Querétaro's botanic garden action towards the accomplishment of Target 8 of the *Global Strategy for Plant Conservation*

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Introduction

Despite the fact that Querétaro is a small State in Central Mexico and unknown to many foreigners, its plants on the other hand, enjoy a worldwide recognition, primarily those of the semiarid region.

Occupying 0.6% of the nation's territory, with an extension of 11,769 square kilometres, Querétaro is located between parallels 20° 01' and 21° 37' and meridians 98° 54' and 100° 35'. Seven hours from Greenwich Time Zone (Nieto 1995). The State possesses a rich biodiversity and it is privileged for this reason. Its geography encompasses evergreen forests in the northeast, scrubs of various types (xerophilous) in the central and southern area, as well as temperate forest filled with oaks and pines and evergreen cloud forest in the peaks of the eastern side of the Sierra Madre. This territory is filled with a wide flora variation, nonetheless, it is not exempt from detrimental and destructive factors resulting from human impact; making the threat of extinction not only a reality, but also a permanent one. Among those species facing the greatest threat of extinction, taxa of diverse families are found, as well as specimens from all type of habitats (Table 1). Without a doubt, the family which has the largest number of species under threat of extinction is the cacti family. (Sedesu 2003)

Although we are a recent foundation, Querétaro's Botanical Garden was founded only 20 years ago, we have had ever since a clear vision of our function as an important propagation center of endangered species and an awareness of the role in safeguarding vegetal germplasm of wild species. Because of the concern of local botanists, a large diversity of species with an important economic and ecological relevance have been reproduced in Querétaro even before a global strategy was declared and the first ecological laws provided the legal and institutional framework for this type of activities in Mexico.

Our Botanical Garden has always strived for the implementation of endangered wild species propagation programs, as well as having a reproductive unit available on site. Although our efforts have been focused in experimenting with and developing new techniques for the propagation of members of the cacti family, throughout the years we have had the opportunity of experimenting with other botanical families as well. The following report presents the progress made so far in our propagation efforts with its results, highlighting the fact that the acquired experience is of great relevance towards the accomplishment of Target 8 of the *Global Strategy for Plant Conservation* (GSPC), primarily because it has been carried out *in situ* very close to where the endangered plants grow.

Botanical Family	Species Name	Habitat	Mexican Legal Protection Status (NOM-059-ECOL-2001) (Semarnat 2002)	International Status (IUCN 2006)
Agavaceae	*1 Yucca queretaroensis*	MS	Pr	
Betulaceae	*2 Carpinus caroliniana*	BM	A	
	3 Ostrya virginiana	BM	Pr	
Bromeliaceae	*4 Tillandsia roland-gosselinii*	BM	A	VU
Cactaceae	*5 Ariocarpus kotschoubeyanus*	MX	Pr	NT
	6 Astrophytum ornatum	MX	A	
	7 Coryphantha elephantidens	MX	A	
	8 Echinocactus grusonii	MX	P	CR
	9 Echinocactus platyacanthus	MX	Pr	
	10 Echinocereus schmollii	MX	P	
	11 Ferocactus histrix	MX	Pr	
	12 Lophophora diffusa	MX	A	VU
	13 Mammillaria hahniana	MS, BTC	A	
	14 Mammillaria herrerae	MX	P	CR
	15 Mammillaria longimamma	MX	A	
	16 Mammillaria mathildae	BTC	P	VU
	17 Mammillaria microhelia	BQ	Pr	VU
	18 Mammillaria painteri	MX	Pr	DD
	19 Mammillaria parkinsonii	MX	Pr	
	20 Mamilaria pringlei	BQ	Pr	
	21 Mammillaria zephyranthoides	MX	A	
	22 Pilosocereus cometes	BTC	Pr	
	23 Strombocactus disciformis	MX	A	
	24 Thelocactus hastifer	MX	Pr	VU
	25 T. leucacanthus subsp. *ehrenbergii*	MX	Pr	
	26 Turbinicarpus pseudomacrochele	MX	P	VU
Cochlospermaceae	*27 Amoreuxia palmatifida*	MS, MX, P	Pr	
Cupressaceae	*28 Cupressus lusitanica*	BP	Pr	R
Cyatheaceae	*29 Cyathea fulva*	BM	Pr	
	30 Cyathea mexicana	BM	P	
Ebenaceae	*31 Diospyros xolocotzii*	BTC	Pr	
Fabaceae	*32 Erythrina coralloides*	BTC, MX	A	
Fouqueriaceae	*33 Fouquieria fasciculata*	MS	A	
Gentianaceae	*34 Gentiana spathacea*	BQ, BP	Pr	
Lauraceae	*35 Litsea glaucescens*	BM	P	
Leguminosae	*36 Albizia plurijuga*	BTC	A	EN
Magnoliaceae	*37 Magnolia dealbata*	BM	P	EN
	38 Magnolia schiedeana	BM	A	EN
Malvaceae	*39 Phymosia rzedowskii*	BQ	Pr	
Meliaceae	*40 Cedrela dugesii*	BTC	Pr	
Nolinaceae	*41 Dasylirion acrotriche*	MX, MS	A	
	42 Dasylirion longissimum	MX, MS	A	
Orchidaceae	*43 Laelia anceps* subsp. *dawsonii*	BQ	P	
	44 Laelia speciosa	BQ	Pr	
Palmae	*45 Brahea moorei*	BQ	Pr	
	46 Chamaedora sartorii	BM	A	
Pinaceae	*47 Abies guatemalensis*	BM	P	VU
	48 Pinus pinceana	BP	Pr	LR/nt
Polypodiaceae	*49 Asplenium auritum*	BM	A	
	50 Campyloneuron phyllitidis	BM	A	
Rubiaceae	*51 Bouvardia rosei*	BQ, BP	Pr	
Taxaceae	*52 Taxus globosa*	BM	Pr	LR/nt
Tiliaceae	*53 Tilia mexicana*	BM	P	
Zamiaceae	*54 Ceratozamia hildae*	BTC	A	EN
	55 Ceratozamia mexicana	BTC	A	VU
	56 Ceratozamia sabatoi	BP	A	EN
	57 Dioon edule	BTC	A	NT
	58 Zamia fischeri	BTC	A	EN

