three hundred and fifty species of pines altogether.

Uniquelly, the garden is still privately owned by the Folly family as opposed to stately owned gardens in other ex-communist countries. Seven years ago, when I took over the garden from my father, we decided to build up a serious brand as we would like to impress our visitors not only by the actual garden but we would like to send a message through our quality products beyond the arboretum.

After working hard for years, we can proudly say that the phylosophy of our business strategy works. The number of our visitors has dramatically grown, therefore, the sales of our products also multiplied. We have managed to bring our business up onto a different level with creating so much more income which we can reinvest into the development of the Folly Arboretum.

**Keywords**: Arboretum, Winery, Pines

## Succulent plants collections of A. V. Fomin Botanical Garden – Conservational and educational activities

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The A.V. Fomin Botanical Garden was founded in 1839. For more than 175 years of history, the garden has dendrological, herbaceous, tropical and subtropical plant collections, holding about 9,000 taxa. The succulent plant collection, the largest in Ukraine, has more than 2700 taxa that belong to 306 genera and 38 families. In 2015 the collection received the status of "National Heritage Collection of Ukraine".

The main task building the collection was to present the amazing diversity of morphological structures marking the adaptation of plants to arid conditions. Other tasks included to show succulents native to different continents, as well as plants that are used in horticulture. In addition to the typical succulents from the families of Cactaceae, Crassulaceae, Apocynaceae, Aizoaceae, Aloaceae, other plants in Burseraceae, Cucurbitaceae, Vitaceae, Didiereaceae, Moraceae, and Moringaceae are also represented in the collection. The plants are either placed on shelves or planted out in the greenhouse.

Analysis of the IUCN Red List of Threatened Species showed that the collection contains more than 500 rare species from 13 families, while our list of CITES species has 1120 taxa from 14 families. The greatest number of rare IUCN red list species belongs to the family Cactaceae, and our CITES-listed taxa to Cactaceae and Euphorbiaceae. About 80% of our succulents entered their generative period of life cycle.

Based on our rich collection, classes are held for students, with a wide range of subjects from the field of ecology and botany. Studies and observations are made and materials collected for the qualification works of bachelors and masters of biological specialties and training practices of students. Tour guides conduct specialized excursions for the general public, especially for schoolchildren, most of whom visit the greenhouses during the flowering period of plants of the Cactaceae family. Employees are in close contact with fans of succulents, who often come to the garden, and exhibit their plants at thematic exhibitions in Kiev.

**Keywords:** succulent, collections, *ex situ* conservation, education

# Larix genus in botanic garden of Klaipėda University – West Lithuania

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The Botanical Garden of Klaipeda University (BG) is located in Western Lithuania, in the northern part of the Klaipėda city, in the valley of the Dane River, near the Baltic Sea (about 3.5 km). It was established in 1993, and since 2002 it has dendrological park status. In general, the area is of 9.3 hectares. The purpose of the Botanical Garden is the conservation of the genetic resources of herbaceous and woody ornamental and medicinal plants in the collections. Compared with other parts of Lithuania, the climatic conditions differ by having a longer growing season. Therefore, these are favourable conditions for plant adaptation. Since 2005, the Botanical Garden is a member of the IPG. Since 2002 it participates in a seed exchange programme and published an annual *Index seminum*. Introduction of *Larix* species in Lithuania was launched in the middle 19th century as a valuable industrial and decorative species. Forestry plantings of *Larix* in our forests began about 160 years ago. In Lithuania, larches are winter hardy and are cultivated in mixed stands associating with *Picea abies*, *Pinus cembra*, *Pinus mugo*, *Fagus sylvatica* or *Abies alba* and can also occur in pure stands. In our botanic garden's dendrological section 16 taxa of *Larix* P. Mill. are grown: L. *sibirica* Lebed., *L. decidua* Mill., L. *kaempheri* (A.B. Lambert.), L. *kurilensis* (Mayr) Cin., L. *laricina* (Du Roi) K. Koch, L. *gmelini*, L.*rossica*, *Larix x marschlinsii, Larix decidua* Mill. 'Pendula', *Larix decidua* Mill. 'Fastigiata' *Larix decidua* Mill. 'Horstman Recurved', *Larix kaempferi* (Lamb.) Carr. 'Diana', *Larix kaempferi* (Lamb.) Carr. 'Blue Dwarf', *Larix kaempferi* (Lamb.) Carr. 'Pendula', *Larix kaempferi* (Lamb.) Carr. 'Jcobsen Pyramid', *Larix gmelinii var. olgensis*. 6 taxa of larches are specific to Europe, 12 to Asia (Japan) and 2 to Russia (Siberia). The age classes of these larches are different, the oldest ones ar e *L. sibirica* and *L. decidua* — 19 years old. In the annual *Index seminum* we could include *L. kaempferi* seeds beginning in 2003. *L. sibirica* Lebed. and *L. decidua* Mill. have been included from 2002, but in 2003-2006, 2009, 2015 and 2016 were not present on the list. *Larix decidua* Mill. 'Fastigiata', *Larix kaempferi* (Lamb.) Carr. 'Blue Dwarf', 'Pendula', 'Jcobsen Pyramid', *Larix gmelinii var. olgensis*, *L.rossica* and *Larix x marschlinsii* have been growing here from 2003 – 2005, but have not produced cones/seeds yet.

**Keywords**: Larix, Botanic garden, seed, taxa.

## The development of electronic carpological atlas for Russian Apiaceae in Botanical Garden of Moscow University

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In the Botanical garden of the Lomonosov Moscow University the Sector of Plant Taxonomy and Geography led by prof. M.G. Pimenov has investigated the family Umbelliferae (Apiaceae) for more than four decades. We published many taxonomic revisions of various genera and some regional treatments of the Carrot family, including "Umbelliferae of Russia". In addition to special publication we developed materials for a broad range of users – students and naturalists. Umbelliferae is a difficult group for identification. We have published an illustrated computer key for plant determination (Apiaceae of Russia, 288 species).

The fruits of Umbelliferae are diverse and their characteristics are of great value for taxonomy of Umbelliferae. The carpological characteristics are important for the delimitation of genera. Our team currently works on an electronic carpological atlas of Russian Umbelliferae, that will be loaded up to the WWW in 2017. We established a set of standardized characters and character states that have taxonomic value in the family. For every species a detailed description of morphology (23 traits), anatomy (15 traits) and micromorphology (11 traits) will be provided. We collected plenty of illustrations, most of them are original: colour macrophotos of fruits made with optical stereomicroscope, schemes of transversal sections of mericarps with anatomical details, coloured microphotographs of transections, and SEM photos of fruit surface.

The atlas is constructed as web-pages, it can be used off-line on personal computers and even on smartphones, and the on-line version will be periodically updated.

We also developed the database and multi-entry electronic key for identification of genera and the species of Umbelliferae of Russia on carpological characteristics. The key was produced on the JAVA platform as executable jar and is compatible with a broad list of operational systems. For identification, you can use any set of characters, depending on their presence on the material and on available instruments.

This work is supported by a grant from the Russian Foundation for Basic Research (No 15-29-02748). SEM studies are performed at the User Facilities Center of M. V. Lomonosov Moscow State University with financial support of Ministry of Education and Science of Russian Federation.

**Keywords**: Apiaceae, carpology, morphology, anatomy

## The display group of „serpentine plants" at the Botanical Garden of the University of Vienna, Austria

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Since 1990, the Botanical Garden of the University of Vienna has been establishing display groups of Pannonian dry area vegetation characteristic to eastern Austria. One of such developments was the layout of a display showing plant species typical for serpentinite rocks.

To create the display area, most of the existing vegetation was removed. The surface was covered with mypex fabric and topped by a layer of sieved serpentinite rock and a layer of ground soil transported from an original serpentinite site and mixed with ground soil from the Botanical Garden.

Prior to this, seeds and plants of „serpentine taxa" collected *in situ* over a couple of years were cultivated in pots and planted at the display group in the autumn of 2015.

Threatened species such as *Notholaena marantae* and *Sempervivum pittoni* (endemic in Styria) are displayed.

Experiences for the first two years: So far, the display area looks fine; there are no losses except one plant of *Sorbus aucuparia*. Two individuals of *Pinus sylvestris* left from the original vegetation at the site had died. Already in 2016 some species begun reproducing (selfseeding). Due to the shallow layer of soil on the mypex fabric, the plants need watering in periods of extreme droughts.

Didactic background and cooperation: At the site, information sheets provide background information on the development of the group and on specific plant species. In the framework of regular guided garden-tours the purpose and characteristics of the display group are also explained. In 2016, the display group was subject of a master thesis. Cooperation with the University of Applied Sciences, Vienna („Boku") has been initiated to undertake further research on soil conditions and accumulation of heavy metals in serpentinite plant species.

**Keywords:** serpentine flora, *ex situ* conservation, public outreach

## The ELTE Füvészkert (Botanical Garden of Eötvös Loránd University)

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The University of Nagyszombat was founded by Péter Pázmány in 1635 and then in 1771 established its botanical garden, the ELTE Füvészkert which is the first botanical garden of Hungary. The Füvészkert had to move five times. The last occasion was in 1847 to the Festetics-manor house. In these days the manor house provides home for the library keeping botanical, horticultural treasures, herbarium, documents showcasing the Garden's history. It is a place for university and scientific presentations and lectures. The famous Hungarian novel the "A Pál utcai fiúk" (The Paul Street Boys) took place in this garden. In the botanical garden there are greenhouses with 2000 $m^2$. The Palm house is one of the oldest palm house in Hungary, now it has been under Hungarian monument protection and the garden has been under Cultural Heritage Protection since 2006. The Botanical Garden has been national nature reserve since 1960, currently awaits its visitors with about 8,200 plant species and varieties, with a rich cactus, bromeliad, orchid, palm and tropical Aracaee collection. Rock gardens consist of montain and alpine plants. The Hungarian Flora is represented by more than 600 species. The Füvészkert has about 300 Hungarian protected and the same number of red listed species from around the world to introduce the public, use for education. Some of these species are replanted to the natural habitat to strengthen their natural population with collaboration the competent natural parks (e. g. *Crepis pannonica*). The arboretum of the Botanical Garden is a unique value with its roughly 3,000 tree (e. g. *Ginkgo* variants) and shrub (e. g. *Lagerstroemia* variants) species and variants, in spite of its relative small size. The ELTE Füvészkert has 40,000 visitors per year. The website, the virtual trip and mobile application help to guide the visitors. Several professional events (e. g. *Sakura*, *Ginkgo*, Fig, Tomato, Tropical fruit) introduce the plants and the gardening and educate the inhabitants. We establish a green school to educate the children, like the Grüne Schule in Palmengarten der Stadt Frankfurt am Main.

## Collections of Hungarian-bred ornamental woody plants in the Buda Arboretum

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The Buda Arboretum was founded in 1893–94 as a study-garden of the Hungarian Royal Horticultural School (the predecessor of the present Faculty of Horticulture), on 3 hectares, with 1000 taxa. Now it covers 7,5 hectares in the heart of Budapest, on the southern slope of the 235 m high Gellért hill. Nowadays the garden is embedded in the green space system of Budapest. The Arboretum is under very strong urban effect: the summer is hot, the winter is milder, the air is polluted, the soil is very limy. The plant material includes now over 1900 woody species and cultivars.

One of the main tasks of the Arboretum is the display and testing of Hungarian-bred woody ornamentals. These cultivars are bred to tolerate the extreme dry climate and unfavorable soil. Selection of stress-tolerant ornamental plants started in Hungary in the 1950s with the leadership of dr. János Domokos on the Department of Floriculture and Dendrology. The first phase of this work resulted in 8 selections of *Sorbus*, 3 *Tilia,* and among others *Fraxinus, Cornus, Juniperus* and other clone collections. From the 1980s we concentrated on the urban and industrial areas, they are most exposed to stress disorders, so except the native vegetation we expanded the research with non-native taxa. After the change of regime in 1989/90, several private nurseries also began to do selecting work independently, for example in the Prenor-, Alsótekeres- and Ifju Nursery, in addition the following persons: E. Barabits senior, E. Barabits junior, M. Bényei-Himmer, J. Domokos, Gy. Folly, Z. Ifju, E. Jámbor-Benczúr, M. Józsa, M. Kiss, L. Komiszár, G. Kósa, L. Lakatos, Gy. Magyar, G. Márk, L. Maráczi, J. Mészáros, B. Nagy, Zs. Nagy, J. Németh, L. Orlóci, J. Retkes, G. Schmidt, P. Szíjártó, E. Sipos, Ferencné Tóth, Gy. Tóth, I. Tóth.

At present, the arboretum has a significant collection of Hungarian cultivars, the latest and (probably) most perspective cultivars: *Prunus laurocerasus* 'Antonius', *P. l.* 'Cippora', *P. l.* 'Gabi', *P. l.* 'Hagar', *P. l.* 'Kleopatra', *P. l.* 'Miki', *P. l.* 'Leander', *P. l.* 'Manó', *Prunus padus* `Auróra`, *Sorbus borosiana* 'Alba Regia', *S. decipientiformis* 'Vallus', *Tilia platyphyllos* 'Pannonia', *Thuja (Platycladus) orientalis* 'Bence', *T. o.* 'Dundi', *T. o.* 'Hunor', *T. o.* 'Telihold'.

**Key words:** Hungarian woody ornamentals, cultivars, breeding, testing, Arboretum

# "Hippocrates Botanical Gardens" Network

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The non-profit organization "Hippocrates 2500 years" is committed to researching, studying, promoting and disseminating Hippocrates' work but it largely involves the creation of an international renowned research centre of the more than 270 herbs that Hippocrates cited in his books and used in the treatment of his patients as well as the foundation of Hippocrates Botanical Gardens (HBGs) consisting of the above medicinal plant species.

As tribute to the "Father of Medicine", "Hippocrates 2500 years" has created many HBGs: initially the HBG of Kos which is Hippocrates' homeland (near the sanctuary of the Asclepius archaeological area) in collaboration with the International Hippocratic Foundation of Kos; another one on the island of Limnos in collaboration with the Department of Food Science and Nutrition of the University of the Aegean; another HBG in the surrounding area and on the rooftops of the bioclimatic headquarter building of Apivita S.A. in Markopoulo near Athens and many other smaller gardens (among them the HBG of Ginza in Tokyo). All the HBGs are open to the public and provide signs equipped with a QR code system that gives the visitor access to plant knowledge database. The available information is updated according to the progress of the study regarding the composition and the medicinal uses of each herb. In the larger HBGs guided tours take place. Among the information given is t he reference of these herbs in Greek Mythology and History. An Herbarium as well as a Seed Bank of Hippocratic plants have also been established. Four of the Gardens are official members of BGCI.

The aim of "Hippocrates 2500 years" is the creation of Botanical Gardens in all locations where great sanctuaries of Asclepius are situated. Thus, a new HBG including the medicinal plants of Greek antiquity will be established at Epidaurus archaeological site. The establishment of dedicated Sections to Hippocratic Plants in existing Botanical Gardens all over the world is also an important goal. Main sponsors of "Hippocrates 2500 year" are Apivita S.A. and Apigea S.A.

**Keywords**: Hippocrates, medicinal plants, Asclepius

# Eco-biological study and *ex situ* conservation of the Georgian endemic species *Aquilegia colchica* Kem.-Nath.

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**Abstract:** This is the first report on the structural peculiarities of the generative organs of a Georgian endemics – *Aquilegia colchica* Kem.-Nath. (Ranunculaceae), included in the Red List of Caucasus. Various stages of development have been studied. The complex eco-biological research of the target species and *ex situ* conservation work has been carried out. The seed production ability, the viability of seeds, and the germination power have also been studied. Based on the obtained results assessed the normal functioning of the generative cycle of *Aquilegia colchica*, the high energetic potential of the male parts and the optimal conditions and terms for seed germination.

**Key words:** reproduction, *ex situ* conservation, seed bank.

## Introduction

Protection of the gene pool of the endemic species, their *ex situ* conservation is a prerequisite for biodiversity conservation. When the Missouri Botanical Garden, published "Seed Conservation. Turning Science into Practice" in 2013, 50 priority species from Georgia were also included (Smith *et al.* 2003). For the current report, we selected as an example *Aquilegia colchica* Kem.-Nath. (Ranunculaceae), the endemic species of Georgia, in assessing the matters of species viability and conservation.

*Aquilegia colchica* Kem.-Nath. (Ranunculaceae), a species included in the Red List of the Caucasus (Schatz *et al.* 2009), is a local Georgian endemic characterized with narrow distribution. It's populations occur on the right bank of the Jrucha river, in Jrucha valley, Imereti, West Georgia.

The research aimed at assessing the reproductive potential, the emergence and sprouting quality of the species from the aspect of its *ex situ* conservation and find out what is the most effective and economical method to follow in the species protection.

## Materials and methods

Materials used for our study (plants and seeds) were collected from the populations of *Aquilegia colchica*, located in its natural distribution range, in the gorge of the Jrucha river, as well as from cultivated specimens, growing on the collection plot of the Department of Plant Conservation of the National Botanical Garden of Georgia.

Phenological observations were carried out at the collection plot of the Department of Plant Conservation of the National Botanical Garden of Georgia.

Laboratory trials were conducted using the methods accepted in structural and experimental embryology (Pausheva 1988).

Materials were fixed using Carnoy's fixing agent (3:1). Material was embryologically studied using the binocular light microscope Carl Zeiss (Germany). Productivity of seed formation, germination capacity and viability were determined according to the method by Robotnov (Robotnov 1960) and methods suggested by the Millennium Seed Bank (Baskin and Baskin 2002; Smith *et al.* 2003).

For establishing *ex situ* collections, the quality of the seed and the degree of their vitality have been determined under the conditions of controlled temperature and lighting at different periods (immediately after seed collection, after one month, three months, six months, one year, and two years). The material was placed on a 1% agar Petri dish under controlled temperature (21°C during the day, 14°C at night) and lighting mode (21/12), in the incubator, refrigerator (4°C) and on a piece of filter paper in the natural, uncontrolled temperature and lighting.

## Results and discussion

In the course of the experiment (in the years 2015–2018), we successively studied the development of the female and male parts of the flowers. The microscopic study of the males showed that the development of the pollen sac is completed according to the main dicot type (Kamelina 1981). The primary parietal layer is divided periclinally into two secondary parietal layers, the cells of which are still divided and as a result endothecium, two intermediate layers, and binucleate secretory type tapetum are formed that is similar to the main type development. The intermediate layer is ephemeral. Sporogenous tissue is formed during the premeiotic period. In the microsporocytes, the meiosis occurs normally with formation of 7 closed bivalents

(2n = 14). Open bivalents are not found. The insignificant derangement in the anaphase and telophase of the second meiotic division does not show regular character and does not cause a violation of a normal course of the meiosis, and eventually viable pollen grains are produced. The formation of tetrad is performed simultaneously. Arrangement of microspores in tetrad is tetrahedral.

