

Conference Proceedings

ISBN 978-83-933846-1-7;

Scientific Reviewer: prof. dr hab. Wiesław Włoch
Editing and proofreading: David Oldroyd
Technical editing: Paweł Mizia and Jacek Jaworski
Copyright © 2011 by Silesian Botanical Garden
Mikołów 2011
ISBN 978-83-933846-1-7

Silesian Botanical Garden
43-195 Mikołów, Sosnowa 5
Poland
www.sibg.org.pl
<http://esdinsibg.wordpress.com>
e-mail: sibg@sibg.org.pl

Back to Eden
Challenges for Contemporary Gardens

Katowice-Ustroń-Mikołów 21st-23rd May 2011

Table of Contents

Introduction and Acknowledgements	7
Ex situ conservation	11
Suzanne Sharrock, <i>Monitoring progress towards Target 8 of the Global Strategy for Plant Conservation</i>	13
Albert-Dieter Stevens, <i>The German Seed Bank Network Project Seed Banking of Crop Wild Relatives</i>	23
Magdalena Jałowska, <i>FlorNaturLBG - ex situ conservation of endangered and protected plant species</i>	33
Włodzimierz Majtkowski and Gabriela Majtkowska, <i>The Reconstruction of Replacement Habitats in the Botanical Garden of the National Centre of Plant Genetic Resources of Plant Breeding and Acclimatization Institute in Bydgoszcz, Poland.</i>	45
Ludmila Vishnevskaya, Dace Klavina, Gunta Jakobsone, Dagnija Šmite, Daina Roze, Signe Tomsone, J. Zilinš, <i>Latvian rare and endangered plants in ex situ collections</i>	53
Magdalena Maślak, Maja Głowacka, Agata Śmieja, Magdalena Bregin, Julia Góra, <i>Community and species translocation as a method of nature conservation: A case study of "Katowice" Airport</i>	71
Paweł Kojs, <i>The Silesian Botanical Garden Network – an introduction to the idea</i>	79
Marta Jańczak, Wojciech Pikula <i>Department of Scientific and Conservation Collections, Silesian Botanical Garden (SiBG)</i>	95
Education for Sustainable Development	99
David Oldroyd, <i>The Challenge of Education for Sustainable Development in Botanical Gardens</i>	101
Bogdan Ogrodnik, <i>The botanical garden as a place for integral education for sustainable development</i>	113
Jacek Jaworski, Agnieszka Szyszka <i>Department of Ecological and Environmental Education of Silesian Botanical Garden</i>	131
Plant Collections and Expositions	135
Jože Bavcon, <i>Can natural plants make a horticultural surprise? Spring Bulbs.</i>	137
Magnus Lidén, <i>ToL – IRL (Tree of Life – In Real Life)</i>	157
Green Katowice	163
Conference program	167

Introduction and Acknowledgements

This year for the first time the Council of Botanical Gardens in Poland had the privilege of organizing a meeting of the European Consortium of Botanical Gardens. The meeting arose from the initiative of Professor Jerzy Puchalski, Director of the Polish Academy of Sciences Botanical Garden – Centre for Biodiversity Conservation in Powsin, delegate of the Council of Botanical Gardens in Poland in the European Consortium of Botanical Gardens and former Chairman of the Council of Botanical Gardens in Poland. His efforts and activity assembled eminent delegates from botanical gardens all around Europe.

The gathering of the European Consortium of Botanical Gardens took place at The University of Silesia in Katowice. The meeting offered a pretext to organize an international conference “Back to Eden: Challenges for Contemporary Gardens” for the Council of Botanical Gardens in Poland which was held in Ustroń and Mikołów in Upper Silesia, Poland from the 21st to 23rd of May 2011.

The conference and the European Consortium of Botanical Gardens meeting was organized under the honorary patronage of Mr. Stanisław Zalewski, Deputy Minister of Environment, Chief Conservator of Nature in Poland.

This meeting was possible thanks to many institutions which helped us organizationally and financially and would not have been possible without the financial assistance of The Provincial Fund for Environment Protection and Water Management in Katowice, the city of Katowice, the State Forest in Poland Regional Forest Administration in Katowice, the University of Silesia in Katowice, the Silesian Botanical Garden in Mikołów and the city of Mikołów.

I would like to express my special thanks to The Provincial Fund for Environment Protection and Water Management in Katowice, the City of Katowice and the Silesian Botanical Garden for sponsoring this publication.

I would like to express my gratitude to all participants which actively took part in this event enriching it with their knowledge and experience.

The conference proceedings are a product of the conference “Back to Eden: Challenges for Contemporary Gardens”. The conference was attended by 70 participants from 23 countries. The papers covered both broad strategic themes as well as accounts of specific research and projects reflecting a wide range of challenges which botanical gardens face and with which they are dealing within the broader international context of nature conservation. The majority of the papers were presented in the English language but also several in Polish using simultaneous translation. Items relating to the region in which the conference took place are also included.

The proceedings are arranged in three sections each of which represents a challenge for contemporary gardens:

Ex situ Conservation

Education for Sustainable Development

Plant Collections and Expositions

I am grateful to all those participants who took the time to prepare their papers for these proceedings especially those for whom English is a second language. I would like to express my special thanks to David Oldroyd who gave valuable support in editing those papers that needed improving to a reasonable standard of English. I am also grateful to Jacek Jaworski who spent many hours assembling the papers and providing technical editing.

I also thank all our volunteers who gave help during the conference sessions and workshops. Finally, I would like to thank all my colleagues from the Silesian Botanical Garden in Mikołów who gave unstintingly of their time to prepare materials for this meeting.

The organisation of the conference was itself a major challenge to the relatively new Silesia Botanical Garden and we trust that the following proceedings testify to our success in meeting this challenge.

Dr. Paweł Kojs
Chairman of the Council of Botanical Gardens in Poland
Director of the Silesian Botanical Garden in Mikołów

Ex situ
conservation

Monitoring progress towards Target 8 of the Global Strategy for Plant Conservation

Suzanne Sharrock

Author note

Botanic Gardens Conservation International, Descanso House, 199 Kew Road, Richmond, TW9 3BW, UK

Abstract

Target 8 for the GSPC called for 60% of threatened plants to be conserved in *ex situ* collections by 2010. Botanic gardens are recognised as the institutions most concerned with the *ex situ* conservation of wild plant diversity and, as a means to record plants in cultivation in botanic gardens, BGCi developed the PlantSearch database. By mid 2010, over 800 botanic gardens from 110 countries (around one third of all known gardens) had contributed data to PlantSearch and the database included records for 261,000 taxa related to nearly 105,000 species. PlantSearch is linked to a number of other databases, including the IUCN Red List of threatened plants. By comparing the data in PlantSearch with the IUCN Red List, it was possible to identify just over 9,000 (23%), of the 40,000 known globally threatened plant species in botanic garden collections. This indicates that there is still some way to go to achieve Target 8 at the global level. Challenges that exist in achieving the revised target for 2020 (75%) include increasing the rate of identification of globally threatened species and obtaining more complete data from botanic gardens in biodiversity-rich countries such as China, Mexico and Brazil.

Introduction

Plants are an essential part of the world's biodiversity. Healthy ecosystems, based on plant diversity, provide the conditions and processes that sustain life and are essential to the well-being and livelihoods of all humankind. Despite the importance of plants, estimates suggest that up to 100,000 species may be in danger of extinction, and rates of loss are likely to increase as global temperatures continue to rise. Plants are endangered by a combination of factors: over-collection, intensive agriculture and forestry, urbanisation and other land use changes, pollution, the spread of alien invasive species, and increasingly, climate change.

In 2002, in the face of the global plant extinction crisis, the Global Strategy for Plant Conservation (GSPC) was adopted by the Parties to the Convention on Biological Diversity (CBD). The 16 output-oriented targets of the GSPC were the first internationally agreed targets for biodiversity conservation, and the Strategy was therefore seen by many as a valuable pilot exercise towards the eventual wider adoption

of targets in other areas of the CBD's work. Achievement of the GSPC requires action by a broad range of stakeholders across sectors as well as implementation both nationally and internationally.

Botanic Gardens Conservation International (BGCI) played a key role in the development and subsequent promotion and implementation of the GSPC, acting as lead facilitating agency for the targets related to *ex situ* conservation (Target 8) and education and public awareness (Target 14). Over the last eight years, the botanic garden community as a whole has embraced the GSPC and it has provided a clear focus for conservation action at all levels. Botanic gardens are helping to implement all the GSPC targets, although as they retain a particular interest in the *ex situ* conservation of wild plant resources, special efforts have been made towards the implementation of GSPC Target 8.

The importance of *ex situ* conservation.

Ever since the 1992 Rio Earth Summit, *in situ* conservation has been recognised as the dominant strategy for biodiversity conservation. *Ex situ* conservation has therefore been relegated to a supportive role, with the main focus being to facilitate the rehabilitation and reintroduction of threatened species into their native habitats. However, with the threats to biodiversity increasing and action on the ground being inadequate, a re-assessment of the role and importance of *ex situ* conservation is now due.

The implications of climate change

Recent studies predict that a temperature rise of 2-3°C over the next century could result in as many as half of the world's plant species being threatened with extinction (Bramwell, 2007). Ecosystems are already rapidly and demonstrably shifting as individual species respond differently to environmental changes and the range areas of species move (Hawkins *et al.*, 2008). Given this, a number of protected areas may soon no longer harbour the species for which they were originally designated and the fixed concept of 'natural habitats' may be approaching meaningless for a number of species (Pritchard and Harrop, 2009). Moreover, migration processes are jeopardised by ongoing habitat fragmentation which inhibits the ability of species to re-colonise in new ranges, or even adjoining areas. Given this, conservation strategies, predominated as they are on the management of habitats and species within specific geographical locations, need to be reviewed. As well as protecting and restoring ecosystems, increased efforts should also be focused on ensuring that all wild plant species are backed-up in well-documented *ex situ* collections as an insurance against extinction, and that such material is available for use in research, restoration and adaptation to climate change.

Ex situ conservation

Ex situ conservation of plants –in the form of seed banks, *in vitro* collections, field gene banks and the living collections of botanic gardens and arboreta – has proliferated in recent years. For example, in the area of plant genetic resources for food and agriculture, a mere half million samples of plant genetic material were stored in less than

ten genebanks in the 1970s. This has risen to more than 7.4 million samples in more than 1,750 gene banks in the present day (FAO, 2009). In relation to the conservation of wild plants, the main institutions involved are botanic gardens, and the number of such gardens has more than doubled in the last 50 years. Today their collections include nearly 105,000 species, almost one third of all known flowering plants.

The value of living collections

Ex situ collections are vitally important as an insurance policy against extinction in the wild. Furthermore, species held as well-documented, genetically-representative living collections have additional value, providing material for:

- Horticultural and field-based research (propagation, growth requirements etc.);
- Propagation to remove or reduce pressure from wild harvesting;
- Taxonomic and systematic research and reference for identification;
- Display, education and community engagement activities;
- Species reintroduction and habitat restoration activities; and
- Identification of taxa for introduction into the nursery trade, local agriculture and crop breeding programmes, amenity planting, local forestry etc.

Monitoring progress towards GSPC Target 8

Target 8 of the GSPC calls for 60% of threatened plants to be conserved *ex situ*, preferably in the country of origin. Botanic gardens were recognised as the institutions most concerned with the *ex situ* conservation of wild plants. However, in 2002, a global review of *ex situ* conservation, noted that "Botanical gardens maintain the largest assemblage of plants species outside nature, but no overall assessment of the diverse array has been conducted. Even though they contain a large proportion of the world's flora, the gardens have traditionally not been integrated, and their holdings have been known only locally". (Keller *et al.*, 2002).

During the development and adoption of the GSPC, BGCI was invited to become one of the two lead facilitating agencies for Target 8, focusing specifically on wild plant species. In response to this, as well as to address the concerns raised by Keller *et al.*, the PlantSearch database was developed to record plants in cultivation in botanic gardens. BGCI has also worked with national and regional botanic gardens to promote the target and support its implementation.

A moving target

In 2002, when the GSPC was adopted, a consolidated list of the world's flora did not exist, but it was believed that the number of known flowering plants stood at around 270,000. Similarly, information on the number of threatened plants was also lacking, but this was estimated at around one third of all species, or some 90-100,000 species. It was therefore predicted that in order to meet Target 8, around 60,000 threatened species would need to be included in *ex situ* collections, from an estimated baseline of 10,000 species. Today, the number of known flowering plants is estimated at 350,000 (Paton *et al.*, 2008), meaning that some 120,000 species could be under threat, and to meet

the target, 72,000 threatened species would need to be in *ex situ* collections. However, as the IUCN Red List for plants still only includes 10,174 threatened species (IUCN, 2010), it is impossible to know which are the globally threatened species that should be conserved. Furthermore, as the effects of climate change start to have an impact on plant species survival in the wild, the estimate of 30% of plants being under threat may also need to be adjusted. Against this backdrop, measuring progress presents a challenge.

PlantSearch as a monitoring tool

BGCI's PlantSearch database is an on-line, publically accessible searchable database of the living collections of botanic gardens around the world. Data is provided by the participating gardens and is compiled into a single list linked to a range of other relevant databases, including the IUCN Red List of Threatened Species

PlantSearch therefore provides an efficient and publically accessible tool to monitor the cultivation of plants – including those of conservation concern - in botanic garden collections. While the user can rapidly determine if a particular species is included in the combined botanic garden collections and how many gardens hold that species, public access does not allow the actual garden location of species to be identified.

PlantSearch data

There are presently around 2,800 botanic gardens around the world. Although many of these gardens were not originally developed as conservation organisations, the GSPC has provided a valuable focus for developing conservation action. Since 2002, with the launch of the PlantSearch database, BGCI has used the database to gather information on the living plant collections of botanic gardens around the world. To date 855, or nearly one-third of all botanic gardens, from over 110 countries have contributed data to PlantSearch. The database now includes records for 261,000 taxa, related to nearly 105,000 species in cultivation in botanic gardens.

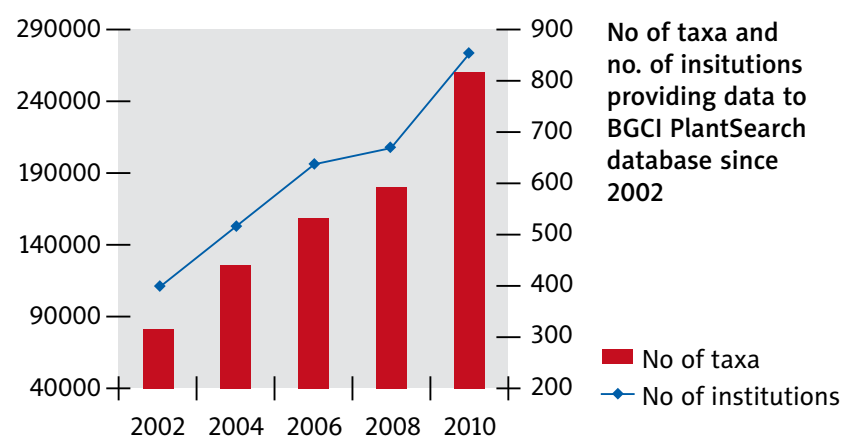


Figure 1: Increase in the amount of data and number of data providers to PlantSearch since 2002

While the total number of species records in PlantSearch is impressive (647,532), collecting data remains a challenge. Despite the anonymity of data in PlantSearch, some gardens are still reluctant to share information on the location of rare plants in cultivation, in case these become a target for collectors or thieves, or because of issues related to intellectual property. Furthermore, many of the smaller, less well-resourced gardens do not have the electronic data management systems in place to allow them to generate plant lists in a format compatible with PlantSearch. For others, language remains a major barrier to contributing data to a database, which is presently only available in English.

Collating the data also presents a challenge and over recent years, BGCI has devoted increasing efforts to removing duplicate and misspelt plant names and liaising with botanic gardens to clarify plant nomenclature issues.

Meeting the target – global assessments

Monitoring progress towards Target 8 at the global level is constrained by the lack of progress in plant conservation assessments. Less than 4% of the world's known plant species have been assessed using the internationally accepted criteria established by the IUCN in 2001 (IUCN, 2010) although a somewhat larger number had previously been assessed (Walter and Gillett, 1998). In the absence of a comprehensive list of globally threatened plants, measurements of progress towards Target 8 are necessarily based on estimates and extrapolation.

Using the data that is available however, we can at least develop a reliable baseline for moving forward. Some 40,000 plant species have so far been recorded as globally threatened (Walter and Gillett, 1998 and IUCN, 2010). Of these, just over 9,000 are recorded in cultivation in botanic gardens. This means that at the global level, at least 23% of globally threatened plant species are known to be in the *ex situ* collections of the world's botanic gardens, clearly indicating that Target 8 has not yet been achieved globally. However, as noted above, this figure must be treated with caution and it is possible that significantly more of the species recorded in PlantSearch may prove to be globally threatened when further assessments are carried out.

Furthermore, a much more encouraging picture emerges when national and regional efforts are taken into account. Mega-diverse countries such as China, Brazil and Mexico have set national targets for *ex situ* conservation which reflect Target 8, and are progressing well towards these targets. These three countries collectively hold at least 25% of the world's plant diversity, and many of their species are endemic. Little of the data for *ex situ* collections in these countries is so far included in PlantSearch. Once this data is combined with the global list, the figure for globally threatened plant species in *ex situ* collections will be much higher than 23%.

Increasing the amount of data provided by botanic gardens to PlantSearch is also an important factor in being able to accurately assess progress towards the target. A recent focus on North America by BGCI resulted in a 5-fold increase in the number

of institutions providing data. Similar initiatives in other countries, such as Russia and Indonesia, where BGCI has worked closely with botanic garden networks, have also yielded further increases in data.

The importance of having a target

Progress towards the implementation of any target can be monitored not only in terms of the degree to which the target itself has been met, but also in assessing the impact the existence of the target has had on stimulating and catalysing action. In the case of Target 8, it is clear that major progress has been made and advances achieved that were unlikely without the adoption of the target. Setting the target has brought botanic gardens together around a common cause at both global and national levels. It has provided a framework for action at various levels, as well as a reference point for monitoring progress. It has also helped to shape expectations and to stimulate a more focused approach to plant conservation, highlighting those species that require urgent action. It has stimulated botanic gardens to think critically about their plant collections and examine the conservation value of such collections, and has resulted in the development of a range of tools, manuals and best practice examples to guide *ex situ* conservation practice in the future (e.g. ENSCONET, 2009; Offord and Meagher, 2009). Finally, it has provided a much-needed entry-point for botanic gardens to engage with the wider biodiversity conservation agenda and for their work to be recognised as an important contribution to the implementation of the CBD as a whole.

Conclusions

There is clearly still much work to be done to achieve Target 8 at the global level. However, our review indicates that despite this, Target 8 has been successful in many ways, most notably in mobilizing botanic gardens and stimulating conservation action at the national level in many countries.

BGCI's PlantSearch database, developed as a direct response to Target 8, is now in place and increasingly being used in a variety of ways. It has been shown to provide an efficient tool for measuring progress towards Target 8 with respect to the living collections of botanic gardens. Resources are now being sought to further develop the database, improving its compatibility with regional and national databases and to increase the capacity of individual gardens to exchange data through BGCI. Furthermore, seed bank data is presently not routinely included in PlantSearch and this needs to be addressed to ensure such collections are included in future *ex situ* assessments.

Without knowing how many and which species are under threat, monitoring progress towards Target 8 at the global level will continue to be challenging. There is therefore a need to accelerate the process of plant red listing – with particular attention being paid to socio-economically important plants, such as medicinal plants and crop wild relatives, as well as woody species necessary for forest restoration and carbon sequestration projects around the world. Moreover, as the impacts of climate change

accelerate, priority for *ex situ* conservation should also be given to species that are potentially vulnerable, even if these are not yet considered threatened.

Target 8 consists of two elements –“60% of threatened species in *ex situ* collections” and “10% of these in recovery and restoration programmes”. Monitoring the second part of Target 8 has proved to be a greater challenge than the first part, and relatively little progress has been made to date. However, as the GSPC enters its second phase and greater attention is focused on the urgent need to restore the world's degraded ecosystems, BGCI will be giving priority to promoting and monitoring this vitally important component of the target.

Furthermore, an analysis of the data indicates that of the 9,000 or so globally threatened species that are in botanic garden collections, around one-third are to be found in only one garden. If *ex situ* collections are considered an ‘insurance policy’, questions must be asked if single-location collections are sufficiently secure. In these cases particularly, it will be important to know how genetically diverse and representative these collections are.

The proposed updated Target 8 for 2020 calls for “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”. Genetically representative collections are essential if they are to be used for recovery and restoration work. The focus and challenge for the coming decade must therefore surely be not only to increase the number of threatened plants in *ex situ* collections, but also on assessing and ensuring the conservation value of such collections. Working collectively, botanic gardens are stepping up their efforts to ensure a future for the world's plant diversity.

References

- Bramwell, D., 2007. *The response of botanic gardens to climate change*. BGjournal 4(2): 3-8.
- ENSCONET, 2009. *Seed Collecting Manual for Wild Species*. European Seed Conservation Network. Available for download at: <http://www.ensconet.eu/>
- FAO, 2009. *The State of the World's Plant Genetic Resources for Food and Agriculture*. Second Edition. Food and Agriculture Organisation of the United Nations, Rome, Italy.
- Hawkins, B., Sharrock, S. and Havens, K., 2008. *Plants and climate change: which future?* Botanic Gardens Conservation International, Richmond, UK.
- IUCN, 2010. *The IUCN Red List of Threatened Species*. Available at: <http://www.iucnredlist.org/>. Accessed 16 September 2010.
- Keller, T., Korn, H., Schmid, H., and Weisser, Ch.F. 2002. *Chances and limitations of ex-situ conservation of species and genetic diversity on a global perspective*. Landwirtschaftsverlag, 2002.
- Offord, C.A. and Meagher, P. F., 2009. *Plant germplasm conservation in Australia: strategies and guidelines for developing and managing ex situ collections*. Australian Network for Plant Conservation Inc., Canberra.

- Paton, A.J., Brummitt, N., Govaerts, R., Harman, K., Hinchcliffe, S., Allkin, B. and Nic Lughadha, E., 2008. *Towards Target 1 of the Global Strategy for Plant Conservation: a working list of all known plant species—progress and prospects*. *Taxon* 57 (2): 602–611.
- Pritchard, D.J. and Harrop, S.R., 2010. *A re-evaluation of the role of ex situ conservation in the face of climate change*. *BGjournal* 7(1): 3-6.

The German Seed Bank Network Project: Seed Banking of Crop Wild Relatives.

Albert-Dieter Stevens

Author note

Albert-Dieter Stevens, Head of Collections and Elke Zippel, project coordinator, both at Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin, Germany.

Abstract

The need is highlighted for *ex situ* measures to halt the loss of plant diversity and their sustainable use through better conservation in seed banks and their accessibility. The situation of German germplasm and seed banks is described with special reference to the official strategy regarding crops and crop wild relatives. Therefore, the German agency for food and agriculture funds a network of seed banks of crop wild relatives. The main objectives are given and the prioritisation of species for collecting are described as well as planning and costs of collecting seeds of target species throughout four regions in Germany.

Introduction

Climatic changes, the misuse of finite natural resources, and unbalanced social developments have an ever more important impact on life on earth. Amongst other factors these contribute to the biodiversity crisis, the damage and finally the extinction of species, ecosystems, and genetic diversity. To halt this loss crucial to the livelihood of mankind a variety of strategies and action plans for plant diversity have been developed at global, regional and national scale. They all highlight the importance of measures to halt the loss of biodiversity and some develop tangible objectives to be achieved in a given time.

One important measure is the storage of seeds as a complementary conservation tool for *in situ* protection, for basic and applied research, for education, and for breeding. Finally, the sustainable use of plant genetic resources in traditional and new technologies depends on the knowledge and accessibility of plant genetic resources kept in seeds for the future.

Crop wild relatives (CWR) are historically conserved in *ex situ* seed banks because of their close genetic relationship to a crop. For a definition of CWR see Maxted et al. 2006 and the European Crop Wild Relative Diversity Assessment and Conservation Forum. According to Maxted et al. (2010) 5.6% of total holdings in crop *ex situ* seed banks are CWR which represent 6% (1,095 species) of the 17,495 CWR species found in Europe. These data are based upon an analysis of the data in the European crop gene bank portal (EURISCO). Maxted also states that much more CWR diversity is held in botanic garden gene banks. 5,756 CWR species are accounting for 61.8% of their total collections representing 33% of the CWR species of Europe. The latter

analysis is based on the data held by the European Native Seed Conservation Network (ENSCONET). Clearly genetic diversity is higher in wild species but Heywood in 1999 mentioned the poor standards of many of the botanic garden accessions which were small and genetically poorly sampled. Much has changed over recent years, not least as a result of the EU-funded ENSCONET project which developed common working standards in the most important European native seed banks. National developments in *ex situ* conservation also increased co-operation and standards of *ex situ* conservation among botanic gardens in Europe.

CWR in Germany and the project goals

In Germany *ex situ* plant genetic resources (PGR) data are held in a common data base by the Federal Agency for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung, BLE). Data are accessible through their website plant genetic resources Germany (PGRDEU). There are approximately 155,000 samples of more than 3,000 species stored or cultivated in a few major and several smaller institutions. Among them is the Leibniz Institute in Gatersleben (IPK) with 148,000 samples of 3,000 species, the Julius Kühn-Institute (JKI) with 6,800 samples of 32 *Vitis* species and 18 fruit species, and the Technological Center for Agriculture (LTZ) with 800 samples of *Nicotiana* species.

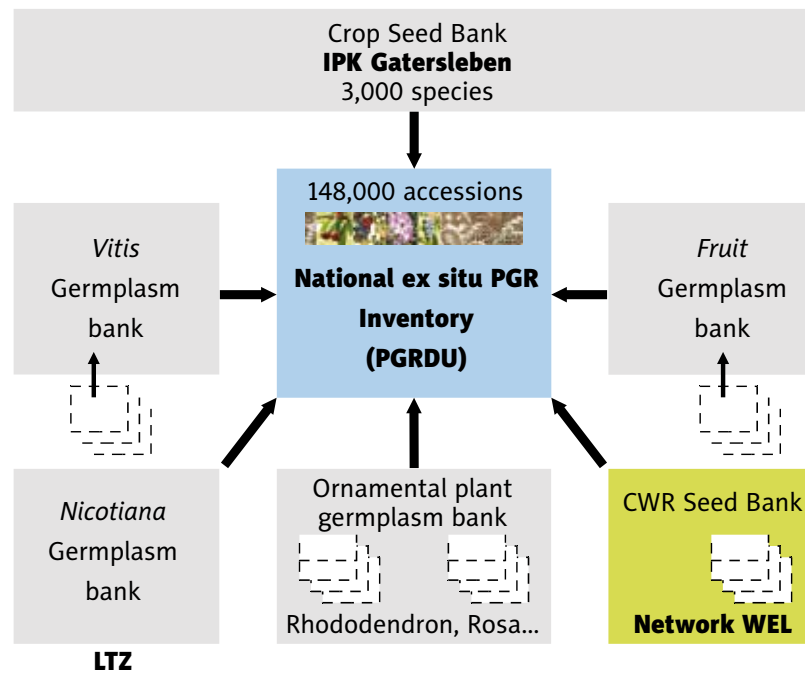


Figure 1: Organisation and documentation of PGR ex-situ-conservation in Germany

To cover the gap in *ex situ* conservation of PGR, the federal ministry is funding germplasm banks for ornamental plants and a seed bank network for CWR which is the German gene bank of wild plants for food and agriculture (WEL). This model project is a network of four seed banks covering the entire area of Germany. The project started in 2009 and will be funded until 2012. The objectives of the project are:

- to collect seed of CWR at population level in order to get broad genetic coverage and representation of the natural regions and priority taxa
- to process, store, and duplicate the seeds in the partner seed banks
- to offer the seeds for research, conservation, and breeding
- to organize workshops and meetings to develop and foster the use of common protocols and to share experiences
- to disseminate information and to raise awareness

The network has distributed responsibilities for collection, processing and storage of seeds according to the natural bio-geographical conditions because of ecological and logistical reasons and existing expertise and infrastructure. The north-west and north-east of Germany is covered by the Botanical Garden of the University of Osnabrück and the Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin respectively. The Botanical Garden of the University of Karlsruhe in collaboration with the University of Education Karlsruhe and the Botanical Garden of the Regensburg University cover the south-west and south-east respectively (see Figure 2).

Duplicates of seed lots will be stored in the facilities of the Osnabrück botanical garden seed bank and offered through a central website catalogue. Seeds are offered according to the international treaty on PGR for food and agriculture regulations and the appropriate standard material transfer agreement.



Figure 2: Regional responsibilities for collecting, processing, and storing of CWR populations within Germany.

Blue: Botanical Garden of the University Osnabrück, **green:** Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin, **pink:** Botanical Garden of the University of Karlsruhe and University of Education Karlsruhe, **yellow:** Botanical Garden of the Regensburg University.

Prioritisation of species for collecting

There are approximately 3,600 plant species native to Germany including apomictic taxa. One thousand are known to be of actual or potential use. By including ornamental species or taxa useful for breeding another 1,800 taxa are added. Thus 78% (2,800 taxa) of German flora can be regarded as CWR. For a detailed list see the website of PGRDEU. The PGRDEU list considers 12 categories of utilisation for the assessment of CWR in Germany:

• Medicinal plants and spices	• Fruits and legumes
• Plants rich in protein	• Pollen and nectar providing species
• Forestry species	• Plants useful for industry
• Fodder plants	• Plants to protect against wind, sun, erosion
• Plants rich in carbohydrates	• Ornamental plants
• Plants rich in oil and fat	• Plants of use for breeding

In order to prioritise the project collecting activities, species with multiple uses (two to six out of the twelve categories) were extracted from the list of 2,800 CWR taxa. The remaining 1,000 taxa with multiple uses were cross-checked with the red list in order to consider the degree of threat. The most vulnerable and rare species have been discarded for practical considerations. The 860 species left on the list then were checked against the holdings within the network and against crop seed bank holdings which reduced the number to 640 species. The most challenging task was to include biological and ecological criteria such as invasiveness and the ease of seed handling and storability (e.g. only orthodox seeds were considered). However, the target list should also cover a broad systematic and ecological spectrum of the German flora. This last step resulted in a list of 300 priority species of which 170 species occur in all four regions and thus will be collected by all partners. Each partner will collect approximately 200 species. Between 75% and 80% of the species in this target list are widespread or common. The list also includes 24 species which are protected by German law and 50 species are red listed in at least one of the federal states.

Collecting Seeds

Seed collection in Germany does require authorisation by local authorities which in some cases does influence the usability of seeds, for example, the transfer of material to third parties. This is in contradiction with the treaty regulations that have been applied to the project by the project funding agency (BLE). Good contacts through existing regional networks with local authorities and other stakeholders alleviated the process of receiving the necessary collection permits, though experiences differ remarkably throughout the network and the regions.

Seed collecting and curation procedures are based on the ENSCONET recommendations (ENSCONET 2009a, b). If necessary they were adapted. For example, data from the grid system mapping of plant distribution (area-based data),

which is broadly applied in Germany, is being used for seed origins instead of GIS based methods (data based on geodetic coordinates).

One of the important objectives of the project is to collect genetically representative samples in order to improve the quality of the seed bank accessions for a variety of purposes. Therefore, seed samples of the entire population of typical sites are collected, if possible seeds of more than 59 individual plants. The genetic representation of taxa will be increased through multiple sampling of different populations within each species and from sites in the four project regions. If possible the number of seeds per accession should be higher than 5,000.

Following the elaboration of priority species and having agreed on common standards and protocols, the collecting strategy for the season 2010 has been developed independently by each regional group. Based on data from species inventories and habitat diversity in north-east Germany, the accessibility of sites was of major importance. This is due especially for wet meadow communities which, next to dry grasslands, were one of the main target habitats in 2010. However, not only inundation but also private land ownership, cattle breeding, and a range of other factors were considered. The core areas identified for collecting in north-east Germany are the eastern Baltic Sea coast; the Oder river valley; the Havel river region; the eastern Harz foreland; and the Saale-Unstrut region (see Figure 3).



Figure 3: The five main collecting areas in north-east Germany (left), the Oder river valley (upper right), and the Harz foreland (lower right).

During this preparatory phase several visits to familiar and new potential collecting sites were helpful. Good contacts with regional botanists (professional and non-professional experts) contributed considerably during this planning phase. Repeated visits and the concentration on collecting areas made collecting efforts efficient and helped to identify adequate collecting times according to

the phenological development in each collecting area. Optimal collecting times differed remarkably in 2010 and 2011 both at species and collecting area level because of increasing yearly variation of climatic conditions.

Field work load varies considerably depending on season, size of population, target species, frequency of species in the collection area, conspicuousness of the species during ripeness of fruits, method of seed harvesting, insect damage during seed set, and the biology of the species (e.g. amount of produced seeds per individual), as well as the weather conditions. Some species like *Tanacetum vulgare*, *Artemisia vulgare* or *Hypericum perforatum* are very conspicuous, occur commonly in extensive populations, and produce many seeds which are very easy to harvest. Species like *Symphytum vulgare* produce only a few ripe fruits at any time. Therefore, several visits were necessary to collect a sufficient amount of nutlets. Other species like *Gentiana pneumonanthe* are very rare and inconspicuous when fruits are ripening. For such species the time dedicated to locate the plants in the collecting area increases. The fruits of several Fabaceae and Asteraceae are often attacked by insects, and the yield of seeds can be very small despite a large amount of fruits and seeds collected.

In 2010 all network partners collected 85% of the 300 priority species. At least one sample per population was collected. In the north-east region 350 accessions of 124 species in 46 families were collected, processed and stored in 2010. A mean of one to five accessions per species were collected.

	North-west	North-east	South-west	South-east
Species collected by all partners	100	102	53	98
Accessions	253	236	222	135
Species collected by one partner	12	22	11	5
Accessions	21	34	21	7

Table 2: Number of collected seeds within the network in 2010

Table 3 gives information of the cost of collecting seed for 2010. A total of 270 accessions were collected during the season from May to November. Throughout the year, an average of 2.03 accessions has been collected for each hour spent in the collecting area. The number of collected accessions per trip depends on the season of the year. Not surprisingly, most accessions have been collected in September (22.3 average number of accessions per trip) when an average of 3.1 accessions per hour were collected in the target areas. However, collecting in June, August, October, and November was also quite effective with approximately two accessions collected per hour. The distance of collecting areas did not influence the collecting success but, of course, has an influence on the costs. This is partly a consequence of concentrating on collecting areas which minimize the time needed for localising target populations.

