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Silesian Botanical Garden as an Element of the *ex situ* Biodiversity Conservation System in Poland

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SUMMARY - *Silesian Botanical Garden as an Element of the* ex situ *Biodiversity Conservation System in Poland* - The Silesian Botanical Garden is the youngest botanical garden in Poland organized in the last 14 years and officially established as union of associations in 2003. Garden is located in the environs of Mikołów City, south of Katowice City, capital of Silesian Voivodeship in Upper Silesian region, the most industrialized part of Poland. The main goal for this new, modern botanical garden is *ex situ* conservation of local flora in Upper Silesia and neighboring areas. There are several examples of successful conservation of some plants, for example *Hacquetia epipactis* (Scop.) DC, a rare species locally threatened with extinction. The large area of this new garden, presently 83 hectares, gives good possibility for good *ex situ* conservation of several plant communities, for example woodland, wetland and xerothermic associations. The habitat conditions are especially suitable for mountain species occurring in limestone soils. It is planned that also a local seed bank for rare and endangered plants in Upper Silesia region will be organized.

RIASSUNTO - *Il Silesian Botanical Garden come elemento della Conservazione del sistema della biodiversità* ex situ *in Polonia* - Il Giardino Botanico della Slesia è il più recente giardino botanico polacco, realizzato14 anni fa e inaugurato ufficialmente nel 2003, grazie all'interessamento di varie associazioni. Il giardino è situato nei pressi della città di Mikołów a sud di Katowice, capitale del Voivodato di Slesia in Alta Slesia, la regione più industrializzata della Polonia. Il principale obiettivo di questo nuovo e moderno giardino botanico è la conservazione *ex situ* della flora locale. Ci sono già molti esempi di piante che sono state conservate con successo, come ad es. *Hacquetia epipactis* (Scop.) DC, una specie rara localmente minacciata di estinzione. I grandi spazi disponibili in questa nuova struttura, attualmente 83 ha, offrono una buona opportunità per la conservazione *ex situ* di svariate comunità vegetali, ad es. boschive, di ambienti umidi e associazioni xerotermiche. Le caratteristiche ambientali locali sono molto favorevoli per le specie montane che vivono su calcare. È stata inoltre pianificata l'organizzazione di una banca del germoplasma per le specie rare e minacciate in Alta Slesia.

Key words: botanical garden, biodiversity conservation, endangered plants, *Hacquetia epipactis,* Silesia, Poland
Parole chiave: giardino botanico, conservazione della biodiversità, piante in via di estinzione, *Hacquetia epipactis*, Slesia, Polonia

1. INTRODUCTION

"Because of the key role
they play in earth's ecosystems,
plants should have the highest priority
in conservation efforts"
Ellstrand and Elam, 1993

The creation of the botanical garden in the most urbanized and industrialized region of Poland encountered for a long time many problems. The garden was perceived as an institution, which spoils the modernist character of region. It was the industry not nature that was the blessing for this region for more than 250 years. But the times have changed. Heavy industry ceased to be profitable, the coal resources in many mines ran low and in others the profit from the coal decreased. Things that so far had guaranteed work and prosperity turned out to be a burden.

More and more people working outside the heavy industry in Silesia started to notice the results of decades of soil exploitation, industrial pollution, degradation of natural environment and threats to biological diversity connected with the disappearance of many habitats. Over last dozen years as a result of growing awareness of these environmental threats in Silesia as well as in whole Poland several actions in order to change this unfavorable situation were taken up. One of such actions was the foundation of Silesian Botanical Garden.

Silesian Botanical Garden was founded in order to conduct scientific research, for didactic and educational activity and protection of nature by:

Scientific research in the field of:

1.1 protection and preservation of biological and genetic diversity;

1.2 biosystematics, taxonomy and analysis of plant's variability;

1.3 collecting plants which can be used in plant production and environment protection as well as their scienti-

fic and utilitarian evaluation;

1.4 creating and application of methods from genetics and biotechnology in order to expand the plant's genetic variability and its practical use;

1.5 study of the influence of environment's pollution on plants and their role in reducing the harmful impact of different pollutions;

1.6 use of plants as indicators of changes in environment;

1.7 philosophy of nature and ecophilosophy.