The mature pollen grain is binuclear, monocyphonic, spheroidal, tricolpate, the aperture surface is tubercular. The pollen grains maintain vitality for 7–15 days. The optimum area for germinating a pollen grain is 7% sucrose, 0.1% boric acid, 1% agar and temperature at 210C. Defective pollen grains are 1–3%. Fertility is 97%, which is a pre-condition for successful fertilization. Female parts also develop normally. The flower mainly consists of 4–5 pistils, rarely 6, and sometimes as an exception there may be 8 pistils. The ovule is anatrophic, crassinucellate with two integuments. *Aquilegia colchica* flower is characterized by morphologically expressed 5 phases of development. (green buds, semi-colored buds, colored buds, semi-opened buds and open flower phase). The green bud phase lasts for 11–18 days. In this phase the bud is smaller (0.4–0.8 cm long and 0.3 cm wide), the two-day buds are undifferentiated. Its thin-walled cells are small. The wall of the 7-day pollen sac is already formed. The inner stamens turn into white membranous staminodia. The staminodia are broad with wrinkled walls that is a characteristic feature of the species. Gynandrophore is cup-shaped. Its excrescence between pollen and the bud is noticeable.

The semi-colored bud phase begins on the 5th–25th day from the bud formation and lasts for 4–7 days. The bud is 0.8–1.3 cm long and 0.6–0.9 cm wide. Some coloring is characteristic for the outer surface of the nectaries. The elliptic-shaped pollen sac is green. The stamens do not mature simultaneously. At this stage, the pollen grain is mononuclear. The stamens are longer than the curved nectarines and they are stuck out. The ovary is elongated and downy. The tyloid (style) is hairless. The round stigma is covered with thin-walled glandular cells. The stigma is dry and physiologically non-active at this stage. The nectaries are funnel-shaped. The inner surface is covered with dense long hair. The spur is twisted and thickened that is a characteristic feature of the species.

The phase of colored bud begins on the 17–26th day. The bud is 1.4–2.4 cm long and 0.9–1.5 cm wide. At this stage the pollen grain begins to turn yellow. The stamen is as long as the pistil. About 18–22 ovules are arranged in two rows in the ovary. The ovules develop synchronously and are in the same phase of development. The stamen and the pistil are on the receptacle, although sometimes stamens are attached to the inner surface of the funnel-shaped nectarium.

The semi-open colored bud phase begins on the 19–30th day and lasts for 7–8 days. The pollen grains are physiologically the most active at this stage (protandry is characteristic). The special position of a stamen is changed, leaning to the sides, the angle of inclination increases and the pollen grains start to fall down.

In the open flower phase the flowers are bicolor. The sepals are blue, ovate-oval and of unequal size. The sepal margins are covered with short white hairs. The nectaries are funnel-shaped with white curving. At this stage the stamens wither, the pistil grows larger; the glandular cells of the stigma become uneven and excrete liquid. The stigma is physiologically active that is ascertained by the peroxidase test. The open flower phase includes pollination, fertilization and seed formation.

The highest percentage of germination (92%) was achieved when the seeds, obtained under the incubator conditions, are sown as soon as they are collected. Duration of storage leads to decrease the emergence energy. The longer is the storage time the less is the percentage of seed germination (76%).

*Aquilegia colchica* is characterized by high productivity (on average 1260 seeds per individual). The anthropogenic stress – habitat destruction – is considered to be the reason of reduction of its populations.

## Conclusions

As a result of the research the following has been ascertained:

- Normal course of formation and functioning of the generative phase; high energetic potential of the male part;
- The pollen sac is developed as the main dicot type in angiosperms. The wall is composed of two intermediate layers of epidermis and tapetum of secretory type. The tetrad is developed in the simultaneous type. The mature pollen grain is binuclear. The ovule is anatrophic crassinucellate;
- Protandry is characteristic and blossom has five clearly expressed phenophases;
- *Aquilegia colchica* can be characterized by high productivity and rapid germination;
- Duration of the seed storage leads to decrease in the germination power. The seeds keep the germination ability for about 3 years;
- The anthropogenic factor is considered to be the reason for decreasing the species' population.

A small population has been established in the living collection of the National Botanical Garden of Georgia. The seeds are preserved in the Caucasus Regional Seed Bank. Duplicate seed material has been sent to the Millennium Seed Bank.

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## Reproduction biology and *ex situ* conservation of *Pulsatilla georgica* Rupr. (Ranunculaceae)

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**Abstract:** The work deals with the studies on *Pulsatilla georgica* Rupr. (EN) – a Red List species, primarily having the status of conservation, its biological peculiarities, seed processing, propagation by seed, and *ex situ* conservation activities.

With the purpose to determine the reasons for the decline of *P. georgica*, the following has been studied: sequential progress of growth and development, degrees of phenophase, terms and characteristics; formation of generative organs and degree of fertility, pollination-fertilization process; ways and types of pollination.

The terms of seed maturity were defined and duration of the life cycle was determined; Ratio of generative and vegetative propagation in the resettlement of the species; Seed capacity of potential and real seed reproduction have been assessed. Based on the obtained data, we concluded that the target species is adapted well to the environmental conditions. Therefore, the reasons for the decline of *P. georgica* populations should be mainly attributed to abiogenic factors.

With the conservation in mind, the seeds of *P. georgica* were collected in its natural habitat and stored in both the Seed Bank of the Caucasus and in the Millennium Seed Bank (UK). Collection of live plants, as well as surplus seed were collected, and stored in a local „backup" seed bank, all these serving future reintroduction in nature.
**Key words:** *Pulsatilla georgica* Rupr. pollination, autogamy, ovule, seed.

The reproduction biology and *ex situ* conservation of *Pulsatilla georgica* Rupr., a species having primary conservation status in the Red List, has been thoroughly studied. The populations of *P. georgica* occur at two localities in eastern Georgia: near Tbilisi at 1297 m, and in Kojori at 1432 m above sea level. The seeds of the target species are produced in early spring, under low air temperature and unstable climatic conditions. The species appears to be resistant to the impact of the environmental conditions by means of increasing of its surviving potential through the change of flower orientation that increases the probability of landing pollen on the stigma, by extending the range of pollination (autogamy, allogamy), as well as by increasing the number of pistils and stamens or by developing a short vegetative period.

The normal functioning of the generative organs stimulates the development of fertile seeds and helps flourishing individuals in the short period of life span (2–4 years). From the limiting factors that influence the development of *P. georgica* individuals, the most characteristic is the damage produced by tourist trails and tamping of populations as a result of the grazing, or by unreasonable cutting of the decorative flowers.

The necessity to carry out *in situ* conservation work, a collection of live plants has been established. The seeds are stored in the Seed Bank of Caucasus at the National Botanical Garden.

It is generally observed that as a result of the intensive anthropogenic and technogenic processes in nature, the quantity of many plant species has either reduced or even become endangered. Currently many of them are facing the danger of extinction. This concerns especially the endemic plants. Conservation is an effective measure to minimalize the effects of these processes that is impossible to realize without studying the reproduction biology of the species.

Our work deals with *Pulsatilla georgica* Rupr., a species that is according to IUCN is on the list of endangered (EN) species – and it is included in our Red List. The species has primary conservation status in Georgia and studies of its biological peculiarities, i.e., the seed formation processes, seed production and conservation activities are greatly needed. It is a perennial herbaceous plant, when it flowers its height reaches 30 cm. It is

densely pubescent with 4-5 cm light purple or violet, single bell-shaped flowers with a great number (up to 139) of stamens and pistils (numbering up to 90).

In Georgia, *P. georgica* has been recorded to occur at two localities, one near Tbilisi, on stony open slopes at Kojori, Koroghli (1297 m), and in open forests at Kojori, Udzo (1432 m). From the threatening factors of *P. georgica* the following are worthy of mentioning: populations are distributed in the surrounding areas of old churches that are often crossed by tourist roads and the land is tramped by visitors and tourists. Another reason is grazing. In addition, due to the lack of other flowering plants in this period of the year, the flowers of *P. georgica* are intensively picked.

*P. georgica* begins its vegetation period in early spring. The first buds are usually observed from the first decade of April. Individuals do not flower simultaneously throughout the April–May period. It is observed that the formation of male and female generative phase mostly passes normally; the number of developed ovules is about 92; the pollen is highly fertile (85%). The *P. georgica* pollination coincides with unstable climatic conditions: rainy, snowy, more often frosty than mild, sunny weather.

With regard to pollination, the species shows a special type of plasticity. In accordance with the variability of climatic conditions, the species has the alternation of autogamy and allogamy: in cloudy and moist weather with low temperatures, the flowers of *P. georgica* are bent down and this way they protect stigma and anther from being damaged. Under the conditions of low temperatures the presence of insect pollinators is minimal (especially in the case of bees, the activity ranges within 12–14°C) and the pollination is carried out by autogamy. Alternatively, in warm weather, the flower turns into vertical position and the possibility of landing pollen on the stigma increases and the occurrence of allogamy is more frequent.

A number of scientific works are dedicated to studies of this alternation aiming at clarifying autogamy and allogamy of *P. georgica* (Back and Peterson 1975; Marr 1973; Sayers and Ward 1966). On the basis of our research and according to these authors we can conclude that the species appears to be resistant to the impact of the environmental conditions by means of being capable to improve its surviving potential. This is marked by 1) the change of flower orientation when there is a greater chance of increasing the probability of pollen landing on the stigma; 2) extending the range of pollination (autogamy, allogamy); 3) increased number of pistils and stamens; 4) developing a short vegetative period.

Other species of the genus *Pulsatilla* use the same surviving potential when passing through pollination, fertilization, seed formation under unfavorable environmental conditions: change flower orientation (to get pollen on the stigma), having increased number of pistils and stamens, and extend the range of pollination (autogamy, allogamy).

The seeds of *P. georgica* mature at the beginning of July. About 40 seeds are formed within the ovary. The number of good quality seeds depends on the annual weather conditions. In order to define the emergence capability of seeds they were sown under artificial conditions. In the laboratory environment an assessment of seed quality was carried out by different methods:

1. Seeds were cut and the development of embryo was observed under the microscope. Results showed that 45% of the seeds are fertile, 55% are empty and/or infected.

2. Seeds were placed on the filter in a Petri dish (at room temperature, at natural lighting regime) and 1% agar substrate, and placed in the incubator. The indices of germination capacity and viability of the seed showed relatively similar values on two different substrates (33.3% on the filter paper and 44.4% on agar).

*P. georgica* shows almost half the potential of the seed production. S/O = 92/40, where S is the number of seeds and O is the number of ovules.

Seed maturation takes about a month. It has rather long, ~2.5 cm seed coat strongly pubescent which significantly promote distribution by wind. The seed can easily attach to the soil with its pointed top. It should be noted that tamping partially helps the seed to be pushed into the soil.

Propagation of the experimental specimens was carried out by seeds. The seedlings begin to bloom on the 2nd, 4th year. Duration of one-year life cycle is 3 months.

In case of necessity and with the purpose to carry out *in situ* conservation work, the seeds were collected, processed and stored in the National Seed Bank in the National Botanical Garden of Georgia and the Millennium Seed Bank, RBG, Kew, United Kingdom. Reserves of surplus seeds and living plant collections were also created.

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# *Ex situ* conservation and seed bank establishing of selected plant species from Amaryllidaceae family in Georgia

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**Abstract:** The present work concerns with *ex situ* conservation, based on selected medicinal plant species from Amaryllidaceae family. With regard to their decorative and traditional medicinal properties, many natural populations are collected in nature. Because of overexploitation it is of urgent necessity to take conservation measures through both *ex situ* and *in situ* protection. For this purpose it is of critical importance to collect data on the distribution of such species and evaluate the vitality and fertility of their populations. *Ex situ* is based on seed stock and collection of live specimens. In Great Britain the work is conducted within the framework of the "Millennium" Seed Bank Partnership of the Kew Botanical Garden, institutes with which we are cooperating. The seeds are placed in the National Seed Bank in Georgia, while duplicates seeds, together with the corresponding herbarium samples are sent to the Millennium Seed B. The live collection obtained from seeds is cultivated in a collection plot of the Plant Conservation Department of the National Botanical Garden of Georgia.

**Keywords:** *ex situ* conservation, medicinal plants, seed bank, living collection.

## Introduction

Georgia`s flora is estimated at 4130 vascular plant species, one fifth of which are endemic. The flora of Georgia is known to contain a remarkably high number of species of medicinal value, with over 700 species utilized in Georgian traditional medication (Grossheim 1943) and 200 taxa registered in the official pharmacopoeia (Davlianidze *et al.* 2018, Gagnidze 2000). Hundreds of Georgian economic plant species are threatened with extinction or exposed to risk of genetic erosion. The vast majority of medicinal plants in Georgia are harvested in the wild and in some cases are severly overexploited. Due to economic difficulties in Georgia, wild flora and habitats are under the permanent anthropogenic pressure such as random tree cut, overharvesting, etc. that causes deterioration and fragmentation of habitats and extinction of many species of medicinal value.

It is of urgent necessity to take conservation measures for these species through both *ex situ* and *in situ* protection methods. For this purpose it is of critical importance to collect data on the distribution of the above species and evaluate the vitality and fertility of their populations.

*Ex situ* conservation via establishing seed banks and living collections is one of the most efficient and comparatively low-cost methods for the protection of plant biodiversity.

As an importand step to combat overexploitation of our genetic resourses, the Caucasus Regional Seed Bank (CRSB) was established in 2001. The foundation of this seed bank was in part implemented within a collaborative project between Georgian botanists and colleagues from the Missouri Botanical Garden. The project title clearly refers to the point: "Sustainable Use & Conservation of Medicinal Plant Resources in the Republic of Georgia". As an output of the above project, seed material of 150 endemic and rare medicinal plant species were collected and deposited into the CRSB. Species of several genera, including *Galanthus*, *Cyclamen*, *Paeonia*, *Colchicum*, *Dioscorea*, *Salvia*, *Gymnospermium*, *Helleborus*, *Anthemis*, *Nepeta* were included in the initial effort.

The next step in developing the Caucasus Regional Seed Bank (nowadays the National Seed Bank as it is called) (NSB) was a collaboration with Kew's Millennium Seed Bank Partnership (MSBP) that started in 2005 and continues to date.

The work hereby presented is part of the "Millennium Seed Bank" Project Partnership Development in Georgia.

## Materials and Methods

The present work refers to 11 species from Amaryllidaceae family included in *ex situ* conservation. All these species are rare, local and endangered endemics of Georgia and the Caucasus mountains.

The National Seed Bank is designed for the long-term storage of seeds. Germination capacity, seed collection and deposition in the Seed Bank (long-term storage at minus 20 degrees). All seed bank procedures are in accordance with international standards and guidelines (Baskin & Baskin 2002; Smith *et al.* 2003).

Live collections were established for the *ex situ* site, in the collection plot of the Department of Plant Conservation of NBGG. Here, conditions are as follows: GPS coordinates at 41°41'150" N, 44°48'140" E, elevation above sea level 504 m; mean annual temperature 12.6°C, mean minimum temperature in January –0.5°C and the coldest recorded minimum is –18 °C; mean annual precipitation 518 mm; summers and winters are moderately dry.

**Table 1.** Seeds of plant species collected from Georgia for the CRSB partnership Amaryllidaceae family 11 species

| Apecies | seed bank number | status |
|---|---|---|
| *Galanthus alpinus* Sosn. | CRSB:35 | endemic to Caucasus |
| *Galanthus caucasicus* (Baker) Grossh. | CRSB:36 | rare |
| *Galanthus kemulariae* Kuth. | CRSB:527 | endemic to Georgia |
| *Galanthus ketzkhovelii* Kem.-Nath. | CRSB:37 | endemic to Georgia |
| *Galanthus lagodechianus* Kem.-Nath. | CRSB:1 | endemic to Caucasus |
| *Galanthus platyphyllus* Traub & Moldenke | CRSB:2 | endemic to Georgia |
| *Galanthus schaoricus* Kem.-Nath. | CRSB:528 | endemic to Georgia |
| *Galanthus woronowii* Losinsk. | CRSB:38 | endemic to Georgia |
| *Leucojum aestivum* L. | CRSB:39 | rare |
| *Pancratium maritimum* L. | CRSB:3 | rare |
| *Sternbergia colchiciflora* Waldst. & Kit. | CRSB:1012 | rare |

## Results and Discussion

The species involved in the study are characterized by limited range of distribution, and are under environmental stress and continuous human impact. People collect and sell their bouquets, plant roots; bulbs are collected and donated or sold to phytotherapeutical pharmacies. The affected species are included in the national Red List (Nakhutsrishvili *et al.* 2013), which results in that Today's target species' populations are not sufficiently assessed. In nature they require protection. Species of the genus *Galanthus* are protected by CITES Convention, but their bulbs are available in natural conditions (especially those of *G. woronowi*) and the rules are violated by humans.

Seeds of the target species that contribute to the creation of the seed bank are to be necessarily collected in the wild. For each species a specific data sheet is filled, which along the geographic and botanical information form a comprehensive picture about the given species, its habitat, and the process of its collecting.

Upon arrival to the seed bank the seeds are counted, dried and then processed (manual cleaning, sorting, removal of infested, damaged or empty seeds, cleaned if appropriate, using a special device (aspirator) – AGRICULEX, and finally, weighted. Depending on the size of a collection, certain number of seeds are cut for testing (cut test), in some cases also staining with tetrazolium chloride (TZ test) to evaluate their viability. Before banking the seeds are dried in a barrel with silica gel and then relative humidity is measured (using the special device Rotronic, Hygrometer) which must not exceed 15–20%.

Dried seeds are placed in aluminium foil bags, sealed using the sealing apparatus (Hulme Martin) and banked in the freezer at –20°C temperature.

At least 500 seeds of each species are deposited at the CRS and the corresponding labelled herbarium specimen is kept at the National Herbarium of Georgia (TBI). The duplicates of the seed collection and herbarium voucher are sent to the Millennium Seed Bank and Herbarium of the Royal Botanic Gardens, Kew (K).

After the primary processing each type of sample is assigned to its own induction number (see Table 1) and all these data are transferred into the electronic database – BRAHMS (Botanical Research and Herbarium Management System) and is electronically exchanged with the MSB and MSB DW (data warehouse).

To create a living collection of the target species, the seeds were sown in laboratory in Petri dishes, in pots and also in the soil (see Figure 1). During these steps determination of the percentage of seed germination and the emergence of seed of the target species can be observed and recorded.

## Summary

*Ex situ* seed bank and a living collection of 11 species of the family Amaryllidaceae was established in Georgia in recent years. The work was done in cooperation with and within the framework of the "Millennium" Seed Bank Partnership of Kew Botanical Garden (UK). The seeds were placed in the National Seed Bank, together with duplicates of herbarium specimens which were sent to the millennium seed bank. The live collection obtained from seeds is placed on the collection plot of the Plant Conservation Department of the National Botanical Garden of Georgia.

In addition, the National Seed Bank has a "Seed Reserve" and a corresponding living collection with seedlings that are offered free of charge to interested organizations and persons. They are also supplied with information about how to best propagate them by seeds and/or vegetative parts.