The travel expenses for the season 2010 total 1,547 € calculated with an allowance of 0.3 €/km. Total staff costs are 9,630 € for the collecting and travel activities during the collecting season. They have been calculated on the basis of 45 € staff cost per hour. Thus collecting one accession in the field averages 41.4 €. The partners in the other regions arrived at similar costs per accession using different cost models.

2010 (collecting trips per month)	Travel distance (km)	Travel time (h) *	Field collecting time (h) **	Accessions per trip (n)	Accessions/ field collect- ing time (n/h)
May (1)	89	2.50	1.5	1	0.7
June (2)	173	2.75	3.3	6.5	2.1
July (6)	154	2.50	4.0	7.33	1.7
August (7)	263	4.57	7.3	14.6	2.0
September(3)	305	4.50	8.7	22.3	3.1
October (4)	185	2.75	4.6	9.5	2.1
November(2)	153	2.25	1.3	2.5	2.0
Total	5,157	84	130	270	
Average				1.22	2.0

Table 3: Average monthly values of travel distance to collecting areas, travel time, collecting time, and accessions collected per trip and per hour collecting time at collecting area in 2010.

* travel time includes traffic jams, diversion routes etc.

** including collection of herbarium specimens, recording of field data, searching target species, collecting herbarium specimen; excluding processing of herbarium specimen and entering of the field data in the database.

References

- ENSCONET (2009a). ENSCONET Seed Collecting Manual for Wild Species.
- ENSCONET (2009b) ENSCONET Curation Protocols & Recommendations.
- Heywood, V. H. (1999). The role of botanic gardens in *ex situ* conservation of agrobiodiversity. In: Gass, T., Frese, L., Begemann, F. and Lipman, E. (eds.), Implementation of the Global Plan of Action in Europe — Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Proceedings of the European Symposium, 30 June – 3 July 1988, Braunschweig, Germany, 102 – 107. International Plant Genetic Resources Institute, Rome.
- Maxted, N., Ford Lloyd, B.V., Jury, S.L., Kell, S.P. and Scholten, M.A., (2006). Towards a definition of a crop wild relative. *Biodiversity and Conservation*, 15(8), 2673–2685.
- Maxted, N. and Kell, S.P., (2009). Establishment of a Global Network for the *In Situ* Conservation of Crop Wild Relatives: Status and Needs. FAO.
- Maxted, N., Kell, S., Toledo, Á., Dulloo, E., Heywood, V., Hodgkin, T., Hunter, D., Guarino, L., Jarvis, A. and Ford-Lloyd, B., (2010). A global approach to crop wild relative conservation: securing the gene pool for food and agriculture, *Kew Bulletin* Vol. 65, 561–576.

Web links

- European Crop Wild Relative Diversity Assessment and Conservation Forum:
http://www.pgrforum.org/cwr_species.htm
- Plant genetic resources Germany PGRDEU website:
http://pgrdeu.genres.de/index.php?tpl=ex_situ
- Plant genetic resources PGRDEU list of CWR in Germany:
http://pgrdeu.genres.de/index.php?tpl=an_liste
- German gene bank of wild plants for food and agriculture WEL:
<http://www.biologie.uni-osnabrueck.de/genbank-wel>
- Osnabrück botanical garden seed bank catalogue:
<http://www.biologie.uni-osnabrueck.de/genbank-wel/Saatgutbestellung/>
- International treaty on PGR for food and agriculture:
<http://www.planttreaty.org/>
- Standard material transfer agreement of the treaty:
http://www.planttreaty.org/smta_en.htm

FlorNaturLBG - *ex situ* conservation of endangered and protected plant species

Magdalena Jałowska

Author note

Magdalena Jałowska, Research and Resources Protection Unit, The Kostrzyca Forest Gene Bank

Abstract

FlorNaturLBG project is dedicated to *ex situ* conservation of endangered and protected plant species. The range of activity includes the western part of Poland. Genetic material, mostly of herbaceous plants is collected in the form of seeds and other plant parts. The primary goal of the project is the long term conservation in seed banks of representative samples of the genetic diversity. Genetic material will be stored in temperatures ranging from -10° to -20°C and also in ultra-low temperatures in liquid nitrogen or its vapours. Collected samples can then be used in research, reintroduction and restoration of weak populations and as well as habitat restoration. Seedlings obtained during germination tests are used by participants of the project to initiate in- and ex-vitro cultures.

Introduction

Environmental changes, especially those induced by a man are often irremediable. Rapid climate changes, air pollution, urbanization, land destruction all have the great impact on the ecosystems. Changes are often severe, and then, barring further disruption, ecosystems and species settle down for another long period of stability. In the face of environmental transformations, conservation of all its elements, particularly of precisely defined biological diversity seems to be very important. Proper management and maintaining of the genetic reproductive material help to prevent effectively the most important components of ecosystems from destruction caused by biotic and abiotic factors.

The Kostrzyca Forest Gene Bank

In response to ecological disaster in the Sudeten Mountains the Kostrzyca Forest Gene Bank was established. It is an organizational unit of the State Forests National Forest Holding, which came into being in 1995. It's main goal is active *ex-situ* biodiversity conservation.



The institution conducts the long-term storage of forest trees and shrubs as well as the monitoring of the quality of reproductive material, these are seeds from the most valuable seed objects of the state forests, national parks, nature reserves as well as nature monuments.

The activity range of the Kostrzyca Forest Gene Bank involves forests across the whole Poland, implementing seed management programmes such as preservation of forest gene resources and forest tree breeding, progeny testing programme, the protection and restitution of English Yew (*Taxus baccata* L.) and Sorbus torminalis Crantz. with creation of clone archives, restitution of Silver fir (*Abies alba* Mill.) in the Sudeten Mountains and also FlorNaturLBG - programme concerning protection of endangered, rare and protected plant species.

Multi-faced activity of the Kostrzyca Forest Gene Bank is an effort undertaken according to the provisions of the Convention on Biological Diversity (CBD), which was opened for signature in June 1992 at the United Nations Conference on Environment and Development, known as the Earth Summit. The CBD was entered to force in 1993 in 167 countries, also in Poland.

FlorNaturLBG – ex situ conservation of endangered and protected plant species



FlorNaturLBG

The realization of the FlorNaturLBG project (“Ex situ conservation of endangered and protected wild plants in the western part of Poland”) is a response to a need of biodiversity conservation.

The main goal of the project is the long term protection and storage of gene pool of rare, endangered and protected plant species originally derived from natural sites. Creation a bank of seeds with high ecological value is not only social but also legal obligation arising from international biodiversity policy.

The aim is to collect seeds of **58** plant species, from **134** sites within **4** years (2009-2012).

Table 1: The amount of seed collection (2009 – 2011)

Location	Number of species	Number of sites	Seed collection	Lack of fructification	Site extinction	Lack of collection
Karkonosze National Park	20	38	38	-	-	
Tatra Mountains National Park	15	17	5	1	-	11
Babia Góra National Park	6	6	5	1	-	
Lower Silesia Province	16	41	9	8	23	1
Silesia Province	1	3	3	-	-	
Western Pomerania and Lubuskie Province	8	9	4	1	4	
Wielkopolska and Kujawy-Pomerania Province	4	11	1	5	5	
Pomerania Province	5	9	2	1	5	1
TOTAL	75	134	67	17	37	13

The collections of seeds derive from sites of western Poland: national parks: Karkonosze NT, Tatra Mountains NT, Babia Góra NT and Provinces: Silesia, Lower Silesia, Western Pomerania and Lubuskie, Pomerania, Wielkopolska and Kujawy-Pomerania.

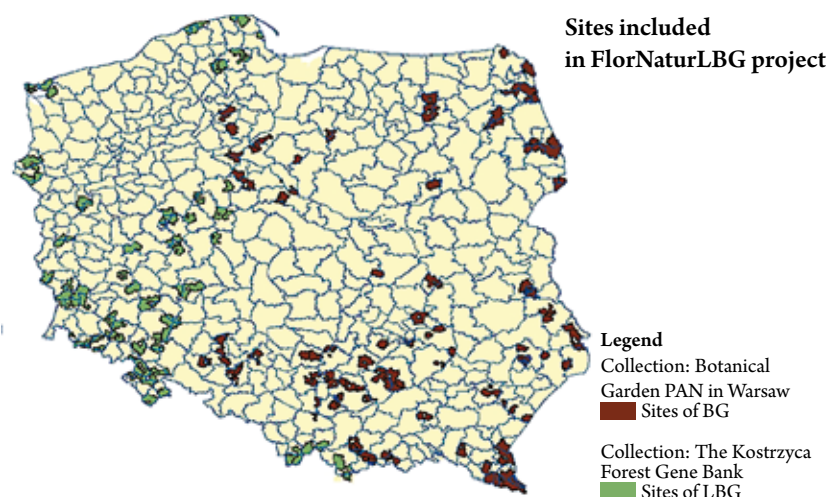


Figure 1: Range of the project

The Botanical Garden Center of Biological Diversity Sciences PAN in Warsaw has undertaken the similar project protecting the plant species derived from natural stands in the eastern part of Poland. Collected seeds will be stored in both institutions and also at the Millennium Seed Bank, Royal Botanic Gardens in Kew.

Plant species dedicated to FlorNaturLBG project

The adopted list of species, mostly herbaceous, is a joint effort of botanists. Plants qualified in the project are classified among the categories and criteria of:

- the International Union for Conservation of Nature and Natural Resources as critically endangered (CR), endangered (EN) and vulnerable (VU);
- included into Bern Convention;

Figure 2: Status of species

- Habitat Directive;
- Polish Plant Red Data Book;
- Red List of Regions;
- classified as a endemics or sub-endemics;
- other, pointed by National Parks;
- under legal protection.

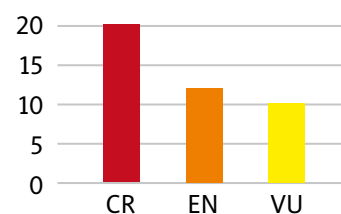


Table 2: The list of plant species included in FlorNaturLBG project

	Plant species	Red List of plants and fungi in Poland (Zarzycki, Szelağ 2006)	Polish Plant Red Data Book (Kaźmierczakowa, Zarzycki 2001)	The Red List of Vascular Plants of Lower Silesia (Kački 2003)	Under legal protection
1	<i>Agrimonia pilosa</i> Ledeb				v
2	<i>Allium sibiricum</i>	V	VU	VU	v
3	<i>Allium victorialis</i>	[E]		CR	
4	<i>Angelica palustris</i> (Besser) Hoffm.	V	EN		v
5	<i>Apium nodiflorum</i> (L.) Lag.	E	CR		v
6	<i>Apium repens</i> (Jacq.) Lag.	E	EN		v
7	<i>Arabis alpina</i>			CR	
8	<i>Astragalus penduliflorus</i> Lam.	E	CR		
9	<i>Betula nana</i> L.	V	EN	EN	v
10	* <i>Campanula bohemica</i> Hruby in Polivka, Domin & Podp.		EN	VU/EN	v
11	* <i>Campanula serrata</i> (Kit.) Hendrych		VU		v
12	<i>Cardamine amara</i> L. subsp. <i>opizii</i> (J. Presl. & C. Presl) Celak.			NT	
13	<i>Cardamine resedifolia</i> L.	E	CR	CR	
14	<i>Carex magellanica</i> Lam.	V	CR	VU	v
15	<i>Carex parviflora</i> Host	R			
16	<i>Cerastium alpinum</i> L. s. s	R	CR		
17	<i>Cochlearia tatrae</i> Borbás	V	VU		v
18	<i>Corrigiola litoralis</i> L.	V	CR	CR	v
19	<i>Cotoneaster tomentosus</i> (Ait.) Lindl.	R			
20	<i>Eleocharis multicaulis</i> Sm.,	E	EN	CR	v
21	<i>Elymus farctus</i> (Viv.) Runemark ex Melderis	E	CR		
22	<i>Erigeron alpinus</i> L.	R	CR		

23	<i>Euphrasia minima</i> ,	R		CR	
24	* <i>Galium sudeticum</i> Tausch	R	CR	VU/CR	v
25	<i>Galium valdepilosum</i> Heinr. Braun	R	EN	CR	v
26	* <i>Gentianella bohemica</i> Skalický			CR	v
27	<i>Gentianella campestris</i>			CR	v
28	<i>Gladiolus paluster</i> Gaudin	E	CR	RE	v
29	<i>Gnaphalium supinum</i>			CR	
30	<i>Kickxia spuria</i> (L.) Dumort.	E	CR	CR	
31	<i>Laserpitium archangelica</i> Wulfen	R	CR		
32	<i>Linaria odora</i> (M. Bieb.) Fisch.	V	VU		v
33	<i>Melica ciliata</i> L.	E	CR	CR	
34	<i>Muscari comosum</i> (L.) Mill.	V	CR	CR	v
35	<i>Pedicularis hacquetii</i> Graf	R	VU		v
36	* <i>Pedicularis sudetica</i> Willd.	E	EN	EN	v
37	<i>Pimpinella saxifraga</i> subsp. <i>Rupestris</i>			CR	
38	<i>Pinus x rhaetica</i> Brüg- ger	V	VU	VU	v
39	<i>Plantago coronopus</i> L.	E	CR		v
40	<i>Potamogeton polygoni-</i> <i>folius</i> Pourr.	E	CR	DD	
41	<i>Puccinellia maritima</i> (Hudson) Parl.	E	CR		
42	<i>Pulsatilla pratensis</i> (L.) Mill.	V		CR	v
43	* <i>Pulsatilla slavica</i> G. Reuss	E	VU		v
44	<i>Pulsatilla vernalis</i> (L.) Mill.	V	VU	RE	v
45	<i>Ranunculus arvensis</i> L.	V		VU	
46	<i>Ranunculus lingua</i> L.	V		NT	
47	<i>Ranunculus oreophilus</i> M. Bieb	[E]			
48	<i>Rhodiola rosea</i> ,			CR	
49	<i>Salix lapponum</i>	V	EN	EN	v
50	<i>Saussurea pygmaea</i> (Jacq.) Sprengel		CR		
51	<i>Saxifraga bryoides</i>			CR	

52	<i>Saxifraga moschata</i> subsp. <i>Basaltica</i>	E		CR	
53	<i>Saxifraga nivalis</i> L.	E	CR	CR	
54	<i>Saxifraga oppositifolia</i> ,			CR	
55	<i>Stipa borysthena</i> Klokov	V	CR		v
56	<i>Stipa joannis</i> Čelak.	V	VU		v
57	<i>Veronica alpina</i>			DD	
58	<i>Veronica praecox</i> All.	E	CR		

*species included in Habitat Directive

RE – Regionally Extinct

CR=E – Critically Endangered

[E] – species highly endangered on isolated sites

EN – Endangered

V=VU – Vulnerable

U1 – unsatisfactory condition

DD – Date Deficient

NT – Near Threatened

R – low risk

FV – appropriate conditions



Methods

As a member of European Native Seed Conservation network (ENSCONET) the Kostrzyca Forest Gene Bank takes part in international working group. ENSCONET is an international organization with an initial task to carry out an inventory and conservation status of species with cooperation with European seed banks. The experience of ENSCONET – collection methodology, evaluation and storage is widely used in realization of the FlorNaturLBG project.

Seed collecting

Seed collecting is a well-defined scientific procedure, widely used for the *ex situ* conservation of plant genetic resources (ENSCONET, Seed Collecting Manual for Wild Species, 2009).

All collections are being made legally, with permission of Regional Directorate of Environmental Protection, Ministry of Environment, land owners – national parks, forest districts and relevant government authorities. The identity of populations is confirmed at flowering by botanists able to do a verification of species.

Description of site is also included as well as the extra information from local experts. Method of sampling and harvesting depends on species and selected sites. According to ENSCONET manual, the general rule is that collectors aim to sample from as many individuals as possible without interfering much into natural processes within the population. Collecting is made at random over as wide area as possible.



Figure 3: Seed collecting – *Elymus farctus*



Figure 4: Seed collecting – *Cardamine resedifolia*



Figure 5: Seed collecting – *Allium sibiricum*

After harvesting collected samples are pre-cleaned and transported to the seed bank.

Seed cleaning

Seed cleaning of wild seed collections requires greater skill than many might expect. Staff need some knowledge of seed and fruit morphology at least at the genus level and how to distinguish seed cover and other structures under the microscope. Brand-new techniques are being applied while seed cleaning to remove structures that are unnecessary for storage. Adapting techniques for different types of fruit/seed is therefore the key to good seed cleaning procedures (ENSCONET, 2009. ENSCONET Curation Protocols&Recommendations).

Many species have very small weight of 1000seeds, for example *Saxifraga nivalis* 0,04 g (in comparison the average weight of *Betula pendula* is about \approx 0,11 g) – that causes difficulties in testing.

Table 3: Thousand – seed weight of evaluated seeds

Plant species	Thousand-seed weight [g]
<i>Saxifraga nivalis</i>	0,040
<i>Saxifraga moschata ssp. bazaltica</i>	0,056
<i>Gnaphalium supinum</i>	0,090
<i>Cardamine resedifolia</i>	0,180
<i>Arabis alpina</i>	0,300
<i>Allium sibiricum</i>	0,850
<i>Pedicularis sudetica</i>	1,070
<i>Allium victorialis</i>	3,560

Determining viability

In a seed bank, it is important to know the viability of seeds that are being stored. Seed viability is defined as the number of seeds that are alive in a seed lot, and have the potential to give rise to a plantlet (Gosling, 2003; Rao et al., 2006). The viability of seeds is determined through germination tests. The methods of testing are very different, for example:

- scarification;
- stratification in 1-percentage agar solution (sometimes GA3);
- finding the optimum temperature amplitudes for germination testing;
- variety of photoperiodism;
- differences in time of lasting seed germination tests;
- sometimes there is a need to sterilize seed coats.

Seed drying

Humidity measurement is done with non-destructive method, using the multi-channel humidity & water activity analyser. According to ENSCONET recommendations seeds are dried out using the silica gel to equilibrium with about 15 % RH (approximately 3.5 – 6.5 % moisture content) at 10 - 20 °C. Then they are placed at sub-zero temperatures (- 20 °C). Apart from the traditional methods, the cryopreservation is also practised. It's a guarantee of conservation of rare, endangered or nearly-extinct plants of Poland.

Funding

The project is carried out within the 5th Priority of the Operational Programme Infrastructure and Environment: „Environment protection and the promotion of ecological habits”.

The value of the project exceeds 2 500 000 PLN. Nearly 2 000 000 PLN of funding comes from the European Union (about 85%). The remaining part is funded from the National Fund for Environmental Protection and Water Management (about 15%).



Coordination Center for Environmental Projects as an implementing and managing institution

Before realization there is a need of acceptance of the CCEP, and then the decision on financing selected project can be made. The utilization of funds is verified as well as the degree of realization of the project, which is periodical, annual and final reported. Controlling of the realization may last up to 3 years after the project closing.

Summary

Plants – static and silent developed very complex lives over several hundred million years of evolution (Stuppy, Kessler & Harley, 2009). By mixing together they create better combination of characteristics that is why it is so important to conduct the biodiversity conservation. Extinction of species is a continuous process causing diminish of biological diversity and threatening the stability of ecosystems.

Genetic material collected and cultivated during realization of FlorNaturLBG project will be used for reintroduction programs and restoration of endangered species. The collected genetic material will also enrich the educational collections of botanical gardens and will allow to conduct scientific research (Gugała, 2010).

References

- ENSCONET (2009) ENSCONET *Curation Protocols & Recommendations*.
- ENSCONET (2009) ENSCONET *Seed Collecting Manual for Wild Species*.
- Gosling, P.G. (2003). *Viability testing*. In: Smith, R.D., Dickie, J.B., Linington S.H., Pritchard H.W. & Probert R.J. (eds). *Seed Conservation: Turning Science into Practice*. Royal Botanic Gardens, Kew, UK, 445-481.
- Gugała, A. (2010) *Główne założenia projektu FlorNaturLBG – „Ochrona ex situ zagrożonych i chronionych roślin, dziko rosnących w zachodniej części Polski”*. Unia Europejska dla zachowania różnorodności biologicznej polskich lasów, Rogów, 317-327.
- Kaźmierczakowa, R. and Zarzycki K. (eds.) (2001). *Polska czerwona księga roślin. Paprotniki i rośliny kwiatowe. Polish red data book of plants. Pteridophytes and flowering plants*. Instytut Botaniki im. W. Szafera PAN i Instytut Ochrony Przyrody PAN, Kraków.
- Kącki Z. (ed.) (2003). *Zagrożone gatunki flory naczyniowej Dolnego Śląska. Endangered vascular plants of Lower Silesia*. Instytut Biologii Roślin Uniwersytetu Wrocławskiego, Polskie Towarzystwo Przyjaciół Przyrody „Pro NATURA”, Wrocław.
- Stuppy, W. et al. (2009). *The Bizarre and Incredible World of Plants*, London.
- Zarzycki, K., Szelaż, Z. (2006). *Red list of vascular plants in Poland. Czerwona lista roślin naczyniowych w Polsce*. In: Mirek, Z., Zarzycki, K., Wojewoda, W., Szelaż, Z. *Red list of plants and fungi in Poland. Czerwona lista roślin i grzybów Polski*. Instytut Botaniki im W.Szafera, Polska Akademia Nauk, Kraków.

The Reconstruction of Replacement Habitats in the Botanical Garden of the National Centre of Plant Genetic Resources of the Plant Breeding and Acclimatization Institute in Bydgoszcz, Poland.

Włodzimierz Majtkowski and Gabriela Majtkowska

Author note

Włodzimierz Majtkowski and Gabriela Majtkowska, Botanical Garden of the National Centre for Plant Genetic Resources, Plant Breeding and Acclimatization Institute - National Research Institute, Bydgoszcz, Poland

Abstract

In the Botanical Garden of the National Centre of Plant Genetic Resources of the Plant Breeding and Acclimatization Institute in Bydgoszcz in 2008, the reconstruction of a natural plant community was started in order to increase the effectiveness of *ex situ* native biological diversity protection. It arose from the 'national protective strategy and balanced utilization system of biological diversity' together with the Activities Program from 2007 to 2013 (Sharrock & Jones 2009). The sites for halophytes and the dune flora were established in 2008 and xerothermic habitat, the sites for ruderal and efemerophytes species in 2009.

Introduction

The work on reconstruction of replacement habitats was preceded by phytosociological observations and soil analysis of selected *in-situ* sites: Rogowo and Włodarka near Trzebiatów (coast dune and halophyte meadow); the area near Solec Kujawski (inland dune) and Janikowo near Inowrocław (halophilic plants site). The plants obtained from the seeds collected in natural conditions were planted on the reconstructed sites. The highest salinity level was observed on a halophilic plants site with waste substrate from a soda plant in Janikowo.

The analysis of the chemistry of soil samples taken from *in situ* sites was conducted in Chemical Laboratory of the Plant Breeding and Acclimatization Institute in Bydgoszcz. In the taken samples there were marked:

- pH and salinity, in distilled H₂O,
- N-NO₃ – with the use of an ion-selective electrode,
- P – colorimetric method (Spekol 11 Carl Zeiss Jena),
- Ca, Mg, K, Na – by atomic absorption method (spectrophotometer PU 9100X Philips).

The preparation of the obligatory halophyte site was connected with the removal of native ground layer at a depth of approximately 1 metre, covering the pit with 1 millimetre thick PCV foil and filling a half of the basin with substrate from the salt waste stockpile in Janikowo near Inowrocław. The soil parameters of the coastal meadow in Włodarka were obtained by filling the second part of the basin with the mixture of river sand, peat and soil from Janikowo in a ratio of 1:1:1. River sand of different fractions was used to build the dune.

Result and discussions

The results of soil analyses are shown in the table 1.

No.	Investigation places	pH	Salinity	N-NO ₃	P	K	Na	Ca	Mg
		in KCl	g/dm ³	mg/dm ³	mg/dm ³	mg/dm ³	mg/dm ³	mg/dm ³	mg/dm ³
	In-situ sites								
1	Rogowo maritime dune	4,9	0,05	6	1	4	2	26	< 1
2	Solec Kujawski dune	2,1	0,07	11	1	5	1	18	< 1
3	Włodarka peat meadow	4,7	0,9	32	2	8	53	107	< 1
4	Włodarka mineral meadow	4,6	0,7	40	6	5	50	54	< 1
5	Janikowo salt waste stockpile	6,5	12,00	125	6	10	267	335	< 1
6	Gruczno xerothermic reserve	7,1	0,28	5,6	18	50	-	2600	67
	Ex-situ sites								
7	Dune	6,6	0,06	10	44	10	3	551	< 1
8	Halophyte meadow	6,7	1,7	23	49	10	111	571	< 1
9	Xerothermic habitat	7,6	0,25	12	26	50	-	4050	126

Table 1. Chemical composition of soils from natural sites and reconstructed in the Botanical Garden in Bydgoszcz

The list of the species observed on natural sites is given in the Table 2 which contains the species that were planted in the spring 2009 on reconstructed sites in the Botanical Garden in Bydgoszcz. During the vegetation season, systematic observations of planted species development were made. The biggest sodding was obtained on the sites for halophytes with the ground transferred from Janikowo. Almost 100% covering of the soil surface by plants was possible thanks to the seeds contained in the transferred ground. The grass planted on the dune created strong root systems, causing the stabilization of the site.

Table 2. List of species observed in natural conditions and planted on reconstructed sites in the Botanical Garden in Bydgoszcz

Observation place	No.	Species
Szweźka Góra n. Solec Kujawski, inland dune	1	<i>Calamagrostis epigejos</i>
	2	<i>Calluna vulgaris</i>
	3	<i>Campanula rotundifolia</i>
	4	<i>Cladonia sp.</i>
	5	<i>Corynephorus canescens</i>
	6	<i>Deschampsia flexuosa</i> *
	7	<i>Festuca ovina</i>
	8	<i>Festuca tenuifolia</i>
	9	<i>Helichrysum arenarium</i>
	10	<i>Hieracium pilosella</i> *
	11	<i>Jasione montana</i>
	12	<i>Pinus sylvestris</i>
Rogowo, coastal dune	1	<i>Alopecurus pratensis</i>
	2	<i>Ammophila arenaria</i> *
	3	<i>Artemisia campestris subsp. campestris</i>
	4	<i>Cakile maritima</i>
	5	<i>Carex arenaria</i> *
	6	<i>Corynephorus canescens</i>
	7	<i>Deschampsia flexuosa</i>
	8	<i>Elymus arenarius</i> *
	9	<i>Festuca rubra subsp. arenaria</i> *
	10	<i>Hieracium umbellatum var. dunense</i> *
	11	<i>Jasione montana var. litoralis</i> *
	12	<i>Pinus sylvestris</i>
	13	<i>Rosa rugosa</i>
	14	<i>Salix sp.</i>

Włodarka, halophyte meadow	1	<i>Agrostis stolonifera</i>
	2	<i>Bellis perennis</i>
	3	<i>Cynosurus cristatus</i>
	4	<i>Dactylis glomerata</i>
	5	<i>Deschampsia caespitosa</i>
	6	<i>Eleocharis palustris</i>
	7	<i>Festuca arundinacea</i>
	8	<i>Festuca pratensis</i>
	9	<i>Festuca rubra</i>
	10	<i>Glyceria fluitans</i>
	11	<i>Juncus conglomeratus</i>
	12	<i>Juncus gerardi*</i>
	13	<i>Lolium perenne</i>
	14	<i>Lythrum salicaria</i>
	15	<i>Phalaris arundinacea</i>
	16	<i>Phleum pratense</i>
	17	<i>Plantago lanceolata</i>
	18	<i>Plantago major subsp. winteri</i>
	19	<i>Plantago maritima*</i>
	20	<i>Poa pratensis</i>
	21	<i>Polygonum hydropiper</i>
	22	<i>Puccinellia distans*</i>
	23	<i>Rumex crispus</i>
	24	<i>Rumex obtusifolius</i>
	25	<i>Scirpus maritimus*</i>
	26	<i>Trifolium fragiferum*</i>
	27	<i>Trifolium pratense</i>
	28	<i>Triglochin maritima*</i>
	29	<i>Triglochin palustre*</i>
Janikowo, halophilic plants site	1	<i>Aster tripolium*</i>
	2	<i>Atriplex prostrata subsp. prostrata*</i>
	3	<i>Puccinellia distans*</i>
	4	<i>Salicornia europea*</i>

Gruczno xerothermic reserve	1	<i>Avenula pratensis*</i>
	2	<i>Calamagrostis epigejos</i>
	3	<i>Campanula sibirica</i>
	4	<i>Epipactis helleborine</i>
	5	<i>Koeleria macrantha</i>
	6	<i>Lapulla squarrosa</i>
	7	<i>Medicago minima</i>
	8	<i>Phleum boehmeri*</i>
	9	<i>Pulsatilla pratensis</i>
	10	<i>Rosa agrestis</i>
	11	<i>R. micrantha</i>
	12	<i>Scorzonera purpurea</i>
	13	<i>Silene chlorantha</i>
	14	<i>Stipa joannis*</i>
	15	<i>Veronica praecox</i>

*species planted on reconstructed sites



Figure 1: Reconstituted halophyte meadow and dune

Belt (1995) turns her attention to the necessity of protecting whole sites. Gramineous plant communities are especially exposed to degradation (Filipiak & Kucharski, 2000). Agricultural development (the ceasing of mowing and grazing in particular) causes meadow habitats and pastures to disappear or undergo transformation. The effect of these changes is mass disappearance of plants. That is the reason why there is an urgent need for the preservation of gramineous plants from anthropogenic habitats.

Building and preserving of natural habitats is one of the most difficult tasks undertaken by botanical gardens. The aim of their reconstructions is to create optimal conditions for plants originating from different habitats as well as to obtain original compositions that have important educational qualities (Łukasiewicz, 1996).

Conclusions

The increase in the effectiveness of native biological diversity in *ex situ* conditions requires the building of habitats in conditions that replicate natural conditions as nearly as possible. The re-creation of phytocenosis in artificial conditions requires giving more attention to ecological criteria occurring in nature, such as: ground type, humidity conditions, height above sea level, land inclination and insolation.

References

- Belt, H. (1995). Założenia metodyczne ekspozycji wybranych polskich zbiorowisk roślinnych tworzonej w sztucznych warunkach w Ogrodzie Botanicznym PAN w Powsinie. *Biul. Ograd. Bot., Muzeów i Zbiorów* 4, 21-30.
- Filipiak, E. Kucharski, L. (2000). Próba odtworzenia półnaturalnej łąki w Łódzkim Ogrodzie Botanicznym. *Biul. Ograd. Bot., Muzeów i Zbiorów* 9, 89-90.
- Łukasiewicz, A. (1996). Budowa i prowadzenie alpinariów w warunkach niżowych. *Biul. Ograd. Bot., Muzeów i Zbiorów* 5, 19-29.
- Sharrock, S. Jones, M. (2009). *Conserving Europe's threatened plants. Progress towards Target 8 of the Global Strategy for Plant Conservation*. BGCi Richmond, Surrey, U.K., 56.

Latvian rare and endangered plants in *ex situ* collections

Ludmila Vishnevska, Dace Kļaviņa, Gunta Jakobsone, Dagnija Šmite, Daina Roze, Signe Tomsone, J. Ziliņš

Author note

Ludmila Vishnevska, Dace Kļaviņa, Gunta Jakobsone, Dagnija Šmite and Daina Roze, National Botanic Garden of Latvia;

Signe Tomsone, Botanical Garden of the University of Latvia;

J. Ziliņš, Kalsnava Arboretum.

Abstract

A significant target for botanic gardens in the Global Strategy for Plant Conservation until 2010 was target 8: “at least 60 per cent of threatened plant species in *ex situ* collections, preferably in the country of origin...” The goal of our work was to make an assessment of the *ex situ* collections of rare and endangered vascular plants in Latvia. We have made a common list compiling together the lists of species from the Red Data Book of Latvia, Regulations of the Cabinet of Ministers of Latvia, and EC Directive 92/43/EEK. The common list has been supplemented with data about species presented in the collections of the National Botanic Garden, Botanic Garden of Latvian University and Kalsnava Arboretum. We stated that in Latvia there are 327 native vascular plant species, which are included in at least one of these lists. At the end of 2010 there were 151 or 47% of these contained in *ex situ* collections, but according to the Regulations of the Cabinet of Ministers of Latvia (the legal base for the conservation, containing 238 species) there were, respectively, 120 or 50.4%. In *ex situ* collections 13 from 14 Latvian vascular plants included in EC Directive 92/43/EEK are represented.

Rare and endangered plants in *ex situ* collections in Latvia

The Global Strategy for Plant Conservation (GSPC), adopted at the Conference of the Parties to the Convention on Biological Diversity in Hague in 2002, provided 16 objectives for vascular plant conservation, which had to be reached by 2010, and its renewed and strengthened version was adopted at the conference of the parties at Nagoya in October 2010. One of the most significant targets for botanic gardens in the GSPC for 2010 was target 8: at least 60 per cent of threatened plant species in *ex-situ* collections, preferably in the country of origin, and 10 per cent available for recovery and restoration programmes. The new target for 2020 is 75 and 20 per cent respectively.

The objective of our work was to clarify the question: how far are Latvian botanic gardens from the 8th objective of GSPC, or, more specifically, how many rare and endangered plants of native flora of Latvia are conserved in Latvian *ex situ* collections?

To answer this question, we first checked the IUCN Red List, but not one species of Latvian vascular plants was found there. Then we made a list of vascular plant species by compiling together the lists of Latvian rare, endangered or even extinct plants included in:

- Annexes II and IV of the European Council Directive on the conservation of natural habitats and of wild fauna and flora - 14 vascular plant species are occurring in the nature in Latvia;
- Annex of the Regulations of the Cabinets of Ministers No. 396 "Regulations of the list of specially protected species and specially protected species of limited use" - 238 vascular plant species;
- Red Data Book of Latvia, 2003, volume 3, Vascular Plants - 319 species, some of them, for different reasons, are not included in the Rules No.396, but some, included in the Rules – not included to the Red Data Book.

The common list contained 327 species (Table 1).

The next step of our work was to ask the keepers of *ex situ* collections in Latvia, if they have rare or endangered plants in their collections. The most likely expectation was to find such collections in the botanic gardens. We also asked other Latvian plant keepers (Agriculture University, nature reserves, and some private collectors), but they did not have any rare Latvian species in their collections.