Table 1. Queretaro's plant species under threat of extinction (Key to names: Habitat: BM: Evergreen cloud forest; BQ: Quercus forest; BP: Pinus forest; BTC: Tropical deciduous forest; MS: Submontane Scrub; MX: Xerophilous Scrub; P: Grassland. ***NOM-059-ECOL****-2001 (Mexican Legal Protection Status): P: Endangered; A: Threatened; Pr: Under Special Protection. IUCN Status: EN: Endangered; LR / nt or NT: near threatened; VU: Vulnerable.)*

Process

The general procedure for the propagation of endangered species has been the establishment of a propagation program based on the construction of greenhouses, which become wild species propagation units. Once the species to be reproduced have been selected- based on the national and international listings of endangered species- a general plan of action is followed, focusing on those with the highest risk of extinction.

The process begins with the recollection of mother plants or propagules (seeds or other non-sexual parts) needed for their reproduction. Afterwards, appropriate reproductive techniques are analysed and implemented in the greenhouses until satisfactory results concerning their germination, establishment, longevity and the production of new propagules are obtained. The main reproductive line in the greenhouses has generally been backed up by the storage of seeds in a small germplasm bank (a refrigeration unit with low humidity) in order to see them preserved for longer periods of time; and by the support of a tissue culture lab in which recalcitrant species are reproduced following this useful propagation technique.

More recently, the artificial propagation process in the greenhouses has been preceded by an on site ecological assessment in which the preservation conditions of such species at their natural habitat has been estimated.

As a final stage of the process, the reintroduction of species to their environment has been outlined and tested. Due to the lack of sufficient protected natural areas able to guarantee their permanence, these efforts have been unsuccessful.

Results

As a consequence of the reproduction programs of endangered species established in the botanical garden in the State of Querétaro, Mexico, techniques for all species of the cacti family have been generated in this federal district. This means that almost 40% of endangered species in the area have been cared for, not to mention that, with a higher or lower rate of success, considerable work has been done on the propagation of species such as the Magnoliaceae (*Magnolia schiedeana*), Nolinaceae (*Dasylirion longissimum*, *D. acrotriche*), Orchidaceae (*Laelia anceps*), Pinaceae (*Pinus pinceana*) y Zamiaceae (*Dioon edule*), among others. Table 2 lists the species that have been artificially reproduced at the Botanical Garden in Querétaro.