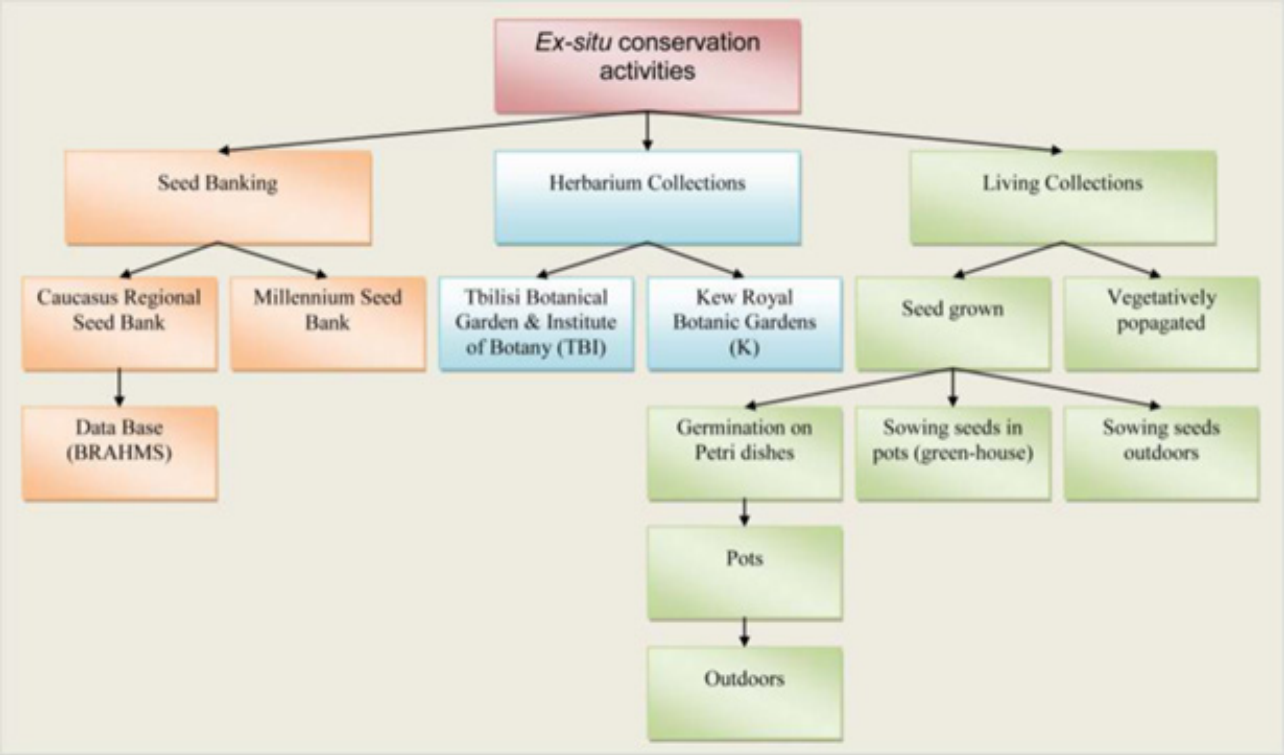


**Figure 1.** *Ex situ* conservation activities at the Department of Plant Conservation of the National Botanical Garden of Georgia

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## Evaluation of the growing conditions of rare plant species at the Botanical Garden of Eszterházy Károly University, Eger (NE Hungary)

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**Abstract:** The Botanical Garden of Eszterházy Károly University was founded in 1967, and the full reconstruction of the Garden took place between 2011 and 2015. Currently 76 plant species protected in Hungary or species included in the Red list of vascular flora of Hungary are grown in the Garden, of which 7 species are strictly protected and 20 are classified as critically endangered or endangered.

The condition of these plants is generally good, though as we have expected, some of them demand cooler climate than it is within the garden – plants like *Arabis alpina* L., *Allium victorialis* L., *Cirsium erisithales* (Jacq.) Scop. or *Lunaria rediviva* L., show considerable decline in viable seed propagation or have slower vegetative reproduction. Surprisingly, certain species such as *Dracocephalum ruyschiana* L. are developing vigorously, even if grow on a sunny site. The population of two orchids, *Orchis purpurea* Jacq. and *Cephalanthera damasonium* (Mill.) Druce, is stable, but their presence has been fluctuating from year to year. Most of the rarest plants of the Garden are native to sunny calcareous bedrock habitats. They are growing well, in some cases with very good seed production and subsequently overtaking the area by producing many new seedlings, e.g. *Hieracium bupleuroides* C.C. Gmel. and *Crepis pannonica* (Jacq.) K. Koch. Others like *Onosma* sp., or *Ferula sadleriana* Ledeb., have prolonged their development from seed to adult stadium. Some of the rare plant species typical for grasslands and forest-steppe habitats on sunny slopes of the North Hungarian Mountains have shown very good reproduction potential and even having spreading tendency such as *Bupleurum rotundifolium* L., *Silene dichotoma* Ehrh., *Inula helenium* L., or some rare species of arable land margins: *Agrostemma githago* L. and *Aegilops cylindrica* Host. Other species such as *Silene nemoralis* Waldst. et Kit. and *Lychnis coronaria* (L.) Desr. proved to be quite invasive in the garden. Generally, these rare species, if needed, could be used potentially for reintroduction (but with careful attention to accurate documentation of their origin). Other rare plant species that are represented by only a small population, still cannot fulfill similar purposes.

**Keywords:** conservation, *ex situ*, rare plants, botanic garden.

## Introduction to the Botanical Garden

The Botanical Garden of Eszterházy Károly University was founded in 1967 and is situated in the outskirts of the city of Eger, North-East Hungary (Fig. 1) and the professional management is provided by the Department of Botany of the Eszterházy Károly University. The area of the Garden is 1 ha. The Garden hosts mainly the native flora of the Carpathian Basin. The structure of the Garden is designed according to the vegetational regions of Hungary. The climate of the Garden is mild with a shift to the sub-continental, featuring hot summers and cold winters and somewhat low precipitation values. Mean annual temperature is 9.9°C and the mean annual precipitation reaches only 543 mm. The living collection consists of about 100 species of trees and shrubs and 600 species of herbaceous plants. Moreover, the botanical collection is extended by a number of sub-tropical and tropical plants located in the Lajos Juhász Greenhouse. The Botanical Garden is a member of Hungarian Association of Arboreta and Botanic Gardens (HAABG). The full reconstruction of the Garden took place between 2011 and 2015: the changes of its whole structure has included new planting habitats, new sidewalk network, and most importantly, the installation of a new irrigation system. Many new herbaceous plants and some trees have been planted, among them some rare native wild plant species also.


**Figure 1.** Map of the location of the Botanical Garden (Eger, North-East Hungary)

## Material and methods

In connection with the reconstruction of the Garden, the conservation programme of 32 vascular plant species was carried out between 2011 and 2014. Seeds of the rare species (including endemic, glacial and interglacial relict species) were collected from the Hungarian Northern Mountains, in collaboration with colleagues from two national parks: Bükk and Aggtelek NP. The main objectives of the project were initiating experimental studies on dormancy and germination of the plant species, eventually resulting in hundreds of individuals that could be planted in the Garden or reintroduced in former habitats if needed. As a result of the conservation programme, various quantities of individuals were grown from the germinated seeds of rare plant species, 18 of them were planted out in the Garden (Kónya-Pénzes, Papp and Tóth 2014).Most of the rare plants were collected from the territory of Hungary, but some of them from the Czech republic, Romania, Austria, Germany, Italy and Lithuania (in addition, plants from seeds obtained from other botanical gardens through the seed exchange program). Nearly one fifth of the rare plant species were planted in the Garden before its reconstruction; two orchid species (*Orchis purpurea* Jacq. and *Cephalanthera damasonium* (Mill.) Druce) appeared spontaneously. Three years after the reconstruction we have 76 species protected in Hungary (Decree of 13/2001. Env. Min.) or species included in the Red list of vascular plants of Hungary (Király 2007), of which 20 are classified as critically endangered or endangered, 5 vulnerable and 23 species are near threatened (Table 1).

## Results: evaluation of rare plant species' growing conditions

The growing conditions and of plants in the Garden are generally good, though as could be expected, some of these plants requiring climate cooler than we actually have, show considerable decline in viable seed propagation, or have slower vegetative reproduction than under their native conditions. This is true, even if the water supply is sufficient, in e.g. *Arabis alpina* L., *Allium victorialis* L., *Cirsium erisithales* (Jacq.) Scop., *Aconitum variegarum* L. and *Lunaria rediviva* L.. On the other hand, excessive irrigated water or abnormally humid summers may result in spreading of powdery mildew on plants. Surprisingly, certain species such as *Dracocephalum ruyschiana* L. are developing vigorously, even if they grow on sunny sites. The population of two orchids, *Orchis purpurea* Jacq. and *Cephalanthera damasonium* (Mill.) Druce, is stable, but their presence fluctuating from year to year. The fruit production of *Orchis purpurea* Jacq. was lower in 2015 and 2016 (in 2016 there were 2 individuals with capsules), but in 2017 and 2018 brought increased seed production: in 2018 there were 16 individuals producing capsules and seeds. Most of the rarest plants of the Garden are native to sunny calcareous bedrock habitats. They are growing well, in some cases with very good seed production and subsequently overtaking the area by producing many new seedlings, as observed in *Hieracium bupleuroides* C.C.Gmel. and *Crepis pannonica* (Jacq.) K. Koch. This behaviour is probably supported by a lower level of species competition in the Garden. Others, like *Onosma* sp. or *Ferula sadleriana* Ledeb. have prolonged development from seed to adult stadium. In case of *Onosma tornense* Jáv. (recently recognized as *O. viridis* (Borbás) Jáv.) a well drained, permeable soil with gravel has proved to be the best condition, especially in time of flowering and seed ripening. Some of the rare plant species typical native to grasslands and forest-steppe habitats, on sunny slopes of the North Hungarian Mountains have shown very good reproduction potential and have even become weedy such as *Bupleurum rotundifolium* L., *Silene dichotoma* Ehrh., *Inula helenium* L., or some rare species of arable land margins: *Agrostemma githago* L. and *Aegilops cylindrica* Host. Other species like *Silene nemoralis* Waldst. et Kit. and *Lychnis coronaria* (L.) Desr. have proven almost invasive in the Garden. Our plant collection includes rare species that are still in seedling stadium of growth (marked by grey lines in the table) and others that we have just received from other botanical gardens, e.g. *Anemone trifolia* L., *Cardamine waldsteinii* Dyer or *Dentaria glanduligera* O. Schwarz. Although they appear to be in good condition, their future development cannot be properly evaluated at this stage of research.

## Conclusions

The growing conditions of rare plant species in the Botanical Garden of Eger are very diverse: plants requiring cooler climate show considerable decline in viable seed propagation or have slower vegetative reproduction rate compared to their native populations, even if the water supply is sufficient. On the other hand some of the rare forest-steppe species have suprisingly good seedling production thanks to a lower level of species competition in the Garden. Generally, these rare species could be potentially used for reintroduction if needed (but with careful attention to accurate documentation of their origin).

*Acknowledgements* – We are grateful to László Papp jun. for his helpful advices. We thank to the botanical gardens in Hungary, especially to Füvészkert – Eötvös Lóránt University Botanical Garden, Budapest, as well as to Siena (Italy) and Vilnius (Lithuania) University Botanical Gardens, for their kind supply of plant material.

**Table 1.** 76 species protected in Hungary (Decree of 13/2001. Env. Min.) or included in the Red list of vascular plants of Hungary (Király 2007) are studied in the Botanical Garden of Eszterházy Károly University. Abbreviations: No = number of individuals, PiH = protected in Hungary, Nt = Natura 2000 species (Annex II), Co = country of origin, HRL = Hungarian Red List

| Plant species | No | PiH | Pih | Nt | Co |
|---|---|---|---|---|---|
| *Angelica palustris* (Besser) Hoffm. | 15 | strictly protected | EN | x | HU |
| *Digitalis lanata* Ehrh.-387 | 25 | protected | NT | | IT |
| *Doronicum hungaricum* (Sadler) Rchb. | 4 | protected | NT | | HU |
| *Erysimum odoratum* Ehrh. | 7 | protected | | | HU |
| *Geum rivale* L. | 30 | protected | | | HU |
| *Globularia cordifolia* L. | 20 | protected | CR | | DE |
| *Linum perenne* L.-151188 | 25 | | DD | | LT |
| *Phlomis tuberosa* L. | 5 | protected | | | HU |
| *Plantago altissima* L. -152140 | 10 | | NT | | IT |
| *Pseudolysimachion longifolium* (L.) Opiz | 50 | protected | | | HU |
| *Achillea crithmifolia* Waldst. et Kit. | 20 | protected | NT | | HU |
| *Aconitum variegatum* L. | 1 | protected | VU | | HU |
| *Adonis vernalis* L. | 1 | protected | | | HU |
| *Aegilops cylindrica* Host | 70 | | NT | | HU |
| *Agrostemma githago* L. | 30 | protected | NT | | CZ |
| *Allium victorialis* L. | 2 | protected | EN | | HU |
| *Amygdalus nana* L. | 1 | protected | NT | | HU |
| *Anemone trifolia* L. | 3 | protected | EN | | HU |
| *Anthriscus nitidus* (Wahlenb.) Hazsl. | 2 | protected | NT | | HU |
| *Arabis alpina* L. | 5 | protected | EN | | HU |
| *Armeria elongata* (Hoffm.) K. Koch | 10 | protected | EN | | HU |
| *Asplenium javorkaeanum* Vida | 2 | protected | | | HU |
| *Asplenium scolopendrium* L. | 2 | protected | NT | | HU |
| *Aster sedifolius* L. | 2 | protected | | | HU |
| *Astrantia major* L. | 2 | protected | | | HU |
| *Bupleurum rotundifolium* L. | 30 | | NT | | HU |
| *Cardamine waldsteinii* Dyer | 2 | protected | CR | | HU |
| *Carduus crassifolius* Willd. subsp. *glaucus* (Baumg.) Kazmi | 3 | protected | | | AU |
| *Carpinus orientalis* Mill. | 2 | protected | EN | | HU |
| *Centaurea mollis* Waldst. et Kit. | 1 | protected | EN | | HU |
| *Centaurea triumfettii* All. | 3 | protected | | | HU |
| *Cephalanthera damasonium* (Mill.) Druce | 10 | protected | | | HU |
| *Cirsium erisithales* (Jacq.) Scop. | 7 | protected | VU | | HU |
| *Crepis pannonica* (Jacq.) K. Koch | 30 | protected | EN | | HU |
| *Dentaria glandulifera* O. Schwarz | 3 | protected | NT | | HU |
| *Dianthus collinus* Waldst. et Kit. | 50 | protected | NT | | HU |
| *Dianthus deltoides* L. | 30 | protected | | | HU |
| *Dianthus plumarius* L. subsp. *praecox* (Kit. ex Schult.) Domin | 10 | strictly protected | CR | | HU |
| *Dictamnus albus* L. | 3 | protected | | | HU |
| *Dracocephalum ruyschiana* L. | 20 | strictly protected | CR | | HU |
| *Eriophorum vaginatum* L. | 10 | protected | CR | | HU |
| *Ferula sadleriana* Ledeb. | 4 | strictly protected | EN | x | HU |

Table 1 (continued)

| Plant species | No | PiH | Pih | Nt | Co |
|---|---|---|---|---|---|
| *Helleborus dumetorum* Waldst. et Kit. | 10 | protected | | | HU |
| *Helleborus odorus* Waldst. et Kit. | 15 | protected | | | HU |
| *Hesperis matronalis* L. subsp. vrabelyiana (Schur) Soó | 10 | strictly protected | NT | | HU |
| *Hieracium bupleuroides* C.C.Gmel. | 30 | protected | CR | | HU |
| *Inula helenium* L. | 30 | protected | | | HU |
| *Iris sibirica* L. | 20 | protected | NT | | HU |
| *Jurinea glycacantha* (Sibth. et Sm.) DC. | 2 | protected | DD | | HU |
| *Lamium orvala* L. | 1 | protected | EN | | HU |
| *Lilium martagon* L. | 7 | protected | | | HU |
| *Linaria angustissima* (Loisel.) Borbás | 5 | | DD | | HU |
| *Lunaria rediviva* L. | 1 | protected | NT | | HU |
| *Lychnis coronaria* (L.) Desr. | 60 | protected | | | HU |
| *Melampyrum arvense* L. | 50 | | NT | | HU |
| *Onosma tornense* Jáv. = *O. viridis* (Borbás) Jáv. | 5 | strictly protected | CR | x | HU |
| *Onosma visianii* Clementi | 4 | protected | NT | | HU |
| *Orchis purpurea* Huds. | 50 | protected | | | HU |
| *Peucedanum officinale* L. | 1 | protected | NT | | HU |
| *Poa remota* Forselles | 4 | protected | EN | | HU |
| *Primula vulgaris* Huds. | 10 | protected | | | HU/ RO |
| *Pseudolysimachion spurium* (L.) Rauschert | 3 | strictly protected | VU | | HU |
| *Pulsatilla grandis* Wender. | 1 | protected | | x | HU |
| *Pulsatilla nigricans* Störck | 2 | protected | | | HU |
| *Rosa pendulina* L. | 2 | protected | NT | | HU |
| *Scabiosa canescens* Waldst. et Kit. | 10 | protected | | | HU |
| *Sesleria heufleriana* Schur | 5 | protected | VU | | HU |
| *Sesleria hungarica* Ujhelyi | 3 | protected | NT | | HU |
| *Silene bupleuroides* L. | 10 | protected | | | HU |
| *Silene dichotoma* Ehrh. | 50 | | NT | | HU |
| *Silene nemoralis* Waldst. et Kit. | 300 | | NT | | HU |
| *Sorbus domestica* L. | 1 | protected | NT | | HU |
| *Telekia speciosa* (Schreb.) Baumg. | 5 | protected | EN | | HU |
| *Tephroseris crispa* (Jacq.) Rchb. | 1 | protected | VU | | HU |
| *Thlaspi jankae* A. Kern. | 5 | protected | | x | HU |
| *Thlaspi kovatsii* Heuff. subsp. *schudichii* (Soó) Soó | 10 | protected | EN | | HU |

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## Population size estimation of three wild orchid species in the Botanical Garden of Soroksár

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The Botanical Garden of Soroksár is an exceptional one among the other Hungarian collections. Large expanse of natural and seminatural habitats can be found within the borders of the 60-hectar garden. The most valuable part of these is the approximately 12-hectar area of *Molinia* meadows which ensures home for numerous rare and endangered species. The Orchidaceae family is recently represented by four protected species in these meadows. Three of them have large populations along the habitat. As a part of the survey of the conservation values of the botanical garden we made an estimation of population size of *Anacamptis palustris*, *Gymnadaenia conopsea* and *Dactylorhiza incarnata*. In 2016 the flowering individuals were counted on the whole area of the *Molinia* meadow. The number of plants without flower was estimated on the base of three 5 m × 5 m sized sampling plots of each species. In these plots all of the individuals were counted and the ratio of the flowering and non-flowering individuals was calculated. The constancy of the flowering – non-flowering ratio was statistically acceptable only in the case of *Anacamptis palustris*. The numbers of the other two species could be estimated with larger errors. We estimated 1240 individuals of *Anacamptis palustris* (1114 flowering), approx. 1460 individuals of *Dactylorhiza incarnata* (520 flowering) and approx. 4350 individuals of *Gymnadaenia conopsea* (2120 flowering). Due to the well-known fluctuations in the flowering behavior of the wild orchids and their tendency for dormancy our study should be evaluated as a first attempt for determining the size of these populations. However, this survey could be the basis for the monitoring of our orchid species in the future and other research on their population dynamics.