We have compiled together the plants from our common list, represented in the collections of botanic gardens. There are 2 institutions in Latvia with the words 'botanic garden' in their official names: the National Botanic Garden of Latvia in Salaspils and the Botanical Garden of Latvian University in Riga. As provided by the Botanic Gardens Conservation International definition: „Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education” (Wyse Jackson and Sutherland, 2000). In such context the term "botanic garden" can be used also for arboretums and other institutions, having special plant collections. In such case one another institution, which can be reckoned among botanic gardens is Kalsnava Arboretum. So, in Latvia there are three botanic gardens:

- National Botanic Garden of Latvia, belonging to the Ministry of Environmental Protection and Regional Development of Latvia, located in Salaspils, established in 1956, occupying an area of 129 ha, and having in collections about 15 000 taxa;
- Botanical Garden of the University of Latvia, belonging to the University of Latvia, located in Riga, established in 1922, occupying an area of 15 ha, and having in collections about 6200 taxa;
- Kalsnava arboretum, belonging to the Latvian State Forests, located in Jaunkalsnava, established in 1975, occupying an area 143,9 ha, and having in collections about 2500 taxa.

Ex situ conservation (conservation of species outside of their natural habitats) of plants may be realized in many different ways: in artificially created model biotopes; in beds or arboreta; in pots, hotbeds or hothouses; in sterile culture vessels (*in vitro*); in seed banks. In our case, Latvia has no seed banks for rare and endangered plants,

and no artificial biotopes (there were some attempts to create model biotopes for education, but not for conservation purposes); three other ways (plants in beds, in pots and in tubes) are represented. Some of the gardens (National Botanic Garden, Kalsnava Arboretum) occupy relatively spacious areas, with partly natural conditions and species, where some rare species are also growing. In such a case we can talk about „*in situ*” or „almost *in situ*” conservation, because sometimes it is difficult to decide whether species always grew or were planted there, or escaped from the collection. The two last cases can be seen as successful reintroduction. Classic examples of reintroduction - replanting of protected species from *ex situ* to *in situ* conditions (natural habitats) - were not presented because of lack of a legislative basis and concern about the danger of genetic diversity of natural populations.

The results of our analysis are presented in the table 1.

Table 1: Latvian rare and endangered vascular plants and their presence in *ex situ* collections

Designations:

+ is (in open area);

- is not;

t is *in vitro*;

w is wild in the garden territory;

RDB – Red Data Book of Latvia, categories:

0 – extinct, 1 – endangered, 2 – vulnerable, 3 – rare, 4 – undetermined;

Reg. 396 – Regulations of the Cabinet of Ministers of Latvia No. 396

EC Dir. - European Council Directive On the Conservation of Natural Habitats and of Wild Fauna and Flora

NBG – National Botanic Garden of Latvia

LU BG – Botanical Garden of the University of Latvia

Kalsnava – Kalsnava Arboretum

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kalsnava
1	<i>Aconitum lasiostomum</i> Reichenb.	Kurpīte, dzeltenā	1	+	-	+	+	-
2	<i>Agrimonia pilosa</i> Ledeb.	Ancītis, spilvainais	-	-	+	+t	-	-
3	<i>Ajuga genevensis</i> L.	Cekuliņš, Ženēvas	2	+	-	-	-	-
4	<i>Ajuga pyramidalis</i> L.	Cekuliņš, piramidālais	2	+	-	+t	+	-
5	<i>Alisma gramineum</i> Lej.	Cirvene, zālainā	1	+	-	-	-	-
6	<i>Alisma lanceolatum</i> With.	Cirvene, šaurlapu	1	+	-	-	-	-
7	<i>Alliaria petiolata</i> (M.Bieb.) Cavara et Grande	Ķīplocene, ārstniecības	3	-	-	+	+	-
8	<i>Allium schoenoprasum</i> L.	Maurloks	3	-	-	+	+	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
9	<i>Allium scordoprasum</i> L.	Sīpols, ķiploku	3	-	-	+	-	-
10	<i>Allium ursinum</i> L.	Laksis	3	+	-	+	+	w
11	<i>Allium vineale</i> L.	Sīpols, vīnkalnu	3	-	-	+t	-	-
12	<i>Alopecurus arundinaceus</i> Poir.	Lapsaste, niedru	3	-	-	+t	-	-
13	<i>Alyssum gmelinii</i> Jord.	Alise, Gmelina	3	+	-	+t	-	-
14	<i>Androsace filiformis</i> Retz.	Vairodzene, pavedienu	2	-	-	+	-	-
15	<i>Anemone sylvestris</i> L.	Vizbulis, meža	4	-	-	+	+	-
16	<i>Angelica palustris</i> (Besser) Hoffm.	Mātsakne, purva	1	+	+	+t	-	w
17	<i>Anthriscus nitida</i> (Wahlenb.) Hazlinsky	Suņburkšķis, spožais	2	+	-	-	-	-
18	<i>Anthyllis maritima</i> Schweigg.	Jūrmalas pārkonamoliņš	3	-	-	-	-	-
19	<i>Arctium nemorosum</i> Lej.	Diždadzis, birtālas	1	+	-	-	-	-
20	<i>Arenaria procera</i> Spreng.	Smiltēnīte, zāļlapu	2	+	-	+t	+	-
21	<i>Armeria maritima</i> (Mill.) Willd.	Armērija, jūrmalas	1	+	-	+t	+	-
22	<i>Armeria vulgaris</i> Willd.	Armērija, parastā	1	-	-	+t	+	-
23	<i>Asplenium rutamuraria</i> L.	Sīkpararde, mūru	1	+	-	-	-	-
24	<i>Asplenium trichomanes</i> L.	Sīkpararde, plūksnu	1	+	-	-	-	-
25	<i>Astragalus penduliflorus</i> Lam.	Tragantzīrnis, nokarenais	1	+	-	-t	-	-
26	<i>Astrantia major</i> L.	Zvaigznīte, lielā	2	+	-	+	+	-
27	<i>Atriplex calotheca</i> (Rafn) Fr.	Balodene, skaistaugļu	3	+	-	-	-	-
28	<i>Atriplex glabruscula</i> Edmondston	Balodene, kailā	2	-	-	-	-	-
29	<i>Atriplex longipes</i> Drejer	Balodene, garkātu	2	-	-	-	-	-
30	<i>Batrachium baudotii</i> (Godr.) F. W. Schultz	Ūdensgundega, jūras	1	+	-	-	-	-
31	<i>Batrachium peltatum</i> (Schrank) Bercht. et J.Presl	Ūdensgundega, trejlapu	1	-	-	-	-	-
32	<i>Betula nana</i> L.	Pundurbērzs	2	+	-	+	+	+
33	<i>Blechnum spicant</i> (L.) Roth.	Ēnpararde, vārpu	1	+	-	-	-	-
34	<i>Blysmus rufus</i> (Huds.) Link	Blizme, rūsganā	2	+	-	-t	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
35	<i>Botrychium matricarifolium</i> A. Braun ex W.D.J.Koch	Ķekarpaparde, zarainā	2	+	-	-	-	-
36	<i>Botrychium multifidum</i> (S.G.Gmel.) Rupr.	Ķekarpaparde, plūksnu	2	+	-	-	-	-
37	<i>Botrychium simplex</i> E.Hitchc.	Ķekarpaparde, vienkāršā	1	+	-	-	-	-
38	<i>Botrychium virginianum</i> (L.) Sw.	Ķekarpaparde, Virdžīnijas	2	+	-	-	-	-
39	<i>Bromopsis benekenii</i> (Lange) Holub.	Zaķauza, Benekena	2	+	-	+	-	-
40	<i>Callitrihe hermaphroditica</i> L.	Ūdenīte, rudens	2	-	-	-	-	-
41	<i>Cardamine flexuosa</i> With.	Ķērsa, izlocītā	2	+	-	+t	-	-
42	<i>Cardamine hirsuta</i> L.	Ķērsa, pūkainā	1	+	-	-	-	-
43	<i>Carex aquatilis</i> Wahlenb.	Grīslis, ūdeņu	1	+	-	-	-	-
44	<i>Carex atherodes</i> Spreng.	Grīslis, akotainais	2	+	-	-	-	-
45	<i>Carex brizoides</i> L.	Grīslis, vizuļu	2	+	-	-	-	-
46	<i>Carex buxbaumii</i> Wahlenb.	Grīslis, Buksbauma	3	+	-	+t	-	-
47	<i>Carex davalliana</i> Sm.	Grīslis, Devela	3	+	-	+t	-	w
48	<i>Carex demissa</i> Hornemann	Grīslis, zemeņu	3	-	-	-	-	-
49	<i>Carex disperma</i> Dewey	Grīslis, divsēklu	3	+	-	-	-	-
50	<i>Carex distans</i> L.	Grīslis, attālinātais	1	-	-	-	-	-
51	<i>Carex heleonastes</i> Ehrh.	Grīslis, kūdrāja	2	+	-	-	-	-
52	<i>Carex ligERICA</i> J. Gay	Grīslis, Ligeras	2	+	-	-t	-	-
53	<i>Carex mackenziei</i> V. I. Krecz.	Grīslis, Makenzija	1	+	-	-	-	-
54	<i>Carex montana</i> L.	Grīslis, kalnu	3	-	-	-t	+	-
55	<i>Carex omithopoda</i> Willd.	Grīslis, pleznveida	3	+	-	+t	-	-
56	<i>Carex otrubae</i> Podp.	Grīslis, Otruba	2	-	-	-t	-	-
57	<i>Carex paupercula</i> Michx.	Grīslis, palu	3	+	-	-	-	-
58	<i>Carex pilosa</i> Scop.	Grīslis, matainā	1	+	-	+	-	-
59	<i>Carex reichenbachii</i> Bonnet.	Grīslis, Reihenbaha	3	+	-	+	-	-
60	<i>Carex rhizina</i> Blytt ex Lindblom	Grīslis, pēdveida	2	+	-	-	-	-
61	<i>Carex rhynchophysa</i> C.A.Mey.	Grīslis, knābja	1	+	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
62	<i>Carex supina</i> Willd ex Wahlenb.	Zemais grīslis	1	-	-	-	-	-
63	<i>Carex scandinavica</i> E.W.Davies	Grīslis, Skandināvijas	2	+	-	-	-	-
64	<i>Carpinus betulus</i> L.	Skābardis, parastais	2	+	-	+	+	+
65	<i>Catabrosa aquatica</i> (L.) P.Beauv.	Avotene, ūdeņu	3	-	-	-	-	-
66	<i>Cenolophium denudatum</i> (Hornem.) Tutin	Dobspārne, kailā	3	-	-	+	-	-
67	<i>Centaurium littorale</i> (Turner) Gilmour	Augstiņš, jūrmalas	2	+	-	+t	-	-
68	<i>Centaurium pulchellum</i> (Sw.) Druce	Augstiņš, skaistais	2	+	-	-	-	-
69	<i>Cephalanthera longifolia</i> (L.) Fritsch	Garlapu cefalantēra	0	-	-	-	-	-
70	<i>Cephalanthera rubra</i> (L.) Rich.	Cefalantēra, sarkanā	1	+	-	-	-	-
71	<i>Ceratophyllum submersum</i> L.	Pusgrimusi raglape	2	-	-	-	-	-
72	<i>Chamaepericlymenum suecicum</i> (L.) Asch. et Graebn.	Pundurgrimonis, Zviedrijas	1	+	-	-	-	-
73	<i>Chenopodium acerifolium</i> Andr.	Balanda, kļavlapu	3	-	-	-	-	-
74	<i>Cinna latifolia</i> (Trevir.) Griseb.	Cinna, platlapu	3	+	+	-t	-	-
75	<i>Circaea lutetiana</i> L.	Raganzāļīte, lielā	2	+	-	+t	-	-
76	<i>Cladium mariscus</i> (L.) Pohl.	Aslape, dižā	3	+	-	+t	-	-
77	<i>Cnidium dubium</i> (Schkuhr) Thell.	Knīdija, mānīgā	2	+	-	-	-	-
78	<i>Coeloglossum viride</i> (L.) Hartm.	Dobziede, zaļā	2	+	-	-	-	-
79	<i>Conioselinum tataricum</i> Hoffm.	Tatārijas stobulis	3	-	-	-	-	-
80	<i>Corallorrhiza trifida</i> Chatel.	Koraļsakne, trejdaivu	3	+	-	-	-	-
81	<i>Corispermum intermedium</i> Schweigg.	Jūrmalas kamieļzāle	3	-	-	-	-	-
82	<i>Corydalis cava</i> (L.) Schweigg. et Körte	Cīrulītis, dobais	1	+	-	+t	-	-
83	<i>Corydalis intermedia</i> (L.) Merat	Cīrulītis, vidējais	2	+	-	+t	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
84	<i>Corynephorus canescens</i> (L.) P.Beauv.	Kāpsmildzene, iesirmā	3	-	-	-	+	-
85	<i>Cotoneaster canescens</i> Vestergr. ex B.Hylmo	Klintene, iesirmā	1	-	-	-	-	-
86	<i>Cotoneaster niger</i> (Wahlb.) Fr.	Klintene, melnā	1	+	-	-	-	+
87	<i>Cotoneaster orientalis</i> A.Kern.	Klintene, austrumu	2	-	-	+	-	-
88	<i>Cotoneaster scandinavicus</i> B.Hylmo	Klintene, Skandināvijas	1	+	-	-	-	+
89	<i>Crambe maritima</i> L.	Krambe, jūrmalas	1	-	-	-	+	-
90	<i>Crassula aquatica</i> (L.) Schonland	Biezlapīte, ūdeņu	1	-	-	-	-	-
91	<i>Crataegus laevigata</i> (Poir.) DC.	Krustabele, divvirbuju	2	+	-	+	-	+
92	<i>Crataegus lindmanii</i> Hrabet.-Uhr.	Krustābele, Lindmaņa	3	+	-	+	-	+
93	<i>Crataegus plagiosepala</i> Pojark.	Krustābele, šķībkausa	1	+	-	+	-	-
94	<i>Crepis mollis</i> (Jacq.) Asch.	Cietpiene, mīkstā	2	+	-	-	-	-
95	<i>Crepis praemorsa</i> (L.) Tausch.	Cietpiene, krūmu	3	+	-	+	-	-
96	<i>Cucubalus baccifer</i> L.	Melnodzene	3	-	-	-	-	-
97	<i>Cyperus fuscus</i> L.	Dižmeldrs, brūnais	1	+	-	-	-	-
98	<i>Cypripedium calceolus</i> L.	Dzegužkurpīte, dzeltenā	2	+	+	+t	-	-
99	<i>Dactylorhiza baltica</i> (Klinge) N.I.Orlova	Dzegužpirkstīte, Baltijas	4	+	-	+wt	+	w
100	<i>Dactylorhiza cruenta</i> (O.F.Muell.) Soo	Dzegužpirkstīte, asinsarkanā	4	+	-	+	-	-
101	<i>Dactylorhiza fuchsii</i> (Druce) Soo	Dzegužpirkstīte, Fuksa	4	+	-	+t	-	-
102	<i>Dactylorhiza incarnata</i> (L.) Soo	Dzegužpirkstīte, stāvlapu	4	+	-	+	-	w
103	<i>Dactylorhiza maculata</i> (L.) Soo	Dzegužpirkstīte, plankumainā	4	+	-	-	-	w
104	<i>Dactylorhiza ochroleuca</i> (Wuestnei ex Boll) Holub	Dzegužpirkstīte, iedzeltenā	4	+	-	+t	-	-
105	<i>Dactylorhiza russowii</i> (Klinge) Holub	Dzegužpirkstīte, Rusova	4	+	-	+t	-	-
106	<i>Delphinium elatum</i> L.	Gaiļpiesis, augstais	2	+	-	+	+	-
107	<i>Dentaria bulbifera</i> L.	Zobainīte, sīpoliņu	3	+	-	+t	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
108	<i>Dianthus arenarius</i> L. subsp. <i>arenarius</i>	Neļķe, smiltāja	-	+	+	+t	-	w
109	<i>Dianthus fischeri</i> Spreng.	Neļķe, Fišera	1	+	-	-	-	-
110	<i>Dianthus superbus</i> L.	Neļķe, krāšņā	1	+	-	+	+	-
111	<i>Digitalis grandiflora</i> Mill.	Uzpirkstīte, lielziedu	3	-	-	+	+	-
112	<i>Diphasiastrum complanatum</i> (L.) Holub.	Plakanstaipeknis, parastais	4	+	-	-	-	-
113	<i>Diphasiastrum tristachyum</i> (Pursh.) Holub.	Plakanstaipeknis, trejvārpu	4	+	-	-	-	-
114	<i>Draba nemorosa</i> L.	Drojene, birtalas	3	-	-	-	-	-
115	<i>Dracocephalum ruyschiana</i> L.	Pūķgalve, Ruiša	2	+	-	+t	-	-
116	<i>Drosera intermedia</i> Hayne	Rasene, vidējā	2	+	-	-	-	-
117	<i>Elatine hydropiper</i> L.	Sīkeglīte, ūdenspiparu	1	+	-	-	-	-
118	<i>Eleocharis multicaulis</i> (Sm.) Desv.	Pameldrs, daudzstublāju	1	+	-	-	-	-
119	<i>Eleocharis parvula</i> (Roem. et Schult.) Bluff, Nees et Schauer	Pameldrs, sīkais	1	+	-	-	-	-
120	<i>Elytrigia junceiformis</i> A. et D.Love	Vārpata, doņu	1	+	-	-	-	-
121	<i>Epilobium collinum</i> C.C.Gmel.	Kazroze, pakalnu	1	+	-	-	-	-
122	<i>Epilobium obscurum</i> Schreb.	Kazroze, tumšzaļā	1	+	-	-	-	-
123	<i>Epipogium aphyllum</i> Sw.	Epipogija, bezlapainā	1	+	-	-	-	-
124	<i>Equisetum scirpoides</i> Michx	Kosa, meldru	1	+	-	-	+	-
125	<i>Equisetum telmateia</i> Ehrh.	Kosa, lielā	1	+	-	+	-	-
126	<i>Erica tetralix</i> L.	Sārtene, grīņa	1	+	-	+	+	-
127	<i>Eryngium maritimum</i> L.	Zilpodze, jūrmalas	1	+	-	+t	+	-
128	<i>Euonymus verrucosus</i> Scop.	Segliņš, kārpainais	-	+	+	-	-	+
129	<i>Euphorbia palustris</i> L.	Dievkrešliņš, purva	2	+	-	+t	+	-
130	<i>Euphrasia micrantha</i> Rchb.	Žibulītis, sīkziedu	2	-	-	-	-	-
131	<i>Festuca altissima</i> All.	Auzene, meža	3	+	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
132	<i>Filago minima</i> (Sm.) Pers.	Pūtele, mazā	1	-	-	-	-	-
133	<i>Gagea erubescens</i> (Besser) Schult. et Schult.f.	Zeltstarīte, iesārtā	1	+	-	-	-	-
134	<i>Galeopsis pubescens</i> Besser	Aklis, pūkainais	1	-	-	-	-	-
135	<i>Galium schultesii</i> Vest	Madara, Šultesa	2	+	-	+t	-	-
136	<i>Galium tinctorium</i> (L.) Scop.	Miešķis, krāsu	1	+	-	+t	+	w
137	<i>Galium trifidum</i> L.	Madara, trejdaļu	3	+	-	-	-	-
138	<i>Galium triflorum</i> Michx.	Madara, trejziedu	1	+	-	-	-	w
139	<i>Gentiana cruciata</i> L.	Drudzene, krustlapu	3	+	-	+t	+	-
140	<i>Gentiana pneumonanthe</i> L.	Drudzene, tumšzilā	2	+	-	-	-	-
141	<i>Gentianella amarella</i> (L.) Boerner	Drudzenīte, rūgtā	2	+	-	-	-	-
142	<i>Geranium bohemicum</i> L.	Gandrene, Bohēmijas	2	-	-	-	-	-
143	<i>Geranium molle</i> L.	Gandrene, mīkstā	1	-	-	-t	-	-
144	<i>Geum hispidum</i> Fr.	Bitene, sarmatainā	1	+	-	-	-	-
145	<i>Gladiolus imbricatus</i> L.	Gladiola, jumstiņu	3	+	-	+t	+	w
146	<i>Glaux maritima</i> L.	Pienzāle, jūrmalas	1	+	-	+t	-	-
147	<i>Glyceria lithuanica</i> (Gorski) Gorski	Ūdenszāle, Lietuvas	3	+	-	-	-	-
148	<i>Glyceria striata</i> (Lam.) Hitchc.	Ūdenszāle, svītrainā	1	+	-	-	-	-
149	<i>Gratiola officinalis</i> L.	Rūgtene, ārstniecības	2	+	-	-	+	-
150	<i>Gymnadenia conopsea</i> (L.) R. Br.	Gimnadēnija, odu	4	+	-	+t	-	-
151	<i>Gymnocarpium robertianum</i> (Hoffm.) Newman	Kailpaparde Roberta	2	+	-	-	+	-
152	<i>Gypsophila fastigiata</i> L.	Ģipsene, garkātu	3	+	-	+t	-	-
153	<i>Gypsophila paniculata</i> L.	Ģipsene, skarainā	2	-	-	+t	+	-
154	<i>Hammarbya paludosa</i> (L.) Kuntze	Sūnene, purva	3	+	-	-	-	-
155	<i>Hedera helix</i> var. <i>baltica</i> Rehder	Efeja, Baltijas	1	+	-	+	+	+
156	<i>Helianthemum nummularium</i> (L.) Mill.	Saulrozīte, naudiņu	3	+	-	+t	+	-
157	<i>Herminium monorchis</i> (L.) R.Br.	Hermīnija, vienguma	2	+	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
158	<i>Hierochloa australis</i> (Schrad.) Roem. et Schult.	Mārsmilga, dienvīdus	1	+	-	-	-	-
159	<i>Hordelymus europaeus</i> (L.) Harz.	Kāpumiēzis, Eiropas	1	+	-	+	-	-
160	<i>Hornungia petraea</i> (L.) Rchb.	Hornungija klinšu	0	-	-	-	-	-
161	<i>Huperzia selago</i> (L.) Bernh. ex Schrank et Mart.	Apdzira	4	-	-	-	-	-
162	<i>Hydrilla verticillata</i> (L.) Royle	Hidrilla, mieturu	1	+	-	-	-	-
163	<i>Hydrocotyle vulgaris</i> L.	Vairoglape, parastā	2	+	-	+t	-	-
164	<i>Hypericum hirsutum</i> L.	Asinszāle, pūkainā	3	+	-	-	+	-
165	<i>Hypericum montanum</i> L.	Asinszāle, kalnu	-	+	-	-	-	-
166	<i>Inula britannica</i> L.	Staģe, Britu	3	-	-	-	-	-
167	<i>Iris sibirica</i> L.	Skalbe, Sibīrijas	2	+	-	+	+	+
168	<i>Isoetes echinospora</i> Durieu	Ezerene, dzeloņsporu	1	+	-	-	-	-
169	<i>Isoetes lacustris</i> L.	Ezerene, gludsporu	1	+	-	-	-	-
170	<i>Jovibarba sobolifera</i> (L.Sims) Opiz	Saulrietenis, atvašu	-	+	-	+	-	-
171	<i>Juncus balticus</i> Willd.	Donis, Baltijas	3	-	-	+t	-	-
172	<i>Juncus bulbosus</i> L.	Donis, sīpoliņu	3	+	-	-	-	-
173	<i>Juncus capitatus</i> Weigel	Donis, galvainais	1	-	-	-	-	-
174	<i>Juncus gerardii</i> Loisel.	Donis, Žerāra	2	+	-	+t	-	-
175	<i>Juncus squarrosus</i> L.	Donis, skrajais	3	+	-	-	-	-
176	<i>Juncus stygius</i> L.	Donis, kūdrāja	1	+	-	-	-	-
177	<i>Juncus subnodulosus</i> Schrank	Donis, strupais	1	+	-	-	-	-
178	<i>Laserpitium latifolium</i> L.	Bezgale, platlapu	3	-	-	+	-	-
179	<i>Laserpitium prutenicum</i> L.	Bezgale, prūšu	1	+	-	-	-	-
180	<i>Lathyrus linifolius</i> (Reichard) Bassler	Dedestiņa, kalnu	2	+	-	+t	-	-
181	<i>Lathyrus maritimus</i> (L.) Bigelow	Dedestiņa, jūrmalas	2	+	-	+t	+	-
182	<i>Lathyrus niger</i> (L.) Bernh.	Dedestiņa, melnā	3	+	-	+	+	-
183	<i>Lathyrus pisiformis</i> L.	Dedestiņa, zirņveida	1	+	-	-	-	-
184	<i>Lemna gibba</i> L.	Ūdensziņš, kuprainais	3	-	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
185	<i>Ligularia sibirica</i> (L.) Cass.	Mēlziede, Sibīrijas	1	+	+	+t	-	-
186	<i>Linaria loeselii</i> Schweigg.	Vīrcle, Lēzeļa	3	+	+	+t	-	-
187	<i>Liparis loeselii</i> (L.) Rich.	Lipare, Lēzeļa	3	+	+	+t	-	-
188	<i>Listera cordata</i> (L.) R.Br.	Divlape, sirdsveida	3	+	-	-	-	-
189	<i>Lithospermum officinale</i> L.	Cietsēkle, ārstniecības	2	+	-	+t	+	-
190	<i>Littorella uniflora</i> (L.) Asch.	Krastene, vienzieda	2	+	-	-	-	-
191	<i>Lobelia dortmanna</i> L.	Lobēlija, Dortmaņa	1	+	-	-	-	-
192	<i>Lonicera caerulea</i> var. <i>pallasii</i> (Ledeb.) Cin.	Sausserdis, Pallas (zilais)	3	+	-	+	-	+
193	<i>Lunaria rediviva</i> L.	Mēnesene, daudzgadīgā	4	+	-	+	-	+
194	<i>Lycopodiella inundata</i> (L.) Holub.	Staipeknītis, palu	2	+	-	-	-	-
195	<i>Lycopodium annotinum</i> L.	Staipeknis, gada	4	-	-	-	-	-
196	<i>Lycopodium clavatum</i> L.	Staipeknis, vālišu	4	-	-	-	-	w
197	<i>Lycopodium dubium</i> Zoega	Staipeknis, mainīgais	1	-	-	-	-	-
198	<i>Malaxis monophyllos</i> (L.) Sw.	Vienlape, purvāja	3	+	-	-	-	-
199	<i>Melampyrum cristatum</i> L.	Nārbulis, sekstainais	1	+	-	-	-	-
200	<i>Moehringia lateriflora</i> (L.) Fenzl.	Mēringija, sānziedu	0	-	-	-	-	-
201	<i>Montia fontana</i> L.	Montija, avotu	2	-	-	-	-	-
202	<i>Myosotis ramosissima</i> Rochel ex Schult.	Neaizmirstule, pakalnu	3	-	-	-	-	-
203	<i>Myosotis sparsiflora</i> Pohl	Neaizmirstule, sīkziedu	3	-	-	-	-	-
204	<i>Myrica gale</i> L.	Purvmirte, parastā	3	-	-	+	+	+
205	<i>Myriophyllum alterniflorum</i> DC.	Daudzlapē, pamīšziedu	2	+	-	-	-	-
206	<i>Najas flexilis</i> (Willd.) Rostk. et W.L.Schmidt	Kaulīnija, lokanā	1	+	-	-	-	-
207	<i>Najas marina</i> L.	Najāda, jūras	-	+	-	-	-	-
208	<i>Najas minor</i> All. (Caulinia minor (All.) Coss. et Germ.)	Kaulīnija, mazā	1	+	-	-	-	-
209	<i>Neottianthe cucullata</i> (L.) Schltr.	Neotiante, cepurainā	1	+	-	-	-	-
210	<i>Nuphar pumila</i> (Timm) DC	Lēpe, sīkā	3	-	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
211	<i>Nymphoides peltata</i> (S.G.Gmel.) Kuntze	Palēpe, vairogu	0	-	-	-	-	-
212	<i>Odontites litoralis</i> (Fr.) Fr.	Sārtzibulītis, jūrmalas	0	-	-	-	-	-
213	<i>Onobrychis arenaria</i> (Kit.) DC.	Esparsete, smiltāju	2	+	-	+t	+	-
214	<i>Ophrys insectifera</i> L.	Ofrīda, mušu	1	+	-	+	-	-
215	<i>Orchis mascula</i> (L.) L.	Dzegužpuķe, vīru	3	+	-	+	-	w
216	<i>Orchis militaris</i> L.	Dzegužpuķe, bruņcepuru	3	+	-	+	-	-
217	<i>Orchis morio</i> L.	Dzegužpuķe, zalkšu2	1	+	-	-	-	-
218	<i>Orchis ustulata</i> L.	Dzegužpuķe, deguma	2	+	-	-	-	-
219	<i>Orobanche coerulea</i> Stephan	Brūnkāte, zilganā	-	+	+	-	-	-
220	<i>Orobanche elatior</i> Sutton	Brūnkāte, lielā	2	+	-	-	-	-
221	<i>Orobanche pallidiflora</i> Wimm. et Grab.	Brūnkāte, bālziedu	2	+	-	-	-	-
222	<i>Pedicularis kaufmannii</i> Pinziger	Jāneglīte, pušķainā	0	-	-	-	-	-
223	<i>Pedicularis sceptrum-carolinum</i> L.	Jāneglīte, dižā	2	+	-	-	-	-
224	<i>Pedicularis sylvatica</i> L.	Jāneglīte, meža	1	+	-	-	-	-
225	<i>Pentaphragma fruticosum</i> (L.) O.Schwarz	Čuža, krūmu	1	+	-	+t	+	+
226	<i>Peucedanum cervaria</i> (L.) Lapeyr.	Rūgdille, briežu	0	-	-	-	-	-
227	<i>Peucedanum oreoselinum</i> (L.) Moench	Rūgdille, kalnu	3	-	-	+t	+	-
228	<i>Phleum arenarium</i> L.	Timotiņš, smiltāja	1	-	-	+	-	-
229	<i>Phyteuma orbiculare</i> L.	Septiņvīre, apaļā	1	+	-	-	-	-
230	<i>Pilularia globulifera</i> L.	Pilulārija, lodaugļu	0	-	-	-	-	-
231	<i>Pimpinella major</i> (L.) Huds.	Noraga, lielā	3	-	-	-	+	-
232	<i>Pinguicula alpina</i> L.	Kreimule, Alpu	1	+	-	-	-	-
233	<i>Pinguicula vulgaris</i> L.	Kreimule, parastā	2	+	-	+t	-	-
234	<i>Plantago maritima</i> L.	Ceļteka, jūrmalas	1	+	-	-t	+	-
235	<i>Platanthera bifolia</i> (L.) Rich.	Naktsvijole, smaržīgā	4	+	-	+	+	w
236	<i>Platanthera chlorantha</i> (Custer) Rchb.	Naktsvijole, zaļziedu	4	+	-	-	-	w
237	<i>Poa remota</i> Forselles	Skarene, skrajziedu	3	+	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
238	<i>Polygonatum verticillatum</i> (L.) All.	Mugurene, mieturu	3	+	-	+	+	-
239	<i>Polygonum mite</i> Schrank	Sūrene, maigā	3	-	-	-	-	-
240	<i>Polygonum oxyspermum</i> C.A.Mey. et Bunge	Sūrene, asaugļu	0	-	-	-	-	-
241	<i>Polygonum viviparum</i> L.	Sūrene, vairvasiņu	2	+	-	-	-	-
242	<i>Polystichum aculeatum</i> (L.) Roth. (P. lobatum)	Cietpaparde, daivainā	1	+	-	+	-	-
243	<i>Polystichum braunii</i> (Spenn.) Fee	Cietpaparde, Brauna	1	+	-	+	-	-
244	<i>Polystichum lonchitis</i> (L.) Roth	Paparde, šķēplapu	1	-	-	-	-	-
245	<i>Potamogeton acutifolius</i> Link	Glīvene, smaillapu	2	+	-	-	-	-
246	<i>Potamogeton trichoides</i> Cham. et Schldtl.	Glīvene, matveida	2	+	-	-	-	-
248	<i>Potamogeton rutilus</i> Wolfg.	Glīvene, iesārtā	3	-	-	-	-	-
249	<i>Potentilla anglica</i> Laichard.	Retējs, pazvilu	1	+	-	-	-	-
250	<i>Potentilla crantzii</i> (Crantz) Beck ex Fritsch	Retējs, Kranca	1	+	-	-	-	-
251	<i>Primula farinosa</i> L.	Bezdelīgactiņa	2	+	-	+w	-	-
252	<i>Prunella grandiflora</i> (L.) Scholler	Brūngalvīte, lielziedu	1	+	-	+t	+	-
253	<i>Prunus spinosa</i> L.	Plūme, ērkšķu	1	-	-	-	-	+
254	<i>Puccinellia capillaris</i> (Lilj.) Jansen (P. retroflexa)	Pukcinellija, matveida (spilvenu)	1	+	-	-t	-	-
255	<i>Pulmonaria angustifolia</i> L.	Lakacis, šaurlapu	2	+	-	+t	+	-
256	<i>Pulsatilla patens</i> (L.) Mill.	Silpurene, meža	4	+	+	+t	+	+
257	<i>Pulsatilla pratensis</i> (L.) Mill.	Silpurene, pļavas	4	+	-	+t	+	-
258	<i>Pycreus flavescens</i> (L.) P.beauv. ex Rchb.	Pikre, dzeltēna	0	-	-	-	-	-
259	<i>Pyrola media</i> Sw.	Ziemciete, vidējā	2	+	-	-	-	-
260	<i>Radiola linoides</i> Roth	Starenīte, linu	2	-	-	-	-	-
261	<i>Ranunculus bulbosus</i> L.	Gundega, sīpoliņu	3	+	-	+	+	-
262	<i>Ranunculus lanuginosus</i> L.	Gundega, villainā	3	+	-	+t	-	-
263	<i>Ranunculus nemorosus</i> DC.	Gundega, birtalas	1	-	-	-	-	-
264	<i>Rhynchospora fusca</i> (L.) W.T.Aiton	Baltmeldrs, rūsganais	1	+	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
265	<i>Rosa cieszelskii</i> Blocki	Roze, Ceseļska	3	-	-	-	-	-
266	<i>Rosa coriifolia</i> Fr.	Roze, ādlapainā	3	+	-	-	-	-
267	<i>Rosa mollis</i> Sm.	Roze, mīkstā	3	+	-	-	-	-
268	<i>Rosa rubiginosa</i> L.	Roze, smaržlapu	3	+	-	+	+	-
269	<i>Rosa sherardii</i> Davies	Roze, Šerarda	3	-	-	+	-	-
270	<i>Rubus arcticus</i> L.	Kaulene, ziemeļu	0	-	-	+	-	-
271	<i>Rubus plicatus</i> Weihe et Nees	Cūcene, krokainā	0	-	-	-	-	-
272	<i>Ruppia maritima</i> L.	Rupija, jūras	1	+	-	-	-	-
273	<i>Salix myrtilloides</i> L.	Kārklis, mellenāju	3	+	-	-	-	+
274	<i>Salix phylicifolia</i> L.	Kārklis, divkrāsu	3	+	-	-	-	+
275	<i>Salix repens</i> L.	Kārklis, ložņu	-	+	-	-	-	+
276	<i>Sanguisorba officinalis</i> L.	Brūnvāļīte, ārstniecības	2	+	-	+t	+	+
277	<i>Saussurea esthonica</i> Baer ex Rupr.	Rūgtlape, Igaunijas	1	+	+	+t	-	-
278	<i>Saxifraga hirculus</i> L.	Akmeņlauzīte, dzeltenā	1	+	+	-t	-	-
279	<i>Saxifraga tridactylites</i> L.	Akmeņlauzīte, trejzobu	3	-	-	+	-	-
280	<i>Schoenus ferrugineus</i> L.	Melncere, rūsganā	3	+	-	+t	-	-
281	<i>Scirpus radicans</i> Schkuhr	Meldrs, sakņojošais	3	-	-	-	-	-
282	<i>Scirpus setaceus</i> L.	Meldrs, saru	1	-	-	-	-	-
283	<i>Scolochloa festucaceae</i> (Willd.) Link	Ērkšķuzāle, ūdeņu	3	-	-	-	-	-
284	<i>Scrophularia umbrosa</i> Dumort.	Cūknātre, spārnainā	1	+	-	+t	+	-
285	<i>Scutellaria hastifolia</i> L.	Ķiverene, šķēplapu	1	+	-	+	-	-
286	<i>Serratula tinctoria</i> L.	Zeltlape, krāsu	3	+	-	+t	-	-
287	<i>Seseli libanotis</i> (L.) W.D.J.Koch	Briežsakne, kalnu	3	-	-	-	+	-
288	<i>Silene borysthena</i> (Gruner) Walters	Plaukšķene, sīkziedu	2	+	-	+t	-	-
289	<i>Silene chlorantha</i> (Willd.) Ehrh.	Plaukšķene, zaļziedu	2	+	-	-	-	-
290	<i>Silene otites</i> (L.) Wibe	Plaukšķene, ausainā	2	+	-	-	-	-
291	<i>Silene tatarica</i> (L.) Pers.	Plaukšķene, Tatārijas	3	-	-	-	+	-
292	<i>Sisymbrium supinum</i> L.	Žodzene, zemā	0	-	-	-	-	-
293	<i>Sonchus humilis</i> N.I.Orlova	Mīkstpiene, zemā	1	-	-	-	-	-
294	<i>Sparganium angustifolium</i> Michx.	Ežgalvīte, šaurlapu	2	+	-	-	-	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal-snava
295	<i>Sparganium glomeratum</i> (Laest.) Neuman	Ežgalvīte, kamolainā	1	+	-	-	-	-
296	<i>Sparganium gramineum</i> Georgi	Ežgalvīte, zālainā	2	+	-	-	-	-
297	<i>Spergularia salina</i> J. et C. Presl.	Pagaura, jūrmalas	1	+	-	-t	-	-
298	<i>Stellaria crassifolia</i> Ehrh.	Virza, biezlapu	3	-	-	-	-	-
299	<i>Subularia aquatica</i> L.	Subulārija, ūdeņu	1	+	-	-	-	-
300	<i>Swertia perennis</i> L.	Svertija, ziemas	0	-	-	+	-	-
301	<i>Taraxacum palustre</i> Lam. et DC.	Pienene, purva	2	+	-	-	-	-
302	<i>Taxus baccata</i> L.	Īve, parastā	1	+	-	+	+	+
303	<i>Teucrium chamaedrys</i> L.	Embotiņš, ozollapu	0	-	-	-	+	-
304	<i>Teucrium scordium</i> L.	Embotiņš, ķiploku	1	+	-	-	-	-
305	<i>Thesium alpinum</i> L.	Linlape, Alpu	1	+	-	-	-	-
306	<i>Thesium ebracteatum</i> Hayne	Linlape, pļavas	1	+	+	-t	-	-
307	<i>Tofieldia calyculata</i> (L.) Wahlenb.	Tofieldija, kauslapu	1	+	-	+t	-	-
308	<i>Tragopogon heterospermus</i> Schweigg.	Plastbārdis, pūkainais	3	-	-	+t	+	w
309	<i>Trapa natans</i> L.	Ezerrieksts, peldošais	1	+	-	-	-	-
310	<i>Trichophorum caespitosum</i> (L.) Hartm.	Mazmeldrs, ciņu	3	+	-	-	-	-
311	<i>Trifolium alpestre</i> L.	Āboliņš, alpu	2	-	-	+	+	-
312	<i>Trifolium campestre</i> Schreb.	Āboliņš, lauka	3	-	-	-	-	-
313	<i>Trifolium dubium</i> Sibth.	Āboliņš, sīkais	3	-	-	+w	-	-
314	<i>Trifolium fragiferum</i> L.	Āboliņš, zemeņu	1	+	-	+t	-	-
315	<i>Triglochin maritimum</i> L.	Āžloks, jūrmalas	3	+	-	+t	-	-
316	<i>Tripolium vulgare</i> Ness	Miķelīte, jūrmalas	1	+	-	+t	-	-
317	<i>Utricularia ochroleuca</i> R. W. Hartm.	Pūslene, gaišdzeltenā	1	+	-	-	-	-
318	<i>Valeriana locusta</i> (L.) Laterr.	Baldriņš, salātu	1	-	-	-	-	-
319	<i>Veronica montana</i> L.	Veronika, kalnu	1	+	-	+t	-	-
320	<i>Vicia lathyroides</i> L.	Viķis, dedestiņu	2	-	-	+	-	-
321	<i>Vicia tenuifolia</i> Roth	Viķis, smalklapu	2	-	-	-	-	-
322	<i>Vincetoxicum hirundinaria</i> Medik.	Indaine, ārstniecības	3	-	-	+	+	-