Figure 1. One of the last specimens of Echinocactus grusonii (Cactaceae), a highly threatened species, still growing in the wilderness of the state of Querétaro, Mexico

Figure 2. Echinocactus grusonii *in the germination chamber.*

Botanical Family	Species Name	Habitat	Mexican Legal Protection Status (NOM-059-ECOL-2001) (Semarnat 2002)	Propagation System
Cactaceae	*Ariocarpus kotschoubeyanus*	MX	Pr	SS, ATC
	Astrophytum ornatum	MX	A	SS
	Coryphantha elephantidens	MX	A	SS
	Echinocactus grusonii	MX	P	SS
	Echinocactus platyacanthus	MX	Pr	SS
	Echinocereus schmollii	MX	P	AC
	Ferocactus histrix	MX	Pr	SS
	Lophophora diffusa	MX	A	SS, AC, ATC
	Mammillaria hahniana	MS, BTC	A	SS
	Mammillaria herrerae	MX	P	SS, AC
	Mammillaria longimamma	MX	A	SS
	Mammillaria mathildae	BTC	P	SS, ATC
	Mammillaria microhelia	BQ	Pr	SS, ATC
	Mammillaria painteri	MX	Pr	SS
	Mammillaria parkinsonii	MX	Pr	SS
	Mamilaria pringlei	BQ	Pr	SS
	Mammillaria zephyranthoides	MX	A	SS
	Pilosocereus cometes	BTC	Pr	SS
	Strombocactus disciformis	MX	A	SS, ATC
	Thelocactus hastifer	MX	Pr	SS
	T. leucacanthus subsp. ehrenbergii	MX	Pr	SS, ATC
	Turbinicarpus pseudomacrochele	MX	P	SS, ATC
Fabaceae	*Erythrina coralloides*	BTC	A	SS
Fouqueriaceae	*Fouquieria fasciculata*	MS	A	AC
	Magnolia schiedeana	BM	A	ATC
Nolinaceae	*Dasylirion acrotriche*	MX, MS	A	SS
	Dasylirion longissimum	MX, MS	A	SS
Orchidaceae	*Laelia anceps subsp. dawsonii*	BP, BQ	P	ATC
Pinaceae	*Pinus pinceana*	BP	Pr	SS
Zamiaceae	*Dioon edule*	BTC	A	ATC

Table 2. Flora species artificially propagated at the Queretaro's Botanical Garden (Key to names: SS = sexually propagated by seed; AC = asexually propagated by cuttings; ATC = tissue cultured. Habitat: BM: Evergreen cloud forest; BQ: Quercus forest; BP: Pinus forest; BTC: Tropical deciduous forest; MS: Submontane Scrub; MX: Xerophilous Scrub; P: Grassland. NOM-059-ECOL-2001 (Mexican Legal Protection Status): P: Endangered; A: Threatened; Pr: Under Special Protection.)

The Regional Botanical Garden in Cadereyta de Montes, México, currently runs a wild species propagation unit in which the following are being reproduced: 1) Cacti in risk of extinction according to Mexican laws dating from March 6th, 2002, 2) succulents from semi-arid regions with an ornamental value; 3) endangered

species from other botanical families; 4) recently discovered species in the area. Current condition of cacti in Querétaro's semiarid areas are now being analysed through field research in order to establish a program for the preservation of rare specimens in the region; based on their quasi-endemic or endemic nature most of them belonging to the endangered species group on a national range. There are 13 endangered species of cacti which are now included in this program (see Figures).

Conclusions

Querétaro has actively participated in flora preservation efforts and through its continuous activities, it has contributed to the accomplishment of Target 8 of the *Global Strategy for Plant Conservation*. Propagation techniques for 22 species of cacti have been developed, which represent 40% of all endangered flora in the region and currently has 13 species in a recovery program that is to say, 22% of endangered species in Querétaro. The Botanical Garden is involved in the propagation of other species as well. The Garden's collection also includes all the endangered species of cacti, as well as 5 other species with a threatened status from 4 botanical families. In this way, Querétaro contributes to the world's flora preservation and fulfils the agreements subscribed by the country in 1992.

Figure 3. Accomplishing Target 8 (GSPC): greenhouse facilities at the Cadereyta´s Regional Botanical Garden of the Science and Technology Council of the State of Querétaro.

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