**Keywords**: wild orchids, population size

## Living collections of tropical orchids in Ukraine: research, educational and conservational missions

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The M. M. Gryshko National Botanic Garden of the National Academy of Ukraine was established in 1935 and opened for the public in 1964. The 130-ha Garden's collections comprise more than 14 thousand species and cultivars including outstanding collections of woody and shrubby temperate plants, annual and perennial ornamentals, medicinal plants as well as the unique collections of tropical plants.

*Ex situ* conservation of tropical orchids threatened with extinction within their native ranges is one of the highest priorities on the research agenda of the National Botanic Garden. The orchid collection, currently comprising approximately 450 species in 170 genera, native to South-East Asia, South and Central Americas, with a few genera from Africa, has been a main focus of the Garden's Living Collections. To promote long-time *ex situ* conservation of orchids, the research activities at NBG focusing on the following issues: studies of developmental biology of orchids (with special reference to reproductive biology of epiphytes and lithophytes as the most vulnerable groups); investigation of structural adaptations and life histories of orchids to survive under a wide range of different habitats; development of in vitro orchid propagation procedures; assessment of biological activity of various orchid plant parts, including seeds; creation of orchid displays as an efficient tool in raising public awareness in issues related to conservation of orchid species that suffered over-collecting, global climate changes and irreversible loss of their natural habitats.

A display glasshouse "Orchidarium", opened for public at NBG in 2005, is a logical end-point of long-time dedicated investigations of orchid plants in their native habitats as well as under glasshouse conditions. This exhibition highlights the diversity of orchid plants, their uniqueness and the ways how these plants can be used by people, and provides education on sustainable living.

To conclude, the NBG's living orchid collections are used as valuable sources of material for diverse scientific projects, conservational and educational programmes linked to public education on plant conservation and improving human attitude to nature.

**Keywords**: orchids, collections, *ex situ* conservation, exhibition glasshouse

## Activity of Kaunas Botanical Garden of VMU on the protection of endangered and rare plants of boreal forests

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Boreal forests are intensively managed to maximize wood gathering notwithstanding the importance of maintaining biodiversity. The preservation of endangered and rare plants has become an important but complicated task in times when drastic forest ecosystem changes are observed following clearcuttings. The Kaunas Botanical Garden of Vytautas Magnus University implements the MEKODINA project (grant No. SIT-1/2015 funded by the Research Council of Lithuania) that includes the task of protecting rare understory plants after clear-cuttings.

We aim at determining the "minimum required conditions" for the survival of rare and endangered species in the clearcut forest areas. While implementing the project several new localities of rare and protected plant species were discovered which led to new sets of information about *Arnica montana* L., *Pulsatilla patens* (L.) Mill., *Silene lituanica* Zapał., as well as *V. myrtillus* var. *leucocarpum* Haussm. and were included in the protected species information system (PSIS). Individuals of *A. montana* and *P. patens* that are recorded in the Lithuanian Red Data Book were found only in very few isolated plots. Our investigations corroborated the crucial influences in the development of juvenile populations of *Lycopodium annotinum* L., *L. clavatum* L., *Diphasiastrum tristachyum* (Pursh) Holub, and *D. complanatum* (L.) Holub. We ensured the protection of these archaic plants by marking their habitats. The conditions of other plant populations were evaluated and means for their protection were proposed. - The endangered plant species need careful restoration activities that may include population translocations or re-introductions, in order to prevent their extinction. We will continue investigations on *ex situ* propagation and preservation of rare and endangered plants at a specific part of the living collections in Kaunas Botanical Garden.

**Keywords**: forest, rare plant, population

## *In situ* and *ex situ* conservation of gypsophilous plant community from the south-eastern part of the Sălaj County, Romania

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The gypsum habitats, due to their particularity, belong to the most threatened habitas in Europe, but they don't receive enough attention yet. Although gypsum soils are considered extremely unfavorable for life, the plant communities encountered here are remarkable and diversified.

The Gypsum from Sfăraj-Jebucu, situated in the south-eastern part of the Sălaj County a very interesting plant community. Our research the past few years has resulted in a record of 293 plant species belonging to 46 families. The area represents a refugium for Carpathian and Transylvanian endemic species ( *Thymus comosus, Sesleria heufleriana, Jurinea transylvanica, Cephalaria radiata, Onosma pseudoarenaria* ) in addition to rare species encountered in Romania including *Gypsophila collina*, *Daphne cneorum*, *Artemisia alba*, *Salvia nutans*, *Plantago argentea*, *Echinops ritro* subsp. *ruthenicus*, *Astragalus monspessulanus* and *Seseli gracile*. The environment is considered only slightly affected by anthropogenic activities, and for the specific requirements of plant life and the survival of the species and their composition it is of great importance to preserve the quality and integrity of this habitat. Our attention focuses on more or less 50 taxa which are a dapted to calcareous and gypsum substrate.

To save the richness and the peculiarity of the vascular flora native to the gypsum sediment of Sfăraș-Jebucu, we pronounced a proposal to conserve site as a protected area.

Over the past few years The Botanical Garden Jibou initiated an *ex situ* conservation program for 50 species of interest. For this purpose an area of about 100 m2 in the garden was separated, and prepared with a special gypsum substrate resembling the natural habitat of Sfăraj-Jebucu. So far, 24 species are included in this unique planting of the Botanical Garden; these plants were obtained from seeds collected in the field at Sfăraș-Jebucu.

**Keywords**: conservation program, gypsum habitat, Botanical Garden Jibou

## Investigations of pollinators of ericaceous species in Lithuania

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Pollinator declines could affect many basic ecosystem services, food security and nutrition, agriculture and wild plant availability. One consequence of pollinator decline may be an increased vulnerability of some plant species to extinction. We focused on three ericaceous subshrub species: *Calluna vulgaris* L. (common heather), *Vaccinium myrtillus* L. (blueberry, bilberry) and *V. vitis-idaea* L. (lingonberry). Apart from the biological and ecological importance, they provide significant socioeconomic services, in the case of *Vaccinium* spp. All three species are entomophilous, pollinated by bees and other insects, and can be characterized by generalist pollination systems. Our study plants exhibit mixed-mating systems, but in all three species insect pollination is important for seed production, and both *V. myrtillus* and *V. vitis-idaea* may be pollen limited and can produce fruit of inferior quality if self-pollinated. The dates of field observations coincided with the peak flowering period of our study plants and observations took place in May for *Vaccinium* species and in August for *C. vulgaris*. Our investigations revealed that flowers of *V. myrtillus* were visited mostly by hymenopterans: social bees (*Bombus terrestris*, *B. pratorum*, *B. pascuroum*, *B. hypnorum*), solitary bees (*Andrena* sp., *Andrena* cf. *jacobi*), ants, and wasps (Vespidae), and also by dipterans (hoverflies Syrphidae); however, most of video- recorded visits (over 95%) were by ants (Formicidae), which fed on nectar. They visited flowers of *V. myrtillus* and *C. vulgaris* utilizing the nectar of both species and were the most abundant visitors to flowers of blueberry, suggesting that they may contribute to pollination, at least in *V. myrtillus*. The investigations were funded by a grant (No. SIT-1/2015) from the Research Council of Lithuania (MEKODINA).

**Keywords**: ecosystem, flower, pollinator.

## Ecological factors affecting demographic parameters of *Cypripedium calceolus* in Latvia

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Orchids are very sensitive to habitat changes. *Cypripedium calceolus* is affected by a combination of several ecological factors. In Latvia, this orchid occurs mainly in partially shaded coniferous and mixed woodland on moderately moist soils, in wooded meadows and in forest clearings. It is sensitive to sudden changes in light conditions, which affects not only the size of the population, but also plant development. In this study we determined the effect of light as tree stand canopy openness (%) and vegetation (vascular plant and moss) cover (%) on *Cypripedium calceolus* demographic parameters (number of ramets, flowering number of ramets, number of flowers and seedpods per ramet). Data were collected in 2016 and 2017 from May to September in 12 populations in Latvia. Circular (1.5 m radius) sample plots with *Cypripedium calceolus* and without orchid (control sample plots) were used to collect data on cover in height classes of shrub and herbaceous species, and also cover of moss. The number of sample plots in each population varied, depending on the size of the population. Tree stand canopy openness was estimated from hemispherical images obtained using a digital camera with a fish-eye lens. Hemispherical images were analysed using the WinSCANOPY program. Poisson regression models were used to determine the effect of ecological factors on orchid demographic parameters. Initial results showed that tree stand canopy openness (%) and cover of moss (%) had significant positive effect on number of ramets and number of flowering ramets. Understory and shrub cover less than 1 m height had significant negative effect on the number of ramets, number of flowering ramets and ramets with two flowers, but other ecological factors lacked significant effect on demographic parameters of *Cypripedium calceolus* in Latvia.

**Keywords**: *Cypripedium calceolus*, demography, lighting, vegetation cover.

## Long-term monitoring in the Soroksár Botanical Garden tracking resilience and change of natural Pannonian habitats

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The 54 years old Botanical Garden of Soroksár is situated at the periphery of Budapest, on the edge of the Pest lowland area, on sandy and alluvial deposits of the Danube river. The garden has a harsh cont inental climate with cold, windy winters and hot, dry summers. The Garden is famous for preserving natural sites and reconstructed vegetation spots that are remnants of the Pannonian forest steppe. The 12 hectare fen community, has been preserved in its natural state while the lake and the surrounding wet habitat, the inland sandy dune as well as the naturally regenerated pedunculate oak forest are reconstructed habitats. In March 2015 we started a long-term monitoring in five sites including the Pannonian fen community and the surroundings of the lake. Five poles were fixed permanently and high resolution pictures are taken from the same position, twice per week all over the year, at the same period of the day. Up to know two years climate data from the meteorological station are evaluated with the collected and processed photo records tracking population dynamics, floral biodiversity and phenology. To get an idea on the changes over space and time in this highly protected area we consider important the long-term monitoring in places that do not change significantly in small time scale. We need to understand stability and its reasons, as much as we need to understand change and its causes in the time of the ongoing climate change to take the best managing str ategy for preservation. Slide shows will be presented.

**Keywords**: fen meadow, photo records, meteorological data

## Conservation of plants by translocation: some examples from the practice of botanical gardens

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In accordance with the terminology of IUCN, the translocation, or living organisms displacement from one territory to another suggests three types of processes: introduction, or movement of organisms beyond their historical natural range; reintroduction, or deliberate movement of the organism into that part of its natural area, from which it disappeared in historical times; restocking, or individuals' movement to reinforce existing populations. The first, during recent years - the second and third directions are widely being used by botanical gardens allover the world for biological diversity conservation.

Botanical Garden of Samara University has been conducting introductory tests numbering more than 2000 taxa of the world' dendroflora, and demonstrated the survival in its new region for 1000 taxa. This includes some invasive woody species ("biological pollution"), primarily *Acer negundo* L., or to a lesser extent *Parthenocissus quinquelfolia* (L.) Planch., *Elaeagnus angustifolia* L., *Ulmus pumila* L. Our ways of restocking of existing populations and reintroduction aimed at the conservation of rare species includes 11, mainly non-woody, species since 2008. Eight of these are included in the Red Data Books (Samara Region and others), namely *Iris aphylla* L., *I. pumila* L., *I. sibirica* L., *Juniperus sabina* L., *Clematis integrifolia* L., *Polemonium caeruleum* L., *Dictamnus gymnostylis* Stev., *Lilium martagon* L.; 3 of them are classified as "disappeared" in the Red Data Book of the Samara Region: *Iris halophila* Pall., *Paeonia tenuifolia* L., *Euonymus europaeus* L.). The field monitoring showed satisfactory state for 5 species in natural biotopes, and a good state for 3 taxa. *Paeonia tenuifolia* L. demonstrates massive flowering, seeding, the presence of self-sowing, and *Euonymus europaea* L. began its flowering and fruit formation. These species can be considered restored in the Samara region.

**Keywords**: plant conservation, introduction, reintroduction

## The flora of walls in University Botanic Garden – Balchik (Bulgaria)

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Restored and constantly cleaned walls present a unique opportunity for spontaneous colonization by the plants of the diversified surrounding landscape. The aim of this study is to establish species diversity, characteristics and trends about the origin and variability of the vascular mural flora („green walls") in the nine sites of University Botanic Garden – Balchik.

During the study we determined more than 80 species and 65 genera and found the most common families are Asteraceae (8%), Caryophyllaceae (8%) Poaceae (7%), Fabaceae (4 %), Rosaceae (4 %), Moraceae (4 %) and Amaranthaceae (4 %).

Some of the species used for „greening the walls" are accepted as an additional ornamental elements and contribute to the complete perception of architectural and historical sites, especially *Cymbalaria muralis*, *Hedera helix, Ficus carica* and *Polycarpon tetraphyllum*. The total representation of alien species on the studied walls is 17% and a few of them are also highly invasive (*Ailanthus altissima*, *Acer negundo*, *Amaranthus hybridus*, *Euphorbia maculata, Oxalis corniculata* and *Oxalis dilenii)*. The dominant floristic elements are Adv (25%), Kos (16%), Eur-As (16%) and subMed (10%) and the wall flora shows characteristics similar to the Mediterranean wall floras.

The wall flora plants in almost all of the studied sites create an additional decorative effect on the walls and the buildings as archeological and historical sites and contribute to their general aesthetic perception. The growth of trees causes a strong and negative effect on their consistence. It is necessary to o bserve constantly the degree of vegetation on the walls and their surrounding area and not to let it spread excessively.

**Keywords**: urban flora, vascular plants, wall flora, wall preservation

## *Ex situ* conservation of the giant plantain (*Plantago maxima* Juss.) in Soroksár Botanical Garden

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The giant plantain is a highly endangered species of the Hungarian flora with a few populations threatened of extinction. Therefore, the *ex situ* conservation is of great importance.

In our study we proposed to get to know the plants' environmental determinants for seed germination for a successful propagation. Also our goal is to get acquainted with the habitat requirements of the species for estabilishing a new back-up population. In 2014 seeds were collected from six ripened spikes of six different plants. We investigated the effect of cold treatment as a factor responsible for breaking the seed dormancy and the light demand for the induction of seed germination. In addition, we compared the seed germination between the different mother plants and the germination rate between the different sized seeds originating from the same plants. We managed to grow a significant amount of plants, which were the initial bases of the *ex situ* populations in Soroksár Botanical Garden. Three experimental populations were relocated to the natural meadows of the garden into different habitats. We measured the development of the plants in every two weeks.

Our results showed that cold treatment is not needed for the initiation of the germination. However, the seeds are positive photoblastic. We detected significant differences of seed germination between the mother plants but according to the size of the seeds we could not detect any differences. Comparing the three habitats we found that the mesophilous habitat differed from the other two in leaf size. In the number of leaves no difference were found between the three habitats.

In 2017 we will continue the measurements and also do some coenological surveys for more complex results also regarded the natural habitats, so that we can compare them to trace out the optimal habitat for the new back-up population in its natural land, close to the threatened original populations.

**Keywords:** *Plantago maxima*, *ex situ* conservation, germination

## Magnolia collection in the Botanical Garden of the University of Latvia

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*Magnolia* is one of the most ancient woody plants; today, the genus is represented by approximately 300 species. Species are distributed in South and East Asia and in South and North America. Most of them are tropical and subtropical plants. The Global Tree Assessment's latest Red List publication highlights that nearly half of the magnolia species are threatened with extinction in the wild and different conservation act ivities are on the agenda. *Ex situ* conservation by the botanical gardens is a part of the Global Strategy for Plant Conservation.

Latvia is located on the north-east coast of Baltic Sea. Generally the climate of Northern Europe with cold winters is too hard for most *Magnolia* taxa. However, the deciduous magnolias which originate in the mountain region, can be appropriate for introduction in Latvia. The experience with the introduction of magnolias in Latvia started in Riga – in the Botanical Garden of the University of Latvia (BGUL) more than 60 years ago. Currently 17 taxa are in the collection 10 of them are species, three are hybrids and four are cultivars. Of the IUCN (International Union for Conservation of Nature) Red List of Globally Threatened Magnoliaceae, 3 species are present in the in BGUL collection: *Magnolia cylindrica* as vulnerable, *Magnolia stellata* as endangered, and *Magnolia wilsonii* as near threatened species. The age of the plants among threatened species is from 13 to 37 years; all of them are blossoming and ripening seeds.

Since the middle of the 20th century BGUL has tried to introduce around 60 species and sorts of magnolia. The natural habitats of tested taxa chosen for introduction are native to North America, China and Japan, wher e the climate is comparatively similar to Latvia. The magnolia species were grown from seeds obtained from other botanical gardens in China, Japan, Germany, Poland, The Netherlands and the Ukraine, but cuttings and plants of cultivars are from Germany, the Netherlands and the Ukraine.

**Keywords**: *Magnolia, ex situ* conservation.

## Peculiarities of propagation and *ex situ* conservation of Georgian endemic species *Campanula kachetica* Kantsch.

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*Campanula kachetica* Kantsch. – the Kakhetian bellflower – is a species of primary conservation status, included in the Red Data List of Caucasus Plants. It is endemic to Georgia and has a very limited distribution range. Currently *Campanula kachetica* is present in a single population, located in East Georgia on limestone rocks of Jurassic period.

For the first time we have carried out a complex study to reveal the propagation and self-regeneration capacity of *Campanula kachetica*, its biological peculiarities, productivity of seed, its seed viability, conditions and terms of seed germination, viability of seedlings, seasonal rhythm of seed development, conditions of seed storage, seed storage behaviour – quality and germination capacity of the seed stored in the seed bank for four years. Our study of the self-regeneration capacity of the seeds collected from open-pollinated plants, as well as seeds produced by isolated individuals revealed a really high percentage of germination – from 85 up to 95%. When sown in soil, the species passes through the complete ontogenetic cycle in two years. Seeds stored in the seed bank reveal high germination capacity.

Our studies have shown that in its natural habitat *Campanula kachetica* propagates mainly vegetatively and rarely by seed. For the seed to germinate it is necessary to fall into favourable environment and un der proper climatic conditions; otherwise propagation capacity by seed is quite high in *Campanula kachetica*. The species is characterized by biological plasticity and a labile character of pollination. In particular, besides allogamy, facultative autogamy is characteristic to the species.

The obtained data together with other criteria are important for the evaluation of natural population of a target species and development of methods for sexual propagation of the species in its natural habitat.

*Ex situ* conservation work has been carried out. Seed collections of *Campanula kachetica* are preserved in the Caucasus Regional Seed Bank and duplicated to the Millennium Seed Bank of the RBG, Kew.

**Keywords**: *Campanula kachetica,* germination, conservation.

## *Ex situ* conservation of some medicinal plants of Georgia

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Georgia's flora is estimated at 4130 vascular plant species, one fifth of which are endemics. Flora of Georg ia is known to contain a remarkably high number of species of medicinal value, with over 700 species utilized in Georgian traditional medicine and 200 taxa registered in the official pharmacopoeia.