No.	Scientific name	Latvian name	RDB, category	Reg. 396	EC Dir.	NBG	LU BG	Kal- snava
323	<i>Viola elatior</i> Fr.	Vijolīte, augstā	1	+	-	-	+	-
324	<i>Viola persicifolia</i> Schreb.	Vijolīte, dumbrāja	2	+	-	-	-	-
325	<i>Viola uliginosa</i> Besser	Vijolīte, dūkstū	3	-	-	+t	-	-
326	<i>Viscum album</i> L.	Āmulis, baltais	1	+	-	-	-	-
327	<i>Zannichellia palustris</i> L.	Diedzene, purva	2	+	-	-	-	-
Sum according to Regulations No.396			223	238	13	106	42	31
Sum all together			319	238	14	136	60	35
% according to Regulations No.396 (from 238 species)						44.5	17.6	13.0
% from all (327 species)						41.3	18.3	10.7
Together in all <i>ex situ</i> collections according to Regulations No. 396							120	
Together in all <i>ex situ</i> collections							152	
% according to Regulations No.396 (from 238 species)							50.4	
% together in all <i>ex situ</i> collections (from 327 species)							46.5	

In Latvia there are 327 plants which are estimated as rare or endangered according to a compilation of the lists (Red Book of Latvia, Regulations of the Cabinet of Ministers and EC Directive), and 152 or 46% of them were in *ex situ* collections in the end of 2010, but according to the Rules of the Cabinet of Ministers of Latvia (the legal base for the conservation, containing 238 species) there were 120 or 50.4%.

Conclusions

In *ex situ* collections in Latvia there are 120 species, which is 50.4% from 238 vascular plant species, protected according to law; this is 9.6% less than it was noted in GSPC as a goal to be reached until the end of 2010.

By 2020 the number of rare and endangered plants in *ex situ* collections should be increased until 75%, or to 179 species, so an additional 59 species should be included additionally.

The question about recovery programs remains open. According to GSPC 48 species should be included in recovery programs by 2020.

By planning the work in forming *ex situ* collection in the definite garden, the first attention should be paid to the species that are not included in the collections of other gardens in order to increase the diversity of common collections.

References

- Andrušaitis G. (ed. in chief) (2003). Red Data Book of Latvia. Rare and threatened plants and animals. Vol. 3. *Vascular plants*, Riga, 691 p.
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. *Official Journal L 206, 22/07/1992, 7–50 p.*
- Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Sixth Meeting VI/9. Global Strategy for Plant Conservation (UNEP/CBD/COP/DEC/VI/9), Hague, April 2002.

- Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting X/17. Consolidated update of the Global Strategy for Plant Conservation 2011-2020. (UNEP/CBD/COP/DEC/X/17), Nagoya, 29 October 2010.
- Regulations of the Cabinet of Ministers of the Republic of Latvia Nr 396 „Noteikumi par īpaši aizsargājamo sugu un ierobežoti izmantojamo īpaši aizsargājamo sugu sarakstu” (Regulations of the list of specially protected species and specially protected species of limited use). *Latvijas Vēstnesis 413/417, 17.11.2000.*, incl. the Alterations (Regulations of the CM Nr. 627, published 30.07.2004).
- Wyse Jackson, P.S. and Sutherland, L.A. (2000) *International Agenda for Botanic Gardens in Conservation*. Botanic Gardens Conservation International, U.K.

Community and species translocation as a method of nature conservation: A case study of “Katowice” Airport

**Magdalena Maślak, Maja Głowacka, Agata Smieja, Magdalena Bregin,
Julia Góra. Silesian Botanical Garden**

Abstract

Species and community translocations are one measure used to provide compensation for damage to protected plant habitats caused by infrastructure investment. The Silesian Botanical Garden is engaged in translocation from Katowice Airport of 25 protected plant species and Natura 2000 habitats - European dry heaths (4030), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae* - 6410) and transition mires and quaking bogs (7140) and alkaline fens (7230). This ongoing project complies with requirements of translocation permissibility. Translocation is acceptable only if (1) other measures of compensation and mitigation are used and the investment cannot be abandoned, (2) detailed investigation of donor and possible receptor sites are conducted, (3) financial means for the after-care management and long-term monitoring are provided.

Introduction

Over the past 40 years the growth of human population and industrial development has resulted in significant losses of biodiversity. Despite European law protecting nature and years of practicing active and passive methods of nature management, there is still an increasing risk of damaging the environment. Species, as well as communities and whole ecosystems, are disappearing rapidly. During the last one hundred and fifty years, around 40 species of vascular plants in Poland have been lost (Andrzejewski & Weigle, 2003). Biodiversity loss is often the result of infrastructure development, which frequently leads to degradation or destruction of many valuable communities and habitats of protected species.

To reconcile nature management and developing infrastructure, environmental impact assessment (EIA) procedures have been established. Every planned infrastructure investment must be assessed in terms of its influence on environment. The *environmental impact assessment* (EIA) seeks to restrict adverse environmental impact and to curb development on valuable habitats. When investment appears likely to have a *significant impact* on the natural environment, the investment may not be undertaken. In some exceptional cases of high-priority investments, for example essential for civil defense, some damage could be permissible, on condition that mitigation and compensation measures are used. This accords with environmental impact assessment law (Polish Law Register 2008.1999.1227) and the Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability

with regard to the prevention and remedying of environmental damage. The expansion of the existing airport in Pyrzowice offers an example of such a high-priority investment and related habitat destruction. The construction of a new runway in the area of “Katowice” International Airport in Pyrzowice, will impact on habitats listed in annex I of the Habitat Directive and sites of 25 protected species (Bregin et al., 2011; Invest-Eko Nature Inventory of “Katowice” International Airport Area, 2009). These habitats will disappear or become endangered because of possible changes in water regime. Adverse environmental impact cannot be avoided by using other locations because this huge runway will require vast infrastructure and accompanying facilities, such as roads, highways and parking facilities. The environmental costs of constructing the runway elsewhere would exceed the costs of expanding the existing airport.

Conservation strategies for mitigating biodiversity crises involve avoiding negative ecological impacts and reducing the negative impacts that cannot be avoided. Compensation involves replacing lost or adversely impacted environmental sites to preserve functions that match the pre-existing environmental values, and remedy any persisting significant negative ecological impacts (Rajvanshi, 2008). Because the damage of valuable habitats in “Katowice” Airport is inevitable, mitigation measures cannot be used for the protection of directly endangered habitats and species. The order of Regional Director of Environmental Protection in Katowice obliges the investing company GTL (Upper Silesian Aviation), to ensure environmental compensation. This involves the translocation of parts of habitats and species populations to a location indicated by the Silesian Botanical Garden. For the habitats which are not directly endangered by the planned investment, the mitigation measures of mowing and removal of brushwood and older trees are ordered.

Translocation is a compensation strategy which involves the physical removal of endangered objects from one site to another in an attempt to offset the impact of development on the natural habitats and wildlife of a site. It could be applied to species as well as to whole plant communities. Species translocation is a conservation strategy that enhances or protects the biodiversity of an area by introducing, reintroducing or restocking carefully selected species (Woodland Trust). Translocation of species is more common than community translocation. In Poland species translocation was used for example, in the case of *Veratrum lobelianum* Berth a population of which was situated in the planned A1 high-way construction site in Bytom. A second example is the translocation of the population of Lesser Butterfly-orchid (*Platanthera bifolia*) located on a stockpile of toxic industrial waste in Jaworzno. Community translocation involves the movement of assemblages of species, mainly plants, (typically including the substrates, such as soil and water, on and in which these species occur) from their original site to a new location. It is one means of minimizing the negative impacts of human activities on nature. This method of mitigation is rarely used in Poland. It became popular in UK and USA (Bullock, 1998), although there is a lot of controversy over the effectiveness of community translocation. There is little published information that includes accounts of appropriate monitoring before and after translocation and exhaustive description of receptor site preparation.

When is habitat translocation acceptable?

Translocation risk assessment requires collecting good data over an appropriate time period for a number of sites. There is a lack of information about the evaluation of translocations. It is also impossible to replicate successful translocation projects, because every translocation is unique – the plant communities, as well as donor and receptor sites environments are always different. Most translocations are of herbaceous or dwarf shrub communities (Box, 2003). Priority should be given to mitigation measures - the avoidance of impacts at source, whether through the re-design of a project or by regulating the timing or location of activities. Compensation, including translocation, can be used only when there is no possibility of avoiding physical damage of the habitat, due to a lack of alternatives (Bullock, 1998).

Botanical gardens and *ex situ* conservation

Botanical gardens and arboreta conduct *ex situ* conservation of native and non-native plant species by creating a conservation collection, by cultivation of rare species and plant varieties and by preparing a place for the new habitat. Seed and pollen collection and storage is another *ex situ* method of plant conservation (Andrzejewski & Weigle, 2003; Symonides, 2008). Nowadays botanical gardens mainly maintain collections to preserve rare species but it is also possible to form a collection of rare communities. This kind of collection has inherent worth and makes feasible the use of translocated communities to habitats for rare species with narrow and very specific microhabitat niche requirements.

Donor site characteristics

According to the nature inventory of “Katowice” International Airport Area, the valuable communities which are to be destroyed are about 2 1000 m² of European dry heaths (Natura 2000 habitat code 4030); 15 000 m² of *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae* – 6410); over 1000 m² of transition mires and quaking bogs (7140); and alkaline fens (7230). In addition, sites of twenty five protected plant species will be destroyed:

- Four species of peat moss *Sphagnum* sp. (*Sphagnum fimbriatum*, *S. squarrosum*, *S. palustre*, *S. capillifolium*)
- Siberian iris *Iris sibirica*
- Variegated horsetail *Equisetum variegatum*
- Greater bladderwort *Utricularia vulgaris*
- Meadow Gladiolus *Gladiolus imbricatus*
- Labrador tea *Ledum palustre*
- Broad-leaved marsh orchid *Dactylorhiza majalis*
- Heath Spotted-orchid *Dactylorhiza maculata*
- Threadleaf Crowfoot *Ranunculus trichophyllus*
- Umbellate wintergreen *Chimaphila umbellata*
- Common Broomrape *Orobancha minor*
- Grass Lily *Ornithogalum umbelatum*

- Marsh Gentian *Gentiana pneumonanthe*
- European centaury *Centaureum erythraea*
- Umbellate Wintergreen *Chimaphila umbellata*
- Stiff Clubmoss *Lycopodium annotinum*
- Wolf's-foot Clubmoss *Lycopodium clavatum*.

Receptor site characteristics

The place proposed for the adoption of communities and plant populations is the Botanical Garden in Radzionków. The area is characterized by strongly diversified habitats; there are wetlands, as well as sunlit, dry hills. Therefore it is potentially ready to adopt habitats from the Airport area. The receptor site should have similar soil, hydrology and topography to the original site and should be located not too far away.

Environmental research was performed at the potential receptor site and at the Airport area. Soil profiles, water regime, soil and water chemistry investigations were conducted, along with detailed investigation of the plant communities in both donor and proposed receptor sites.

Radzionków Botanical Garden was chosen as a appropriate receptor site, mainly because of its location in the same mesoregion as the donor site (Tarnogórski Hump 342.12, Kondracki, 2002). Chosen receptor site is also located in the vicinity of the airport at Pyrzowice. The site provides the opportunity for the researchers to re-create the demanded habitats and maintain control over their design. Also the fact that there are areas in Radzionków Botanical Garden (reclaimed quarry areas), which are not environmentally valuable – was crucial for this decision. No valuable habitats will be destroyed because of the re-creation of Natura 2000 habitats in this area.

Preparation of the receptor site for translocation

According to Bullock (1998) in most translocation projects the top-soil layer of the receptor site is excavated to reduce fertility and to create a bed of appropriate depth for the turves. When the receptor site is drier than the donor site it is possible to lower the soil surface relative to the water table. Sometimes herbicide is applied as part of the preparation process of the receptor site. The removal of top-soil layer is also beneficial for the translocated vegetation because it removes the soil seed bank of competing plants. Translocated communities are unable to compete with local vegetation in subsequent years after transplantation (Box, 2003).

The area in the Botanical Garden in Radzionków will be adapted for the transplanted communities and plants to allow control, monitoring and modification of the environmental conditions. First, the top soil layer will be excavated to reduce the fertility and remove the seed bank. Then the water regime within the communities will be controlled by creating soil layers with different levels of permeability. Eutrophication of soil and water is well known and common cause of the biodiversity decrease. Habitats with a lower level of nutrients are rare and mostly valuable, so it is impossible to transplant communities into such locations without destroying local vegetation worthy of preservation. To solve this problem, a system of water strainers

will provide a lower fertility of water to a previously fertile site. Communities and species with lower water demand will be situated on raised sites.

Choice of transplantation method

Bullock (1998) distinguished four translocation techniques: hand turving; machine turving; macroturving; and the spreading of excavated soil and vegetation. In most cases vegetation is excavated with a specifically adapted excavator in the form of large turves (1 m – 2 m) and pieced together on the previously prepared receptor site (macroturving). At the receptor site, spreading soil collected from the donor site containing diaspores is a less effective method with regard to changes in species composition after translocation (Bullock, 1998). Hand turving involves cutting and lifting small pieces of sod. Desiccation of small turves is a disadvantage of this method and it is time-consuming, so this method cannot be applied to large areas.

We chose macroturving as the method of translocation. This method is preferred for wet as well as dry habitats and allows for fauna transfer with the soil and vegetation (Box, 2011).

Measurement of success – the monitoring after translocation

The evaluation of the success of translocation should include detailed monitoring for an appropriate time period, for example for 10 years, as proposed by Box (2003). Only a few community translocation projects have had sufficient monitoring after translocation and there is a lack of publications which give detail of long-term monitoring data. Monitoring, in most cases, has taken place for 3-4 years after translocation (Bullock, 1998).

Effectiveness of translocation process can be evaluated by comparison of donor and receptor site vegetation. This kind of evaluation does not include the natural changes in time of plant communities, which is particularly important for communities in the early stages of succession. Over a period of 10 years of monitoring marshes or fens, the species composition will be changing and some species will disappear as a result of the succession process. The changes in species composition that could arise are not necessarily due to the translocation of the community. The other method for evaluating translocation success is the examination of donor and control site vegetation. Long-term monitoring takes into account changes in the communities over time, but can only be carried out in field experiments. During our project the evaluation process will be based on the comparison of the donor and receptor site vegetation and habitat conditions, because possibility is not possible to leave intact a part of the original community in the industrial investment area. The construction of a new airport runway will change the hydrological conditions and other properties of the habitat significantly. This will lead to dramatic changes in species composition and prevents the comparison of the vegetation of the receptor and control sites.

The proposed monitoring includes:

examination of protected species populations (number of specimens in the case of a small population; or density of specimens in larger populations; visual condition of specimens; fertility; the extent of vegetative propagation);

- examination of the condition of the communities (number and participation of characteristic and favorable species; number and participation of invasive and expansive species; community structure).

Monitoring will be conducted at receptor site for at least for ten years after translocation and for two years before translocation at the donor site.

Also problematic in community translocation projects is the lack of appropriate after-care management. In the majority of translocations conducted so far, the communities have received no or little after-care management. This led to characteristic species loss and obscured the effectiveness of receptor site preparation and the translocation method (Bullock, 1998). Appropriate monitoring shows the need for treatment, which has to be conducted for enhancing the biodiversity of communities. It is a fact that special attention is needed to preserve transient vegetation.

Summary

Translocation of communities is a risky undertaking but sometimes it is the only way to preserve valuable habitats. This project complies with the official requirements that permit translocation. Other measures of compensation and mitigation were used and the investment at the airport site cannot be abandoned. Detailed investigation of donor and possible receptor sites was conducted. Financial support for after-care management and long-term monitoring are provided. The transplanted communities will become a part of the Botanical Garden in Radzionków and will provide suitable habitats for rare species requiring a particular microhabitat niche.

References

- Andrzejewski, R. & Weigle, A. (2003). *Różnorodność biologiczna Polski*. NFOŚ, Warszawa 2003.
- Box, J. (2003). Critical factors and evaluation criteria for habitat translocation. *Journal of Environmental Planning and Management*, 46, 839-856.
- Box, J., Brown, M., Coppin, N., Hawkeswood, N., Webb, M., Hill, A., Palmer, Q., Le Duc, M., Putwain, P. (2011). Experimental wet heath translocation in Dorset, England. *Ecological Engineering* 37, 158–171.
- Bregin, M., Góra, J., Smieja, A. 2011. *Initial phytosociology inventory prepared for the Project „Translocation of donor habitats from International Airport “Katowice” in Pyrzowice to receptor sites on an area of the Silesian Botanical Garden – Association of Societies”*. Mikołów 2011, pp. 49.
- Bullock, J.M. (1998). Community translocation in Britain: Setting objectives and measuring consequences. *Biological Conservation* 84, 199-214.
- Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:143:0056:0075:en:PDF>
- Environmental Impact Assessment Law (Polish Law Register 2008.1999.1227, <http://isap.sejm.gov.pl/DetailsServlet?id=WDU20081991227> – in Polish only)
- Invest-Eko (2009). *Nature inventory of International Airport „Katowice” in Pyrzowice* (in Polish). Invest-Eko, June 2009.
- Kondracki, J. (2002). *Geografia regionalna Polski*. Warszawa: PWN, 2002.
- Rajvanshi, A. (2008). *Mitigation and compensation in environmental assessment*. In T.B. Fisher, P. Gazzola, U. Jha-Thakur, I. Belčáková & R. Aschemann (Eds.), *Environmental Assessment Lecturers’ Handbook* (pp. 167-199). <http://www.twoeam-eu.net/handbook/05.pdf>
- Symonides, E. (2008). *Ochrona przyrody* (2nd ed. pp. 587-594). Wydawnictwa Uniwersytetu Warszawskiego.

The Silesian Botanical Garden Network – an introduction to the idea.

Paweł Kojs

Author note

Silesia Botanical Garden, Mikołów, Poland

Introduction

The Silesian Voivodeship is a province, in southern Poland (Fig. 1.), with its capital in Katowice. It is divided into 36 counties (powiats). These include 19 city and 17 rural counties (Fig 2.). The counties are further divided into 167 gminas. The Silesian Voivodeship has the highest population density in the country (377.4 people per square kilometre, compared to the national average of 124). It is the most urbanized region in Poland: 78% of its population live in towns and cities (3,675,602). Both urbanization and high population density negatively influence the biodiversity of the region. Dynamic economic development of Silesia during last few years has created new threats and was responsible for further losses of regional biodiversity. The Red List of Upper Silesian plant communities and the Red List of Upper Silesian plant species show the extent of these threats (Parusel, 1996; Celiński et al. 1997). One of the strategic goals of the Silesian voivodeship is sustainable development of the region. Biodiversity conservation and nature protection are very important

Geographical Regions in Poland Areas

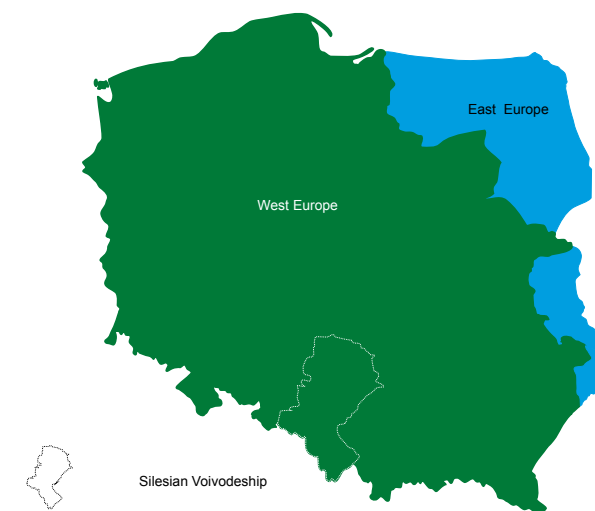


Figure 1: The physical-geographic location of Silesian Voivodeship in West Europe.

Administrative map of Silesian Voivodeship - division into counties



Figure 2: The Silesian Voivodeship is divided into 36 counties (powiaty). These include 19 city and 17 rural counties.

targets which are complementary in this strategy. Botanical gardens are one of the tools which help to fulfil the requirements of the regional programs of biodiversity conservation. The question is how to protect nature effectively and at the same time support regional development. One of the possible ways is to establish a regional network of botanical gardens which will monitor the condition of natural ecosystems and, when necessary, will actively support *ex situ* biodiversity conservation.

From the Silesian Botanical Garden to the Silesian Botanical Gardens Network

The Silesian Botanical Garden was formed in 2003 as an Association of Societies. The Association was set up to work collaboratively towards horticultural/botanical excellence, advocacy, promotional activities, assisting other botanical garden developments, sharing exhibitions/displays, conservation and to help the community to become more aware of the value of plants and biodiversity conservation by means of education and explanation.

The Silesian Botanical Gardens Network operates under the common auspices of the Silesian Botanical Garden – Association of Societies.

The Mission of the Silesian Botanical Gardens Network

The Silesian Botanical Gardens Network enables its members to gain mutual benefit through cooperation, exchange of knowledge, ideas and experience, sharing of resources and increased strength associated with belonging to a regional organisation. Botanical gardens in the Silesian voivodeship need to be recognised, supported and enhanced at all levels of the region to ensure that they achieve their potential as essential guardians of the biodiversity and environmental heritage of Silesia. Independent and self-governing botanical gardens lose a lot of resources in maintaining themselves as separate single institutions. Operating in isolation is more expensive than operating together and thus economically ineffective. The biggest problems are:

- an unavoidable redundancy of certain educational, scientific or administrative departments in the regional *ex situ* conservation system,
- lack of coordination of nature protection and biodiversity conservation programmes run by different botanical gardens,
- minor impact of independent actions for nature protection and biodiversity conservation (both at local and regional levels),
- low scientific impact (very often lack of scientific activity of the botanical garden's staff)
- low educational impact (generally local impact only)
- low promotional impact (regional promotion on TV, radio, the internet and in journals is expensive and thus, for a single botanical garden, is too expensive)
- low political impact (in fields of a nature protection, a biodiversity conservation, ecological education).

The proposed solution for such a situation was the establishment of the Silesian Botanical Garden – Association of Societies which functions as a Regional Network of botanical gardens in Silesian voivodeship.

The Regional Network includes a wide range of governmental, university, municipal, community/village, NGO, private and other relevant institutions and organisations. It also encourages volunteers to take part in reaching botanical gardens

goals and supports a wide range of voluntary activities. The work of the Regional Network encompasses all activities of botanical gardens but gives special attention and concern to the conservation of indigenous plant diversity, as well as environmental education, research, identification, documentation and dissemination of knowledge (including traditional ethno-botanical knowledge) about biodiversity in the Silesian region. The Regional Network supports the development of a Biodiversity Action Plan for Botanical Gardens and Arboreta in Silesia, to guide and support the work of an established network and to highlight priority tasks for individual institutions and for the entire network. This Action Plan will include measurable targets to provide a focus for the work and achievements of botanical gardens over the coming years. The Regional Network develops the means to ensure that data and information in support of the implementation of the Action Plan are widely accessible in electronic and other published forms (website, database, newsletters, technical manuals and other publications) while at the same time safeguarding the intellectual property rights of data providers. It also promotes and represents the interests of botanical gardens in Silesian voivodeship to the broader environmental community.

Another important role of the Regional Network is the conservation and sustainable use of horticultural plants, which are an important resource for sustainable and ecological horticulture, as well as being a vital part of cultural heritage. In the near future it will also add the conservation and sustainable use of medicinal plants, which are an important resource for primary healthcare as well as being a vital part of cultural heritage. The regional programme on the conservation of indigenous plants will use all appropriate methodologies, including the integration of *in situ* and *ex situ* techniques and the recovery of threatened plants.

The commitment of botanical gardens in the Silesian voivodeship supports sustainable livelihoods in local regions by developing and implementing appropriate community-based programmes. The botanical gardens also provide high quality environmental education programmes that contribute to formal (curriculum-based) education and informal learning, both within botanical gardens and their outreach activities. It is agreed that the Regional Network should seek to enhance the effectiveness of botanical garden education throughout the whole Silesian voivodeship.

The Silesian Botanical Garden – Association of Societies has established a Scientific Council to steer the development of the Network. The Council includes representatives from different scientific institutions and organisations focused on nature protection and biodiversity conservation from different parts of Poland.

Objectives of the Silesian Botanical Gardens Network

1. Promoting Botanical and Horticultural Excellence

To share of staff and knowledge, promote staff exchanges;

To share best practice (practices, standards, systems);

To adopt uniform approaches to:

- pest, weed, fungi, phytoplasma, bacteria and viruses management;
- invasive plants management (Sharing information, and policy, on potentially invasive alien plants in Botanical Gardens);
- seed and plant exchange.

2. Support

To make collective political representation and to be a single body that is recognised across the region with respect to Regional Botanical Gardens Network;

To develop smaller working groups to collect views and respond to region-wide issues.

3. Promotion

To offer collective publicity or promotional activities;

To promote the value of Silesian Botanical Gardens for tourism;

To develop a collective website.

4. Assist individual members in development

To advocate and/or support the need for funding for conservation plans/management plans;

To exchange or contribution to redundant collections;

To rationalise collections, particularly where duplication is not productive;

To operate an integrated system of public procurement.

5. Collaboration

To collaborate within the framework of the International Plant Exchange Network, a system for the exchange of non-commercial plant material between botanical gardens, based on the Convention on Biological Diversity;

To collaborate on the international level within the framework of the BGCI (Botanic Gardens Conservation International);

To collaborate on the national level within the framework of the Council of Botanical Gardens in Poland;

To engage in common conservation programmes and projects at the regional, national and international levels;

To mount intensive environmental actions;

To shared educational programmes;

To organise collaborative tours of specific collections or exhibitions;

To engage in developmental programmes in selected fields of activity of botanical gardens.

Geographical Regions in Poland
Provinces (Kondracki 2002)



Figure 3: There are 7 physical-geographical provinces in Poland and 3 of them in the Silesian Voivodeship (Kondracki, 2002).

Geographical Regions in Silesian voivodship
Mesoregions (Kondracki 2002)

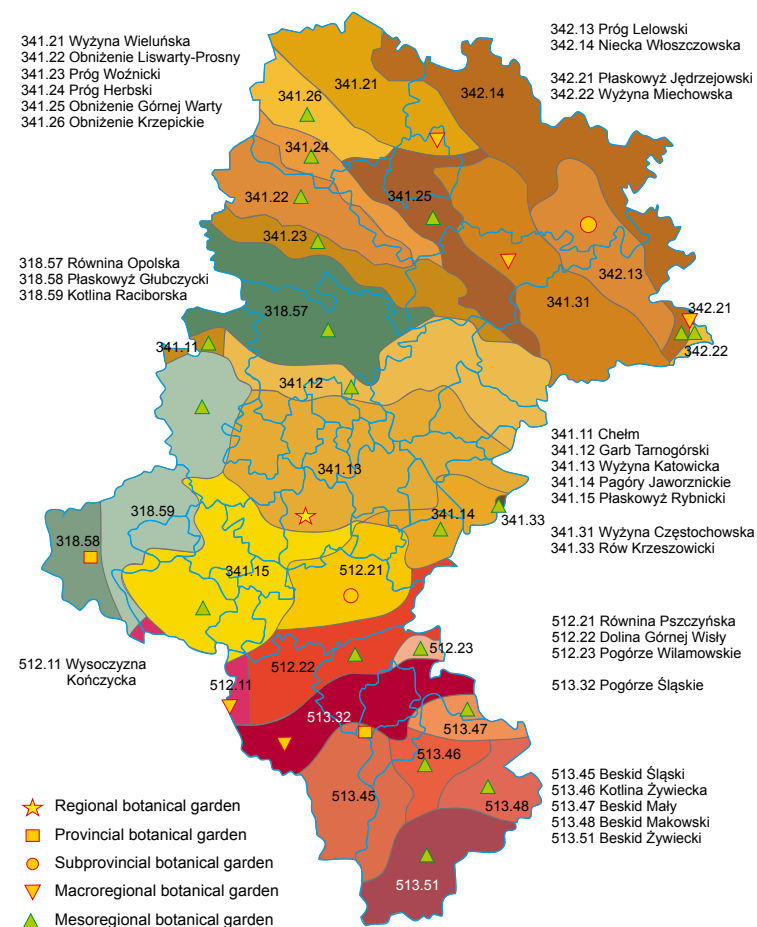


Figure 4: There are 30 meso-regions in Silesian Voivodeship (Kondracki, 2002). The proposal for the entire system of biodiversity conservation at the regional level is based on hierarchical physical-geographical divisions. The basic unit of this hierarchy is the meso-region. At this level both *in situ* and *ex situ* conservation can be more precise and effective.