2. Didactic activities for university students and educational for primary and high school students from the fields of botany, genetics and biotechnology of plants, gardening, bioagronomy, forestry, ecology, environment and landscape protection.

3. Propagation of knowledge from the field of natural, agricultural and forest sciences, mostly the issues concerning the use of plants by man and the issues of threats and protection of natural environment.

4. Making available for society the Center's plant collections, expositions and exhibitions for propagating, educational, recreational and cultural purposes.

5. Organizing the production, promotion and plant distribution especially for ecoagriculture, nursery, gardening and environment protection.

It is necessary to stress that the goal of Silesian Botanical Garden is an active protection of biological diversity of region's flora. It is protection *ex situ* and is connected with preservation of genetic resources in a form of field collections, seed banks and *in vitro* cultures.

Among the species currently occurring on the area of Silesian Voivodeship fully or partly protected by legal law are 136 species of vascular plants: *Aconitum firmum, Aconitum lycoctonum, Aconitum variegatum, Aconitum x lengyelii, Aldrovanda vesiculosa, Anemone sylvestris, Aquilegia vulgaris, Arctostaphylos uva-ursi, Arum alpinum, Aruncus sylvestris, Asarum europaeum, Aster amellus, Atropa belladonna, Carex arenaria, Carlina acaulis, Centaurium erythraea, Cephalanthera damasonium, Cephalanthera longifolia, Cephalanthera rubra, Cerasus fruticosa, Chimaphila umbellata, Cimcifuga europaea, Cirsium pannonicum, Cochlearia polonica, Coeloglossum viridae, Colchicum autumnale, Convallaria majalis, Corallorhiza trifida, Cortusa matthioli, Crocus scepusiensis, Cypripedium calceolus, Dactylorhiza fuchsii, Dactylorhiza incarnata, Dactylorhiza maculata, Dactylorhiza majalis, Dactylorhiza sambucina, Dactylorhiza traunsteineri, Daphne mezereum, Dianthus arenarius, Dianthus armeria, Dianthus carthusianorum, Dianthus deltoides, Dianthus gratianopolitanus, Dianthus superbus, Digitalis grandiflora, Digitalis purpurea, Doronicum austriacum, Drosera anglica, Drosera intermedia, Drosera rotundifolia, Epipactis albensis, Epipactis atrorubens, Epipactis helleborine, Epipactis leptochila, Epipactis palustris, Epipactis purpurata, Epipogium aphyllum, Erica tetralix, Frangula alnus, Galanthus nivalis, Galium cracoviense, Galium odoratum, Gentiana asclepiadea, Gentiana cruciata, Gentiana pneumonanthe, Gentianella amarella, Gentianella bohemic, Gentianella campestris, Gentianella ciliata, Gentianella germanica, Gentianella lutescens, Gentianella uliginosa, Gladiolus imbricatus, Gymnadenia conopsea, Hacquetia epipactis, Hammarbya paludosa, Hedera helix, Helichrysum arenarium, Hepatica nobilis, Hierochloë australis, Hierochloë odorata, Iris sibirica, Jovibarba hirta, Jovibarba sobolifera, Ledum palustre, Leucorhis albida, Ligularia sibirica, Lilium martagon, Lindernia procumbens, Liparis loeselii, Listera cordata, Listera ovata, Malaxis monophyllos, Mellitis melisophyllum, Menyanthes trifoliata, Neottia nidus-avis, Nuphar lutea, Nymphaea alba, Nymphoides peltata, Ononis spinosa, Orchis mascula, Orchis militaris, Orchis morio, Orchis pallens, Ornithogalum umbellatum, Pedicularis sylvatica, Phyteuma orbiculare, Pinguicula vulgaris, Pinus mugo, Platanthera bifolia, Platanthera chlorantha, Potentilla silesiaca, Primula elatior, Primula veris, Pulsatilla patens, Pulsatilla pratensis, Pulsatilla vernalis, Ribes nigrum, Salix myrtilloides, Saxifraga paniculata, Scilla bifolia, Sorbus torminalis, Spiranthes spiralis, Staphylea pinnata, Streptopus amplexifolius, Swertia perennis, Taxus baccata, Thesium ebracteatum, Tofieldia calyculata, Trapa natans, Traunsteineria globosa, Trollius altissimus, Trollius europaeus, Veratrum lobelianum, Viburnum opulus, Vinca minor.*