Hundreds of Georgian economical plant species are threatened with extinction or exposed to risk of genetic erosion. The vast majority of medicinal plants in Georgia are harvested in the wild and in some cases are even overexploited. Due to economical difficulties in Georgia, the wild flora and habitats are under the permanent anthropogenic pressure such as tree felling, overharvesting of wild species, etc. that cause deterioration and fragmentation of habitats and extinction of many species of medicinal value.

It is of urgent necessity to take conservation measures for these species through both *ex situ* and *in situ* protection methods. For this purpose it is of critical importance to collect data on the distribution of the above species and on the vitality and fertility of their populations.

In 2001, the Caucasus Regional Seed Bank (CRSB) was established as part of a collaborative project between Georgian botanists and colleagues from Missouri Botanical Garden "Sustainable Use & Conservation of Medicinal Plant Resources in the Republic of Georgia". As an output of the above project, seeds of 150 endemic and rare medicinal plants were collected and deposited to the CRSB. These are species that belong to the genera *Galanthus*, *Cyclamen*, *Paeonia*, *Colchicum*, *Dioscorea*, *Salvia*, *Gymnospermium*, *Helleborus*, *Anthemis*, *Nepeta*, etc.

The next step in the further developing of the Caucasus Regional Seed Bank was collaboration with Kew's Millennium Seed Bank Partnership (MSBP) which was commenced in 2005 and continues to date.

Georgian botanists are keen to gather information on 700 medicinal species occurring in Georgia, collect the seeds and deposit them both to the CRSB and MSB.

**Keywords**: *ex situ* conservation, medicinal plants, seed bank.

## Testing of herbal perennials to invasiveness

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During the direct introduction of plant material in botanical gardens, nurseries, it is possible that different types of cultivated plants may escape into and naturalize in local habitats. To prevent this, the objective of the study is to develop methods and test them for currently invasive herbal species identification and for predicting potential risk of invasiveness of new alien taxa. This will help to do corresponding actions in the future and control or limit the risk of invasiveness at regional and national levels.

The collection of ornamental herbal perennials of the Botanical Garden of the University of Latvia (BGUL) was studied. In the territory of BGUL the phenological, self-sowing and vegetative distribution data of 537 introduced alien taxa were collected for 21 years.

For the study, the group of 48 taxa with very good signs of adaptiveness was selected. All of them had high seed production capacity and showed possibility to invade their surroundings within artificial and seminatural plant communities. Of these, 11 have already been recognized as „garden escapers", and one of them – *Lathyrus latifolia* – in 2016 was found in the natural habitat of Latvia.

The other group for the study consisted of 254 taxa with good acclimatization: only 7 of them possessed good self-sowing in seminatural communities (*Allium cernuum, Arabis caucasica, Aruncus dioicus, Dianthus barbatus*, *Primula elatior, Telekia speciosa, Verbascum olympicum*) and 35 of them exhibited intense vegetative expansion. 6 taxa had already been known as garden escapers in Latvia: *Fallopia sachalinensis, Fallopia japonica, Physalis alkekengi* var. *franchetii, Tulipa sylvestris, Vinca minor*.

It is concluded that 73 taxa from the BGUL herbal perennial plant collection have a potential to become invasive.

**Keywords:** adaptation, invasiveness, herbal perennials, self-sowing

## Habitat restauration of old-fields in Körös-Maros National Park (Hungary) with *ex situ* propagation and planting of loess grassland species

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In recent decades the *ex situ* conservation of endangered species has become one of the most important tasks of botanical gardens because of worldwide loss of habitats, increasing vulnerability of plant species and decreasing biodiversity.

The SZTE Botanical Garden has recently carried out a project in the territory of the Körös-Maros National Park. Tasks included collection of propagulums from natural loess grasslands, *ex situ* propagation and plantation of at least 3000 individuals of rare and protected loess plants to old-fields with different ages.

The collection of the propagulums was carried out during 2011. The outdoor propagation of 29 species was started with seed-sowing in the autumn of the same year. The seeds of 21 species were sowed in a light- chamber in March of 2012. Outplanting was carried out in October of 2012. The propagation was successful; the end result was 5914 individuals encompasssing 32 species. Four, partly restored former arable fields were choosen as planting sites in the northern part of the National Park. The plantings to the four sites were organized in a pre-arranged matter; individual plants were planted out in a grid system of 5 m × 1 m on the suitable parts of the old-fields. Outplanting was made by imitating the spatial pattern of a natural loess grassland community. Individuals of abundant species (*Silene otites, Phlomis tuberosa, Senecio doria, Thalictrum minus, Filipendula vulgaris*) were planted to each sites, while species with low abundance (*Ajuga laxmannii, Astragalus austriacus, Peucedanum alsaticum, Carduus hamulosus, Scutellaria hastifolia*) were planted to only one site. The condition and survival of plants was monitored yearly between 2013 and 2016 in the experimental sites, the number of new individuals was recorded.

According to our four-year data the plantation experiment was successful; out of 32 planted species, 29 survived and reproduced in all habitats, the survival of one species was uncertain and only individuals of 2 species disappeared.

**Keywords**: Körös-Maros National Park, habitat restauration, loess grasslands

## Fruit micromorphology in some Apiaceae of Eastern Europe

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While working on the taxonomy of Old World Umbelliferae, we made a collection of fruit SEM images for about 700 species. Here we present an analysis of species of the European part of Russia and some taxa of ajacent countries, a total of 140 species. We compiled a dictionary for the characters and character states for the umbelliferous fruits and made comparable descriptions. SEM images give us an opportunity to interpret our observations with an optic stereomicroscope and find new data for plant identification and taxonomic work.

The most complex micromorphology is inherent in zoochoric fruits. *Turgenia*, *Daucus*, some species of *Torilis* have anchor-like glochoidia, in *Turgenia* and *Torilis* glochodia are armed by numerous small hooks, in *Daucus* and *Caucalis* glochidia are smooth. *Torilis japonica, Caucalis, Otlaya, Sanicula* have hooked emergences. The species with secondary ribs bear straight thick-walled hairs with tuberculate or rugulose surface on privary ribs. Some species have pubescent fruits with simple unicellular hairs. The hairs in species of *Anthriscus* and *Heacleum* have milticellular bases. In *Pimpinella* and *Trinia* the hairs are solitary, while *Seseli* and *Ferula karelinii* have tufted hairs. The latter species has densely pubescent ovary; however, the fruit stretches to 10–15 mm long and 7–8 mm broad and the pubescence becomes sparse.

Cell borders are often inconspicuous. If visible, cells are arranged in rows or at random, cell borders are raised or sunken and always straight in species under discussion. Outer periclinal walls are concave, flat, convex domed, with small papillae, with sharp or blunt projection. Conspicuous, solid, convex exocarp cells are present in some genera: *Ostericum, Pleurospermum, Aulacospermum* and *Taeniopetalum.* These cells are distinguishable as shiny granulate surface in optical stereomicroscope. Cuticular foldings often correlate with wall shape: flat or concave walls are striate, convex walls are rugulate, sharp projections are striato-knotted. Epicuticular secretions ("wax") are often absent and cuticular sculpture is clearly visible. Wax layer sometimes masks cuticula. In many *Bupleurum* species wax has the form of tiny scales.

Several species have glabrous fruits, inconspicuous cell borders and poor cuticular foldings, in this case there are no diagnostic micromorphological traits.

**Keywords:** Umbelliferae, taxonomy, identification, fruit morphology

## *Ex situ* conservation in the Botanical Garden of Eötvös University

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Botanical gardens were the first institutions where people dealt with *ex situ* conservation around the world. The Botanical Garden of Eötvös University (ELTE Füvészkert) is the oldest botanical garden in Hungary, founded in 1771 to educate the medical students, then the garden was enriched by ornamental plants. During his many travels Pál Kitaibel, our second director registered the locations of the native Hungarian species, including the rare *Crambe tataria* which was planted in the garden at that time. In the fifties of the 20th century our director, Szaniszló Priszter was among the first who investigated the propagation possibilities of rare an d endangered plants in Hungary. From 1987 up to now we have had four *ex situ* conservation projects. In the ELTE Füvészkert we cultivate 8259 plant taxa, including 336 protected and 339 red listed species from all around the world, but just a few specimens per species. In 2007 we started developing genetically variable *ex situ* populations of 31 species with 100-200 individuals per species; we have been keeping them for long term. Some of these are glacial (e.g. *Primula farinosa*) or interglacial relicts (e.g. *Carpinus orientalis*). Hungary is located at the crossroads of atlantic and forest steppe zone, where a wide range of species of steppes, forest steppes and closed forests can be found. Some other „*ex situ* species" are phytogeographycally important: these may be Pannonian endemic or relict endemic species (e.g. *Ferula sadleriana*) or Pontic (e.g. *Dracocephalum austriacum*) floristic elements, which are distributed to East Europe and West Asia. The *ex situ* conservation programs have different means and targets, mainly introducing endangered plants, but some of them undertake developing an „*ex situ* population" and re-introduce the plants to their former natural habitats. The ELTE Füvészkert has done such reintroductions in some cases (e.g. *Telekia speciosa*) and plans to do this with two other species (*Crepis pannonica, Senecio umbrosus*) in cooperation by the appropriate national parks.

Every year we organise events related to conservation (e.g. International Day for Biological Diversity); we established a „green school" (Grüne Schule) to educate the children, similarly to that in Palmengarten der Stadt Frankfurt am Main. The ELTE Füvészkert is a member of certain international (IPEN, BGCI) and national (MABOSZ) organizations and takes part in domestic and international sharing/exchanging its plant resources and data.

**Keywords**: ELTE Füvészkert, plant introduction, reintroduction, protected plants

## Contribution of seed banks across Europe towards 2020 GSPC targets 8 & 9, assessed through the ENSCONET database

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To meet the international biodiversity targets of the Global Strategy for Plant Conservation (GSPC), it is important to assess the success of coordinated *ex situ* plant conservation initiatives such as the European Native Seed Conservation Network (ENSCONET), which operated from 2004 to 2009, and the ENSCONET Consortium, which was established in 2010. In particular, analysis of the ENSCONET database (ENSCOBASE) indicates that *ex situ* seed banks (especially of Eastern and Central European countries) have been making significant progress towards meeting GSPC targets 8 (at least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20% available for recovery and restoration programmes) and 9 (70% of the genetic diversity of crops, including their wild relatives and other socio-economically valuable plant species, conserved, while respecting, preserving and maintaining associated indigenous and local knowledge) for native European species. However, the infraspecific diversity of threatened species stored in ENSCONET seed banks needs to be increased to meet research and conservation objectives.

**Keywords:** ENSCONET, Global Strategy for Plant Conservation, *ex situ* seed conservation, infraspecific diversity

## 2017 Update of the 2013 Strategy for Plant Conservation in Botanical Garden of the Faculty of Science, University of Zagreb

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Zagreb Botanical Garden of the Faculty of Science is the main Croatian institution actively participating in conservation of endangered plant species according to GPSC 2020, by maintaining live specimens, banking seeds, researching germination ecology and introducing plants to the horticultural trade. Since Croatia joined EU in 2013, the main focus of our work are the Natura 2000-species living wild in our country.

Research on germination ecology of Croatian Natura- and statutorily strictly protected species (*Degenia velebitica* (Degen) Hayek, *Ligularia sibirica* (L.) Cass, *Klasea lycopifolia* (Vill.) A. Kern., *Scilla litardierei* (Breistr.) Speta, *Genista holopetala* (Koch) Bald. and *Adenophora liliifolia* (L.) A.DC.), collected in the wild according to the special permits obtained from the Croatian Ministry of Environment and Nature Protection, was finished successfully. Seedlings of all investigated species were grown to be planted in the Botanical Garden rockeries with collections of indigenous plants, as required by the permits.

For every species grown in such manner, further cultivation requires finding the best planting position and creating the most natural conditions for them to thrive. Such a spot should have the potential to effectively conserve the particular species, as well as to continue the study of its life-span and to promote public awareness on the importance of preserving plant diversity.

Building the necessary capacities for the implementation of Strategy for plant conservation and preservation of threatened species from the wild in the Botanical Garden collections is our continuous mission.

**Keywords**: Croatia, Botanical Garden, Natura 2000, conservation

## The occurrence of *Vinca major* polycorms in the Soroksár Botanical Garden

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*Vinca major* is a low, creeping dwarf shrub with overwintering foliage. It is native in the Mediterranean region and frequently used in European gardens for centuries. Therefore it became widely naturalised, but its curr ent alien status in Central European countries isn't established yet.

In Hungary, *V. major* has sporadic occurrences in the wild which is probably due to the illegal placement of the garden waste in forest habitats close to settlements. It has a definitely powerful vegetative reproduction ability and can be self-propagated by the tore down stem pieces.

The species has a large population in the Soroksár Botanical Garden where it was planted shortly after the foundation (1960s). In the present study, we measured and digitalized the exact prevalence data of the species within the Garden and evaluated the possibilities of its escape from there.

We recorded altogether 24 clearly separated patches. Additional 3 points were also recorded, with an area less than 1 $m^2$. These latter spots consist of only about 2–3 individuals. The *V. major* spots cover a total of 6.899 $m^2$ in the Garden, that is, 1.15% of the whole area. The smallest polycormon is about 1.6 $m^2$, while the largest 1.851 $m^2$ (average 287 $m^2$). The species drifted long distances in the Garden as the maximum distance between the two most distant spots is 1.1 km.

*V. major* usually occurs under forest plantations, the largest spots are located under *Robinia pseudoacacia* forest, whose foliage provides a fair amount of light to the undergrowth.

*V. major* has also a 15 $m^2$ spot in the so called "Rock Garden" unit where it grows together with *Geranium sanguineum*. The surrounding trees provide some shadow, but the microclimatic circumstances are not optimal for the species there.

Two large polycormons are bordered by the outer fence of the Garden. So far, the concrete base of the fence prevented the spreading of *V. major*, but its developing sunlight- and dryness tolerance draw attention to the potential danger of its expansion into the Great Hungarian Plain, under *Robinia* forests.

**Keywords**: *Vinca major*, large periwinkle, invasion, naturalised alien

## The conservation of the Romanian flora in one botanical garden – the first project of this kind in the country

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The "Vasile Fati" Botanical Garden Jibou (Sălaj County) is the second largest botanical garden in Romania (circa 27 ha). Here we initiated one of the most important conservation projects related to the native flora of Romania. The area allocated for conservation the Romanian flora covers more than 3 ha, so we decided to represent all the different habitats of the country. Different kinds of species need different kinds of habitats, which requires a lot of work and planning. The final result will consist in representing all the 372 types of habitats encountered in Romania.

The area granted for the Romanian Flora was initially covered almost entirely with forest, therefore we had to transform the landscape, which fortunately is uneven. The work started in 2013 and so far, we managed to realise more than 40% of the project. First, were designed the rockeries similarly to those encountered in the Carpathians and Dobrudja. We used limestone and rocks with acid substrate. Next we created two major peat bogs. Ongoing works consist in planning the continental sand dunes, sea shores, steppes, swamps and lakes.

Of the more than 3000 species of the Romanian flora, the Botanical Garden Jibou shelters more than 800 taxa. Most of them are obtained from seeds collected in the wild. Some Carpathian and Transylvanian endemic species are found in the rockeries (*Silene zawadzkii, Thymus comosus, Campanula carpatica, Sesleria heufleriana, Onosma pseudoarenaria* etc.). The peat bogs shelter rare species such as *Drosera rotundifolia, Andromeda polifolia, Vaccinium oxycoccus, Lysimachia thyrsiflora, Viola epipsila, Typha shuttleworthii, Betula nana, B. humilis* etc. *Corynephorus canescens* is growing on the sand dunes, while *Dianthus nardiformis, Sempervivum zeleborii*, and *Iberis saxatilis* are present in the Dobrudja rockery habitats. From the rare species growing in the botanical garden, *Fritillaria meleagris* is an example of a successful conservation project thanks to the work of our researchers.

**Keywords**: Romanian flora, conservation, habitats, botanical garden

## Changes in the Bryophyte flora in Botanic Garden of Eszterházy Károly University (Hungary)

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The 1-ha protected area belonging to the Botanical Garden of Eszterházy Károly University is situated in the northern edge of Eger. Recently, a garden reconstruction program took place in the botanical garden supported by a KEOP project. As a consequence some microhabitats disappeared; changed or got disturbed while during project new habitats were also formed (a swamp garden, new rocky grassland, central space, and new patches).

More recently, two research efforts were made to check the bryophyte species in the botanical garden: one investigation was started before the reconstruction took place and one after the works ended.

The results show that several species disappeared from the previously known microhabitats but also new species occurred in the new habitats created in the garden. As an example, *Homalothecium lutescens* formed great cushions in-between the grass species but after making a swamp there was no habitat for the species. As a parallel process, new species occurred on the wet surfaces of the swamp garden not seen there before (*Marchantia polymorpha, Physcomitrium pyriforme*). As an example for a regeneration process, *Climacium dendroides* can be mentioned. The distribution area of this species decreased during the works but it survived and shows an expanding presence.

There were no changes in the species composition of epiphytes because the old trees of the garden were not disturbed. The reason for changes in the species composition of the garden was evidently the reconstruction process. The research of the first author was supported by NKFI OTKA 115796 research project.

**Keywords**: bryophyte flora, disturbance, short-term changes

# Roof garden – Biology classroom

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**Abstract:** Work in botanical gardens does not encompass only care for plant collections, seed banks, and protection of plant species, but also includes, to a large extent, education. Education activities are conducted directly in botanical gardens, in the form of educational tours, workshops, exhibitions, and similar activities. However, it is increasingly important that gardens spread their knowledge beyond their boundaries and reach the public. The Botanic Garden of the University of Ljubljana is already successfully collaborating with various institutions in promoting the rich flora of Slovenia. In 2014, we started the planting project for the roof garden, parking lot, and school-adjacent greens at Gimnazija Ledina in Ljubljana. The roof garden includes three longitudinal concrete roof-adjacent channels, each with its own specific sun exposure, leading to slightly different selections of plant species. We thus prepared an imitation of a karst garden and forest undergrowth. In the exterior part, on the school courtyard, where the amphitheatre is intended for students, we planted shade-tolerant species that are not too sensitive and do not require special care. All species selected for planting were autochthonous, because we wanted to educate students and teachers on Slovenian biodiversity. The roof gardens and the garden in the courtyard were also used as teaching aids in botany classes. We presented the concept of planting to the students, who then marked the plants with labels themselves. Within the scope of the project, each student chose a specific plant species and monitores its phenological stages, and finally prepares a seminar paper. Additionally, they present their findings to their classmates in the form of an exhibition. With such collaboration, we expanded the activities of the Garden beyond our boundaries, and arranged a living teaching aid for botany classes in high school.