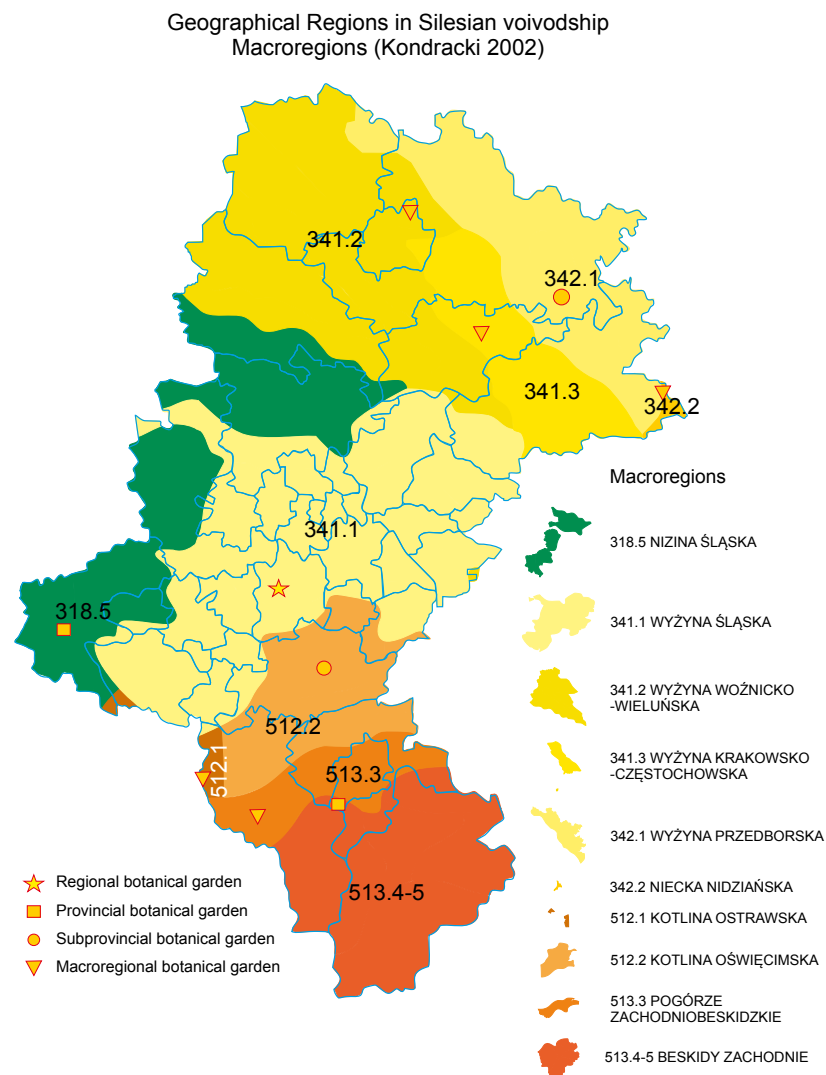


Figure 5: There are 10 macro-regions in the Silesian Voivodeship (Kondracki, 2002). At this level macro-regional botanical gardens organize and coordinate *ex situ* conservation programs.

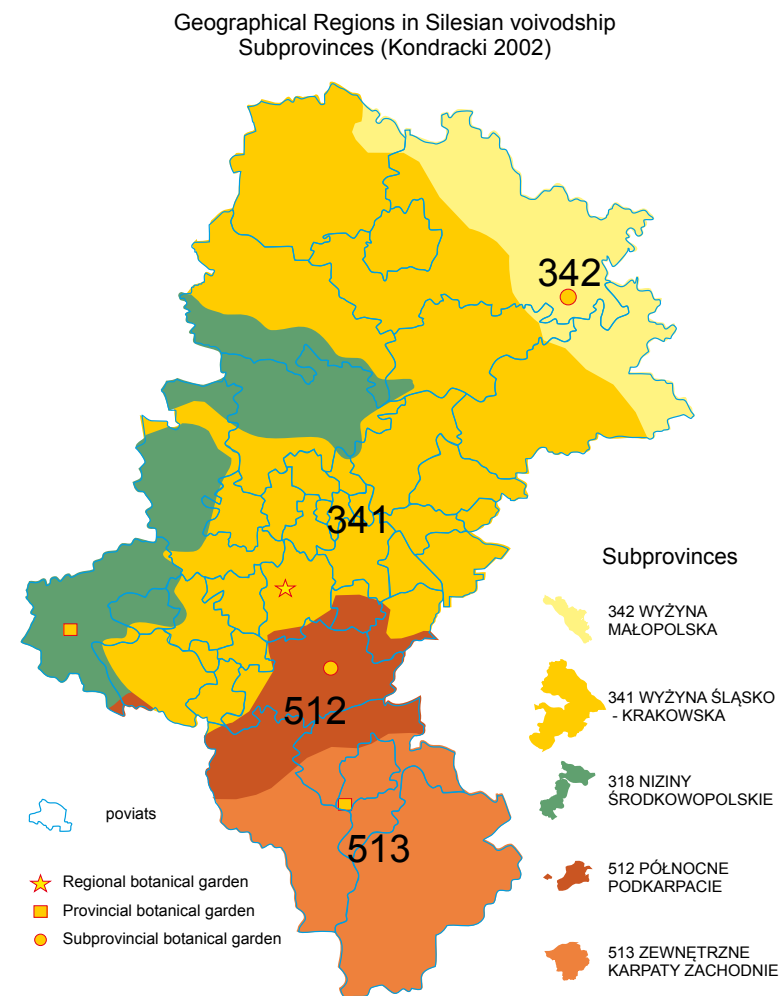


Figure 6: There are 5 sub-provinces in the Silesian Voivodeship (Kondracki, 2002). At this level sub-provincial botanical gardens prepare reports and working materials concerning the *ex situ* conservation programs undertaken by the coordinated group of gardens.

Geographical Regions in Silesian voivodship
Provinces (Kondracki 2002)

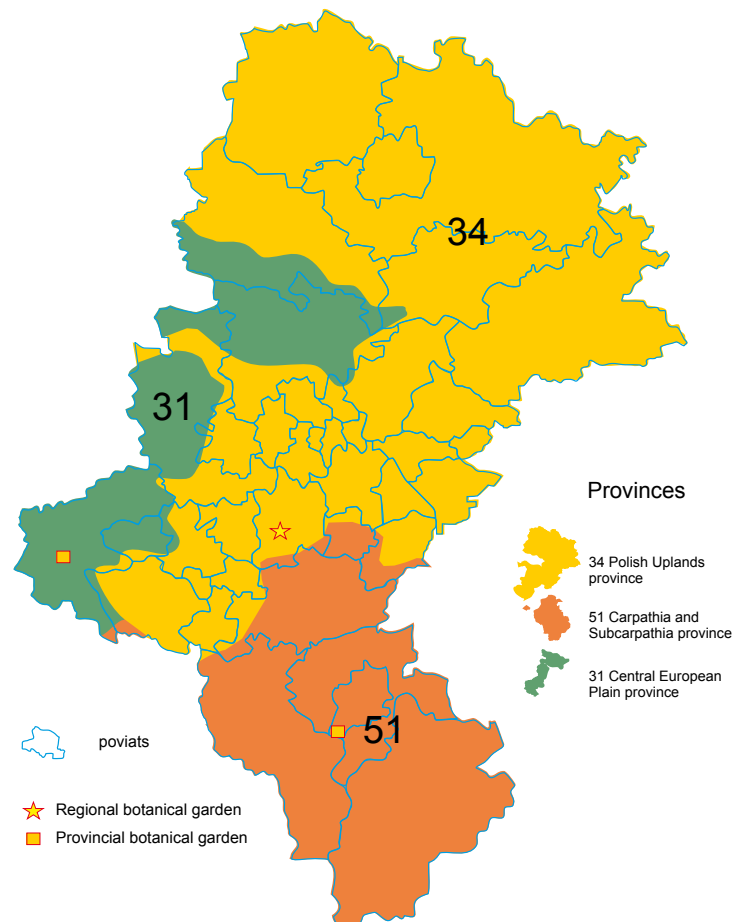


Figure 7: There are 3 provinces in the Silesian Voivodship (Kondracki, 2002). At this level provincial botanical gardens organize and coordinate *ex situ* conservation programs at the regional level. One of these botanical gardens has the status of regional botanical garden. At this level the Scientific Council of the Silesian Botanical Garden Network will establish a Regional Action Plan for the Silesian Botanical Garden Network.

Administrative map of Silesian Voivodship -
potential places for botanical gardens



Figure 8: Potential places in the Silesian Voivodship for meso-regional botanical gardens (20) are marked with green triangle; macro-regional botanical gardens (5) with a yellow triangle; sub-provincial (2) with a yellow circle; and provincial botanical gardens (3) with a yellow square. They are superimposed on an administrative map of the Voivodship. Because provincial botanical gardens are placed in given sub-provinces, macro-regions and meso-regions carry out the function of sub-provincial, macro-regional and meso-regional botanical gardens. The same applies to sub-provincial and macro-regional gardens. In total in the Silesian Voivodship there is a place for 30 botanical gardens which will cover 30 physical-geographical meso-regions with their activity.

6. Conservation

To preserve within each botanical garden a representation of local indigenous flora (from meso-region, macro-region, sub-province or province) within the framework of the Action Plan for Botanical Gardens;

To work closely with local community conservation groups and provide assistance, where possible, for local conservation projects.

7. Education and Interpretation

To assist each other with educational and interpretational materials and personnel;

To foster community interest in the local botanical gardens;

To recognise the community interest in ornamental, cultivated varieties and local indigenous plants by providing display gardens as educational tools;

To increase the community awareness, knowledge and appreciation of plants.

(Based on <http://www.anbg.gov.au/chabg/bg-nsw/index.html>)

Silesian Botanical Garden Network: Theoretical assumptions

The idea of the Silesian Botanical Garden Network is based on a systemic approach towards *ex situ* biodiversity conservation which is an important part of the system of biodiversity conservation at the regional level. In constructing this system, the main assumption is that the basic role of botanical gardens is to protect local biodiversity. Local biodiversity is a derivative of climatic and bio-geographical conditions. We therefore adopted Kondracki's (2002) approach that uses physical geography as a basis defining regions (Fig. 3.). We use this hierarchy of regions in the voivodeship to indicate where the botanical gardens of the network should be located. The proposal includes four types of botanical gardens: provincial, sub-provincial, macro-regional and meso-regional. In addition, one of the provincial botanical gardens is given the status of a **Regional Botanical Garden**. This means that it has additional function of organising and coordinating the work of other botanical gardens at the regional level.

Meso-regional botanical gardens constitute a basic element of this system. Such botanical gardens may employ only one person based on a small area (1-5 ha) but can be rich in natural habitats. This type of botanical garden monitors and provides *ex situ* conservation of the biodiversity of a given meso-region (Fig. 4.).

Macro-regional botanical gardens have some additional functions connected with coordination and planning of *ex situ* conservation in several meso-regional botanical gardens. These types of a botanical gardens should be bigger than meso-regional ones (5-15 ha) (Fig. 5.).

Sub-provincial botanical gardens, in addition to these functions, have to prepare reports based on data received from macro-regional botanical gardens which show the state of rare and endangered species in given sub-province (Fig. 6.).

Provincial botanical gardens prepare these data for the Scientific Committee of the Silesian Botanical Garden Network as a basis for strategic decision-making concerning *ex situ* and *in situ* biodiversity conservation in the Silesian voivodeship. A provincial botanical garden performs the most important function in this system. Besides reporting and planning activities it also trains and educates staff of other botanical gardens in the province (Fig. 7.).

The whole system should cover the entire voivodeship and provide a nature protection system at the regional level supporting the *in situ* system whenever it is necessary. This system can be also a useful tool in the naturalization of land changed by human activity and/or in the transfer to new sites of valuable habitats endangered by investments.

In the Silesian Botanical Garden this multi-level system has been developing since 2003. Currently it comprises 3 botanical gardens in 2 provinces [Polish Uplands (34), Central European Plain (31)]. Two of these gardens in Mikołów and in Racibórz are potential provincial botanical gardens. In the Carpathia and Subcarpathia province (51) a suitable place in Bielsko Biała has been chosen to build the third provincial botanical garden. Developing this network involves activities of different types of institutions. Between others there are: Silesian voivodeship, powiats and gminas of the region, the Silesian University, the Polish Academy of Sciences and several non-governmental organisations (Fig. 8.).

Glossary of terms

Physical-geographic region – a relatively uniform area easily distinguished from neighbouring areas on the basis of characteristics of the features of a natural environment.

Micro-region – a small part of a bigger area (meso-region or macro-region) separated on the basis of specific geographical, natural, social or economic features.

Meso-region (physical-geographic meso-region) – a division of a region, consisting of a large area with similar environmental and landscape characteristics. In the hierarchical Physical-Geographic Regionalization of Poland (Kondracki 2002) a meso-region is a unit of lower rank which is a part of macro-region. In certain regions with more complex natural environments, further division into smaller units is recommended, namely micro-regions.

Macro-region – a physical-geographic division of a sub-province which comprises of large area with comparable environmental and landscape characteristics.

Sub-province – a physical-geographic division of a province which comprises of large area with comparable climatic and landscape characteristics.

Province – a physical-geographical division of a mega-region.

References

- Celiński F., Wika S., Parusel J.B. (Eds.) 1997. *Red List of Plant Associations of Upper Silesia*. Centre for Nature Heritage of Upper Silesia. Raporty i Opinie, 2:38-68 Katowice.
- Kondracki J. 1994. *Geografia Polski. Mezoregiony fizyczno-geograficzne*. PWN, Warszawa.
- Kondracki J. 2002. *Geografia regionalna Polski*. PWN, Warszawa.
- Parusel J. B. (Ed.). 1996. *Czerwona lista roślin naczyniowych Górnego Śląska*. Centrum Dziedzictwa Przyrody Górnego Śląska. Raporty i Opinie 1: 8-42. Katowice.
- <http://www.anbg.gov.au/chabg/bg-nsw/index.html>

Department of Scientific and Conservation Collections, Silesian Botanical Garden (SiBG)

Marta Jańczak, Wojciech Piukuła

Author note

Silesian Botanical Garden, Mikolow, Poland

Conservation Collection ‘Old Varieties of Fruit Trees’

The Conservation Collection ‘Old Varieties of Fruit Trees’ was founded in 2005. Now the SiBG orchard has 588 apple trees consisting of 270 varieties and also several varieties of cherry, pear and plum trees. These trees are located in two orchards totalling 2,38 ha in area. The great majority of the plant material originates from the Polish Academy of Sciences Botanical Garden Centre for Biological Diversity Conservation in Powsin (Warsaw, Poland) and from nursery-gardens with old varieties of fruit trees.

Educational Collection of ‘High Energy Plants’

The Educational Collection of ‘High Energy Plants’ occupies an area 0.16 ha. There are 8 species of high energy yielding plants: *Salix viminalis*, *Salix purpurea*, *Rosa multiflora*, *Sida hermaphrodita*, *Panicum virgatum*, *Miscanthus giganteus*, *Helianthus tuberosum* and *Silphium perfoliatum*. This collection was created as basis for educational activities.

Projects in implementation

The Department of Scientific and Conservation Collections – related activities projects take place thanks to financial support granted by (Wojewódzki Fundusz Ochrony Środowiska i Gospodarki Wodnej w Katowicach) a regional fund for environmental protection and water management in Katowice.

So far in the SiBG, the following projects have been implemented:

- “Establishment of fruit cultivation - collection of old varieties and locally grown fruit trees in the SiBG in Mikolow”
- “Expansion of the collection of traditional varieties of apple orchards in SiBG in Mikolow” an
- “Expansion of horticultural collections of traditional varieties of fruit trees with the establishment of rootstock nurseries - Phase II”
- Currently being implemented are the following projects:
- “Expansion and addition to the collection of traditional fruit varieties of fruit trees along with the expansion of rootstock nurseries - Phase III”
- “Expansion of The Educational Collection of High Energy Plants in the SiBG in Mikolow”

The first project is a continuation of the expansion of orchard collections and shelves of rootstock nurseries, which in future will be the basis for the preservation of local varieties. The second project aims to expand the Educational Collection of High Energy Plants, by planting the most popular species. This Collection was originally founded in 2007.

In addition, in 2010-2012 the Department of Scientific and Conservation Collections is implementing the project: "Analysis of biodiversity with an emphasis on old varieties of cherries in the St. Anna's land Association area and necessary measures for their rescue." The main objective is to inventory the historic cherry avenue located around St. Anna's Mountain in Opolskie and to preserve the genetic resources of these varieties. First, accurate documentation is made based on field expeditions. Scions are then collected from selected trees. Collected scions grafted onto rootstocks will be collected in the SiBG. These will in future replace old and dying trees in the St. Anna cherry avenues.

Future plans

1. Successive expansion of The Conservation Collection 'Old Varieties of Fruit Trees' together and enlarging its area.
2. Carrying out field expeditions whose purpose will be downloading and grafting scions of the old and locally grown varieties of fruit trees.
3. Conducting research on alternative energy sources and development of the Educational Collection of High Energy Plants.
4. Conducting research in the Department of Scientific and Conservation Collections.

Education for Sustainable Development

The Challenge of Education for Sustainable Development in Botanical Gardens

David Oldroyd

Author note

David Oldroyd, Permanent Secretary ENIRDELM (www.enirdelm.org)

Abstract

The urgency of threats to sustaining global socio-ecological systems on 'Space Station Earth' is first outlined. This urgency is great enough to argue firstly, that education for sustainable development (ESD) needs to play a central role in educating the public and future generations about these threats and how to deal with them. Secondly, the case is presented that education programs in botanical gardens are ideal arenas for contributing to this challenge of ESD. It would require that such programs broaden their focus beyond environmental education to offer an understanding of the interaction of humans with nature at the planetary level. The freedom of botanical gardens from the constraints faced by schools make them better placed to offer ESD by means of direct contact with the living world and the processes that connect its inter-dependent life support systems. One such program in the Silesian Botanical Garden's Centre of Education for Ecological and Environmental Education (C3E) is identified and finally networking with similar programs is proposed with some initial suggestions about possible links.

Introduction



Figure 1: Earth as a Space Station

There is an urgent need to help the public and especially young people, to see the proper place of humans within (not above) nature. This requires seeing the Earth and its inter-related systems as whole, as our only 'space station', our only 'Garden of Eden', powered by the sun's energy. On Christmas Eve 1968 in "the most influential environmental photograph ever taken" (Anders, 1968) from the Apollo 8 orbit of the moon, the Earth seems like a beautiful blue and white orbiting space station driven by solar power. We humans are the crew, the astronauts, who must care for the spaceship and its entire living species that are part of our on-board life support systems. (There are at least 1.3 million species in the Catalogue of Life). Even young children can appreciate the analogy of the Earth with a space station that cannot be increased in size and must keep its life-support systems working if the crew is to survive. The collaboratively man-made International Space Station in Figure 2 definitely has a limited carrying capacity, so has Space Station Earth. The life support systems of our planet are far more complex than those of the man-made international space station (Pearce, 2010).



Figure 2: International Space Station

Figure 3: Pale Blue Dot

Carl Sagan, the great cosmologist and educator, offered an even larger perspective on the Earth seen from outer space as a "Pale Blue Dot" (in the centre of Fig 3) possibly one of many planets where life evolved in a sequence he described as:

"a planet, newly formed, placidly revolves around its star; life slowly forms; a kaleidoscopic procession of creatures evolves; intelligence emerges which confers enormous survival value; and then technology is invented. It dawns on them that there are such things as laws of Nature ... Science, they recognize, grants immense powers. In a flash, they create world-altering contrivances. Some planetary civilizations see their way through and place limits on what may and what must not be done, and safely pass through the time of perils. Others, not so lucky or so prudent, perish". (Sagan, 1994)

He speculated that there might be many planets in the universe with life systems, and traced two scenarios:

- *Sustainable civilizations* that survive by 'placing limits' on their numbers and activities to stay in harmony with the laws of nature
- *Civilisations that perish*.

According to interdisciplinary researchers (Rockstrom, et.al, 2009a) the human species, as the most powerful of the passengers of Space Station Earth, has reached the last decade in which to choose between these two scenarios in what could be 'Our Final Century' (Rees, 2003) on 'The Plundered Planet' (Collier, 2010). The most urgent mission of our times is to educate leaders and public opinion about the urgency to place limits on exponential growth of human systems in order to live in sustainable harmony with nature.

In May 2011 a gathering of Nobel Prize winners at the 3rd Nobel Laureate Symposium in Stockholm added to the many declarations about these issues that have been issued over the last four decades, but have failed to achieve what they call "a mind-shift for a great transformation". Their declaration - 'The Stockholm Memorandum: Tipping the scales towards sustainability' - contains the following introduction that reinforces Sagan's concerns about 'civilisations that perish' when they transgress planetary boundaries and fail to become stewards of their planetary, space station home:

'...we are the first generation with the insight of the new global risks facing humanity. We face the evidence that our progress as the dominant species has come at a very high price. Unsustainable patterns of production, consumption, and population growth are challenging the resilience of the planet to support human activity. At the same time, inequalities between and within societies remain high, leaving behind billions with unmet basic human needs and disproportionate vulnerability to global environmental change.

... we call upon all leaders of the 21st century to exercise a collective responsibility of planetary stewardship. This means laying the foundation for a sustainable and equitable global civilization in which the entire Earth community is secure and prosperous. Science indicates that we are transgressing planetary boundaries that have kept civilization safe for the past 10,000 years. Evidence is growing that human pressures are starting to overwhelm the Earth's buffering capacity.

Humans are now the most significant driver of global change, propelling the planet into a new geological epoch, the *Anthropocene*. We can no longer exclude the possibility that our collective actions will trigger tipping points, risking abrupt and irreversible consequences for human communities and ecological systems. ... We must respond rationally, equipped with scientific evidence. ...In an interconnected and constrained world, in which we have a symbiotic relationship with the planet, environmental sustainability is a precondition for poverty eradication, economic development, and social justice. Our call is for fundamental transformation and innovation in all

spheres and at all scales in order to stop and reverse global environmental change and move toward fair and lasting prosperity for present and future generations.'

The global scale of this recent strong and urgent challenge to maintain 'sustainable civilisation' on 'Space Station Earth' will now be further examined and then directed towards education for sustainable development in botanical gardens.

The Challenge of Education for Sustainable Development

Humans and Natural Earth 'Spheres'

The UN has for forty years been trying to raise public awareness of the growing threat of human population and activity to the planet. In 1972 the United Nations Conference on Human Environment in Stockholm responded to the realisation that growth of environmental degradation needed international attention and collaboration. That conference resulted in the creation of the United Nations Environment Programme (UNEP). As one of a long series of efforts the UN declared 2005-2014 the Decade of Education for Sustainable Development to help promote 'big picture' global systems thinking and integrated learning about our place and prospects in our planetary home. What do we mean by 'the big picture' and integrated learning about humans in nature? The Earth seen as a complex spherical space station has many inter-related 'layers'. It is an incredibly complex 'system of systems' that form 'layers' spread across the spherical surface. These inter-dependent 'spheres' have evolved over the last 3.5 billion years: but the spheres created by humans, only since the evolution of homo sapiens in the last half million years.

Table 1: Inter-acting 'Spheres' of Planet Earth

Natural World		Human World	
'Geosphere'	'Bio/ecosphere'	'Memosphere'	'Technosphere'
<i>The material earth</i>	<i>The organic earth</i>	<i>World of ideas, beliefs & actions</i>	<i>Totality of 'stuff' of human activity</i>
LAYERS Lithosphere (solid crust & soil) Atmosphere (gas) Hydrosphere (liquid) Cryosphere (frozen) Garbo-sphere (human waste)	KINGDOMS e.g. Viruses Bacteria Plants Animals (including the human Demo-sphere) etc.	MEANINGS AND WORLDVIEWS Magic Myth Pre-modern Modern Post-modern	PRODUCTS OF TECHNOLOGY Infrastructure Energy & Industry Biotechnology Genetics Robotics ICT & Cybersphere Nanotechnology
Physical and Earth Science	Life Science	Humanities & Social Science	Applied Science

We live in unprecedented times. 'Space Station Earth' now has too many humans and human activities and wastes to continue safely beyond the near future. There has been a 'Great Acceleration' of the human impact on the natural earth since 1940

when the global population was just over 2 billion humans. The natural world is finite and subject to the laws of autopoiesis (self-generation) but currently one species is increasing exponentially. Human population will reach 7 billion in October 2011 and 9 billion by 2050 (1.1% annual compound growth - a doubling rate of less than 70 years). The latest forecast from the UN (2011) is for 10.6 billion by 2100. The two 'Human Worlds', the *memosphere* (knowledge explosion - 'memes' = units of meaning postulated by Dawkins (1976) as self-replicating through culture in the way that 'genes' self-replicate in organisms) and *technosphere* (the material layer: cities, transport, pollution, etc., added by human technical and economic activity) are growing even faster (currently 4.2% annual compound growth, doubling every 13 years). Among the connected, inter-dependent 'spheres' the *demosphere* and *technosphere* are now the major forces transforming the planet's surface layers (Our geological era is now called the Anthropocene because of this human impact). The *demosphere*, *technosphere* and *garbo-sphere* are in 'overshoot' whereas others, energy reserves and biodiversity loss, are being depleted at an alarming and accelerating rate. The rapid depletion of the energy resources that underpin our industrial civilisation is possibly the most alarming impact and is graphically illustrated by a five-minute on-line presentation from the Post-carbon Institute (2011). The *atmosphere*, *hydrosphere* and *cryosphere* are being changed by non-recyclable human wastes and synthetics. 2011-2020 is very likely to be the crucial decade for choosing between a sustainable future and the collapse of human civilisation to which Sagan referred. Botanical Gardens can play their part in educating about the need for radical change in the relations between humans and nature.

Threats to Life Support Systems

The harnessing of cheap fossil energy initiated the Industrial Revolution and the Anthropocene Era. By converting this energy for technological advances in food production, transport and medical care, human population was enabled to increase from 1 billion around 1880 to over 7 billion in 2010, but energy resources are fast depleting and increasing in price (Post-carbon Institute, 2011). The economic growth that energy supplies fuels is doubling every 13 years or so. 'Planetary boundaries' (ceilings on how much growth the planet can contain) set limits to growth within Planet Earth. Some boundaries may already be over-reaching 'safe operating states' (as opposed to 'limits') according to the Stockholm Resilience Institute researchers. They identify nine such planetary 'boundaries at the lower edge of uncertainty'.

Table 2: Nine Planetary Boundaries

- *Atmospheric CO₂** - thought by some to be 350 p.p.m (now 390 and accelerating)
- *Stratospheric ozone layer* - so far addressed by the Montreal Protocol
- *Ocean acidification* - resulting in collapse of biomass
- *Fresh water use* - needed by terrestrial biomass
- *Landuse* - replacement of natural with man-made systems
- *Loss of biodiversity** - regulation of ecosystems

- *Phosphate and nitrogen cycles** - overload of mined phosphate and manufactured nitrogen fertilisers entering ecosystems
 - *Chemical pollution* – introduction of synthetic chemicals
 - *Aerosol loading* – soot, sulphates and other particles
- * = planetary boundary probably already exceeded

Rockstrom (2009b)

Of course, the growth of human population, technology and economic output underlie the pressure on these planetary boundaries. Paul Ehrlich, Professor of Population Studies and President of the Center for Conservation Biology at Stanford University in California concludes:

India and China are both vastly overpopulated by the simple standard that they are living on (and exhausting) their natural capital - agricultural soils, ground water, and the biodiversity that runs our life-support systems. Until and unless we can humanely begin to shrink the global population, following the lead of over-consuming and over-populated European nations, the future seems grim.

These two countries have economies now growing at almost 10% per annum which mean a doubling of all their man-made goods and services every 7 years as they catch up with richer countries. Ehrlich adds that:

Overpopulation is helping to drive climate disruption, land-use change, ocean overharvesting, toxification of the entire planet, the increased probability of novel epidemics, and greater threats of resource wars - especially a nuclear one - has not abated.

These few examples of threats to the life-support systems of our planetary home are supported with much more evidence from concerned scientists who are examining the complex interconnections of the socio-environmental systems or 'earth's spheres'. The widespread denial of, and distraction from, this inter-connected evidence of global scale problems needs to be urgently counteracted by scientists and educators. Surely it is not unreasonable to ask educators in botanical gardens to consider addressing them?

Education for Sustainable Development - A priority for Botanical Gardens?

Given the urgency of the situation sketched above the challenge of educating the public to live sustainably within nature is clear: understanding the connectedness and inter-dependence of the earth's spheres (our life-support systems); getting exponential growth of human population and the related technosphere under control; dealing with the consequences of:

- *'overshoot'* of the earth's carrying capacity within 'planetary boundaries';
- *depletion* of energy, mineral and food resources;
- *disruption* of natural systems by waste products.

Integrated education on these themes that modifies prevailing worldviews and lifestyles and promotes 'big picture,' systems thinking is crucial and urgent. The proverbial problem of the blind men trying to identify an elephant is often used to illustrate our blindness to the 'big picture' of the planet's complex interacting systems. We need to overcome the fragmented, subject-based approach that prevails in most school systems beset by 'subject empires' competing for time in the curriculum and influenced by over-specialised research in universities. Conventional environmental education (EE) has been a step in the right directions, but ESD offers a broader and more fully integrated way of examining the interactions between human and natural systems with a view to addressing current crises. The United Nations has for many years been promoting ESD as 'The Decade of Education for Sustainable Development' confirms, but the impact of UN conferences and symbolic declarations seems slow to filter into educational practice.

There is, therefore, a strong case that Botanical Gardens could and should play their part in educating public opinion about the need for radical change in the relations between humans and nature. Clearly, the educational programs of botanical gardens are one of several aspects of their work and there are considerable differences in the extent to which various gardens provide educational activities. But there are compelling reasons why they might provide ideal locations for ESD:

- Botanical gardens occupy a special place between diverse, world-wide nature and local gardens where the connections between local and global scales can demonstrate 'the big picture' of how humans depend on nature.
- They can offer direct contact with natural processes that stimulates all the senses and engages values & feelings as well as deeper understanding.
- They are able to connect learning about nature, culture and science with help of staff who respect nature and often care passionately about its preservation.
- Young people can be encounter nature in safety in botanical gardens and their surrounding regions.
- Non-formal education providers have the freedom and flexibility to design learning programs outside the school system and its constraints of separate subjects, tests, examinations, etc.

In the relatively newly established Silesian Botanical Garden and its Centre for Ecological and Environmental Education (C3E) in Mikołów, Poland this challenge has been responded to in the form of the Process Education for Sustainable Development (PESD) program (Ogrodnik, 2011). The program has been developed by educators from three disciplinary backgrounds – ecology, philosophy and psychology – and employs a pedagogy known as 'process education' influenced by the work of A.N.Whitehead and others that uses a broader range of learning goals and events than would be possible in conventional schooling. The innovative ESD program is offered in C3E alongside more conventional EE programs and importantly is accompanied by a leader training course for teachers and others who implement the three-year program for young people that takes place in both the botanical garden and the local areas from which the students come. The website in English that describes the PESD program in detail is at <http://esdinsib.wordpress.com>.

Connecting networks for ESD

There are already several thriving networks and initiatives that are rising to the challenge of spreading ESD although none of them specifically attempts to link the good practice that is appearing in some botanical gardens such as the Silesian Botanical Garden. If botanical garden education programs are to be networked across Europe, two strategies for mutual support and sharing expertise might be considered: creating a new network specific to botanical gardens; joining already existing networks.

If a network dedicated specifically to ESD in botanical gardens is to be formed, then the European Consortium of Botanical Gardens might offer a platform. If joining other networks is desirable, then the following networks or institutions might possibly be approached:

- **ENIRDELM** – this European network to which the author belongs, focuses on developing educational leadership and has an EL4SD sub-group working on ‘educational leadership for sustainable development’. The leaders of educational programs within both formal and non-formal institutions might find the on-line resources of the ENIRDELM initiative which include the findings of a research project that compares the attitudes of school leaders in 14 countries to issues relating to ESD. Sweden emerged from the study as well ahead at both government and institutional levels in holding values that promote ESD. www.enirdelm.org
- **Environmental Network for School Initiatives (ENSI)** links schools across Europe by developing teaching and learning for local and global ESD by means of a digital platform (consisting of data, examples) for collaborative knowledge building. Among other aims ENSI encourages the creativity of students to have a self-corrective attitude; concentrate of being in harmony with nature and to challenge the definition and theory of sustainability (ESD) <http://www.ensi.org/Projects>
- **Schumacher College** in England provides individuals and groups from across the world with the opportunity to learn on numerous levels about subjects relating to environmental and social sustainability. The college was established in 1991 and named after Fritz Schumacher whose ideas about sustainable development captured in his concept ‘Small is Beautiful’ (Schumacher, 1973). Through a range of educational activities, participants experience deep and holistic engagement with transformative learning for sustainable living. They are encouraged to consider some of the most urgent challenges of sustainability and to take responsibility for delivering effective solutions in their own working and personal environments.
- **SEEd** (School Development through Environmental Education) is a European network that disseminates news on sustainable development in the Education sector, ESD, jobs, funding and any upcoming events, courses or consultations. se-ed.org.uk
- **The Center for Ecoliteracy** based in California and Directed by integral thinker Fritjof Capra, has been a leader for 20 years in the green schooling movement.

It provides a framework and services for schooling for sustainability in more than 400 communities across the United States and numerous other countries. The Center is best known for its pioneering work with school gardens, school lunches, and the integration of ecological principles and sustainability into school curricula. It also offers books, teaching guides, seminars, a sustainability leadership academy, keynote presentations, and consulting services. www.ecoliteracy.org/

Conclusion

The ‘mind-shift for a great transformation’ that the Nobel Laureates in Stockholm and many others advocate can only come about through scientists, educators and above all, politicians working on many fronts. This article has offered a challenge to educators in botanical gardens to join in this effort. It has argued that they are well placed to build the consciousness of our proper place in nature which needs to be one of planetary stewardship and a concern for a sustainable future on our ‘Space Station Earth’. Well-constructed integrated programs of ESD of the sort developed at the Centre of Ecological and Environmental Education in the Silesia Botanical Garden rise to this ‘ultimate challenge’ and networking with similar efforts is a desirable further step towards a sustainable future. A first step towards networking will be taken by C3E by organising and invitational seminar of potential collaborators in such an important initiative.