Among the listed above species according to the law act of Environment Minister from July 9th, 2004 concerning the occurrence in the wild and protected by law the following species of vascular plants from Silesia requiring the active conservation were chosen:

Adonis vernalis, Aldrovanda vesiculosa, Anemone sylvestris, Cerasus fruticosa, Cirsium pannonicum, Cochlearia polonica, Coeloglossum viride, Colchicum autumnale, Crocus scepusiensis, Cypripedium calceolus, Dactylorhiza spp., Dianthus armeria, Dianthus gratianopolitanus, Galium cracoviense, Gentiana cruciata, Gentiana pneumonanthe, Gentianella bohemica, Gentianella campestris, Gentianella germanica, Gentianella uliginosa, Gladiolus imbricatus, Gymnadenia conopsea, Hacquetia epipactis, Iris sibirica, Ligularia sibirica, Liparis loeselii, Nymphoides peltata, Orchis spp., Potentilla silesiaca, Trollius spp.

Presently the projects on the implementation of *ex situ* conservation programmes are carried on plant species which have natural or semi-natural sites.

2. STUDY AREA

The southern edge of Upper Silesia is one of the most diversified places of this region in terms of nature and landscape. Around 40% of species of vessel flora are to some extent bound to extinct here (Parusel *et al*. 1996).

Nowadays the constructed Silesian Botanical Garden has area of 83 hectares and is the harmonic element of spatial complex of nature and land.

This spatial complex of 524 ha includes also: Special Farm in Forestry Management in Kobiór (70 ha), ecological landscape park (182 ha) with lagging and area with preserved structure of present agricultural use (141 ha).

The area reserved for the Silesian Botanical Garden astounds with its variety of differentiated biocenosis with the habitats of water and land flora and fauna. And so, vessel flora has over 650 species, this including over 100 rare and 30 legally protected taxa (Duda *et al*. 1998). In garden many unique for Upper Silesia natural landforms can be found. The most important events of the last several million years in landscape evolution had distinctly been recorded in the geological structure (Gądek & Gądek 1994). Silesian

Botanical Garden is located on carbon layers followed by layers of Middle Trias. In this place on the north-eastern slopes of Fiołkowa Góra (340 m npm) quarries were created. The exposed layers of rocks form lime stones (Fot. 1.). In the upper part of quarry the lime dolomites, marls and conglomerations can be found. Conserved in some layers of limestone and marls the traces of waves prove that they were gathering in the shallow zone of sea of the time. In the formations of Middle Trias (the shell limestone) the fossils of sea fauna are very common. The pieces of echinodermata (mainly sea lilies) and mollusks (mainly shellfish) predominate among them. The teeth and scales of fishes and the pieces of reptile skeletons can be found as well (Duda *et al*. 1998).

There are identified altogether 49 *syntaxons* in the area of Botanical Garden in Mikołów-Mokre: 35 associations and 14 communities, among which there are 8 communities of unestablished syntaxonomical position. *Syntaxons* are represented by 14 classes, 16 orders and 24 assemblies. There belong diverse fitocenosis: woodlands, water, swamps, muddy banks, temporally flooded swamps, meadows, grasslands, nitrophilic forest margins, clearings, and ruderal fitocenosis. 6 communities occur in the Red List of Upper Silesia. Special attention should be paid to the communities of unidentified syntaxonomical position, composed of strictly conserved plants: community with *Equisetum telmateia* and community with *Gentianella ciliata*. The location of thematical sections of the collections were considered in respect of the most suitable characteristics of the habitats occurring in the area, and are presented on three examples: water and swamp plants (Fot. 2.), arboretum and rock gardens (Ostoja, unpublished data).