**Keywords:** roof garden, autochthonous plants, botany teaching

## Introduction

Botanic gardens have always been tasked with more than just storing, updating and presenting their plant collections to the public. Furthermore, their goals are not just scientific and research activities, but teaching on all levels of education. Ultimately, botanic gardens were established for educating medical students, as lack of knowledge of plant species used in health care could cause problems, even the patient's death (Cappelletti, 1994; Rogers, 2007; Johnson, 2007). Botanic gardens were therefore generally part of universities and faculties of natural sciences. Botanical knowledge is essential for human survival (Bennett, 2014). For this reason, some botanic gardens in the past educated the general public, not just students, about plants. Even Carolus Linnaeus held public lectures in this garden, as well botanical excursions, attended by up to 300 participants (Harnesk, 2007; Liden, 2007).

In 1810, the Botanic Garden of the University of Ljubljana was founded primarily for education purposes. It was established at the time of Illyrian Provinces as part of the central schools (Ecole centrale), which had the status of a university in Slovenia. One of their required sections was a botanic garden (Polec, 1929; Ciperle, 2009). Article 9 of the Decree by Marshall Auguste de Marmont on 4 July 1810 states that, in addition to a library, a department for physics and a department for chemistry, a botanic garden must be established (Polec, 1929; Pintar, 1939; Baras, 1984; Šumrada, 1999). At that time, the garden was called the Native Flora Garden. It is therefore not surprising that the founder of the botanic garden, and the first head of the garden, Franc Hladnik (1773–1844), was a teacher of natural sciences and botany at institutions of higher education (Praprotnik, 1994, 2012; Bavcon, 2000, 2010; Bavcon & Ravnjak, 2015). Until 1834 he was renowned by his botanical lectures, which as an elective course represented an advantage of education in Ljubljana compared to education in other regional cities that did not have this option (Pintar, 1939; Praprotnik, 1994, 2012; Ciperle, 2001). With his knowledge, his botanical lectures inspired many people to study the flora. Quite a few of his student later became famous botanists. One such student was Henrik Freyer (1802–1866), who later became the first custodian of the Estate Museum of Carniola. He also inspired apothecary Žiga Graf (1801–1838) and Muzio Tommasini (1824–1897), who was the pioneer in teaching botanical studies in the Slovenian Littoral. He was also an inspiration for Aleksander Škofic (1822–1892), who in 1845 founded an organisation for exchange of plants, and in 1851 started editing the Austrian botanical journal, Österreichische Botanische Zeitschrift (Praprotnik, 1994, 2012). With his knowledge and education, he certainly had the most profound influence on his gardener, Andrej Fleischmann (1804–1867), who arrived at the botanic garden as a young man. In addition he accompanied Hladnik on his botanical travels. As a good student, he took over as head of the Botanic Garden after Hladnik's death. As head of the garden, Fleischmann brought the Botanic Garden closer to the

general public. His educational activities were extremely extensive, with focus on the importance of teaching natural sciences. He published his opinions in newspapers, like the Novice. In one of his articles published in 1849, he discussed how important for every person is to have some basic knowledge of nature. He discussed the use of plants and the fact that natural sciences we should be teaching to children. In the next publication of Novice in the same year, he expressed his sadness that natural sciences are only taught in school for one year, which he considered to be absolutely insufficient. However, he is pleased that the new decree on education requires natural sciences to be taught for several years in a row. Fleischmann also promoted the development of suitable textbooks in natural sciences (Praprotnik, 2004, 2015; Praprotnik & Bavcon, 2016). He always emphasised that in general, botany and natural sciences must be accessible to all people. In 1851 in the botanic garden, he began a series of lectures on plants for the general public. Lectures were held on every Wednesday at 6 PM, and were announced in Novice newspaper. One year earlier, he held a lecture at the Veterinary School in Ljubljana. These lectures took place also at the botanic garden, as he was saying "because true knowledge of plants can not be achieved from books and painted images, but where the plants grow." In addition to such teaching, he also studied applied botany. He helped farmers across Carniola with his advices (Praprotnik, 2004, 2015; Praprotnik & Bavcon, 2016). The next head of garden, Alfonz Paulin (1853–1942) had developed the Botanic Garden to the level of other botanic gardens of universities across Europe. As a consultant and supporter, he collaborated in arranging various school gardens (Wraber, 2008; Bavcon & Ravnjak, 2015).

The tradition of educating both the experts and general public continued in the following decades. Today, the Botanic Garden of the University of Ljubljana is providing education on plants and nature in general not only within its own borders, but beyond them as well. A large part of visitors are scholar groups of various educational levels. During guided tours and with the help of a worksheet, we present the kingdom of plants and everything related to it. For the general public, we organise lectures on the topic of plants, using the same schedule as that of Andrej Fleischmann (Wednesday at 6 p.m.). We also organize various exhibitions that include knowledge of the plant of the world (Bavcon *et al.*, 2010; Bavcon *et al.*, 2015). Furthermore, we organise practical workshops and seminars for the general public. At practical workshops, participants get a chance to learn how to reproduce plants, how to graft, how to cultivate and use them correctly, etc. We do not hold lectures only in the garden, but elsewhere as well. We are often invited to libraries and various societies that are interested in plants (Ravnjak & Bavcon, 2017; Bavcon & Ravnjak, 2017). Recently, there has been a lot of public interest in honey plants. We therefore hold lectures on honey plants for apicultural societies, and provide advice in planting gardens with honey plants. We are also a partner in the project LIFE Naturaviva Biodiversity – Art of Life, whose main goal is to promote biodiversity in the general public.

The Botanic Garden of the University of Ljubljana operates not only on its own land, but beyond it as well. Such activities include the planting of the roof garden at the Gimnazija Ledina high school. As a request of the headmaster and biology teachers, we prepared a plan for planting autochthonous plant species to be used for educational purposes, in the existing concrete rooftop planters. The plan was to use the roof garden in the educational process to showcase plant diversity, to present the different habitats, and to use the plants as the source of plant material in laboratory exercises.

## Methodology

The roof garden at Gimnazija Ledina was established in 2014 in two phases (Bavcon & Ravnjak, 2014).

*Planting* – In the first phase, we planted the roof garden. Plants for the roof garden were planted in three concrete rooftop planters, which had different exposure to sunlight and dimensions. Because of different exposure to sunlight, different plant species were selected for every flowerbed; however, all plants selected were of our native flora. Furthermore, with the selection of plants we made sure that at least a few plants were flowering at any time during the growing season. When selecting plants, we considered their habitat and maintenance requirements. We therefore chose primarily those plant species that we assumed not be difficult to maintain, taking into account that we recreated, to the greatest degree possible, the conditions of their natural habitat. The combination of the above points ensures that maintenance of such a garden require the least amount of work.

Before planting, the roof flowerbeds were suitably prepared, e.g. watertight, with planting substrate commonly used for roof gardens. This substrate is much lighter than regular soil. We did not arranged an irrigation system in rooftop planters, because they are exposed to precipitation and all chosen plant species are adapted to shortage of moisture in the soil. In the concrete rooftop planter having a northern exposure and shady, we arranged a roof garden with plant species that comprise the forest undergrowth (Table 1). In the roof planter most exposed to sunlight, we planted karst plant species that tolerate strong sunlight and dry rocky soil conditions (Table 2). In the roof planter exposed to sunlight for half a day and in the shade for the other, we planted species that are adapted both to partial shade and to moderate sunlight (Table 3). All planted

plants were marked with wooden tags that showed the scientific names of plants. After planting, we filled the sunny and partially shady rooftop planter with fine granular dolomite, with 8–12 mm granule size. We thus prevented growth of weeds and created a warmer microclimate for the karstic plant species.

*Education* – In addition to its aesthetic function, the roof garden is dedicated primarily for education. We also marked some specimens of plant species with wooden tags, so that students could be educated on plant species. Second-year students of two departments were given a tour and a presentation of the roof garden. We then organised a guided tour in the Botanic Garden of the University of Ljubljana, with a discussion of plant systematics. We presented the habitats that we arranged on the roof of their school, as well as typical representatives of such habitats. At the same time, we wanted the students to pay attention to the arrangement of the garden and marking tags listing the species of plant and other attributes (e.g. genus, family, and origin of species). As part of their project tasks in 2015/16 academic year, all students of the two departments chose plant specimens of different species (every student had a different species, or at least a specimen) growing on the roof garden, and monitored their phenological stages throughout the year. At the end of the year, they prepared two descriptions of their chosen plant species and presented the changes over the season. They presented an extensive description of the plant species and the phenological stages of their specimens to their classmates. Short descriptions with plant/species photographs were exhibited in the classroom facing one of the roof gardens as educational material for everyone visiting the classroom. A description of the project was also posted nearby for any passers-by. The plan also included three posters, with descriptions of the three different types of habitat arranged on the roof gardens, which was posted in the classroom facing individual gardens. These are not yet

**Table 1.** Plant species planted in the shaded rooftop planter with northern exposure.

| Shade | No. of specimens |
|---|---|
| *Cyclamen purpurascens* Mill. | 50 |
| *Danaë racemosa* (L.) Medicus | 6 |
| *Dentaria penthaphyllos* L. | 5 |
| *Eranthis hyemalis* (L.) Salisb. | 10 |
| *Galanthus nivalis* L. | 30 |
| *Geranium macrorrhizum* L. | 5 |
| *Helleborus niger* L. | 25 |
| *Hepatica nobilis* Mill. | 10 |
| *Leucojum vernum* L. | 10 |
| *Ornithogalum umbellatum* L. | 10 |
| *Phyllitis scolopendrium* (L.) Newm | 5 |
| *Sarcococca saligna* Müll. Arg. | 2 |
| *Vinca minor* L. | 10 |

**Table 2.** Plant species planted in the rooftop planter most exposed to sunlight.

| Sunny | No. of specimens |
|---|---|
| *Ajuga genevensis* 'Istra' | 15 |
| *Allium ochroleucum* Waldst. & Kitt. | 25 |
| *Allium senescens* L. | 25 |
| *Artemisia alba* Turra | 5 |
| *Aster amellus* L. | 5 |
| *Aster linosyris* (L.) Bernh. | 5 |
| *Capparis spinosa* L. | 2 |
| *Ceterach officinarum* DC | 10 |
| *Cotinus coggygria* Scop. | 2 |
| *Crithmum maritimum* L. | 5 |
| *Cyclamen purpurascens* Mill. | 50 |
| *Dictamnus albus* L. | 9 |
| *Eranthis hyemalis* (L.) Salisb. | 10 |
| *Galanthus nivalis* L. | 30 |
| *Inula hirta* L. | 5 |
| *Prunus mahaleb* L. | 2 |
| *Polypodium australe* Fée | 10 |
| *Ruscus aculeatus* L. | 12 |
| *Salvia officinalis* L. | 5 |
| *Satureja montana* L. | 5 |
| *Sedum acre* L. | 30 |
| *Sedum maximum* Suter | 15 |
| *Sempervivum tectorum* L. | 30 |
| *Thymus* sp. | 30 |

**Table 3.** Plant species planted in the rooftop planter with partial shade.

| Partial shade | No. of specimens |
|---|---|
| *Ajuga genevensis* 'Istra' | 18 |
| *Aster lynosiris* (L.) Bernh. | 5 |
| *Cyclamen purpurascens* Mill. | 50 |
| *Eranthis hyemalis* L. | 10 |
| *Galanthus nivalis* L. | 30 |
| *Jovibarba hirta* (L.) Opiz | 10 |
| *Laserpitium siler* L. | 12 |
| *Ligusticum seguieri* (Jacq.) Koch | 12 |
| *Ornithogalum umbellatum* L. | 10 |
| *Paeonia officinalis* L. | 3 |
| *Scabiosa graminifolia* L. | 5 |
| *Sedum acre* L. | 15 |
| *Sedum maximum* Suter | 10 |
| *Sempervivum tectorum* L. | 30 |
| *Viola odorata* L. | 10 |

implemented as part of this project (the project work was performed by students as part of the project "Eco-Schools – Biotic Diversity"). Students also prepared indicators with names of plant species and photographs for plants growing in the roof garden. By means of teaching the roof garden plants, teachers can present the concept of plant biodiversity and its importance to their students. For this purpose, a questionnaire on the concept of biodiversity was prepared and handed out to students.

## Results

*Planting* – After planting the roof garden, we monitored the growth of plant species in all three rooftop planters in the following years. We found that the plants have successfully formed micro-populations. Mediterranean species, such as *Crithmum maritimum* and *Capparis spinosa*, which were planted in the roof garden as a first experiment, successfully survived the winter. Of the three rooftop planters, the most effective growth was in the shady and sunny planter. In the shady planter, the populations that grew most intensively were *Vinca minor*, *Hepatica nobilis*, *Helleborus niger* and *Geranium macrorrhizum*. Mosses also started to cover the ground surface, which means that after three years the ground in the planter resembled the ground of a forest undergrowth. During the three years, we found that the species with highest rate of propagation were in the sunny rooftop planter, with plants including *Sedum maximum*, *Aster amellus*, *Artemisia alba*, *Ajuga genevensis* 'Istra' and *Thymus* sp. All these species reproduced successfully both with seeds and vegetatively. In the partially shady rooftop planter after three years the dominant species were *Viola odorata*, *Scabiosa graminifolia* and *Aster lynosiris*. We have had problems with weeds in all planters but when any weed appeared they were promptly removed by the caretakers. As the planted species had overgrown certain parts of the planters, additional work on the roof garden was not required.

## Education

Students' annual project ended with a term paper, in which they classified their chosen plant species, listed their morphological features, described their habitats, defined their distributions, its potential use value and other interesting facts, and added an overview of the phenological phases. Some students prepared an overview of species in a certain plant group, such as spring plants in the roof garden. Their project tasks encouraged students to observe plant species throughout the years. Students could also compare different species that live in the same habitat, as well as adaptation of species to these environments. Furthermore, students learned how to do independent work that requires patience and good observation skills.

## Discussion

Despite that at first glance the creation of a roof garden (in concrete rooftop planters) seems quite an unusual idea, planting was successful and the plants are still overgrowing the roof garden today. The garden was exceptionally well received among students and teachers. In the upper classrooms, where the windows only provided the view of bare rooftops of the neighbouring buildings, the roof garden is a welcome sight and proven a good experimental area for students. Through the phenological changes of vegetation, they had a chance to observe the different seasons, the changing view from the classroom one day to the other, throughout the year. Plants have a positive effect on the education process. For example, students' progress in learning increased by 10% to 14% in the classrooms where plants were present (Doxey *et al.*, 2009; Daley *et al.*, 2010). We observed the students' better attitude to follow the course of lectures in the classrooms with a view on planted roofs – in comparison to students who could only see urban, artificial, constructed environment (Benfield *et al.*, 2015). The study also showed that students who could see nature from their classroom also had higher grades at the end of the semester. Aside from significant psychological effect on students and employees, plants included in the school facility can serve as an effective teaching implement. Active participation of students in the process of managing and care of the school garden, students, by doing practical work can learn about the basics of gardening and about the plant's needs. By planting useful plant species, teachers can educate students about the dependency of human life on plant production (www.lifelab.org). Furthermore, teachers have fresh plant material and live plants available at all times for laboratory exercises, thus making it easier to teach botany using practical examples (http://jardinermonecole.org/wp-content/uploads/2016/07/GFLBook; van Pelt, 2015).

However, school facilities in dense urban environment constantly face a shortage of space. Therefore, there is not sufficient space to arrange the gardens despite all the positive effects gardens provide for teachers, students, and to educational process. In such cases, roof gardens are especially suitable. Modern buildings many times have flat roofs, which are best suited for planting roof gardens. Of course, certain safety requirements must be fulfilled, especially in the case of a school roof gardens that will be accessible also to students. The roof

needs to have sufficient load-bearing capacity, a safety fence has to be constructed around the roof or garden, safe access must be provided to the roof, the roof can not have any windows or shafts that a person could fall through, the roof must have an appropriate drainage system, and the surface on the garden and roof should not be slippery when wet (Tank, 2010). Considering the function of the roof garden, the most important things to consider are preparation of the surface and the selection of the best suited plant species. To arrange a garden that requires minimal maintenance, it is best to use a prepared commercial planting substrate. Such a substrate is much lighter than soil. Considering that the surface is directly exposed to quite intensive sunlight, we recommend applying plant species that are resistant to increased sunlight and drought. This eliminates the need for an additional irrigation system. Plants suitable for planting in roof gardens, with a natural appearance and minimal maintenance required, include various species from the genera Sedum, Sempervivum, Thymus, Festuca, species like Allium carinatum, A. schoenophrasum., A. tuberosum, etc. (Liepelt, 2016; Sincalir, 2017; Hawke, 2015). Species on the roof can then be left alone to grow and reproduce naturally. We only have to remove any potential weeds and invasive plant species.

Hay residue from the dry meadow is also suitable for planting roof gardens with a natural outlook (Bavcon, 2013; Bavcon & Ravnjak, 2016). Even for schools, the most suitable roof gardens are those with vegetation that looks as natural as possible. Such gardens required less maintenance, as they're practically self-sufficient. This is particularly important during summer holidays, when there is no staff working in the schools. Roof gardens undoubtedly have a very positive effect in the urban environment, also from the perspective of building management. They reduce the carbon footprint in the city, act as water retention measures in rainy weather, prevent heat loss during heating season, resulting in lower heating costs, and cool the upper building floors during the summer months (Tant, 2010).

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## Why shall we visit the Botanical Garden in Vácrátót? The educational system in the National Botanical Garden

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**Abstract**: The National Botanical Garden is the taxon-richest living plant collection of Hungary, situated only 30 from Budapest. It is also among the country's most popular botanical attractions with more than 40.000 visitors a year. Our botanical garden has to be well prepared for such level of interest and, when preparing guiding and information materials, be prepared for even the most unexpected questions that might be raised by visitors, schoolchildren and retired people from various age groups, with different educational levels and range of interest. Some people come only for a pleasant walk in the fresh air, away from the city. Other visitors want to learn about plants and animals, and perhaps are keen gardeners or plant enthusiasts. Last but not least there are those, who would really like to know more about how plants function, learn about botany or the science of ecology. To meet the above described demands is not easy at all, especially that these are additional to our basic scientific, collection-managing and overall development tasks, which remain the same as usual. The versatile educational information system that we provide for the public has several elements, such as guide booklets, plant of the month leaflets, information boards for permanent and current attractions, didactic trails (with guide booklets), permanent exhibitions on changes of the environment and on the environmental challenges of the 21st century.

**Keywords:** visitors information panels, boards, leaflets, plant collections

The National Botanical Garden located in Vácrátót is the most taxon-rich living plant collection of Hungary. The garden was founded in the early 19th century, in the style of the landscaped gardens of the Georgian age. It was owned by several different families. In 1870 the garden came into the property of Count Sándor Vigyázó, devoted to science, who transformed the garden into a rich collection together with Vilmos Jámbor, famous landscape gardener of his age. In the early years of the 20th century, the Vigyázó romantic landscaped castle garden was well known for the richness of its dendrological collection, rock gardens and greenhouses.

The Vigyázó family donated the estate to the Hungarian Academy of Sciences in their testament. After the damages and the ruins of World War II the garden was cleaned and restored to its original beauty according to the original plans. The garden opened its gate to the public in 1961 and since then it is part of the Institute of Ecology and Botany.