References

- Anders, W. (1968). *Earthrise*. Retrieved from *Pictures that Changed the World* [online], <http://www.stoneyburn.com/picchange/earth.htm>
- Collier, P. (2010). *The Plundered Planet: How to reconcile prosperity with nature*. London: Allen Lane.
- Dawkins, Richard. (1989). *The Selfish Gene* (2nd ed.). United Kingdom: Oxford University Press.
- Ogrodnik, B. (2011) In this publication.
- Pearce, F. (2010). From ocean to ozone: Earth’s nine life support systems. *New Scientist* [online], <http://www.newscientist.com/special/ocean-to-ozone-earths-nine-life-support-systems>
- Post-carbon Institute (2011). *300 Years of Fossil Fuels in 300 Seconds* [online], <http://www.ecoliteracy.org/blog/300-years-fossil-fuels-300-seconds>
- Rees, M. (2003). *Our Final Century: Will civilisation survive the twenty-first century?* London: Arrow Books.
- Rockstrom, J. et al. (2009a). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology and Society* 14(2): 32. [online] URL: <http://www.ecologyandsociety.org/vol.14/iss2/art32/>
- Rockstrom, J., Steffen, W., Noone, K. et al. (2009b). A safe operating space for humanity. *Nature* 461 (7263), 472-475.
- Sagan, C. (1994). *Pale Blue Dot: A vision of the Human Future in Space*. New York: Random House. Retrieved from <http://obs.nineplanets.org/psc/pbd.html>

- Schumacher, F (1973). *Small is Beautiful: Economics as if people mattered*. New York: Harper and Row.
- Stockholm Memorandum. (2011). *Tipping the Scales towards Sustainability*. <http://globalsymposium2011.org/wp-content/uploads/2011/05/The-Stockholm-Memorandum.pdf>
- United Nations (2011). *World Population Prospects: the 2010 Revision*. Retrieved from http://esa.un.org/unpd/wpp/Analytical-Figures/htm/fig_1.htm
- Zalasiewicz, J., Williams, M., Steffen, W., and Crutzen, P. (2010). The New World of the Anthropocene. *Environmental Science & Technology*, 44 (7): 2228–2231.

The botanical garden as a place for integral education for sustainable development¹

Bogdan Ogrodnik
Silesian Botanical Garden, Mikolow, Poland

Abstract

The paper presents a conceptual overview of process education as background for advocating a deeper and integrated approach to education for sustainable development (ESD) that can be offered in the non-formal educational setting of botanical gardens. It then and gives an example of the implementation of such a program for young people and adult leaders in the Centre of Education for Ecological and Environmental Education at the Silesia Botanical Garden. In conclusion, the case is made for making botanical gardens centres of education for sustainable development and for international collaboration in bring this about to provide the sort of educational experiences promoting an integrated view of being in nature that formal education finds difficult to provide.

Introduction – a general view on education

An educational system is a subsystem of society and serves as the “adaptive tissue” of society assisting it to maintain itself and develop its ‘human capital’ to cope with its needs. The education system aims both to maintain continuity by conserving aspects of society’s heritage while, at the same time, changing other aspects of that heritage in order to adapt to new realities, both internal and external to the society. Nowadays an adaptive sustainable development strategy is one of the most important requirements for every society (and its subsystems). For the first time in history, political leaders from all over the world appear to agree that humankind has managed its environment unwisely resulting in problems that require a fundamental rethink. Account needs to be taken, not only of threats to ecology, but also to social justice at a global scale. Unfortunately the notion of sustainable development has become fuzzy and contains many inconsistencies. It needs to be researched and developed as a central adaptive process for the educational system, the fragile sub-system which, as “adaptive tissue”, serves to shape society.

Education as an adaptive process

Education supports human adaptation to the environment. In exploring this particular function of education some terms need to be clarified in order to avoid

¹ I thank David Oldroyd for his help in framing the structure of the educational programs at the Silesian Botanical Garden and for his substantial discussion of many points, and also help in drafting the paper.

misunderstandings arising from their common usage. For instance, the word *adaptation* is often used as a synonym of *integration*, *reintegration* or even *conformity* with society.

Understanding the term '**process**' as a kind of flow or continuous change is to understand it too narrowly, as science (from physics to psychology) to demonstrate. Process is characterized by its structure and its rhythm and most importantly, process consists of units, which build its continuity. The process of education has a complex structure and possesses many rhythms. In fact it is a nexus of a range of many different processes and connections with many environments (see below).

'**Adaptation**' is a special process which occurs when there is tension and lack of balance between an organism and its inner or outer environment. Humans seek a balance or harmony in many of their dispositions such as knowledge, creativity, consistency, sensitivity or resistance to stress. The educational process of adaptation requires such well-balanced dispositions as a source of aims and motivation. Adaptation (e.g. the educational process) consists of two elements: growth and development. Growth has quantitative character, development – a qualitative or structural character. Both elements alternate to play a crucial role in making adaptation effective.

Each human undergoing an '**education process**' has an 'initial aim', which at the start of each educational unit guides his or her direction of development and determines the materials needed. In addition, each person has a so-called 'subjective aim' that arises from each person's worldview. This subjective aim is largely tacit and often vaguely sensed. Both initial and subjective aims have to be constantly and creatively reconciled with a person's heritage and changing environments. Such reconciliation requires alternate phases of analysis and synthesis of educational material, not only from textbooks (formal education) but also from many areas of life (non-formal and informal education). The education process involves all stages of human life and this way of thinking is today increasingly common, for example, from the perspective of life-long learning, permanent education, courses for adults and the elderly. The education of young people should prepare them for the whole process of education and for participation in its later stages.

Integral education is a term that emphasises the interconnectedness of the educational process in the mind of the learner who must always integrate what is new with what is already known. It can also signify the bringing together of different disciplines and specialist authors to construct a program in order to provide a holistic perspective that reconciles the initial and subjective educational aims of the participant in the educational event. A further 'integration' is that of bringing together four 'environments' that encompass a person's inner and outer realities.

The importance of exposing children and youth to many environments to stimulate their development is increasingly well understood. Competent performance is often limited to the environment where the competence was acquired.² The simplest classification of learning environments which are natural for humans (and important for the education process) is fourfold:

- Inner environment - physiological, psychological

² ????????

- Outer natural environment
- Outer social environment - family, cultural, technical, economical, civic, etc.
- Spiritual³ environment

There is a danger of limiting an educational environment to one or only a few aspects of these four environments. Such limits to integral education may arise from the culture of a given society, its history or current trends, or from philosophical, religious and common-sense premises inherent to a given civilization.

Characteristics of an education system based on the above assumptions

An education process that integrates the four environments outlined above requires a web-like, dynamic approach within the education system in which it is provided. This involves co-operation between formal education institutions, non-formal education institutions and informal education processes. Ideally, formal education might have schools providing such integrated programs authored and taught by committed teachers. However, where such innovative programs or teams of committed teachers are not found in schools, non-formal education can provide integral programs designed by animators who can adapt them to the local environment and also train those who lead the programs.

Teachers who lead such integrated programs need to develop their interpersonal communication, psycho-educational and self-development abilities. They should also possess attitudes and a world view adapted to and suitable for contemporary times. Non-formal education, especially when provided by specially trained educators, can systematically complement the formal education process by developing competence in environments unavailable in the formal system. Informal education can draw upon a vast area of experience and knowledge to promote deeper learning by young people if aided by trusted advisors and guides.

Profile of a participant in the education process sketched above

Ideally an integral 'process education' to prepare young people to adapt to the need for sustainable development would help them to become:

- A person sensitive to the world and to his or her inner self and resilient to stress caused by the higher level of sensitivity
- A person with a high level of motivation and an open-minded attitude to both tradition and change
- A person able to build proper relations with others and who has no problem with self-acceptance
- A critical and self-critical person capable of recognising the need for solutions to current problems, unless no better one can be found

³ Spirituality is here understood in a non-religious way, as a special kind of sensitivity which make possible to go beyond a narrow ego towards more broadly apprehended values concerning other people, Nature, God etc.

- A creative and thinking person with a questing mind, not afraid to experiment but appreciative of the value of predecessors' achievements
- A person with a store of information essential for living in the present day and at the same time willing to develop a worldview based on the synthesis of various kinds of knowledge and personal experience

Education for Sustainable Development⁴

The Decade of Education for Sustainable Development was declared by UNESCO in 2005 but the idea of sustainable development remains marginal to mainstream formal education, certainly in Poland and probably elsewhere. The general view offered above on education as an integral adaptive process raises several questions:

- Does formal education satisfactorily prepare humans to adapt to the complex world (inner and outer)?
- In which way, if any, do schools help pupils to acquire the features, abilities and dispositions of young people profiled above?
- Which of the four outlined learning environment(s) are lacking in contemporary formal education?
- Can children and youth clarify their subjective aims and develop their own world view as a result of conscious synthesis of knowledge and experience?

The answers to these questions are likely to be discouraging if not obvious⁵ therefore let us sketch an example of education for sustainable development that combines formal, non-formal or informal types of education. Sustainable development is an idea which tries to bring into harmonious interconnection the relationships between three systems: society, economic and natural. In fact, nobody knows whether such long-term sustainable interconnection is possible. There is much evidence that the transformation to sustainability cannot be made 'mechanically' by adding new rules to the current systems which will regulate their interactions 'in a new way safely for all'. This is very naïve scenario. A sustainable relationship between human and natural systems must be 'organic' and modelled on natural not mechanical systems. Thus a basic condition of success is the transformation of social and economical systems towards the principles that govern organic systems.

Let us narrow the issue to education: what would the organic approach that we call 'process education' mean, especially in relation to education for sustainable development? If we accept the working definition of education as "a process of human adaptation to environment" then all types of environments, in particular

4 Ogrodnik B., Kulik R. Skubala P.: Philosophy, psychology and ecology in education for sustainable development. Silesian Botanical Garden, Mikolow 2010. (in Polish). Another approach is developed in: Regnier R.: Education for Sustainable Development. In: Process. Religion and Society. Ed. K. Kachappilly. Dharmaram Publication. Bangalore 2010.

5 See: Sustainable Education. Re-visioning Learning and Change. S. Sterling. Schumacher Briefing No. 6. Green Books 2001.

the natural environment, need to be incorporated. This is a difficult task for formal education due to the constraints of schooling, such as fragmented curricula, teaching for examinations, largely classroom-based learning, as so on. Better opportunities may exist through non-formal or informal education. What non-formal institutions can likely undertake such a task? Botanical gardens, especially modern ones, can arguably assume this role.⁶ They are usually not a part of the formal education system but even where they are (e.g. as a department of university) they have greater independence than schools tied to national curricula and many competing priorities and conflicting demands from stakeholders.

Another important feature of 'process education' is the special phases of the process involving the whole person. What 'the whole person' means depends on one's concept of what it is to be human. There are plenty of such concepts derived from humanistic or naturalistic philosophies but only a few try to reconcile all dimensions of the human condition with the inner and outer environments (physiological, psychological, social, natural, spiritual) with which humans interact. One of the philosophies that reconciles these dimensions is the 'philosophy of organism' or 'process philosophy' created by Alfred North Whitehead in the 1920s.⁷

Despite inconsistencies contained in how the notion of sustainable development is understood and used, the complex interconnection between all elements and processes is a central idea. Such complexity cannot be fully controlled. Pedagogical consequences for a deeper, more integrated 'process education' approach to sustainable development follow from these fundamental ideas about complex interconnectedness. The main, but not only, task is to develop in children and youth the sensitivity which allows them to rebuild connections with their natural world (inner and outer) and other people. These connections may have been broken due to their early socialisation, particularly in consumer-saturated urban environments. This delicate pedagogical matter lies at the intersection of biology, psychology and philosophy and is unlikely to be undertaken in formal education settings unless a deep transformation of conventional education happens in the near future.

An example of integrated ESD in Silesia Botanical Garden (Poland)

The Centre for Ecological and Environmental Education (C3E) Programs

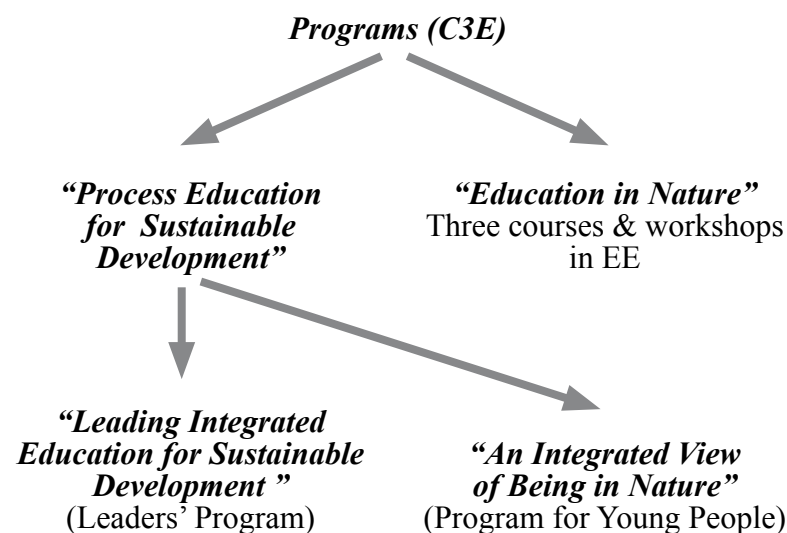
For several years the staff of the Silesian Botanical Garden (SiBG - www.sibg.org.pl) has developed a garden-based enrichment program for selected school pupils. Since 2009 we have pioneered a program for adult leaders who present this enrichment program in their own local areas. The programs that constitute the Centre for Ecological and Environmental Education have been operating since 2006 and currently there are two major programs:

6 See the paper by David Oldroyd in the present publication.

7 There are a few good introductions to process philosophy. See for example: C. R. Mesle: Process-Relational Philosophy: An Introduction to Alfred North Whitehead. Templeton Press 2008.

1. **Education in Nature** – 3 courses in conventional environmental education (EE)
2. **Process Education for Sustainable Development** – an innovative environmentally-based ‘process education’ course for young people and a leader training course for facilitating a deeper and more holistic education for sustainable development (ESD)

Figure 1: The Centre for Ecological and Environmental Education programs



Environmental educational programs (“*Education in Nature*”) have been offered for several years, based outdoors within the garden and also in rented premises, schools and colleges. More recently the innovative program called “*Process Education for Sustainable Development (PESD)*” has been piloted with grant aid. The program consists of two parts, each spread over six semesters:

- “*An Integrated View of Being in Nature*” a course for children initiated in 2006 and revised in 2010. Primary and secondary school children are selected from schools around Silesia to take part in this integrated program.
- “*Leading Integrated Education for Sustainable Development*” was started in 2009 with Norwegian and other foreign grant support. It is based on the “An Integrated View ...” program for children and prepares and certifies adults to lead the learning activities for children enrolled in the enrichment course.

“Education in Nature”

These traditional environmental education programs are attended each year by significant numbers of young people aged 7 to 19. In 2009 around 2500 young people

participated and in 2010 there were around 1500. “Education in Nature” consists of the following three courses each taught in the Botanical Garden:

- “*Encounters with the Environment*” – for school students of all ages devoted to environmental themes (habitats, flora and fauna) from the natural sciences. Each active learning workshop meeting lasts 4 hours and involves content from biology and ecology.
- “*Plants and Climate*” – to familiarize high school students with inter-disciplinary scientific methods and problems involving the use of microscopes, multi-media presentations based in classroom laboratories at the Centre.
- “*Naturally Active*” – a play-based artistic learning experience for children aged 7 to 10 involving around ten meetings over two semesters (per 1 group) in the natural environment of the Botanical Garden and its surroundings.

“Process Education for Sustainable Development” (PESD)

“Process Education for Sustainable Development” program courses:

- “*An Integrated View of Being in Nature*” - for young people
- “*Leading Integrated Learning for Sustainable Development*” – for course leaders

are the result of an innovative project that trains program leaders to offer local integrated learning activities to selected children and students around Silesia. The courses are based on educational methods derived from the process philosophy of Alfred North Whitehead and others. They place particular emphasis on ecological, philosophical and psychological principles to help young people not only understand, but also experience in many ways, the inter-relatedness of human life with the environment. The ‘process education’ program moves beyond the traditional approach to environmental education (EE) to include an integral and deeper education for sustainable development (ESD) for both the adults leaders and the children that relates nature, humanity and the self.

What is the purpose of the PESD program?

The PESD program offers an extra-curricular opportunity that supplements regular schooling. It contains a strong element of direct experience of the natural environment in a variety of locations around Silesia led by teachers trained by C3E Program staff. Its broad purpose for both the adult leaders and the young learners is to develop a ‘*pro-ecological attitude*’ involving: ecological and self awareness; sensitivity to the connectedness of natural and human systems; adaptability to changes in oneself and one’s world. Learning is seen as a process that involves the learners in developing themselves by making meaning, acquiring new skills, attitudes, values and ways of seeing, understanding, being and acting in their world. Their experience of nature is focused on helping them to ‘finding a proper place for humans among natural processes’.

By educating carefully selected future 'leaders' in a new way the course seeks to help them acquire:

- a realisation of the 'wholeness' and inter-relatedness of humans and nature;
- deeper relationships and sense of harmony with nature;
- sensitivity, alertness, resilience and adaptability for a rapidly changing world
- a moral, balanced and ecologically harmonious life
- a grasp the local, global and universal connectedness of the inner self to the cosmos
- a sense of ecological responsibility⁸ at local through to global levels

These ambitious aims need to be modelled by the life-stances and lifestyles of the SiBG team which values the quality of life and living with and in nature as opposed to dominating and exploiting nature in pursuit of a standard of living defined by economic production and consumption alone. These aims require asking deeper questions - philosophical, psychological as well as ecological - about interconnectedness, sustainable development and the limits to, and dysfunctions of, our growth-addicted society.

What subject disciplines form the core of the program?

Three main disciplines, those in which the program designers specialized, form the main background to the PESD program:

- **Ecology** – in particular, knowledge about relationships between organisms and their environment with a local and global perspective on the sustainable and safe co-existence of humans and the rest of the living world (humans and nature in harmony).
- **Psychology** – elements of cognitive, gestalt, integral and process psychology, but also eco-psychology that connects psychology and ecology in order to show humans ways to heal alienation, build a sane society and a sustainable culture.
- **Philosophy** – the primary influence comes from process philosophy (A.N. Whitehead) that sees change and dynamism and interconnectedness as the cornerstone of reality. This core philosophy is enriched by other philosophical perspectives and exploring the worlds of dreams, art, mythology, religion that can inform contemporary life.

What model of teaching and learning is involved?

The learning process used in the PESD program has its own rhythm. Each 4-hour educational event has a rhythm of five phases based on Whitehead's concept of 'an educative event' understood as 'a unit of the process of life experience'. This approach can be described as '*process pedagogy*'. (Whitehead emphasised rhythm and 'organic

⁸ The root of 'responsibility' is 'response' which implies making a connection, being a part of all things.

wholeness' in learning. Psychologist and anthropologist Jean Gebser proposed that the human psyche has evolved and is still evolving through five phases (archaic-magical-mythical-rational-integral) from which mental maps of reality are formed. These elements built the main stages of human social evolution and are reflected in ontogenesis of the single organism. Process pedagogy aims to reincorporate and integrate the early layers of social evolution (archaic-magic-myth) sequentially with the later stages (rational-integral). Conventional pedagogy tends to omit the ritual and emotional stages.

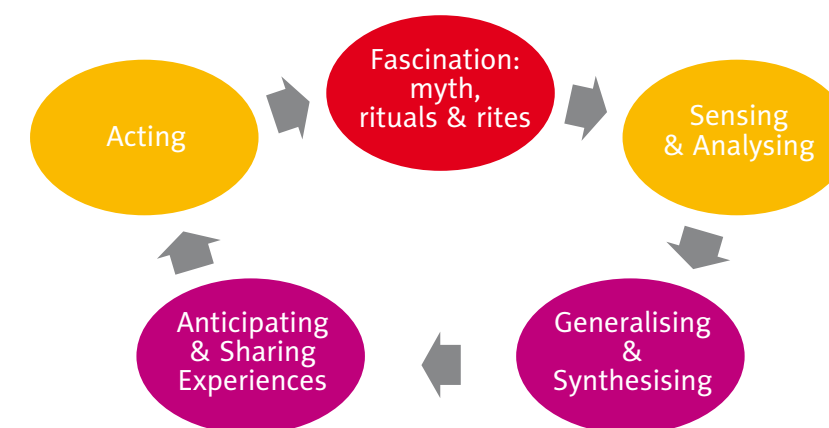
The phases of a learning event are:

1. initial aim of the learning (stories, myths, rituals and rites)
2. sensing & analysing (experiencing, feeling & sense-making)
3. generalising and synthesising (conceptual formation, seeing and expressing the whole)
4. sharing & anticipating experiences
5. satisfaction with the learning event (ready and confident to act in the period between workshops)

Each educational event is designed to be an integrated experience that helps learners to synthesise, into a temporary worldview, several different components of human experience: feelings, emotions, thoughts, ideas and memories. This evolving worldview is important in helping young people to form a deeper understanding and pro-ecological attitude towards nature and towards themselves in relation to nature and to the interconnectedness of natural, physical and social phenomena and processes.

Following Whitehead's approach to 'process education', a five-phase rhythm of learning experiences for each educational event has been developed for the pupils.

Figure 2: The Rhythm of a 'Process Education' Learning Event



These phases aim to stimulate students’:

- fascination with, and curiosity about, their own relationship with nature;
- readiness to engage in investigation;
- responsibility for their own understanding, respect & reverence for nature;
- awareness and creation of their own values and actions.

How is the program evaluated?

In both the PESD programs for pupils and for leaders, open-ended responses to a questionnaire about their experience of the program are completed at key points during the year. In the course for leaders a more complete investigation of participants’ perceptions is used. Both programs require a thorough and careful evaluation and, for this reason, an external evaluator familiar with the principles behind the program will be employed to design and implement a formative and summative evaluation strategy.

The PESD course for young people “An Integrated View of Being in Nature”

Started in 2006, the current educational program consists of five 4-hour educational events per semester per group spread over six semesters, lasting three years. Already 20 groups of children have been through the original version of the program. Versions of the program are now being refined for primary, lower and upper high school students. They provide learning through direct sensory experience of nature, both in the Botanical Garden but mostly in students’ local areas. They aim to provide a ‘developmental pathway’ by means of deeper contact with nature that helps young people discover their proper place in nature and include it into their personal world.

Themes of meetings in the Primary School Version

Year IV Semester 1 - **Trees**

Aim: To build subjective relationships between children and the most representative group of plants

Year IV Semester 2 - **Mammals**

Aim: To build subjective relationships between children and the most representative group of animals

Year V Semester. 1 - **Life and its dynamics**

Aim: To enable children to experience many facets of life such as germination, growth, reproduction, movement, migration

Year V Semester. 2 - **From the individual to the ecosystem**

Aim: To make children aware of links between elements in ecosystems, their complexity and to experience how humans fit in to the “web of life”

Year VI Semester. 1 - **Nature in danger - How can I protect nature?**

Aim: To recognise and experience the risks to nature in ourselves, in others, in the world and to find remedies

Year VI Semester. 2 - **Nature is my home**

Aim: To experience one’s roots and a sense of security in contact with nature

The adult program “Leading Integrated Learning for Sustainable Development”

This grant-supported program was first developed in 2009-10 for around 30 teachers and other adults who will lead the six-semester “An Integrated View of Being in Nature” program for young people. It consists of three parts, each part based on the contributing discipline and designed by a specialist in that field. Each part consists of a series of 4-hour long workshops intended to prepare around 30 adults to become leaders of the enrichment program for young people

- Ecological workshops for Adult Leaders
- Psychological workshops for Adult Leaders
- Philosophical workshops for Adult Leaders

Together, the three parts introduce potential leaders to an integrated view of humans in nature and explore the ecological, psychological and philosophical principles that underpin “An Integrated View of Being in Nature”. The overall purpose of the leaders’ program is to help them to implement effective approaches to encouraging young people to increase their knowledge, sensitivity and emotional commitment towards the sustainable development of natural and human systems. Themes of the three parts are set out in detail in the Appendix to this article.

The Future of the PESD program

Further funding is being sought to prepare a new group of 30 leaders by means of an upgraded version of “Leading Integrated Learning for Sustainable Development”. This will involve closer contact with those who have already graduated from the first course. Further assistance will be provided for these graduates in recruiting children likely to benefit from this program and in implementing the course in their local areas. The consolidation of what has already been developed will also include classes in the new C3E buildings opened in 2011 and more time to experience the natural ecosystems of the Botanical Garden along with the less conventional elements of the pedagogy. Additional seminars for the graduates of this course for adult leaders will be provided to help them build on their skills, based on evaluation and consultation with the program leaders as they continue their work in this new area of experiential process pedagogy.

Conclusion: botanical gardens as centres of non-formal education for sustainable development

Our world is under increasing pressure from global factors such as climate change, economic crisis, overpopulation and the devastation of nature and natural

capital. In all these cases complex systems must transform themselves or be destroyed. Sustainable development involves co-existence between humans, their societies and economies and the natural world, but its realization needs deep social and economical change. The most sensitive and adaptable “tissue” of society is its educational sub-system. A complete education for sustainable development is impossible without incorporating its non-formal and informal parts. There are few such institutions able to elaborate and provide this kind of education, but botanical gardens offer a potential location for children and youth to receive integrated enrichment learning in a relatively short time. Botanical gardens possess great educational potential having many plant collections and suitable infrastructure which can be easily adapted and extended. They have a well-established position as institutions which satisfy higher social needs (e.g. aesthetic enjoyment and peaceful surroundings) and are not identified with formal education. However, they rarely have appropriate personnel to construct modern educational programs for sustainable development based on a contemporary philosophical and psychological content suited to current social, economical and ecological realities. In the Silesian Botanical Garden we have begun to build such a program but its further development and broader implementation depends on international co-operation with other European institutions, especially European Botanical Gardens and Arboreta which have educational programs, centres connected with nature protection. Additional support could come from pedagogical institutes interested in innovative integrated learning and process education as well as other institutions which have an interest in deeper approaches to ecology, philosophy and psychology and sustainable development.⁹

References

- Cobb J.B. Jr. (2008) *Whitehead Word Book. A Glossary with Alphabetical Index to Technical Terms in Process and Reality*. P&F Press
- Mesle R.C.: (2008) *Process-Relational Philosophy: An Introduction to Alfred North Whitehead*. Templeton Press.
- Ogrodnik B., Kulik R. Skubala P.: (2010) *Philosophy, Psychology and Ecology in Education for Sustainable Development*. Silesian Botanical Garden, Mikolow (in Polish)
- Oldroyd, D. *The Challenge of Education for Sustainable Development in Botanical Gardens* (in this publication)
- Regnier R.: (2010) Education for Sustainable Development. In: *Process. Religion and Society*. Ed. K. Kachappilly. Dharmaram Publication. Bangalore
- Scarfe A.C. (2009) (Ed.) *The Adventure of Education. Process Philosophers on learning teaching and research*. Rodopi Press
- Sterling S.: (2010) *Sustainable Education. Re-visioning Learning and Change*. Schumacher Briefing No. 6. Green Books.

⁹ The staff of C3E is seeking suitable partners for study visits to share experience and exchange of approaches. Contact Address: d.oldroyd@wp.pl

APPENDIX:

Themes of the Adult Leaders' Program “Leading Integrated Learning for Sustainable Development” (See also <http://esdibinsibg.wordpress.com/>)

Introduction and Rationale

These 25 workshops introduce potential leaders to the integrated view of nature and humans and explore the ecological, psychological and philosophical principles that underlie effective approaches to encouraging young people to increase their understanding of the sustainable development of natural and human systems and readiness to make adequate and permanent changes in their private worldview.¹⁰

Part 1: Ecological workshops for Adult Leaders

Workshop 1: *Forest life – a new view on forest*

1. Appreciating the importance trees in nature and human life
2. Understanding the ecological situation of forests in Poland and in the world
3. Identifying influence of our life style on preservation or degradation of nature
4. Introducing an ability to think holistically about the needs of both nature and humans
5. Using the senses more fully in contact with nature
6. Stimulating interest in studying of biology

Workshop 2: *Making friends with a tree*

1. Understanding relationships in forest ecosystems
2. Discovering secrets of the forest by using all the senses
3. Responding emotionally to nature and with sensitivity to its beauty
4. Promoting a desire to protect nature and respect all forms of life

Workshop 3: *Becoming a friend of the Earth by forming environment-friendly attitudes in children and teenagers*

1. Promoting relationships between humans and the environment
2. Examining the risks of civilization for nature and human health
3. Developing an ability to evaluate everyday behaviour
4. Becoming ready and skilled to act rationally to preserve ecological systems

Workshop 4: *Meditations on Nature – helping ‘Mother Earth’*

1. Examining ecological ways of thinking in different cultures
2. Becoming familiar with how different cultures and beliefs show intuitive awareness of the basic laws of contemporary ecology
3. Promoting the need for nature conservation and respect of all forms of life

¹⁰ There are a few philosophical terms in the list of subjects. Most of them come from process philosophy and we recommend the following introductory text for familiarizing with them: John B. Cobb Jr. “Whitehead Word Book. A Glossary with Alphabetical Index to Technical Terms in Process and Reality” P&F Press 2008 which can be downloaded for free from the Centre for Process Studies website: www.ctr4process.org

Workshop 5: Why should we protect nature? Conceptions and motives in nature conservation

1. Understanding different methods of solving of environmental problems
- Developing a capacity to assess human attitudes critically in relation to nature

Workshop 6: Effective ecological education – alternative methods for leading ecological workshops in school and natural surroundings

1. Exploring ecological assumptions important in education development
 2. Becoming familiar with different influences on children during ecological learning
- Understanding of alternative methods of leading exercises in school and in nature

Workshop 7: Ecological tournament - Developing environment-friendly attitudes through play

1. Mastering new concepts from ecology and environmental protection
2. Choosing of pro-ecological solutions in school and homes
3. Demonstrating knowledge of the risks of civilization to nature and human health
4. Demonstrating the ability to choose healthy food

Part 2: Psychological Workshops for Adult Leaders**Workshop 1: Group integration**

1. Encouraging participants to get to know each other
2. Exploring participants' expectations of the program
3. Developing participants' motivation and commitment to learning
4. Developing group co-operation mutual support
5. Building participants' sense of security within the group

Workshop 2: Sensory contact with nature

1. Using the senses in contact with nature
2. Establishing emotional contact with natural phenomena
3. Developing empathy with nature
4. Exploring emotional relations between humans and the natural environment
5. Aligning emotions with a commitment to sustainable development

Workshop 3: Awareness of crisis - a turning point

1. Raising awareness of the global ecological crisis
2. Taking responsibility for the environment
3. Discovering ways of preventing environment damage
4. Building awareness of the deep interdependence between humans and nature
5. Building motivation for pro-ecological activities

Workshop 4: Ritual as an educational practice – “The Council of All Beings”

1. Identifying selfish human-centred attitudes towards natural objects
2. Using drama and artistic creativity in ecological education
3. Widening participants' identification with objects from the external world
4. Deepening participants' relations with nature

Workshop 5: Attitudes: shaping, changing and persuading

1. Discovering how attitudes are shaped and changed
2. Exploring the process of persuasion in education for sustainable development
3. Constructing educational programs that make an impact on attitudes

Workshop 6: The role of emotions in education for sustainable development

1. Understanding the nature of emotional experience and its particular role in learning
2. Identifying why most people seem emotionally indifferent to nature
3. Introducing empathy and compassion as a responsible basis for environmental protection

Workshop 7: The Ecological Self as a basis for education for sustainable development

1. Introducing the principles of eco-psychology
2. Examining personal identity in human-environment relationships
3. Examining the factors behind spontaneous ethical behaviour towards the environment
4. Connecting personal development with a reverence for nature

Workshop 8: Principles and practice of leading workshops

1. Identifying one's strengths and weaknesses as a workshop leader
2. Clarifying the mission and values of a workshop
3. Developing strategic and operational goals for workshops
4. Elaborating individual scenarios of ecological workshops
5. Knowing of principles and techniques of workshop evaluation
6. Anticipating group processes and coping with different potential difficulties of implementation

Part 3: Philosophical Workshops for Adult Leaders**Workshop 1: Individual and Society**

1. Outlining the initial aim and meaning of the course
2. Comparing the match between initial aim and participants' expectations
3. Elaborating what “to meet others” means in this course
4. Building respect and social solidarity between leaders and the children in the group
5. Exploring the contrast between the goals of social and ecological stability and egotism

Workshop 2: 'Prehensions' and feeling as the basis of an educational event

1. Seeing the world through sensual feeling and non-sensual feeling
2. Exploring emotion and other subjective forms of feeling
3. Understanding the place of 'subject' in a feeling & developing empathy
4. Examining a range of feelings and considering the depth of participants' empathy
5. Developing of subjective commitment to activities that protect natural systems

Workshop 3: Types of social order and their stability

1. Examining the reasons for stability and instability of social order
2. Identifying the appropriate role of an individual in an unstable environment
3. Understanding consciousness as a subjective form of feeling
4. Exploring the nature and essence of responsibility (as ability to response)
5. Seeing the distinction between emotional feeling and conscious feeling

Workshop 4: Rituals as a process of opening up to nature

1. Identifying the role of rhythm in society
2. Analysing the hierarchy of rhythms in nature
3. Understanding ritual as a rhythm and transmission
4. Becoming aware of the dangers of rituals – ritualism
5. Developing a ritual of participation in nature

Workshop 5: The world as a process – the world as a society

1. Formulating an alternative worldview to the dominant materialistic-mechanistic worldview
2. Developing the ability to examine the consequences of a given worldview
3. Identifying personal ideas which belong to different worldviews

Workshop 6: From a biological organism to a metaphysical organism

1. Developing a capacity to discern features of organicity (the interconnectedness of reality)
2. Examining philosophical terms which adequately describe different world levels
3. Understanding the metaphysical organism as a sentient being

Workshop 7: Humans as a part of nature

1. Distinguishing between humans as societies and humans in society
2. Examining the dynamic harmony between "empirical ego" and "metaphysical ego"
3. Comparing human creativity and the creativity of nature
4. Considering human values that are in harmony with nature
5. Exploring what is required to achieve human satisfaction in relation to nature

Workshop 8: Education for sustainable development and process pedagogy

1. Examining the main assumptions of process pedagogy
2. Comparing the similarities and differences between pedagogies
3. Outlining how process pedagogy and process philosophy can enhance learning
4. Developing practical aspects of process pedagogy to promote sustainability

Additional Workshops for Adult Leaders**Workshop 1: How to found Ecological NGOs and co-operate with others**

1. Analysing Polish law relating NGOs
2. Learning how to found an NGO
3. Outlining principles of effective co-operation with NGOs

Workshop 2: Acting locally to promote sustainable development

1. Examining sociological, psychological and pedagogical perspectives on local society
2. Founding local centres for activities in schools and kindergartens
3. Enhancing the role of NGOs in activating local society in support of sustainable development

Department of Ecological and Environmental Education of Silesian Botanical Garden

Jacek Jaworski, Agnieszka Szyszka

Author note

Silesian Botanical Garden, Mikolow, Poland

The aim of our department is to provide education about nature for different educational levels. Especially important for us is to bring children into contact with nature, so they become more aware of the world around them, and to help them understand what should be the unbreakable bond between humans and nature. Our educational programs include psychological and philosophical perspectives to help children to feel and understand nature in a better way. Currently the Silesian Botanical Garden provides environmental education at all levels: early school, older elementary school, middle school, high school, colleges, adults and disabled people. Some of our programs are unique in Poland.