In the landscape of created Botanical Garden fields, meadows and forests predominate. The forest complex is accompanied by *Pruno-Crategetum*. All this area is covered with hills and valleys of Promna and Jasienica streams. Among plant associations an attention should be paid to shrubs (*Pruno-Crategetum*), oak-hornbeam-lime forest (*Tilio-Carpinetum*) and xerotermic grass of *Festuco-Brometea* class. They can be observed for example in Sośnia Góra where *Carlina acaulis* and *Primula veris* grow (Wika & Włoch l998). Equally interesting are areas of beech with dominating in undergrowth *Convallaria majalis*. Some associations described as rushes are built by one predominant rush species and they lack other species characteristic for *Phragmitetea* class. However, the meadow species can be found. It concerns *Glycerietum maximae, Phragmitetum communis, Phalaridetum arundinaceae, Caricetum gracilis, Caricetum rostratae* and *Sparganio-Glycerietum fluitantis*. The enumerated phytocenosis can be considered as developed in damp meadow habitat.

The area reserved for the Garden is unique in terms of amount of trees having the monumental size -51 were described.

Presently in the Silesian Botanical Garden research studies are carried on generative propagation of protected by law or endangered with extinction plants, especially difficult for their seed preservation in seed banks as well as their introduction into natural primary localities. An example of such successful studies is preparation and utilization of generative propagation method for local rare plant: *Hacquetia epipactis* (Scop.) DC.

Forrest communities	Threat categories
Ass: *Circeo-Alnetum* Oberd. 1953	V
Ass: *Luzulo pilosae-Fagetum* Mat. 1973	V
Ass: *Tilio-Carpinetum* Tracz. 1962	V
others	
Ass: *Filipendulo-Geranietum* Koch 1926	R
Ass: *Aegopodio-Petasitetum hybridi* R. Tx. 1949	R
Ass: *Cirsietum rivularis* Ralski 1931	I

Tab. 1 - Associations of endangered plant occurred in the wild on the area of Silesian Botanical Garden listed in red list of plant associations in the Upper Silesia Region.
Tab. 1 - Associazioni di vegetali minacciate di estinzione verificatesi nella zona selvatica del Silesian Botanical Garden elencati nella lista rossa delle associazioni vegetali nell'alta Slesia.

3. METHODS

The seeds for experimental propagation were collected from the plants widely growing on locality of *Hacquetia epipactis* in Rozumice as big population as well as from plants forming two tussocks near Bełsznica and from three single fruiting plants in the Moravian Gate Arboretum in Raciborz.

In the second half of June the mature seeds were removed from the infructescence with finger and immediately planted into moist sand. Later imbibed seeds were sawn into soil and their germination (ability from 30 to 43 %) usually started in May next year. The remaining seeds did not show any germination ability after two, nor three years.

4. RESULTS

The conducted researches took care of generative reproduction of local populations of *Hacquetia epipactis* under the threat of extinction from the seeds gained from the natural *ex situ* cultivation and dealt with problems connected with plants return to their natural habitat. The reasons of the lack of natural rebirths and the procedures of getting the seeds and methods of their *ex situ* cultivation were specified. The species has a complicated biology of generative reproduction; the seeds are very sensitive to withering and traditional methods of collecting and storage cause the complete loss of seed viability (Duda *et al*. 2001).

Summarizing our studies on distribution and generative propagation of endangered local plant *Hacquetia epipactis* in the environment of Raciborz City, we can conclude that its *ex situ* conservation is fully possible and rather simple. But the following rules should be taken into consideration:

seeds should be collected at early maturity stage and must be kept with initial moisture content, but not dehydrated;

the seedlings at cotyledon stage must be kept in shade

and just only in late summer could be taken into sunny place;

the growing plants require enough water nutrients but fertilization is not recommended before September 10th;

the well fertilized mature plants of *Hacquetia epipactis* should be covered to protect them against frost during first year of wintering;

The plants obtained through *ex situ* propagation with covered roots can be reintroduced into primary site, where they were collected just after when the threat of their extinction will stop. In the first year the juvenile plants planted in the forest should be protected against eating be roe deer. It could be done by covering them with dry spruce twigs or fir twigs without needles.