The National Botanical Garden is situated at only 30 km distance from Budapest. It is the richest botanical garden in Hungary, with more than 12 000 species presented in a beautiful landscape garden, covering more than 27 hectares. With its lawn, trees, lakes, interesting and beautiful plants, the Garden is waiting for those wishing to get away from the harms of the civilization and for tourists or students who want to learn about botanical gardens.

The Garden is open every day of the year; the main visitor seasons: April–May and middle of September to middle of October; the rush hours: Easter, 1 of May, Pentecost; September: school excursions, first Sunday of October: our yearly plant and food fair.

The Garden is very popular, we receive more than 60.000 visitors yearly, family, children, seniors as well. There are 110–130 student groups per year. Our purpose: providing botanical knowledge, shaping attitude in leisure time.

Visitors can get information of our programs (what's on, plant of the month, programs, opening time, ticket prices etc.) on the webpage and facebook site of the Garden. Arriving to the entrance gate they can buy tickets, information booklets, and arrange for guided walks. Two big maps on panels and maps in the guidebooks, plus indicators throughout the Garden are available to guide people around.

## Educational system of the National Botanical Garden

Our botanical garden has to be well prepared for an extremely diverse package of predictable expectations and questions formed, but not asked yet by visitors, schoolchildren and retired people from various age groups, with different educational levels and ranges of interests. Some people come only for a pleasant walk in the fresh air away from the city. There are visitors who want to learn about plants and animals, and perhaps are keen gardeners. Last but not least there are those, who would like to know more about how plants function, they would like to acquire knowledge in botany and ecology.

All these are the main demands (not easy ones at all) of our educational system in our garden that has to be met, while the scientific and collection-managing functions of the botanical garden remain intact.

This versatile educational information system has several elements, such as the Guide booklet, Plants of the month leaflets, information boards for permanent and current attractions, educational trails (with guide booklets), permanent exhibitions dealing with changes of the environment and on other challenges of the 21st century.

### *1. Information booklets*

Garden guide – overview: about history, geography, collections, etc.

Plants of the month is an A4 format black and white leaflet about 8–9 interesting plants currently blooming, with a map included.

Educational plant trails: thematic walks of 10–20 stations, with the support of a booklet and map. Currently we have several plant trails.

The „Botany Plant Trail" is teaching about the organisation of plants. Scholar groups particularly prefer this.

The "Chinese and American Plant Trail" presents the plants and their role in the cultural history.


**Figure 1.** Ticket window of the Vácrátót Botanical Garden.

## 2. Boards

In different parts of the Garden, there are large, permanent panels showing information on the major collections in the garden (plant system, rock garden, Hostas, greenhouses). Other large panels present the fauna of the garden (birds, fish, water habitats). The permanent small panels in the greenhouses are for people interested in exotic and houseplants. There are seasonal small boards about herbaceous native plants for people interested in wildflowers. There are also some panels describing herbs and medicinal plants for people interested in gastronomy and ethnomedicine.

The Plant Systematic Collection was designed and created in 1954 by Miklós Ujvárosi, former leader of the garden. His project was based on the phylogenetic system of plant by Rezső Soó, member of the Academy of Sciences. In 1954, Professor Soó developed a vertical system of structure with six parallel evolutionary series (4 Dycotiledones, 2 Monocotyledones) arranged in a way, that the nearly 90 plant families, grouped in separate beds and show simultaneously their mutual relationships and phylogenetic evolution. The beds were arranged like a fan, with an artificial hillock at the centre. We find the most ancient flowering plants on the hillock-top, and the individual branches of the system are separated by avenues leading from the hilltop, showing the parallel directions of evolution.

The collection primarily aims at showing herbaceous plants, but in order to relieve summer heat and to avoid the monotony, it became necessary to diversify the panorama with the help of smaller shrubs and climbing plants.

We use not only permanent boards, but during the season we exhibit some boards about garden history (family history of the owners, garden buildings, etc.), about current points of interest (tulips, Eremurus, wild garlic, Gunnera, etc.) and notable plants (tallest tree, etc.), for people interested in culture, history or other curiosities. In periods when usually families with children visit the garden, stopping boards with plant tales and legends entertain and teach parents and children at the same time. During a frost-free period there is a temporary plant trail on plants of the Bible for Christians, and people who want to learn about the Bible. The twelve stops present the fruits, vegetables and spices mentioned in the Bible. Visitors also learn about the role of the vine or cedar in the Bible, and can see the papyrus and the myrrh in the greenhouses.


**Figure 2.** Information panels for medicinal plants in the Vácrátót National Botanical Garden


**Figure 3.** Permanent board introducing wetland habitats in Vácrátót National Botanical Garden


**Figure 4.** Karbonház Visitor Centre in Vácrátót National Botanical Garden

### *3. Visitor Centers*

The Garden has two permanent interactive exhibitions, which are very important as educational means to acquire the environment-conscious attitude, but also a good alternative for families when visiting the garden in poor weather conditions.

Berkenyeház Visitor Center is situated at the garden entrance, presenting the functions of the botanical gardens, the importance of the seed banks and explaining the multilevel relationships between plants and people. The display accentuates the responsible behaviour of everyday life for scholar groups and families.

The Karbonház Visitor Center can be found near the greenhouses, next to the cactus house. It contains permanent exhibitions explaining the meaning of the ecological footprint, renewable energy sources, biodiversity and several other environmentally important topics, for secondary school and university students and those who are interested in the environmental challenges of the 21st century.

## Problems, challenges

Keeping up of the educational system is expensive, because needs yearly renewing or updating in every other year and so requires continuous attention. Updating the webpage and paying attention to keep the Grden's facebook site active is an everyday task. Aesthetic aspects are relatively costly because it is very important to create our displays uniform and on decorative boards. The botanical garden is a historic landscape garden too, so it is not recommended to use too many and unproperly designed boards. The role of the staff at the ticket office is also great as they give the first impression to visitors when entering in the garden. It is also essential that they should speak foreign languages, at least a basic English.

**Figure 5.** Visitors study the information material on medicinal herbs in Vácrátót National Botanical Garden

## Why botanical gardens matter for neuroeducation?

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A new approach to educational neuroscience is developed on the basis of the Bayesian framework for cognition. According to it, cognition is powered by hypothesis-testing brain, constantly minimizing its prediction error. Expectations the brain generates are at three distinct levels of computations: (1) sensatio ns are guesses about what the brain is going to receive from the physical world, (2) perceptions are guesses about the cognitive niche, and (3) conceptions are guesses about the axiological mind. If prediction error is small (i.e. the place is perfectly matched with brain's expectations), the surrounding can be treated as a part of the extended human mind.

The botanical garden can be part of the extended human mind, enhancing its cognitive abilities. Firstly, it reduces the stress level. Secondly, it can promote efficient action. Thirdly, it can stimulate creative reflection. All three functions supported by three distinctive cortical networks can find application in both science and humanistic education. The need for leisure time in educational process, during which the most important-mental processes take part, is crucial for a human mind. Botanical gardens are perfect places for implementing education based on sustainable development of all human cognitive, emotional and motivational needs.

**Keywords**: neuroeducation, cognition, Bayesian framework

## Educational activities and events in the Botanical Garden of the Faculty of Science in Zagreb

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The organized guided tours of the Garden for children and general public are the oldest of our educational activities in the Botanical Garden of the Faculty of Science. Recently, numerous educational exhibitions were mounted and workshops organized in the exhibition pavilion after the renovations in 2007. The Garden undertakes coordination and participation in the national event called *Week of Croatian Botanical Gardens and Arboreta*, which takes place annually in May. During the Week, hundreds of visitors participate in various workshops, attend the lectures or listen to concerts free of charge. The Children's Flower and Vegetable Garden, opened in 2013, where the children from the nearby primary school can learn how to grow their own vegetables and flowers, has proven not only popular but also of great educational value. Another very popular event is visiting the Victoria House and watching Victoria cruziana flowers changing colour during the night. In addition, horticultural lectures and presentations in the Garden are organized parallel with the annual flower show Floraart in Zagreb.

**Keywords**: education, workshop, exhibition

## Higher education at botanic gardens: The HEI PLADI Project

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HEI-PLADI (Higher Education Innovation in Plant Diversity: flexible learning paths for emerging labour market) project was funded by EU Programme Erasmus+. This project relays on a constructive cooperation between seven different educational institutions, botanic gardens and a research institute from Italy, Portugal, Malta, Bulgaria, Poland and Greece.

The main goals of HEI PLADI are supporting implementation of reforms in line with the 2011 EU Modernization Agenda's priority areas; development of a European Area of Skills and Qualifications; enhancement of digital integration in learning, teaching, training and youth work at various levels.

Target audience: undergraduate and PhD students interested in Plant Biodiversity, Conservation, Management and Sustainability.

As a main output the HEI PLADI project provides teaching materials available as "open learning objects" in an e-learning platform for a wide number of professionals beside students as well as seven short-term training activities as part of the "flexible blended pilot program" which includes field works, field visits, practical and laboratory activities focused on developing skills and deepen knowledge on topics treated in th e e-learning courses.

As a long-lasting result project promotes the ideas that conservation and sustainable utilization of plant diversity have a pivotal role in contributing to food and nutritional security. Furthermore, the Convention on Biological Diversity (CBD), the Global Strategy for Plant Conservation (GSPC) and International Agenda for Botanic Gardens shall be recognized as important documents to build scientific and technological skills in plant taxonomy, *in situ* biodiversity management and *ex situ* conservation of both wild and domestic biodiversity.

**Keywords**: Botanic Gardens, biodiversity, management, education

## The role of the Buda Arboretum in landscape architecture education in Hungary

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Landscape Architecture education in Hungary is in an exceptionally privileged position, as its campus is located within the boundaries of a 7.5-hectare thematic plant collection. The Arboretum provides an excellent opportunity for students to prepare for a wide variety of courses and subjects both during and after lectures. The arboretum has a wide variety of microclimates, including some areas with climatic conditions unique in Budapest. Therefore, species with very different demands can be grown and displayed here. Apart from providing morphological knowledge, the presence of old plants (the old est Parrotia persica specimen of the country, for example) helps students visualize how different taxa look in later stages of their lives, which vastly benefits their long-term approach to planting design.

The Buda Arboretum does not only play a major role in subjects on plants themselves (Dendrology 1–3), but also in primary (Geodesy, Free-hand drawing), management (Landscape Construction and Management) and design courses (Dendrology 3, Planting Design). The foreign-language courses of the Master of Landscape Architecture programme and ERASMUS subjects are also largely based upon the Arboretum and its plants. The garden also hosts courses on the subjects of tree surveying, tree care and maintenance, soil studies, environmental education and environmental psychology, all of which contribute to the multi-disciplinary training of landscape architects of all levels at Szent István University.

**Keywords**: Buda Arboretum, landscape architecture, Szent István University

## Managing botanical illustration course in the Main Botanical Garden (Moscow, Russia)

Olga Yatsenko, Igor Yatsenko

*Main Botancal Garden named after N.A. Tsitsin RAS, Moscow, Russia*

The Main Botanical Garden (MBG) in Moscow is the leading botanical garden in Russia. For many years it was mostly an academic organisation with a lot of closed doors for the visitors. Most of the information about collections and plants was confidential and only for staff. But the times had changed and we decided to make our botanical garden more friendly for visitors. When we came to work here at 2008 we noticed that there aren't any activities for the visitors in the Main botanical garden which could interest people in knowing more about plants or invite visitors to different departments such as Greenhouse, Arborethus et ctr. MBG still doesn't have an official social representation in Facebook, or in other social network. So we made an account for Greenhouse. And we decided to start with a Botanical illustration course with our classmate painter. We chose the Botanical illustration course as there such courses in our beloved botanical gardens such as KEW Gardens or Royal Botanical gardens in Edinburgh. As we couldn't get any additional financing from our administration we invited artists to work with us as volunteers. At the begging it was only one painter with more than 100k followers in Instagram. Now we have 4 of them and we start to pay them some money from the money we earn on the class. We made an announcement in Instagram and on Facebook page of our Greenhouse and in the Botanical garden. Now our classes are for people at age 12+, with any painting level. Earlier we tried to make classes especially for kids but there were 2–3 at a time and we decided to stop them for a change. The main idea of our class it that we teach is that you don't have to have special skills to draw a plant right away. We put emphasis on the illustration for botanical literature. The class is 2–3 hours long with 40 minutes lecture about plants that we'll draw. Mostly about its botanical features and what features will differ them from other plants. On our classes we usually draw living plants. Now we are working to make a real course of Botanical illustration containing 8–10 classes, which could complement each other, and so the student could draw a real botanical illustration in the end.

**Keywords**: botanical illustraition, botany

## Targeting different audiences: education in Warsaw University Botanic Garden

Marcin Zych, Iwa Kołodziejska, Krystyna Jędrzejewska-Szmek, Hanna Werblan-Jakubiec

*University of Warsaw, Faculty of Biology, Botanic Garden, Warsaw, Poland*

Our garden is an old university institution in 2018 celebrating its 200th anniversary, and firmly established in the city structures. Nevertheless we felt the need to know more about our audiences. That is why three years ago a sociological research was conducted, to verify who and why comes to our Garden. Audiences which were reached at that time where mostly elderly people, families and school children. The results also showed that many visitors are attracted by the beauty of the site rather than by the scientific and educational values. In 2015 and 2017 for the first time we conducted pilot anthropological research on the Night of the Museums (annual festival of the museums), during which we observed the behaviour and reaction of the visitors to the event. That allowed us to broaden our knowledge about the audiences and their needs. Co-creating with the new audiences raises new challenges and opportunities. For example, collaboration with NGOs gives new communication pathways and a linkage to professionals with different background, but may also cause difficulties. Crossing the garden's borders by going out with educational actions to the communities allows reaching people who never visit the garden. During the talk we will present some examples of events that where co-created with different community groups, migrants, artists and pupils; we will also invite to participate in BGCI's 10th International Congress on Education in Botanic Gardens to be held 9–14 September 2018 in Warsaw.

**Keywords**: audience, informal education, social network, university

# Round table discussion: Current challenges for botanical gardens 10th October, 2017 (National Botanical Garden Vácrátót, Hungary)

A summary by Mária Windisch on behalf of HAABG

Moderator: Michael Kiehn, Scientific Director of Botanical Garden of University of Wien, Austria
Participants: Pawel Kojs, President of Polish Network of Botanic Gardens
Géza Kósa, President of Hungarian Association of Arboreta and Botanic Gardens
Miklós Persányi, Director General of Budapest Zoo & Botanic Garden


## Themes of the round table discussion

- How to save functions of "classic" botanic gardens in the 21st century
- The importance of botanic gardens as national strategic wealth
- Expectations of the society from botanic gardens
- Rational separation of strange and acceptable demands vs. social pressure (strategies to separate between the acceptable demands from the non-acceptable ones)
- Innovative approaches, new solutions, directions and threats

**Michael Kiehn** states that the aim of the whole session is to improve our capablitiy to deal with these challenges which are before us. Asking the first question: How to save functions of classical botanic gardens in the 21st century, we have to identify functions we want to save (must define them according to our needs); we have to evaluate elements which are useful for the 21st century; and we have to show the relevance to the stakeholders.

**Miklós Persányi** feels being the odd one out in the company as the institution he represents is a zoo and botanical garden, with around one million visitors per year, and the focus of their interest is mainly on the zoo part, less on the botanical part – though it is still a traditional historical garden. Defining the theoretical functions of botanical gardens he mentions "the pure science".

According to Mr. Persányi the key question is that how pure science and non-pure science as well as the interest of the public can be met. Functions of science have changed during the last 200 years since we are talking about public botanical gardens. It is a different demand in the 21st century, with much stronger relevance to conservation. There was a time when classification, scientific taxonomy, and development of plant science in general was the main goal. But is it still a main goal in the 21st century? How can we use the traditional BGs for modern science, for all kind of technical innovations? For gene technologies, as a reserve for genetically modified organizations? At the same time how can we conserve this genetic pool that BGs must be proud of? There are mixed functions and at the same time there is a demand from the society for pleasure, education, leisure etc. It is an interesting duty to preserve traditions and meet modern demands at the same time.

**Pawel Kojs** tries to refine the problem from a different side, asking a question which he asks always when dealing with an institution: whether or not is it adapted?

Asking about an activity of an institution, he also asks about the potential of the surroundings. If the institution is supported without any questions, it can do anything, because it does not have any financial problems. Most of the botanic gardens are dependent upon financial support they achieve from different sources. So it is an important issue to realize who the key player in our surrounding is, and who can support our ideas. This way the question about traditional or classical BGs is also the question about the society and about the change we have undergone for the last 200 years. In order to receive enough support most BGs must adapt to the changing surroundings. BG's can try if tradition is worth to be sustained, but sometimes the question is: how to change and not to lose the main ideas of contemporary BGs which are actually very closely related to biodiversity conservation. Institutions must think over the role, the mission of contemporary botanical gardens. If it is needed, we should find a way to adapt.

**Géza Kósa** states that he is really conservative regarding this question, and is afraid of any change of the functions of BGs. He feels that sometimes functions of BGs are against the owner (even if it is the Hungarian Academy of Sciences) who might have very strange ideas about what to do in a BG, which is a big challenge. It is out of question that we must follow changes. According to Mr. Kósa a classical BG is a well-kept and maintained scientific collection, helping other branches of science like ecology, horticulture etc. besides the basic function. In his opinion BGs should stick to their original function, even if there is a big pressure coming from the society to do strange things in BGs. There are strict rules in their garden which you can read on signs walking around the garden. In his opinion there are different types of gardens, e.g. a garden for the children, a garden for the sportsmen, a garden for the tourists and a garden for the botanists, and we have to separate these functions from each other. According to Mr. Kósa it is not a good idea to mix the functions, it is better to make a clear function. It should be a botanical garden as a clear function, following the new results of botany and plant ecology. The BG lead by him has a gene bank, a seed collection, they keep & propagate endangered species and hold the hand of other botanical directions but don't want to open for strange directions. He agrees with Mr. Kojs on the strong dependence on supporters, and that financial problems exist everywhere and affect daily work. At the same time in his opinion we have to keep BGs as scientific collections on the first, second, and third place.

**Michael Kiehn** summarizes the different views and opinions about the diverse functions of BGs, how to keep them or deal with them and how external elements are influencing these. There were some controversial views on how to adapt, how to be proactive. Adaptation is a question everybody would agree. The question is in which frame to adapt…

**Miklós Persányi** believes we must realize that we are living in a changing world which means there are tourist functions for scientific BGs, and the key question is that who is paying the piper? There was always someone financing BGs, either a wealthy aristocrat or someone else, somebody was supporting it. There was a time when citizenship collectively financed the development of science.

Nowadays running a botanical garden includes that there must be some services upon demand – the question is who sets the demand, and who is able to put the money behind the demand.

At the beginning of the 21st century he doesn't believe in self-satisfactory services, doesn't believe that they are enough. There must be some kind of economically, socially well set system of goals and objectives, why BGs are worth to run, to justify why not to do something else on that piece of land.

BGs must prove why they are important for the public & for the society, not arguing why they are important for science (as society is not so interested in science). It must be justified why BGs are there and why society from different sources should spend money on them.