Academy of Education for Sustainable Development

This is the an educational project for adults. It is part of the Process Education for Sustainable Development (PESD) program and the course is entitled "Leading Education for Sustainable Development". It consists of 150 hours of workshops that serve to provide participants with qualifications concerning education for sustainable development. The participants not only gain knowledge about how to lead ecological education in an interesting and effective way, but they also engage in a process of self-development.

Plants and Climate

The workshops introduce young people to the interdisciplinary character of our current knowledge about nature and climate. The program has complements and supplements the formal education offered in high school educational programs of the national curriculum. The workshops are designed to help youth recognize specific and essential relationships within natural processes. They also acquaint the participants with some methods and conditions of used in scientific work at university level, including methods of correct observation, analysis and interpretations of microscope preparations.

Closer to the Garden, Closer to Nature, Closer to Humanity (An Integrated View of Being in Nature)

This is the most extensively developed of our educational programs for children. Workshops are performed in cycles of five meetings, 20 hours in sum. They focus on four spheres essential for developing a pro-ecological attitude: emotionally-perceptive, intellectual, behavioral and philosophical. The distinctive educational component in the emotional sphere strongly connects participants' inner motivations and degree of engagement to the content of the program to help the young participants to learn with concentration and to construct of consistent worldview.

Encounters with the Environment of Silesian Botanical Garden

Workshops lasting 4 hours and performed in the natural environment of our garden or other selected interesting natural places in our voivodeship make up this program. Participants encounter many distinct groups of plants and animals to learn how to recognize them and understand their habitats and the broader ecological processes that relate them to the broader ecological context.

Naturally Active

This cyclic program is directed at the youngest of the schoolchildren. It involves systematic observation of nature as it changes during subsequent seasons of the year. The meetings aim to create friendly situations that favour the development of imagination, sensitivity and a recognition that the world is highly complex net of interconnections of mutual interdependence in which humans are only one component. Children are invited into the amazing world of nature by six marvelous characters in the form of sympathetic insects – founders of “Naturally Active” club.

Plant Collections and Expositions

Can natural plants make a horticultural surprise? Spring Bulbs.

Jože Bavcon

Author note

Jože Bavcon, University Botanic Gardens Ljubljana, Department of Biology, Biotechnical Faculty, Ižanska, cesta 15, 1000 Ljubljana, Slovenia. E-mail: joze.bavcon@botanicni-vrt.si

Abstract

Slovenia lies at the crossroads of different influences. Its north western and central northern regions make part of the Alps, in the southwest it reaches into the sub-Mediterranean, while its north eastern and eastern parts belong to the sub-Pannonian region, and its south western and central southern parts to the Dinaric world. The relatively small territory of 20 256 m² is home to 3452 species, 3119 of these autochthonous and naturalized. In addition to species and subspecies, there is an exceptionally high level of intraspecies diversity. This paper presents intraspecies diversity of the following species on the territory of Slovenia: *Galanthus nivalis* L., *Leucojum vernum* L., *Crocus* L., *Narcissus poeticus* L. subsp. *radiiflorus* (Salisb.) Baker.

Keywords: intraspecies diversity, variety, hybrid, groups, yellow-tipped, green-tipped, star-shaped, windmill-shaped

Introduction

The territory of present-day Slovenia lying at an intersection of the roads leading to the Adriatic both from the lowlands and across the Alps, has always been widely visited and researched. This is why its flora began to be studied in the distant past. The first known records of Slovenian plant names date back to 1415 and were published in the work *Liber de simplicibus Benedicti Rinii*. The first natural scientists to study the vegetation of the then Slovenian territory were Pietro Andrea Mattioli (1501-1577), whose work *Commentarii in libros sex Pedacii Dioscoridis Anazarbei de materia medica* (1544, 1554) includes the first references to the plants of our country, and Carolus Clusius (1526-1609) in his work *Stirpium Nomenclator Pannonicus* (1583) (Petkovšek, 1967, Gosar & Petkovšek, 1982). In the second half of the 18th century the scientific activities and research reached their peak in the work of Joannes Antonius Scopoli (1723-1788), so Voss (1884) defines the time between 1754 and 1800 as the classical period of botany in Carniola. Scopoli came to Idrija in 1754 as the first mine physician and worked there till 1769. In addition to treating the local miners toiling in the mercury mine and falling ill from inhaling the vapours of native mercury, he researched flora and fauna, while extending his studies also to other fields. Besides exploring the surroundings of Idrija, he travelled extensively in the then Carniola. In 1760 Vienna saw the publication of the first volume of his

work *Flora Carniolica*, in Latin, embracing 1000 species of higher and lower plants (Petkovšek, 1960, 1977). In 1772 the first part was followed by a second two-volume publication where he already uses binary nomenclature. In this work he described already 1277 higher plants and ferns from this area (Scopoli, 1772).

The period between 1760 and 1775 is marked by Scopoli's fairly intensive correspondence with the famous Swedish botanist Carl Linné. Scopoli sent him plants and their seeds so that the plants from the territory of Carniola (central part of present-day Slovenia) were described also in Linné's works. There exist thirteen letters sent to Scopoli by Linné (Soban, 2004).

In addition to Linné, Scopoli conducted a very widespread correspondence with other researchers: Adanson, Allioni, Arduino, Banks, Dolomieu, Fabricius, Gessner, Gleditsch, Gmelin, La Grange, Haller, N. de Jacquin, L. de Jussieu, Lapeirouse, Mygind, Seniber, Schaeffer, Schreber (Voss, 1884).

Franz Xaver Wulfen (1728-1805) was another botanist active in the territory of Slovenia, staying in Gorica in 1755 and 1761, and in Ljubljana from 1762 to 1763. During his stay in Slovenia he wandered through an important part of present-day western Slovenia (Praprotnik & Wraber 1998). He collaborated with Scopoli and later published his own works. In Ljubljana he met Jožef Erberg who was keenly interested in plants. He was mentor to Karl Zois and later also to Franc Hladnik. Both Zois and Hladnik sent him plants to Celovec to identify (Praprotnik & Wraber, 1988).

In 1766 Balthasar Hacquet (1739 or 1740-1815) was lured to Idrija by the very fame of Scopoli. Between 1773 and 1787 he worked also in Ljubljana. Like Scopoli, he was a very versatile scientist. He researched and collected plants for a herbarium collection and published the work *Plantae alpinae carniolicae* (1782) (Praprotnik, 2003a). Karel Zois (1756-1799) researched primarily Alpine flora. His botanic records and herbarium collection have survived (Praprotnik, 1998). D. H. Hoppe first visited Carniola in 1803 and came for another visit in 1816 (Praprotnik, 2001, 2003a).

After 1809 and 1810 Carniolan flora began to be seriously studied by Franc Hladnik (1773-1844), founder of the Ljubljana Botanic Garden. Accompanied by his pupil Andrej Fleischmann (1804-1867) he wandered all over Carniola. Not only his local flora (*Flora bochinensis*) but also his Flora of Carniola (*Flora carniolica*) remained in manuscript. In the latter he described 2492 taxa from this area (Praprotnik 1994, 2010). Like Scopoli, Hladnik maintained a lively correspondence with other botanists in Central Europe and also sent them botanic material. He provided W. D. J. Koch with plants for various editions of his *Synopsis Florae germanicae et helveticae* (1835-37, 1838, 1843-1845), and did the same for H.G.L. Reichenbach's *Flora Germanica excursoria* (1830-1832) and herbarium collection *Flora Germanica exsiccata* (1830-1845). With N. T. Host he shared numerous data for the latter's works *Salix* and *Flora austriaca*. He collaborated with M. Tommasini who, like Host, also visited Ljubljana (Voss, 1884; Praprotnik, 1994, 2010).

1844 saw the publication of Fleischmann's Survey of Carniolan Flora - *Übersicht der Flora Krains* in which Hladnik's pupil Fleischmann described the flora of the

territory. Another of Hladnik's pupils was also Žiga Graf (1801-1838). He researched Carniolan flora and described the flora of Ljubljana and Šmarna gora Mt. He collaborated with numerous botanists of his time (Praprotnik, 1993a)

In the meantime Henrik Freyer (1802-1866), also Hladnik's pupil and the first curator of the Carniolan Provincial Museum, was working on his own flora. He did not publish it though he had found and described some new species, among them the celebrated *Daphne blagayana*, which was displayed at the 1838 flower exhibition in Dresden and presented as a new and horticulturally extremely interesting species of Carniolan flora (Praprotnik, 2003b, 2004). In 1864 Carniola was visited by Anton Kerner (Voss, 1884).

After 1886 Carniolan flora became a major theme of research by Alfonz Paulin (1853-1942), the then head of the Ljubljana Botanic Garden. In addition to his other publications (Wraber, 2008), the most remarkable work of Alfonz Paulin is his Dry Herbarium Collection of Carniolan Flora, *Flora exsiccata carniolica*, in 20 centuriae with 2000 numbers in which he published as many different species and subspecies (Wraber, 1966). Besides publishing his own collection he collaborated in compiling Kern's herbarium collection *Flora exsiccata Austro-Hungarica*, Hayek's collection *Flora stiriaca exsiccata*, in the work *Flora der Sanntaler Alpen*, and also in Hegi's work *Illustrierte Flora von Mitteleuropa*. He wrote about twenty treatises published between 1895 and 1917, disclosing data on the newly discovered and rare species of Carniolan flora. (Petkovšek, 1934).

In the years 1912 and 1913 Julij Glowacki (1846-1915) published two volumes of the key Flora of Slovenian Provinces. The next Key for Determining Flowering Plants and Ferns, by Dr. Angela Piskernik, came out in 1941, to be followed by a revised and extended edition in 1951. In his 1952 List of Ferns and Flowering Plants of the Slovenian Territory Ernest Mayer (1920-2009) described all species and subspecies then known to be present in the Slovenian ethnic territory. Similar developments occurred in the subsequent years. The first edition of the determination key Small Flora of Slovenia was published in 1969, the revised editions following in 1984, 1999, and the latest in 2007. In the meantime two other works came out, Register flore Slovenije (Trpin & Vreš, 1995) / Register of Slovenian Flora / and Gradivo za Atlas flore Slovenije / Materials for the Atlas of Flora of Slovenia (Jogan et al. 2001), and beside these comprehensive works numerous articles by various authors, on individual species and specific areas of Slovenia.

Gabrijel Tomažič (1899-1977) was a phytocenologist and florist. He headed the Botanic Garden during World War II. Before, during and after the war he was engaged in the research of plant communities and Slovenian flora. After World War II Slovenia had a number of fine, now already deceased, botanists whose work made an important contribution to the knowledge and new discoveries in the field of Slovenian flora, as well as to the description of new species. Let me mention at least the most prominent among them. Maks Wraber (1905-1972) was engaged in phytocenology and botany. He divided Slovenia into four major phytogeographic regions: Alpine, Dinaric, sub-Pannonian, sub-Mediterranean, and two transitional

regions, pre-Dinaric and pre-Alpine. This division continues to be relevant and is still most widely used. Wraber was followed by Viktor Petkovšek (1908 – 1994) who published articles on Slovenian flora in various scientific and popular scientific journals. Beside the already-mentioned List of Ferns and Flowering Plants of the Slovenian Territory Ernest Mayer (1920- 2009), a professor of systematic botany and later a regular member of the Slovenian Academy of Sciences and Arts, authored numerous articles on single species of Slovenian flora and was a keen researcher of Balkan flora. Vinko Strgar (1928-1992), head of the Botanic Garden between 1967 and 1992 and author of articles on new species of Slovenian flora, specialized also in the use and breeding of plants for horticultural purposes. Ljerka Godicl (1930-2006) was an expert in Pannonian flora and rare and endangered species of the former Yugoslavia. But the author who published the largest number of papers on Slovenian flora in various scientific and popular scientific journals was Tone Wraber (1938 - 2010). First a botany curator of the Slovenian Museum of Natural History, he later became a professor of systematic botany at the University of Ljubljana. He authored also a number of popular scientific books on Slovenian flora.

Slovenia lies at the crossroads of different influences. Its north western and central northern regions make part of the Alps, in the southwest it reaches into the sub-Mediterranean, while its north eastern and eastern parts belong to the sub-Pannonian region, and its south western and central southern parts to the Dinaric world. All of this endows Slovenia with a particular charm reflected in its plant diversity. The relatively small territory of 20 256 m² is home to 3452 species, 3119 of these autochthonous and naturalized (Martinčič et al., 2007). In addition to species and subspecies, there is an exceptionally high level of intraspecies diversity, which is often cursorily reported in many of the aforementioned works, but is particularly pointed out in more recent works written primarily by foreign horticultural experts who describe Slovenia as exceptionally diverse (Grey-Wilson, 2002; Gerritsen, 2008). This very intraspecies diversity is what makes Slovenian flora even richer than it may seem at the first sight.

Material and Methodology

I have been collecting the research material for the last 15 years, more intensively in the last decade. The plants which I brought from various parts of Slovenia stood apart from the standard descriptions of single species, or they were plants that made themselves conspicuous within their local populations.

I collected the species in different parts of Slovenia. It often happens that due to a short period bloom it takes several years to gain insight into the diversity of a particular species. Only then it is possible to start collecting specimens that distinguish themselves from the usual ones.

However, the very part of the year when a plant is transferred to garden conditions usually marks the height of its season. It is quite rare that after being collected, a species can be observed and compared in the garden already in the collection year: this usually occurs only when barely blooming specimens are collected, but that may not be entirely satisfactory since only a fully developed flower reveals

something about its characteristics. Further problems are associated with different years and the breeding of all the special features in culture, with each plant requiring specific conditions for optimal growth. The growth of these plants in garden beds or substitute habitats is normally unproblematic. However, if plants are to be monitored very closely, they have to be subject to a pot experiment where every pot is numbered and in the subsequent years the plants' outward appearance is duly watched. This, of course, implies much more work.

Before actually starting with collection in nature, I first took a walk around, carefully examining the surfaces where local populations were really dense. I immediately collected the most deviating specimens and made a selection of others only after surveying most of single local populations. Each specimen was first photographed in its growing site and then dug out. I put all specimens from the same habitat in one bag, adding some soil and water, if necessary, and took them to the Botanic Garden. Each single plant was described and planted into a mixture of compost and leaf mold, using rectangular plastic pots (10 x 10 cm to 14x 14 m) which I simply placed on a foil which prevented weed growth. Thus, the only weeds that need to be removed are just those on the surface of pots. I watered the plants to keep them green as long as possible. I harvested the seeds from all the seeding plants and later sowed them. Over the year the pots were watered only in the very dry part of the season and shaded to prevent excessive drying. At the end of the following winter when the plants burst into bloom once again, I examined each pot, recorded its special features and compared them with the original record. I also took yearly photos of all interesting specimens so as to ensure a less subjective comparison between single years. I checked the stability of special characters at intervals of several years. In describing new varieties I adhered to the rules for describing new varieties as laid down by the international standards (Brickell et al. 2004, 2009).

Results

Galanthus nivalis L.

The largest collection revealing the diversity of a single species is that of *Galanthus nivalis* L.. With regard to the works published to date (Bavcon & Marinček, 2004; Bavcon 2007, 2008), diversities can be divided into groups allowing an easier mutual comparison. These are:

- Flower shape and size, and number of flowers of a plant as a whole,
- Shape of outer and inner perianth segments,
- Number of outer and inner perianth segments,
- Green markings of outer perianth segments,
- Pattern of inner perianth segments (shape, colour),
- Shape and colour of ovary,
- Spathe (shape and size), extra bracts and
- Leaves (number, width, colour).

A number of new special features have meanwhile been found within these groups, but they would require a more in-depth study. I shall therefore limit myself to some data

that need to be added to the previously established facts and their critical examination. The increased number of collection specimens, particularly a larger number of specimens for single groups, showed that the forms that had been reported in the work as unstable or as merely resulting from ecological factors can be stable as well. What we need is a sufficient number of specimens of a specific anomaly, in which case any such change may also be stable, meaning that we are dealing with a mutation and not an impact of environmental issues. This is illustrated by the specimen with a bigeniculate flower stem that in 2007 (published in 2008) that I still described as unstable, and yet, a type found among the new specimens has been maintaining the same characteristics for the last four years – meaning that the original statement is not valid and that it is only correct to state that all we need is a sufficient number of single anomalies from among which a stable mutant for that form will emerge.

Leucojum vernum L.

The local populations of *Leucojum vernum* are no less abundant than those of common snowdrop. In some localities the growing sites overlap but in most cases they merely border one another. Although, compared with the species *G. Nivalis*, this species reaches into and occupies extreme habitat types, growing in completely swampy habitats as well as on steep calcareous slopes provided with sufficient humus, appearing from lowlands to higher levels, and also deeper in the Alpine world, the intraspecific diversity of *Leucojum vernum* in Slovenia is significantly less than *G. Nivalis*. Based on my longtime observation in nature and in culture, I suggest the following division into two types:

- Yellow-tipped - with yellow-coloured tips of the perianth segments;
- Green-tipped - with green-coloured tips of the perianth segments.

The characteristic feature of these two types is that the yellow-tipped prevail in local populations growing at higher locations. In these locations faintly greenish green-tipped specimens appear very rarely. The green-tipped - particularly those in dark green - are characteristic of lowland swamp forests and also lower, likewise swampy areas. The yellow-tipped specimens can be found here as well, however, the type with yellow-tipped perianth segments is very rare.

Between these two types a range of variations can be observed with regard to the yellow or green coloration, its intensity, the shape of perianth segments. Perianth segments may differ in shape; some are very broad and fully overlapping, others are more or less protruding and usually narrower.

In the course of my ten-year monitoring a number of particularly interesting features have emerged. Among these I describe a type in which the tips of the perianth segments reveal more of the green markings than is usual in the specimens of this species. Adhering to the rules for denomination of new plant varieties (Brickell et al., 2004, 2009), I hereafter describe this green-tipped group type as a potentially new variety:

L. vernum '**Kamna Gorica**' differs from giant common snowdrop in that its perianth segments maintain a green-yellow coloration fairly deep into the interior of

the perianths. Normally, just the tips of the perianth segments are green whereas in this variety the flower as whole creates an impression of a green-yellow coloration. The green-yellow markings reach as far as a half or even more than a half of the perianth segments.



It is named after the locality of Kamna Gorica where the first specimen of this kind was found. I later found similar specimens in three other locations in Slovenia. Other diversities, namely multiple flowers on the same stem, flower size, spreading of perianth segments, such as most usually appearing in single populations are not always stable. In certain populations the incidence of two or three flowers on the same flower stem is higher and in some places there is a well-balanced phenomenon of biflorous and uniflorous specimens, but in garden culture these characteristics will not maintain themselves equally well, or they appear alternately, one year the plants are uniflorous, the subsequent year some of them are again biflorous.

Crocus reticulatus Steven ex Adam and Its Hybrids

Another research topic is the genus *Crocus* L.. In Slovenia it is represented by four species or subspecies, depending on how they are ranked. There is a high level of intraspecies diversity among them (Bavcon, 2010). In the present paper new findings are reported, as yet unpublished in the mentioned works. Last year and in the course of the present year, in an area notable for its presence of *C. reticulatus*, I found, for the very first time in Slovenia, white-flowered specimens of this species in which the throat and part of outer perigon leaves are yellow. Until then I had come across such specimens only in the environs of Zgonik in Italy. New findings are recorded in some



locations around Tomaj and Komen in the Slovenian Karst area. The specimens are stable, providing an image entirely different from the usual species. Once the plant is dug out, we can see that the corm is enveloped in a characteristic reticulate tunic.

The previously mentioned work on crocuses (Bavcon, 2010) does not yet include description of the specimens of hybrids between the species *C. vernus* subsp. *vernus* x *C. reticulatus*. After several years of field work I finally hit upon the first specimens growing around sinkhole edges in the environs of Tomaj, once again in the Karst area. These specimens differ from both respective species and reveal intermediate characteristics. They bloom earlier than the subspecies *C. vernus* subsp. *vernus*, i.e. at the time of the optimal blooming of the species *C. reticulatus*. Ecologically speaking, they grow on the margins of the habitats of both species. In Karst *C. vernus* subsp. *vernus* thrives in sinkholes in very shady and damp positions often overgrown with shrubs, whereas *C. reticulatus* grows in dry karst meadows spreading away from sinkholes, out in the open and in sun-exposed positions. The hybrids always appear only around the edges of sinkholes. They look like *C. vernus* subsp. *vernus*, only the coloration of their throat is more yellowish, the perianth segments still show slight stripes, particularly if the plant is viewed against the light. The corms are smaller than those of both mentioned species, but they are more similar to the subspecies *C. vernus* subsp. *vernus* than the species *C. reticulatus*. Similarly as in the case of *C. vernus* subsp. *vernus* and *C. vernus* subsp. *albiflorus* where the hybrids have intermediate characteristics (Bavcon, 2010), the same is seen also with these hybrids. All of them have smaller corms, the tunic resembles that of the subspecies *C. vernus* subsp. *vernus*. With respect to their size, they are closer to the species *C. vernus* subsp. *vernus* than *C. reticulatus* where the specimens are usually smaller. The hybrids have smaller flowers.

Narcissus poeticus L. subsp. *radiiflorus* (Salisb.) Baker

In Slovenia poet's narcissus (*Narcissus poeticus* subsp. *radiiflorus*) is best known in connection with Golica or the mountain meadows above Jesenice, in the Karavanken Mts., where it is present in very large numbers (Praprotnik, 1993b,c). As its local populations are most abundant, a similar diversity would be expected as with *G. nivalis*. Contrary to the expectations, the research carried out on the local populations revealed relatively low levels of diversity. Among these rich populations single specimens can be found, standing apart from the usual ones, but they rarely prove stable in garden culture. Local populations in other parts of Slovenia where poet's narcissus is known to grow are less abundant, yet the established diversity levels are higher. The Karst narcissi are a little lower as a result of sharper Karst environment, less soil and less humidity, the temperatures are higher so narcissi bloom earlier. Considering the abundance of the local populations, poet's narcissus would be expected to be as diverse as *G. nivalis* but the results show hardly any diversity at all. After several years of work I at last found some specimens distinguishing themselves from the usual plants. Single specimens have two or three flowers on a common stem. One finds also such with six, even seven or eight perianth segments, or specimens with a double number of perianth segments. Few, however, prove stable in culture - "stable" meaning that a certain property is hereditarily

transmissible. Beside the usual specimens these populations include also such with six, even seven or eight perianth segments, or specimens with a double number of perianth segments. The stability of such specimens brought from different parts of Slovenia and studied in the Garden culture has proven very low. Very rarely does a specimen preserve such properties. Proceeding from my own long-year observation of narcissus specimens in nature and the Botanic Garden, I herewith propose a division into two basic types that remain unchanged also after several years in culture:

- Star-shaped - the perianth segments are broader, usually shorter, more triangular at the tips, overlapping one another.
- Windmill-shaped - the perianth segments are narrow, long, not overlapping or touching one another, with empty space in between.

Among the specimens collected in the Karst area, having very narrow, greenish coloured, windmill-type perianth segments, one specimen raised in culture preserved the same characteristics which became even more pronounced in culture, so following the rules for denomination of new plant varieties (Brickell et al., 2004, 2009) I hereafter describe it as a potentially new variety:

- *N. poeticus* subsp. *radiiflorus* 'Kras': This variety is characterized by very narrow perianth segments, the flower produces a windmill-like impression. Compared with others which before unfolding the flowers have yellow-green perianth segments that subsequently turn white, the perianth segments of this variety preserve their green colour also when the plant is in full bloom. The hypanthial tube has two bigger, curved leaves in yellowish-green, protruding out of the usual circle. Both the mother plant and the specimens obtained by corm division preserve the described characteristics also after several years in cultivation.

Numerous specimens showing similar faintly yellow-green coloured signs after unfolding their flowers, failed to reproduce these characteristics in culture.

Discussion

Galanthus nivalis

The natural distribution of the species extends from the Pyrenees in the west to western Ukraine in the east. It does not grow more to the north than Paris. In the south it does not reach Asia Minor but is present in the European part of Turkey (Davis, 1999). The diversity of the species within the said area follows also from some old drawings with pre-Linnean names (Basilius, 1613). The denomination of the two species remained also when binominal nomenclature began to be used (Davis, 1999). In the 19th and the 20th centuries numerous other names were used for different varieties which the authors described as independent species, but as reported by Davis (1999), these were later found to merely express the intraspecific diversity. All of these statements point to the diversity within the species, which may explain an ever present tendency to find a new species within the known one. Slovenia is home to just one species of the genus *Galanthus*, i.e. *G. nivalis* (Martinčič et al., 2007). As no other species is present in Slovenia, all aspects of diversity are bound to this one species only. Thus, there is

no chance of hybrids. Surprisingly, *G. nivalis* alone has been planted in the Slovenian gardens whereas other representatives of native flora have only exceptionally found their place there. Considering the outstandingly vast populations of common snowdrop that colours groves, meadows and forests literally white, the chances of finding special features are much higher. Although literature refers to numerous varieties, and while in addition to the 18 natural species and subspecies every year new varieties are found in gardens and further varieties bred from them (Brickell, 1996; Bishop et al., 2001; Mcardle, 2002; Klein, 2006; Leslie, 2007; Hobbs, 2007; Baxendale 2007; Sanham 2008), numerous new ones have been discovered within the abundant local populations in Slovenia. This supports the hypothesis that as a result of the great diversity in Slovenia of various aforementioned influences and the extraordinary diversity of Slovenian flora, there exist high levels of intraspecific diversity. This is particularly so with such species that count as diverse *per se*. Some of this was reported in various shorter texts (Prelec, 1994; Merljak, 1995; Rešetič, 1995; Slatner, 2007), but no comprehensive research had been done on this topic in Slovenia. It was only a systematic collection of research material from the entire territory of Slovenia that enabled a more in-depth examination which revealed that, in spite of extremely abundant local populations, diversity levels differ. Some populations are completely uniform, in others single deviations can be spotted more easily. Generally speaking, the highest levels of diversity are observed in transitional areas occupying the meeting points of different influences, e.g. Alpine and sub-Mediterranean areas with their mineral diversity, on the margins of different habitats, on transitions from meadow to forest, from acidic to alkaline substrates or in most extreme habitats such as growing sites along the coast where the habitats actually look like maquis. Although *G. nivalis* is not supposed to grow there (Davis, 1999), in Slovenia it is present also in such habitats where it usually begins to bloom already in the first days of January. Irrespective of the first conclusions (Bavcon & Marinček, 2004), namely, that single diversities can be divided into three groups, stable, less stable and unstable, I am now, after more than ten years of research, in a position to confirm that any, even an apparently improbable form, can be stable, if only it is found in several repetitions, meaning that there is a greater chance that at least one of them is already stable. Bearing in mind the diversity within the genus *Galanthus* (Davis, 1999; Bishop et al., 2001) and after long years of studying *G. nivalis* in Slovenia, I herewith put forward the thesis that within a single species in different varieties appearing in Slovenia, diversity emerges in the floral region as known for all described 18 species (Davis, 1999). The question is primarily of a pattern appearing on the inner circle of the perianth segments which are characteristic of each individual species and more or less repeat themselves also in the above described varieties that I present for Slovenia (Bavcon, 2008).

Crocus reticulatus and Its Hybrids

C. reticulatus is known to be distributed in the sub-Mediterranean region of Slovenia (Martinčič et al., 1969, 2007). It grows in karst meadows, less so in forests, from the lowest areas to the montane zone. Its corm is wrapped into a reticulate

tunic. It has white or delicately lilac perianth segments with pronounced dark purple stripes (Martinčič et al., 2007). Some other varieties have also been known for a long time. Herbert reports already in 1847 a yellow, a faintly purple and a white varieties in connection with the Slovenian border area. He adds that he came upon pale purple specimens near Lipica, Slovenia, and in Monte Spaccato (Gabrov hrib Mt) near Trieste. He also affirms that here one finds only specimens with pronounced stripes, in contrast to those from the Trieste area which are white. He says that the seeds of the latter are different, that he sowed the specimens and attempted to cross-breed them but failed to complete the work prior to the publication of his work. It was in the environs of Zgonik near Trieste where *C. weldenii* (Wraber, 1990), which is white or faintly flushed with purple, grows naturally, that I found, in 1998, the first specimens of striped crocus which I had long failed to find in Slovenia. To be reliably determined, the plant has to be dug out to examine the corm since the white variety of striped crocus also has a markedly reticulate tunic. In the course of my long research I had not found any yellow-white varieties in Slovenia. But last year I came across such varieties as described by Herbert (1847), i.e. white with a pronounced yellow colouring in the throat, also in Slovenia, in two separate locations in the environs of Tomaj, i.e. in the sub-Mediterranean phyto-geographic region. In both locations the specimens of the white variety notable for the yellowness of its throat are relatively close together; in terms of varieties which in other species usually appear individually, they are surprisingly numerous, i.e. a number of them together on some square meters. Both locations have a perfectly natural character free of any potentially possible human influence – planting of various cultivated varieties. A larger number of specimens within a few square meters points to a high probability that the mentioned variety can propagate also by seed. This still needs to be confirmed in the years to come.

According to Mathew (1982), hybrids are rare, which applies also to gardens with a large number of different species. All of this points to the genetic stability of single species and powerful obstacles to the occurrence of hybrids. Mathew reports that of his 45 attempts at cross-breeding different species, only one specimen developed fertile seeds, meaning that it was successful. Mathew (1982) adds that in his experience dissimilar species, or better said, not closely similar species, do not cross-breed easily in spite of having the same number of chromosomes. Vice-versa, morphologically similar species cross-breed easily although they have a different number of chromosomes. Judging by cytological analyses, hybrids occur rarely among crocuses. In his analysis of the genus *Crocus* in the former Yugoslavia, Pulević reports that hybrids are in fact very rare. Hybrids are referred to also by older authors from this area, i.e. Nicić (1892) and Adamović (1908), and later on also Randjelović et al., 1990. They cite some hybrids for Slovenia which are documented or even described under other names. Pulević (1976) cites *C. x fritschii*, which Derganc found near the old castle in Ljubljana (Derganc, 1897). Poschinger (1973) reports hybrids for Austrian Carinthia. I found such a hybrid between *C. vernus* subsp. *vernus* and *C. vernus* subsp. *albiflorus*, in a few locations (Bavcon, 2010) where they are present in very small numbers. All along my ten-year research I had never come upon hybrids between *C. reticulatus* and *C. vernus*

subsp. *vernus*, which frequently appear together in the sub-Mediterranean region, above all in cooler parts of Karst such as sinkholes. It was only this year that I found hybrids between the two species in one of the locations around Komen where also *C. weldenii* (Tommasini, 1844; Koch, 1844 according to Dakskobler & Wraber, 2008) allegedly grows but has not been seen ever since the first finding. *C. reticulatus* typically grows in warm and dry karst meadows whereas the characteristic growing sites of *C. vernus* subsp. *vernus* in Karst occupy sinkhole bottoms or cooler and shady valleys but never sun-exposed sites, at least not so at lower positions. I found hybrids in one of such sinkholes possessing all of the described characteristics. Although I had searched for them in many sinkholes, it was not until then that I finally got lucky. I may have missed the time of their bloom, which is more than likely with plants like crocuses as they bloom a relatively short time. It is true, however, that my very first examination of the sinkhole, taking place still in the winter season, revealed characteristics of transitions all of which were potential indicators for the presence of hybrids. After two disappointing visits in February, my third visit was a success: I found the first hybrids on the edge of the sinkhole. They appear at the very transition from a still mesophilic to a perfectly thermophilic habitat. There were several hybrids. They distinguished themselves from the first, otherwise rare specimens of *C. vernus* subsp. *vernus* in a different coloration of the throat and slightly smaller flowers, and from *C. reticulatus* in the coloration of the perianth segments. Once dug out, the plants clearly proved to be hybrids. All specimens had smaller corms wrapped in a tunic similar to that of *C. vernus* subsp. *vernus*. The flower throat was faintly yellow-purple while the perianth segments had barely visible stripes similarly as in *C. reticulatus*, i.e. something that would be unusual in *C. vernus* subsp. *vernus*. The hybrids had already unfolded, *C. reticulatus* was already past its optimal bloom while only single specimens of *C. vernus* subsp. *vernus* were beginning to bloom or were on the point of pushing their way out of the ground. Speaking in terms of habitat conditions as well as morphologically and phenologically, we are dealing with intermediate specimens showing transitions from one species to the other. With regard to my long search and the findings of numerous authors (Maw, 1886; Bowles, 1952; Mathew, 1982), I can only confirm that the hybrids between the species are rare but they do exist. Bearing in mind the character of hybrids where fertility is low also in other species, I do not expect these hybrids to develop fertile seeds – or at least the chances of this happening are very small.

Leucojum vernum

Although *L. vernum* has a very wide distribution area in Europe, extending from Spain to Romania and as far as western Russia (Webb, 1980), literature describes it as less diverse (Grimshav et al., 2007). Reference is most often made to two varieties, namely *L. vernum* var. *carpathicum* and *L. vernum* var. *wagneri* (Grimshaw et al., 2007). In connection of the genus *Leucojum* recent sources likewise cite only two species, *L. vernum* and *L. aestivum*, whereas all the other species that used to make part of this genus which counted 10 species are mostly being transferred to the new genus *Acis* (Lledó et al., 2004; Grimshaw, 2006).