In the area of Silesian Botanical Garden were chosen the best suitable sites for *Hacquetia epipactis* growth and their cultivation will be used with the aid of described method. Presently are carried studies concerning the minimal population size which will be not threaten with genetic erosion. The gained experience and worked out procedures will be used in the program of rehabilitation of damaged plant habitat in Silesia region by using gene banks resources (Baskin & Baskin 1998; Emery 1988; Young & Young 1986; 1992).

5. DISCUSSION

On the territory of Silesian Botanical Garden the research on restoration of the existing plant associations is conducted in order to bring them back to form similar to natural. This process will be based on the method of enriching chosen plant associations by planting appropriate species of herbaceous plants, trees and bushes. There are also activities aiming at restitution of potential plant communities.

Because of convenient location in the center of Silesian conurbation and wonderful terrain conditions (diversity of accessible habitats) and relatively large territory Silesian Botanical Garden has particular possibilities of protection of big populations of plants which are bound to extinct in Silesia in seminatural conditions. This issue is important because it concerns one of the most basic questions if botanical gardens and gene banks in present form are able to fulfill their tasks that is collecting of living plants or their seed gathered form the different populations of rare or endangered species, subspecies and strains in order to preserve them and if necessary reintroduce to original or alternative environment.

To answer this question we have to ask another one: what conditions must be fulfilled to create a collection of living plants of rare or dying species and subspecies?

Let's stress that it is not about the collection of specimen, but the collection including the population of species or subspecies. Only such collection will have any sense in the biodiversity conservation program. It must be mentioned that the collection consisting of single specimen representing the chosen population will have at most the cognitive, educational or ornamental meaning but cannot be perceived as collection *ex situ* which is significant for biodiversity conservation. We presume that the issue of *ex situ* collection is not clear and requires extended discussion (Berge *et al*. 1998; Byers & Waller 1999; Charron & Gagnon 1991; Fischer & Matthies 1998; Hanski 1985; Holderegger & Styehlik 1999; Maschinski *et al*. 1997; Pluess & Stocklin 2004; Stacey & Taper 1992).

Let us start from the basic issue - the habitat. The habitat conditions should be similar to natural conditions as much as possible in order to protect the next generations of plants from extended selection caused by the change of environmental conditions (to avoid the selection in the direction appointed by conditions present in the garden) and genetic erosion caused by too small population on a not big area. The chosen population should not be treated as "something separate" but as a part of plant association. The appropriate size of population must be provided and it must be similar to the minimal size of natural population. Moreover, if the species can be found on the area of whole country the population should come from region in which the *ex situ* is cultivated (local population) not from other regions (the protection from blending the genetic material of different local populations). It can be mentioned that in botanical gardens providing *ex situ* conservation the conditions to create the natural plant associations on a scale assuring their self-reproduction should be fulfilled. These conditions should be under constant control and if necessary the processes of unwanted succession should be by the garden's workers appropriately corrected. To sum up, it can be said that the activities in gardens should aim at creating appropriately large habitat which would be identical or similar to natural habitat and providing there plant association which elements (populations of plants: protected, endangered or rare) are the direct subject of conservation activities. The proposed solution refers to part of "genetic heritage" which should be protected in collections of native plants growing wild (for example protected, endangered, rare). This solution in our opinion should concern collections of the highest priority in the national programs of biodiversity protection. The important element of this solution is a good reconnaissance of natural positions of plants protected, endangered and rare in particular region, taking content-related care of natural reservations, ecological arable lands and natural monuments in order to get the seeds as well as strengthening the wild growing populations by planting strong specimen from *ex situ* cultivation. A garden like this can be fully treated as a gene bank of local populations. The restitution of *Hacquetia epipactis* (Scop.) DC presented above can be an exampleThe important activity aiming at biodiversity conservation is preservation of rare plant associations which can be found on Red List of Silesian District. (Celiński *et al*. 1997). On the territory of Garden 6 this type associations can be differentiated (Tab. 1.).

The advantages of Silesian Botanical Garden allow for taking under protection many species of vessel plants in their natural or seminatural associations mentioned above.

6. CONCLUSION

The experiences gained during the research on the generative reproduction of endangered plants and the natural potential of Silesian Botanical Garden allow for conducting the revitalization and renaturization of areas degraded as a result of human activity towards the potential flora.

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