**Pawel Kojs** talks about the importance of being able to compromise for which we need some specific skills. On the long term everyone will need to adapt. This adaptation is partly disconnected with acceptance not only by public but also by policy in which we incorporate. The ability to network is also very important: to be in group of equally important institutions, and to be able to say and to show that we have some strength not only coming from the institution but also from the thinking about our institution by the audience, by our surroundings.

It is possible to build BGs starting from nothing and to convince many institutions, people and politicians that it is quite important to have BGs he explained mentioning an example from the region of Silesia.

As BGs we have to be very strongly connected to people. It is not because we do not know how botanical gardens should work; it is because we know what we need. We must convince others that it is worth to pay for it.

In the case of BGs adaptation can mean many things, and we can do more what we do, but we do as much as we want, and don't do things which are not necessarily important, not necessarily connected to classical functions of BGs. A BG doesn't have to become a playground, but the question is whether it should have a place where children after a short or longer walk can stop and say: yes, it was a very nice place. Because after ten or twenty years they will remember, they will have emotional connections with this place.

**Michael Kiehn** summarizes the two points; the long existing BGs with a long history on one hand, and the changes in the financial situation and the structure of these gardens and arboreta. There is a need for creating new BGs or revitalizing BGs according to new situations.

There was the Polish example about starting something from a very new perspective, adaptation, looking for supporters and for potential partners. It is quite important to set up something which is operational and can be improved. Not perfect being from the beginning, but aiming at fulfilling more and more functions.

From the traditional point of view, if a BG has a historical background, it has the reputation, as a center of science and research. The first and final aim of a BG is a well maintained and documented scientific collection. At the same time BGs must make sure that their value is acknowledged properly by surrounding audiences, by governing audiences, by those who are paying for or making decisions about BGs.

According to **Géza Kósa** the first issue is to know what a BG is, and it is far beyond the BGs. He tries to explain the functions of BGs, and finds that there is not much knowledge about botany in the families or at different school levels. BGs are basic for knowledge of plant life, can help to learn more about plant life and the value of plants in the 21st century. If visitors come to the garden without any knowledge about BGs – we can do as much as possible – there will be no results. Society should know about this question, we should disperse knowledge about BGs.

**Michael Kiehn** describes the familiar situation that many BGs are linked with other organizations which are under another organization etc. – and decisions are often made at higher levels. There is an impression that what BGs are doing is not seen, and is not understood.

He is not sharing Mr. Kósa's view that there is nothing to do against it. We can do something, just not immediately. We all have missions – and that came out clearly of the statements. He asks the audience to share what positive and negative effects they experienced due to the shifting of the society, and the perception of science.

**Bert van der Meijden** tells that in the Netherlands there are 25 botanical gardens, most of them small (their garden is 2,5 ha), and they are working under an umbrella: a Dutch society of BGs. In the past they were in trouble so several of them were shut, but they were lucky to get a donation of 3 million euros. They started to think what is necessary to do, how to reach out for the public, especially for younger people. It was decided that using modern technology should be part of it, and they worked on that for 5 years to find instruments, and developed a fantastic website. As a side product they found that when working together for a couple of years people on different levels of organizations got to know each other, and it results more organizational benefits.

**Michael Kiehn** draws the lessons that there are a number of potential solutions we can find on the national or regional levels depending on the situation in different countries. One part of the statement is going beyond regional approaches: it is network. From the experience we have from the European level: networking is really increasing options to, first of all, have the knowledge about what is happening around, so having the chances to fit in if you are not fitting in, and also to become proactive. Proactivity is another word for adaptivity, because it also means that you are not following directions, but try to create those directions. Try to create something which is based on your strengths.

Different gardens represented here have totally different demands coming from the outside world. Those demands we cannot control, those settings are quite different. But if we access the settings, that is the first step, what we should do: to know exactly what is the demand, what is the pressure and from which side. One of the obvious pressures is that scientific work has not the same value any more in society that it used to have; it has not the same respect as it has had before. It is not an evidence to finance a university or an academy anymore. We must accept that first of all, but that is only a starting point, because we have our strengths, views, we have the scientific background – we only need to know what to do with it.

Regarding education there is a big lack of basic biological knowledge all over around. Once he had a strange experience sitting on the tram, hearing two people talking about a tree – why does it grow there. They said it should be cut down to make sure there are no leaves falling down. It shows well that our perspective towards watching a tree is probably quite different from someone who has to pay the costs for cleaning the streets. We in BGs know which trees have more/less litter. A BG has been asked to help the city to find the right trees for the streets – that is one of the best practice examples where our knowledge in horticulture and in cultivating trees for hundreds of years is used. It is important that decision makers know that the knowledge is around, we have to make these connections. It is helpful for raising awareness about the knowledge in BGs.

Aggregation is really the keyword and we can do lots of meaningful activities in conservation – we can have a fantastic collection documented – if we are not able to make sure that it is understood first of all for the kids, then through all levels of society – then it is obvious why we don't get enough (financial) support. We must make sure we make it clear and make all levels of society understand the role and functions of BGs, the valuable knowledge preserved in and by BGs.

Looking at the education system, we are not satisfied with the way how botany or ecology is currently positioned. Can we do something in that regard? How many gardens do have green school programs? As BGs are

already a green something… A garden is an inviting place – otherwise people would not seek a garden – for leisure, – there is something from the comfort point of view why most people like the gardens – and green schools take advantage of that.

There are a number of gardens connected with universities. Which of those gardens are directly involved in curricula, in teaching the future teachers? We have all the knowledge which is needed to get involved.

It is important that we look at our strengths: collections, historical collections, scientific knowledge is a big strength, it is our strength.

It is important that we look at our missions. To make sure that conservation works, to make sure that the knowledge about botanical works – these are traditional tasks of botanic gardens which are extremely relevant in the 21st century. So the connection between those things – that is the challenge. There is no contradiction between, for instance, heritage and modern demands of society.

For instance in Austria people love places connected to Empress Elizabeth, where they put a sign "Sissy was here" – and make pilgrimage there. Obviously heritage has an attraction. We have to make sure to present it to the people. Just like in Schönbrunn – of course that is not the core mission but it can link to a plant family, to vegetative propagation, it links to tradition and horticulture. One of the key missions is to find out the particularities of our own BG – and try to build stories around that, to tell those stories.

Another example from two years ago, when we had an event: making the invisible to visible. With a microscope and some explanation of genetics they showed how fast Arabidopsis roots grow in time. They've had Arabidopsis plants from different parts of the world, and the roots were growing at different velocities. So a betting bureau was made to bet which root from where grows the fastest. With a result people asking: why. Arabidopsis is not the most fashionable plant of the world, but what happened was that more than 200 people came to bet. At the same time they saw the results of our research on pollen. They knew that there are allergic reactions to pollen, but they have never seen a pollen grain before in their life. Now they know that pollen grains are beautiful. This connection between the fact and the science and aesthetics is another key issue. Even the president of the republic came to that exhibition.

A Polish plant ecologist shares his experience using the expression that we are "plant people" but most people are not. We should start to think about how to show them that plants are fascinating. We are sure that plants are important part of life, there is no life without plants – but the rest of the society does not know that. We need to convince them about it. It was said before that animals might be more interesting than plants. Then let's start it with animals. Plants need pollinators, seed dispersal; animals eat plants… and so on. Starting from animals we can get to plants. If we accept that the society is plant-blind and start to teach basic things – then it gets better and better.

**Pawel Kojs** raises another question: whether emotions come first, then knowledge or knowledge comes first and then emotions? It is very difficult to keep people's interest. We say we are plant lovers, we think that all people should follow us. But they will only follow when we tell a story which is emotionally attractive. People will not like the plants first, but the teacher, then the plants. Sometimes I like the subject not because of the teacher but because of my father or mother or uncle… We are connected to the world through emotions. So when talking about modern, contemporary BG we should think about it as we were a flower. Flower is not only for attracting pollinator. Flower is to make possible the reproduction of the plant. But it is necessary to be very attractive to make this process, to fulfill. So that is why it is so attractive. BGs should try to attract people. Of course the essence is somewhere else. The space for making a true botany should be sustained and should be very valuable, but it is not enough.

**Miklós Persányi** has three key ideas regarding this discussion.

1.) How can we make BGs "sexy"? The main message, our story is not plants, it is life and nature. There is compartmentalization in science and in academy in general, but there is no compartmentalization in nature. Nature is unified. We must tell the full story, not only a story about one specific plant. The main goal is to tell the story for humans about nature.

2.) All institutions in our society, including BGs, need to justify their existence. Justification is very strongly based on that who are the constituents, for whom are BGs working for and why. Who is setting the demands? If we narrow it down to a university or another academic or scientific institution that might be right in some specific cases. But in many other cases the constituency is at least as important as to incorporate the local or the national community, not just scientists. It is also important to link people who are not part of the scientific community, but still have demands towards an interesting living collection. A good historical or botanical garden is a landmark for generations. It must be, or in many cases it is a popular place for many people who use it for many purposes. They went there to learn when they were a child, and then they took their grandchildren to the same place. It is an important mission to serve and operate as a landmark. There are those "present time services" for ordinary people meaning that it is quite useful if a scientific BG also serves as an extra rich garden center and provides practical advices for the city halls. Remembering the justification of the existence – by this

way gardens can raise reputation and respect in society. If respect is there, it influences decision makers. If they consider it is important for the population, then it starts to be important to them.

3.) Missions are changing whether we like it or not. In 1992 there were four key missions for zoos (and other living collections): scientific, conservation (*ex situ* or *in situ*), education, and touristic mission (leisure) for the population. People pay for their fees. If we want to keep BGs only as living museums – storehouses of genetic resources, it is not an option. Besides these four, there are much more missions of zoos as well as BGs. Like heritage missions, living heritage, built heritage or design, all kinds of caritative services, art and culture etc. We must take into consideration that at the same time these gardens (either with animals or with plants) are community areas. Not just the backyards of botanists or scientists. Considering the future of BGs – the key issue is: how can we link these modern functions without risking the traditional functions.

**Michael Kiehn** is asking from the audience any observations from their side related to the sexiness of life and nature, and the definition of missions in a social environment trying to keep the bases. Putting some important features coming out of being a heritage site we are all trying to be the flower for attracting the bees – the visitors – to the gardens.

Another **conference participant** adds that for those gardens which are directed or founded from communal support it is right to say that they are property of the community. It is proper to reach out for this community saying: you support us; this is what we are giving back to you. We do it the best way we can. We must have an open eye to the society around us, to modern needs, which change very quickly.

**Michael Kiehn** explains it another way. We all need best practice examples: personal experiences, gardens' experiences about trying to overcome problems. If an example fits for one garden it might fit for another garden with a similar social environment.

To start with university gardens as the appreciation of science has changed and it is not an evidence any more, universities have to look what university gardens can give back to society and what can they do to raise the reputation of the university garden, for the institutions which are still responsible for them.

All of us receive many visitors. The first question – is it clear to everybody that the garden belongs to a university, to an academy, that the academy or the university is supporting financially the maintenance of that garden? Most people think that gardens are nature grounds or open areas that they can visit for free or for a small entrance fee – and people often have no idea who is financing it, it is not self-evident. Closing a garden due to lack of money normally results in an outcry in the mass media. It was the case in Vienna when a garden had to be closed. A private sponsor stepped in, put a little bit of a pressure onto the university. We still do not have the same opening hours we used to have, but we could overcome that problem.

As a second point teaching must be mentioned. In Austria universities fight to keep the lead in educating future teachers (there are many organizations trying to do the same). We have to offer something unique. So we have put in courses related to the botanic garden in each group – that way a university can show that it is fulfilling the requirements by the government.

The third issue: international and national conservation activities. Are your departments dealing with conservation work closely together with BGs? Are they using garden areas for doing *ex situ* conservation or small trials? That is what we have started in Vienna. At the moment we have about 30 research projects that are directly connected with plants and a botanic garden. So now our dean is not asking any more what is a garden good for, he is convinced.

This is a small piece to look into the requirements, and then try to act in the framework of our capacities.

Another BG was lost as a botanical garden. It is still there, but it is not really functioning any more as a BG, because it has become a stage for public/cultural events. The city realized that there is much better income to keep it as a stage for cultural events than to keep it as a botanical garden. We have to avoid that by using our strengths, showing our strengths, and if it comes to international conventions, all governments are in high needs of experts from the botanical side to identify plants when they are confiscated, to help them when setting up rules related to plant organisms, and who else than our organizations can do that. For instance CITES list and work regarding that can be a role of BGs even if they don't like it too much because of the lots of lots of paper work. If you get involved with your government, you might become official leaders, partners, and then you are deciding or at least co-deciding the rules, and they are not put on your head.

That is our part in raising awareness in our acquaintance, raising reputation and raising respect – so everybody knows what BGs are doing. Then BGs are getting invited to look at national responses, to give advice, and of course you cannot do that for free. You have to put a price tag on your work in order to have it valued. Because that is the language understood by decision makers.

A last example regarding taxonomy: we are all convinced that it is needed, but the amount of teaching taxonomy decreasing. On the other hand there is control at the borders, people must identify plants, even the international structures need checklists… so you can put there and employ taxonomists – to do that work to the government. Kew Gardens has parts of its reputations as it serves such an expert activity. We have to promote that – we still have to learn and see how others do it. That is why networking is so important.

A **conference participant** shares an anecdote about a family and their young kid, who at the science day (held ones a year in a BG) became so interested, that he is now a student at the university. He was touched: emotion first, then knowledge… You have to conquer the heart first before you can instruct the brain.

**Michael Kiehn** raises the question, why do kids say that plants are boring? Is that right, that they are not moving? They are not moving in a way we are sensing them, but we can start with moving plants – we need to learn how to tell interesting stories, and get young children interested. We should start this education at kindergarten age. BGs have a target group among school teachers, but should work more with kindergarten teachers.

**Pawel Kojs** often have to deal with government and its representatives who fund BGs. One of them told him to make them proud for the garden for that support they give them, so they have made lots of things not connected to botany but with storytelling. Talk to people who decide and are not interested in botany at all – about different things but not botany. How can we convince them that they should make decisions to spend more on BGs rather than for schools, hospitals or other things which always are on the table when we are talking about different needs of the society? How can we tell in a city hall to our audience (decision makers) that BGs are more important than kindergartens? Tell them that a BG can do good service for kindergartens; other kindergartens cannot make such a good service for children without a BG. The ways we are presenting things are also important. We all know that the core function should be preserve but sometimes we better do not even talk about it, because when we start to talk about it and try to convince them that botany is so important, we will not get any support. Perhaps after 25–30 years someone from the kindergarten will become a local politician, and remember, that BGs are very important.

**Michael Kiehn** compares the evolution of flowers (think of Magnolia) and the first visitors (they are quite detrimental). One part of the evolution was the segregation of niches and the segregation of interactions. This picture fits quite well: we also have to take into account that some developments change our "used structure". Co-evolution developed differently in different environment and in different types of BGs. It is good to know who is eating on your pollen, on your flower.

We will have another conference – the EuroGard conference which will be focusing very much on what we have discussed about at this round table discussion. Botanical Gardens Conservation International is developing a new action plan for botanic gardens in Europe, and this action plan is organized around the major scenes BGs deal with: science and horticulture, conservation, heritage, education. This action plan tries to set the scenes and to give best practices examples mentioned at this discussion or what anyone can send us via email. It raises your reputation if your garden is showing us a best practice example in the action plan for Europe. That is also a way to show our influence for decision makers: our garden is so good in what it does, that it is featured in the action plan.

**Vince Zsigmond** mentions an example from Bristol Zoo Gardens (UK), how can we awake the responsibility in children and other people. In the UK there are so called national collections. They intend to develop national collections of Calendula all over the world in the frame of a project. They realized that they can involve several school and other entities and they gave them seeds of different Calendula species and showed them how they should grow the plants. It is a really good way to have responsibility. By this these children and these people became a sort of a stakeholder of a conservation action. By this they can explain the importance of these kinds of things.

**Pawel Kojs** brings another example from a BG where small children got a tea and got lots of plants out of which they could make their own herbal tea. They did it so enthusiastic. They were so happy to have this tea at the end, and to make, to prepare their own tea themselves. It is low cost activity. Then they come back very often with their parents to show them the place where they have prepared the tea. It is a kind of trap of course. They remember the place, they remember the taste, they remember emotions – sometimes they remember that they were in a BG. Make the place important.

**Michael Kiehn** summarizes that good examples show how important these green school activities are. There is a demand for guided tours, especially at the end of the school year when teachers look desperately for places to go to. The BG of the University of Wien has obligatory courses at the teacher's education: Didactics of outside locations for teaching – and one of the sites is a BG. When the students have passed this course positively, they are entitled to become a guide in that botanical garden. They get some money fort that, and they work there for one year. After they become teachers many of them come back to the garden with their class. This is a sustainable action for BGs. Universities provide facility to do that. It works in a number of contexts. That works in communal or federal gardens – where we have a similar demand, have programs to bring kids in contact with nature.

Hoping you can take some ideas with you which are useful in your own situation, keep in mind the upcoming event for BGs – it should serve additional help for you to get your gardens and the values of your gardens very well and with good examples in the 21st century.

# CONFERENCE EXCURSION DAY

## National Botanical Garden Vácrátót

The 180-year-old romantic landscape-designed garden, national monument as well as nature conservation area, is the richest scientific plant collection of Hungary . The scenes of this 27 hectare park are engaging in all four seasons. Annual plant exhibitions, intimate trails, rose and geranium collections, and countless tiny wonders of nature await our guests throughout the year.

## Danube bend

The Danube bend is the richest destination in art and history in Hungary. Cruise along the old royal town, enjoy a superb view of the Danube bend, the ruins of forts and castle, heading to the artists' town.

## Szentendre

The picturesque town of Szentendre sits at the foot of the Pilis Hill, where you'll experience a Mediterranean atmosphere that few other Hungarian settlements can offer you. No wonder that lots of artists come to find inspiration and work here. Let this unique aura enchant you too.

## Open Air Museum of Ethnography

The collection of the vernacular architecture and interior furnishings, objects and spiritual relics contributes to the conservation of the cultural heritage of rural Hungary.

# List of Participants

| Country | Lastname | Firstname | Workplace |
|---|---|---|---|
| Austria | Kiehn | Michael | University of Vienna, Core Facility Botanical Garden |
| | Knickmann | Barbara | Universität Wien, CF Botanischer Garten |
| Bulgaria | Iliev | Ognyan | Sofia University "Sv. Kliment Ohridski" |
| Croatia | Juretic | Biserka | University of Zagreb Faculty of Science, Department of Biology, Botanical Garden |
| | Kovacic | Sanja | |
| | Sandev | Dubravka | |
| Estonia | Tamm | Heiki | University of Tartu, Museum of Nature History and Botanical Garden |
| Georgia | Gabedava | Laura | National Botanical Garden of Georgia, Dept. Plant Conservation |
| | Japaridze | Elene | |
| | Kobakhidze | Lia | |
| | Melia | Nina | |
| | Mikatadze-Pantsulaia | Tsira | |
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| | Papp | László | Eötvös Loránd University, Botanical Garden |
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