Beside these two varieties of *L. vernalis* some others are known, among them *Leucojum vernalis* 'Gertrude Wister' that has doubled perianth segments. Grimshaw et al. (2007) indicate the possibility of some other new varieties, but they too affirm that their diversity is not comparable to that of the genus *Galanthus* and its varieties. If natural diversity alone were more pronounced, it would find expression in a significantly larger number of forms which in horticulture are usually treated as new varieties. One of the reasons for lesser diversity may lie in that in this species all perianth segments are of the same size and that there is no division into the inner and the outer circles, as this is the case with the genus *Galanthus*. Furthermore, the presence of just two species, *L. vernalis* and *L. aestivum*, also indicates a weaker potential of this genus, if newer findings on the taxonomy of this genus are to be taken into consideration. Similarly as the species *L. vernalis*, also the species *L. aestivum* reveals no particularly important intraspecific diversity (Grimshaw, 2008), which is once again reflected in a smaller number of varieties, irrespective of *L. aestivum* having been cultivated in gardens for the last 400 years. Regarding the number of specimens in single local populations, the species *L. vernalis* and *G. nivalis* do not differ greatly since wherever they appear side by side they are both present in very large numbers. Numerical diversity therefore enables equal possibilities for the occurrence of mutations. It would seem, however, that this species has in fact a weaker diversity potential, meaning that it is more uniform, since the research in Slovenia over an even longer period than that dedicated to *G. nivalis* reveals very low diversity levels in the specimens that distinguish themselves from the general description, and even these have poor stability in culture. This is why over all these years one single special feature has proved to digress sufficiently from the standard description, thus having a chance to be identified as a new variety. Following the relevant denomination rules (Brickel et al., 2004, 2009), I describe it as *L. vernalis* 'Kamna Gorica'.

Narcissus poeticus subsp. *radiiflorus*

In some areas of the Golica mountain range and mountain meadows above Jesenice, respectively, *Narcissus poeticus* subsp. *radiiflorus* is present in such enormous numbers that it colours green surfaces completely white (Praprotnik, 1993b, c), but the populations we find there are highly uniform. All of them are white, only when the flowers are unfolding one catches an impression of a faint yellow-green coloration which subsequently disappears. Irrespective of the outstanding uniformity of these populations, they include also specimens with six up to nine perianth segments, but as stated before, not all of such specimens are completely stable. However, a fine distinction can be made between two basic flower types, the star-shaped and the windmill-shaped, both of which can be observed in the populations. In Slovenia a distinction used to be made between the narcissus from Golica, *Narcissus radiiflorus*, i.e. poet's narcissus, and the narcissus from other parts of Slovenia, i.e. *Narcissus stellaris* – Prekmurje narcissus (Piskernik, 1941), (In A. Piskernik (1951) refers to poet's narcissus as *Narcissus angustifolius*) but they were later found to be the same species just slightly different in another environment (Mayer, 1952; Martinčič et al.,

1969, 2007). While completely similar to the latter, the narcissi of Karst and Slovenian Istria are in fact a little lower as a result of somewhat drier habitat conditions, a thinner layer of soil than on the mountain meadows above Jesenice where precipitation is more abundant than in the Mediterranean part where the species is also present, for with



the exception of the pre-Dinaric world it grows in all other phyto-geographic regions (Martinčič et al., 2007). Similarly as in the case of the species *G. nivalis* often revealing higher diversity levels in extreme habitat conditions than in meadows and groves which it literally covers in white in much the same way as *N. poeticus* subsp. *radiiflorus* in Golica Mt, the diversity of the latter is higher in the sub-Mediterranean where some more intraspecies diversity is observed, though still relatively low in comparison to the species *G. nivalis*. The genus *Narcissus* is known for its wide diversity, with more than 25 000 varieties having been cultivated from the natural species (daffodil.org, 2011), and among these *N. poeticus* is one of the groups dividing all of these varieties into several groups. Irrespective of the fact that just one species grows naturally in Slovenia while all the others have run wild, similar levels of diversity could be expected as with *G. nivalis*, but the actual situation is quite the opposite. The reason might be associated with the fact that the Slovenian area of *G. nivalis* lies closer to the center of the area of the species than this is true of *N. poeticus* whose distribution is narrower (France, Switzerland, Italy, Slovenia) (Brickell et al., 1996), with Slovenia lying close to the margins of distribution area of the aforementioned narcissus species. Intraspecies diversity of this species can nonetheless be observed also in local populations in Slovenia although it fails to meet the expectations based on its massive presence in various local populations in five out of six phyto-geographic regions.

References

- Adamović L. (1908). Flora jugoistočne Srbije. *Rad JAZU* 175(44), 206-207.
- Basilius B. (1613). *Hortus Eystettensis*, reprodukcija 2000 Benedikt Taschen Verlag GmbH, Köln.
- Bavcon J. and Marinček A. (2004). *Galanthus nivalis* in Slovenia and observed anomalies. In: Abstracts: *Botanic gardens: a world of resources and heritage for humankind*.
- Bavcon J. (2007). Snowdrop (*Galanthus nivalis* L.) and its phenotypic diversity in Slovenia = *Acta biol. Slov.* 50 (1), 53-58.
- Bavcon J. (2008). Common snowdrop (*Galanthus nivalis* L.) and its diversity in Slovenia. Ljubljana: Biotehniška fakulteta, *Oddelek za biologijo*, 94.
- Bavcon J. (2010). *Žafrani (Crocus L.) v Sloveniji = Crocus (Crocus L.) in Slovenia*. Ljubljana: Botanični vrt, Oddelek za biologijo, Biotehniška fakulteta, 2010, 176.
- Baxendale M. (2007). *Breeding New Snowdrops Cultivars, Daffodils snowdrops and tulips Yearbook 2007- 2008*, RHS 2007, 56-60.
- Bishop, M., Davis, A., Grimshaw, J. (2001). *Snowdrops, A Monograph of Cultivated Galanthus*. The Griffin Press, UK, 361.
- Bowles, E. A. (1952). *A Handbook of Crocus & Colchicum for Gardeners*. Revised edition. London, 213.
- Brickell, C. (1996). *A-Z Encyclopedia of Garden Plants*. Dorling Kindersley, London, New York, Stuttgart, Moscow, 1080.
- Brickell, C.D. et al. (2009). *International Code of Nomenclature for Cultivated Plants*. Eight edition, 184.
- Brickell, C.D., Baum, B.R., Hettterscheid, W.L.A., Leslie, A.C., McNeill, J., Trehane, P., Vrugtman, F., Wiersema, J.H. (2004). *International Code of Nomenclature for Cultivated Plants*. Seventh edition, 123.
- Dakskobler, I. and Wraber T. (2008). *Crocus biflorus* Mill. (Iridaceae) - A new species in the flora of Slovenia. *Razprave IV razred SAZU XLIX*, 165-205.
- Davis, A. P. (1999). (Reprint 2000): *The Genus Galanthus. A Botanical Magazine Monograph*. The Royal Botanic Gardens, Kew, in association with Timber Press, 297.
- Derganc, L. (1897). Ueber zwei vielverkannte Crocus- arten der Krainer Florra *Österreichische botanische Zeitschrift*. 47, 16-18.
- Gerritsen, H. (2008). *Essay on Gardening*. Architectura & Nature Press.
- Glowacki, J. (1912-1913). *Flora slovenskih dežel*. Slovenska Šolska Matica, Ljubljana.
- Gosar, M. and Petkovšek, V. (1982). Naravoslovci na Slovenskem (Prispevek o njihovem delu in prizadevanjih od začetka 15 stoletja do ustanovitve Univerze v Ljubljani leta 1919). *Scopolia No 5*, 1-38. Ljubljana dec.
- Grey-Wilson, C. (2002). *Cyclamen: A guide for Gardeners, Horticulturists and Botanists*. New edition. B T Batsford, London. 224.
- Grimshaw, J. M. (2008). Variation in *Leucojum aestivum*. *The Plantsman*, March, 50-54.
- Grimshaw et al. (2007). Variation in *Leucojum Vernum*. *The Plantsman*, March, 38-43.
- Grimshaw, J. M. (2006). A flurry of snowflakes. *The Plantsman* n.s. 5 (1), 2-25
- Herbert, W. (1847). A history of the species of *Crocus*. *Hort. Soc. London 2*, 249-293.
- Hobbs, R. (2007). *Heyrick Anthony Greatorex: his Snowdrops and his legacy, Daffodils snowdrops and tulips Yearbook 2007- 2008*, RHS 2007, 52-56.
- <http://www.daffodil.org/daffodil/classdefs.htm>
- Jogan N., T. Bačič, B. Frajman, I. Leskovar, D. Naglič, A. Podobnik, B. Rozman, S. Strgulc Krajšek & B. Trčak (2001). *Gradivo za Atlas flore Slovenije*. Center za kartografijo favne in flore, Miklavž na Dravskem Polju pp.
- Klein C. (2006). Mrs Snowdrop. Veronica Cross has a passion for *Galanthus*. *Gardens Illustrated*, February: 22-28.
- Leslie A. (2007). *Snowdrops at the RHS Shows, Daffodils snowdrops and tulips Yearbook 2007- 2008*, RHS 2007 pp. 94-97
- Lledó Ma., D. Davis, AP. Crespo, MB. Chase, MW & Fay, MF (2004). Phylogenetic analysis of *Leucojum* and *Galanthus (Amaryllidaceae)* based on plastid matK and nuclear ribosomal spacer (ITS) DNA sequences and morphology. *Plant Syst. Evol.* 246: 223-243
- Martinčič A & Sušnik F. (1969). *Mala flora Slovenije*. Cankarjeva založba, Ljubljana
- Martinčič A. & F. Sušnik (1984). *Mala flora Slovenije*. Cankarjeva založba. Ljubljana, 2. izdaja. 515 pp.

- Martinčič A., T. Wraber T, N. Jogan, V. Ravnik, A. Podobnik, B. Turk, B. Vreš. (1999). *Mala flora Slovenije. Ključ za določanje praprotnic in semenk*. Tehniška založba Slovenije, Ljubljana, 845 pp.
- Martinčič A., T. Wraber T, N. Jogan, A. Podobnik, B. Turk, B. Vreš, V. Ravnik, B. Frajman, S. Strgulc Krajšek, B. Trčak, T. Bačič, M. Fisher, K. Eler., B. Surina (2007). *Mala flora Slovenije. Ključ za določanje praprotnic in semenk*. Tehniška založba Slovenije, Ljubljana, 967 pp.
- Maw G. (1886). *A Monograph of the Genus Crocus*. Dulau & Co. London 326 pp.
- Mayer E. (1952). *Seznam praprotnic in cvetnic slovenskega ozemlja*. Slovenska akademija znanosti in umetnosti, Razred za prirodoslovne in medicinske vede, Inštitut za biologijo, Ljubljana: 427 pp.
- McArdle C. (2002). The legacy of Lambrook Manor. *The Garden* 127 (1): 18-23.
- Nicić DJ. (1892). *Jedan priložak za Floru Kraljevine Srbije* Beograd.
- Merljak, K. (1995). Presenečenje v spomladanskem šopku. *Proteus*: 57 (9-10): 402.
- Petkovšek V. (1934). Alfonz Paulin. *Proteus* 1 (1): 14–16. Prirodoslovno društvo Slovenije, Ljubljana.
- Petkovšek V. (1960). *Začetki botanične vede pri Slovencih*. Zbornik ob 150 letnici botaničnega vrta v Ljubljani., pp. 11-23.
- Petkovšek V. (1967). Ob štiristoletnici florističnih prizadevanj predhodnikov I. A. Scopolija. *Biološki vestnik* 15: 51-62.
- Petkovšek V. (1977). *J. A. Scopoli, njegovo življenje in delo v slovenskem prostoru*. Slovenska akademija znanosti in umetnosti. Razred za prirodoslovne vede. Razprave 20/2: 1-104.
- Piskernik A. (1941, 1951). *Ključ za določanje cvetnic in praprotnic.1* in 2 izdaja Ljubljana, 253 pp.
- Poschinger D. (1973). Über die Verbreitung von *Crocus napolitanus* Mord. Et Loisel. In *Kärnten. Carinthia II* 163(83): 463-466.
- Praprotnik N. & T. Wraber (1998). *Prispevek Franca Ksaverja Wulfena k poznavanju semenk Slovenije*. Separatum ex: Jezuitski kolegij v Ljubljani 1597 – 1773. Zbornik razprav, Ljubljana pp. 111- 112.
- Praprotnik N. (1988). Botanik Karel Zois. *Proteus* 51 pp. 83-89.
- Praprotnik N. (1993a). *Florist in vrtnar Andrej Felischmann (1804 – 1867)*. Zbornik za zgodovino naravoslovja in tehnike Slovenska matica v Ljubljani 12 pp. 63-93.
- Praprotnik N. (1993b). Karavanske ključavnice. *Planin. vestn.*, 93 (5): 215-219.
- Praprotnik N. (1993c). Rastišča zapeljivih ključavnic. *Planin. vestn.*, 93 (6): 260-262.
- Praprotnik N. (1994). Botanik Franc Hladnik (1773–1844). Ob 150-letnici smrti. *Proteus* 57 (3): 94–99. Prirodoslovno društvo Slovenije, Ljubljana.
- Praprotnik N. (2001). *Balthasar Hacquet in njegovo botanično delovanje na Kranjskem*. Razprave IV razreda SAZU, XLII-2 4/ 173-185.
- Praprotnik N. (2003a). Baltahsar Hacquet in njegovo botanično delovanje na Kranjskem. *Hacquetia* 2/2: 85- 92.
- Praprotnik N. (2003b). Ob 200. obletnici rojstava Henrika Freyerja (1802 – 1866). *Argo, Journal of the Slovene Museums* 46/ 1:15-22.
- Praprotnik N. (2004). Botanični vrt Karla Zoisa na Brdu. *Kronika* 52: 167–174.
- Praprotnik N. (2010): Franc Hladnik, “ilirskih rož vertnar” = Franc Hladnik, “jardinier des fleurs illyriennes”. V: Dular, A. (ur.), Podpečnik, J. (ur.), Šumrada, J. (ur.). Pod Napoleonovim orlom. 200 let ustanovitve Ilirskih provinc. Narodni muzej Slovenije. Str. 230-237.
- Prelec. M. (1994). Nenavaden zvonček. *Proteus* 56 (9): 347.
- Pulević V. (1976). *Revizija genusa Crocus L. u Jugoslaviji*. Doktorska disertacija. Ljubljana- Titograd. 129 pp.
- Pulević V. (1977). A contribution to the knowledge of taxonomy and horology of some species of genus *Crocus* L. from Yugoslavia. *Glas. Rep. Zavod. za zaščitu Prirode- Prirodn. Muzej Titograd* 10: 81- 99.
- Randjelović N, D. Hill & V. Randejlović (1990). *The genus Crocus L. in Serbia*. 52 pp.
- Rešetič M. (1995). Nenavadna trobentica in zvonček. *Proteus* 57/9-10:402.
- Sanham C. (2008). *Collecting Snowdrops - some observations, Daffodils snowdrops and tulips Yearbook 2007- 2008*, RHS 2007 pp. 57-59.
- Scopoli I. A. (1772). *Flora carniolica*. Impensis Ioannis Pavli Kravss, 448 pp.
- Slatner J. (2007). Mali zvonček (*Galanthus nivalis*). Marija Prelec Nov kultivar. *Welwitschia* 7 (1-4)/ 43–44.
- Soban D. (2004). *Joannes A. Scopoli – Carl Linnaeus Dopisovanje / correspondence 1760 – 1775*. Prirodoslovno društvo Slovenije, 349 pp.
- Trpin D. & B. Vreš (1995). *Register flore Slovenije. Praprotnice in cvetnice*. Znanstveno raziskovalni center SAZU, zbirka ZRC 7 Ljubljana.
- Voss W. (1884). *Versuch einer Geschichte der Botanik in Krain (1754–1883)*. I Hälfte Laibach.
- Webb, DA (1980). *Leucojum*. *Flora Europaea*. Vol. 5. Cambridge University Press, Cambridge
- Wraber T. (1966). *Paulinova »Flora exsiccata carniolica« XIX. in XX. centurija*. Razprave 4. razreda SAZU 9 (3): 125–164.
- Wraber T. (1990). *Sto znamenitih rastlin na Slovenskem*. Prešernova družba Ljubljana.
- Wraber T. (2002). *Henrik Freyer kot botanik*. In: Predin, Š. (uredn.), *Slovenski farmacevti v naravoslovju. Zbornik referatov s simpozija ob 200-letnici rojstva Henrika Freyerja (1802–1866) v Mariboru*, 14. 6. 2002: 105–140. Mariborske lekarne Maribor
- Wraber T. (2008). *Pisna zapuščina botanika Alfonza Paulina v biblioteki SAZU, SAZU, Sedemdeset let bibliotek slovenske akademije znanosti in umetnosti* pp. 199- 236.

ToL – IRL (Tree of Life – In Real Life)

Magnus Lidén

Author note

Magnus Lidén, Uppsala University Botanic Garden (Linnaean Gardens of Uppsala)
magnus.liden@botan.uu.se

Introduction

A systematic field is a standard feature of a botanic garden, but frequently fails to deliver its message, be it to the general public or to university students. When occasionally it is included as an educational instrument in a basic course, it requires interpretation and disclaimers. I believe some reasons for the failure are that the systematic quarter tries to achieve too much, too little and to make full use of all available space. So, what do we want it to do?

1. show plant diversity
2. show plant relationships (phylogeny)
3. indicate important evolutionary innovations
4. explain systematic biology and taxonomic categories

Some would consider it a plus if it could also convey the basics of a particular formal plant classification.

The Dahlgrenogram

The system builder Rolf Dahlgren (1975) devised the “Dahlgrenogram” (figure 1a), a graphic illustration of the plant kingdom with bubbles representing plant orders or super-orders organised in two dimensions, with supposedly related groups closer to each other, similar to some pre-Darwinian constructs. It was taken up by other authors, and was used for example to show the distribution of characters.

If the primary bubbles are joined by successively more inclusive closed curves or shapes as in an Euler-diagram (figure 1b), the model will be able to show more than one level in the hierarchy, and we would get a structure possible to interpret as a phylogeny; if not, the Dahlgrenogram will be able to communicate clearly only the first of our four desiderata.

The two-dimensional structure of the Dahlgrenogram makes it easy to realise in the garden. There are systematic fields of this kind, often hinting at more than one level in a phylogenetic or taxonomic hierarchy, in quite a few gardens: Bonn, Paris, Cambridge, Göteborg (figure 1c) and – up till now – Uppsala, to name but a few.

But even if laid out as an Euler-diagram with multiple levels, the evolutionary message of such an elaborate bubble wrap will not be translucent to the uninformed student.

Finally, one of the branches satisfies the fourth of our desiderata, that of explaining systematics and taxonomic categories. We have chosen the Centrosperms (or Caryophyllales) as an example, showing order, family and subfamily levels as you climb out on the branch – and eventually (in one of the leaves) genera and species.

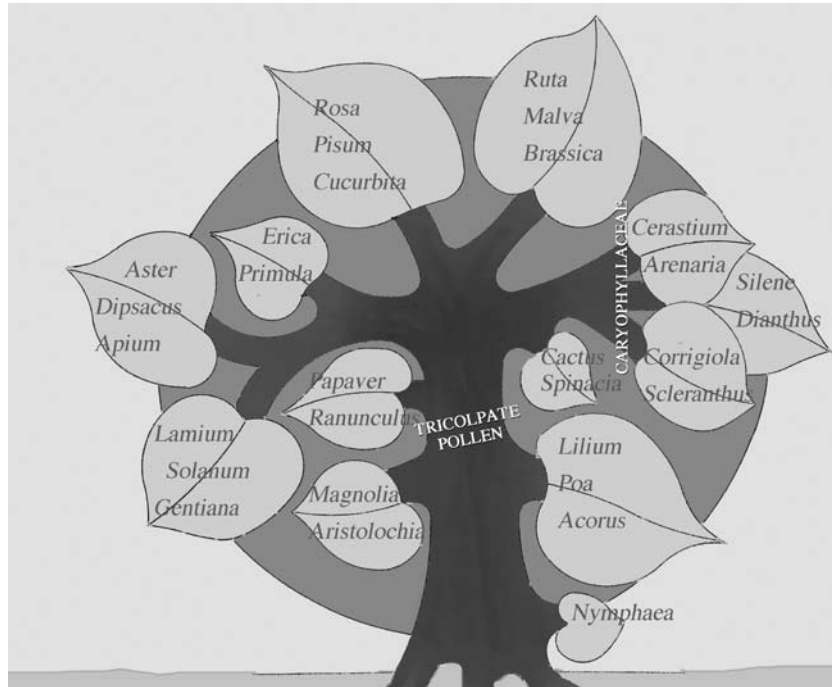


Figure 3: The new Uppsala tree, with a few examples of plants.

Acknowledgement

Annika Vinnersten (Uppsala University Botanic Garden) and I jointly sketched the master phylogeny. She also suggested several improvements to the text.

Mats Lindegren took our tree to the drawing board and made the complete design, from trunk to leaves and borders. Further, Mats will act as building master during the whole process. Uppsala University generously granted funding for this realisation of a long-held dream that finally is about to come true.

References

- Angiosperm Phylogeny Group (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* 161 (2), 105–121.
- Dahlgren, R. (1975). The distribution of characters within an angiosperm system. I. Some embryological characters. *Botaniska Notiser* 128, 181-197.

Green Katowice

General Information

Katowice is the most urbanised part of the Silesian conurbation, while as much as 41% of the city area is covered by forests. 7.5% is occupied by cultivated green areas, and 15% by agricultural land. Katowice has been placed first in the voivodeship and second in Poland as regards the size of its forest area. We have 6.6 thousand hectares of greenery constituting a shelter belt around the conurbation, countless tracks for walkers, nearly 100 kilometres of cycle routes and nature "right at your fingertips".

The Kłodnica and Ślepiotka Rivers flow through the central-western part of the city, including the Districts of Ligota, Piotrowice and Ochojec. The northern part of the city (i.e. the Districts of Tysiąclecie, Załęże, Koszutka, Wełnowiec, Bogucice, Zawodzie, Szopienice and the City Centre) is watered by the Rawa River, and the north-eastern part – by the Bolina River (the Districts of Giszowiec and Janów). The Mleczna River flows through the southern part of the city. There are also streams in Katowice, i.e.: the Leśny, the Kokociniec and the Ławecki.

The area of Katowice not only consists of the forest parks presented below, i.e.: Kościuszko Park, Katowice Forest Park, interesting recreational places such as Janina or Bolina, Murckowskie Forests, but also the floral reserve of Ochojec and the ecological site of Płone Bagno. The forests at Panewniki in the western part of Katowice are also of high recreational value and you can visit them using the cycle routes no. 2, 3 and 122.

In recent times, the number of interesting green areas intended for recreation has grown considerably – among others, a part of the Ślepiotka River basin and the



nearby Zadole Park in the District of Ligota have been modernised within the RE-URIS Project.

The Valley of Three Ponds

This part of Katowice Roman Stachoń Forest Park, gets its name from the number of ponds existing here in 19 c. Nowadays there are 11 water reservoirs located in the valley of the Leśny stream. This place is very popular among strollers, cyclists and skaters, as well as fishermen. The canoe rental attracts fans of water sports. There is a public bath with sandy beach, football fields, chess tables and ping-pong tables. The guests visiting "Silesia" Metropolis may stay at "Camping 215", consisting of outdoor swimming pool, tennis court and modern reception with gastronomic and sanitary facilities. The Valley of Three Ponds is also a perfect place to discover nature. There



are well preserved riparian and mixed forests, luxuriant and rich ground cover full of protected species such as yellow water lily (blooming water perennial). The biggest cultural events such as OFF Festival have been held in the valley for several years.

Tadeusz Kościuszko Park

This is the largest and the oldest park in the city. Today it extends over an area of 60 ha. The park was established at the end of the nineteenth century and replaced the little spinney located in that area. Nowadays the charming climate of the forest is created by exceptional flower-beds and natural old trees formed into the forest, occupied even by wild boar. There is also something for children and youth – winter chute, ski run and playgrounds. The park reveals also some history of II World War. The Parachute Tower, the only one in Poland, witnessed the desperate defense act

of Polish Scouts against German Army attack on the 4th of September 1939. The cemetery of Russian soldiers killed during the liberation of the city in 1945 is another historical monument of the past. The wooden church of Michael the Archangel from 1510 relocated from Rybnik Land in the 1930s is undoubtedly an interesting piece of historical architecture.

Murckowski Forest

This relic of the Silesian Wilderness – is a significant forest complex gladly visited by Katowice inhabitants who find here some peace and quiet away from the hustle and bustle of the city. Whoever is interested in active recreation can use foot paths, cycle paths or horseback riding paths. Although the wildlife comes always first and that is why the forest is full of deer, pine marten, wild boars and the variety of birds species. For the protection of animals two sanctuaries were designated: "Murckowski Forest" (about 102 ha) with 150-230 year old beech trees and oak trees from the end of the nineteenth century; „Ochojec" (about 27 ha), established to preserve White Twisted-stalk – the plant typical of mountain landscapes.

Back to Eden

Challenges for Contemporary Gardens

Katowice – Ustroń – Mikołów 21st – 23rd May 2011

BGCI/IABG European Botanic Gardens' Consortium 1st Semi-annual Meeting 2011 Program

May 20, 2011 (Friday)

Arrival in Katowice

Accommodation: Hotel "Qubus Prestige",
Katowice, Uniwersytecka Street 13 (4-star hotel, city center)

17:00 – 19:20 Sightseeing tour to Katowice.
Historic miners' settlements Giszowiec and Nikiszowiec

19:45 Departure from the hotel for dinner

20:15 – 23:00 Welcome dinner. Pub "Zielona Gęś" (Green Goose)
Katowice-Murcki, Bielska Street 2

Please note! Because of late arrivals the previously announced times of the bus departure for dinner were postponed and will be 1 hour later.

May 21, 2011 (Saturday)

7:00 – 8:30 Breakfast in the hotel "Qubus Prestige"
Participants are requested to check out from their rooms in the hotel after breakfast and leave luggage in the hotel storage room or take it to the university.
We will leave Katowice in the evening.

9:00 – 18:00 **Whole day European Botanic Gardens' Consortium Meeting according to the agenda**

1. Welcome
2. Apologies for absence.
3. Minutes of the last meeting.
4. Matters arising out of the Minutes.
5. Botanic gardens and GSPC Target 8 – reports on PlantSearch updating
6. IPEN (International Plant Exchange Network) progress and implementation and update on Nagoya Protocol
7. Update on invasive alien plants in EU

8. Pan-European seed list search
 9. Updating the Action Plan for Botanic Gardens in the European Union
 10. Plans for Eurogard VI
 11. Planta Europa
 12. Report from ENSCONET/ENSCRI
 13. Fund raising for the Consortium
 14. Matters arising from reports from National representatives
 15. Update on activities of IABG
 16. Update on activities of BGCI
 17. Update on recent developments on the Global Strategy for Plant Conservation
 18. Any other business
 19. Date and venue of the next meeting
 20. Conclusions and Close
- 10.30 – 11.00 Coffee break
- 13.00 – 14.00 Lunch
- 15.30 – 16.00 Coffee break
- Venue:** Silesian University, Building of Rectors Office, Main Aula, Katowice, Bankowa Street 12 (5 minutes walk from the hotel)
- 18:00 – 19:30 Travel by bus to Ustroń-Jaszowiec (distance 85 km)
Accommodation: Hotel "Jaskółka"
Ustroń-Jaszowiec, Zdrojowa Street 10
- 20.00 – 23.00 Barbecue joint party for the EBGC meeting participants and members of the Polish Botanic Gardens Network (Council of Botanical Gardens in Poland) Regional Center for Ecological Education of State Forests "Leśnik", Ustroń-Jaszowiec, Turystyczna Street 7

May 22, 2011 (Sunday)

- 8:00 – 9:00 Breakfast in the hotel "Jaskółka"
- 9:00 – 13:30 **International Conference of Botanic Gardens "Back to Eden – Challenges for Contemporary Gardens"**
- Venue:** Regional Center for Ecological Education of State Forests "Leśnik", Ustroń-Jaszowiec, Turystyczna Street 7
- 9:00 – 9:30 Opening and welcome addresses
- 9:30 – 11:10 **Session 1: "Challenges for contemporary gardens – Ex situ conservation of endangered plants"**
- 9:30 – 9:50 Suzanne Sharrock "Botanic Gardens and the implementation of GSPC Target 8"

- 9:50 – 10:10 Matthew Jebb "A report from the recent EU meeting formulating a strategic approach to ex-situ conservation in Europe, and its relevance to botanic gardens"
- 10:10 – 10:30 Costantino Bonomi "RIBES: a network for native seed conservation in Italy"
- 10:30 – 10:50 Albert Dieter Stevens "German Seed Bank Network on Crop Wild relatives"
- 10:50 – 11:10 Eleni Maloupa et al. "Ex situ conservation of Crocus taxa in the frame of a European Network: Collection, conservation and documentation"
- 11:10 – 11:30 Coffee break
- 11:30 – 13:30 **Session 2: "Challenges for contemporary gardens – Tasks for old and new botanic gardens"**
- 11:30 – 11:50 Bogdan Zemanek "The Jagiellonian University Botanical Garden"
- 11:50 – 12:10 Magnus Lidén "The Tree of Life IRL. Magnus Lidén presents the new systematic field in Uppsala Botanic Garden"
- 12:10 – 12:30 Paweł Kojs "The Silesian Botanical Garden Network"
- 12:30 – 12:50 Leszek Trząski, Waldemar Szendera "Revitalization of the urban valley of the Ślepiotka River as an example of ex situ conservation"
- 12:50 – 13:10 Magdalena Jałowska "FlorNatur LBG – Ex Situ Conservation of Endangered and Protected Plant Species"
- 13:10 – 13:20 Jože Bavcon "The new greenhouse in Ljubljana Botanical Garden. A short report"
- 13:20 – 13:30 Roksana Krause "Introduction to the floral biodiversity of the Silesian Beskidy Mountains"
- 13:30 – 14:30 Lunch
- 14:30 – 18:30 **Session 3: "Floral biodiversity of Silesian Beskidy Mts." Field trip to the Silesian Beskidy Mountains in region of Bielsko-Biała: Gondola cable railway up Szydzielnia Mountain, followed by a walk from Szyndzielnia Mt. to Klimczok Mt.**
- 18:30 Arrival in Bielsko-Biała
- 19:00 – 22:00 Conference dinner in Karczma "Straconka"
Bielsko-Biała, Górská Street 111
- 22:30 Return to Ustroń-Jaszowiec

May 23, 2011 (Monday)

- 7:00 – 8:00 Breakfast in the hotel "Jaskółka"
Participants are requested to check out of their rooms after breakfast and collect their luggage
- 8:00 Bus departure from Ustroń-Jaszowiec to Mikołów (distance 73 km)
- 9:30 Arrival in Mikołów

- 9:30 – 17:00** **International Conference of Botanic Gardens “Back to Eden – Challenges for Contemporary Gardens” continuation**
Venue: Mikołów Municipal Library, Karola Miarki Street 5
- 9:30 – 10:00** Welcome to the participants by the organizers and the Mayor of Mikołów
- 10:00 – 12:00** **Session 4: “Catalogue of Life” – (4D4 Life Project).**
 Workshop and discussion.
 Organizer: Ms. Suzanne Sharrock (BGCI)
- 12:00 – 12:30** Sandwich lunch
- 12:30** Departure of the first minibus to Katowice
- 12:30 – 13:45** **Session 5: Challenges for contemporary gardens – Environmental education**
- 12:30 – 12:45** Petr Hanzelka “Environmental education programs in Prague Botanical Garden”
- 12:45 – 13:00** David Oldroyd “The challenge of environmental education for botanical gardens”
- 13:00 – 13:15** Bogdan Ogrodnik “Environmental education in the Silesian Botanical Garden”
- 13:15 – 13:30** Justyna Wiland-Szymańska, Alicja Kolasińska, Wanda Wójtowicz, “The reintroduction of plant species protected by law as an educational challenge for botanical gardens”.
- 13:30 – 13:45** Costantino Bonomi “The INQUIRE project: Inquiry-based education in European botanic gardens”
- 13:45 – 14:00** Coffee break
- 14:00 – 15:15** **Session 6: Botanical gardens and secondary habitats conservation**
- 14:00 – 14:15** Ludmila Vishnevskaya “Latvia rare and endangered plants in *ex situ* collections”
- 14:15 – 14:30** Andrzej Czyłok “Anthropogenic landscape transformations and their potential role as secondary habitats for rare and endangered species”
- 14:30 – 14:45** Monika Stanicka “Regional Directory of Environmental Protection activities in introducing endangered species into substitute habitats – the example of *Cochlearia polonica*”
- 14:45 – 15:00** Iwona Dyc “Regional Directory of Environmental Protection activities in introducing endangered species into substitute habitats – the example of *Ligularia sibirica*”
- 15:00 – 15:15** Magdalena Maślak, Maja Głowacka “A case study of Nature 2000 community translocation in Pyrzowice Airport.”
- 15:15** Departure of the second minibus to Katowice
- 15:15** Departure to the Center for Environmental and Ecological Education (C3E) at the Silesian Botanical Garden in Mikołów-Mokre

- 15:30 – 16:00** **Poster session “The current tasks for botanical gardens beyond 2010”**
- 16:00 – 16:30** Dinner
- 16:30 – 17:00** Visit to the Center for Environmental and Ecological Education (C3E) at the Silesian Botanical Garden and the opening of the exhibition of photos by Andrzej Mróz and Maria Lankosz-Mróz “The Jagiellonian University Botanical Garden in Cracow – the oldest botanical garden in Poland
- 17:15** Departure of the final bus to Katowice

Organizers

The Council of Botanical Gardens in Poland • Silesian Botanical Garden – Union of Associations • Polish Academy of Sciences, Botanical Garden-Center for Biological Diversity Conservation in Warsaw • Regional Directorate of State Forests in Katowice • Botanic Gardens’ Conservation International • BGCI/IABG European Botanic Gardens Consortium • Silesian University in Katowice • Communal Office Mikołów

Sponsors

Regional Fund for Environmental Conservation and Water Resources in Katowice • Regional Directorate of State Forests in Katowice • Katowice City • Mikołów City • Silesian Botanical Garden – Union of Associations • Polish Academy of Sciences, Botanical Garden-Center for Biological Diversity Conservation in Warsaw • Silesian Voivodeship



Dofinansowano ze środków Wojewódzkiego Funduszu Ochrony Środowiska i Gospodarki Wodnej w Katowicach

Treści zawarte w publikacji nie stanowią oficjalnego stanowiska organów Wojewódzkiego Funduszu Ochrony Środowiska i Gospodarki Wodnej w Katowicach