

# Tracing a path for plant conservation in central Mexico: the evolution of the Cadereyta Regional Botanical Garden

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## Abstract

The Cadereyta Regional Botanic Garden (CRBG) is actively contributing to the conservation of the Mexican flora. It focuses on the arid zone of the State of Queretaro, which is a small state with less than 1% of Mexico's land but with a remarkable plant richness of nearly 4,000 species. The CRBG collections include 82 endangered species, according to the Official Mexican Standard, 46 species are in the risk categories of the IUCN Red List and 185 in the CITES Appendices. Propagation tasks include the development of propagation protocols and the cultivation of more than 100 native plant species, which are available for reforestation and restoration activities. The Garden has an active environmental education programme, oriented to elementary school pupils, with an increasing audience in the recent years. Its scientific work supports the correct assessment of extinction risk for endemic species. In the last three years, new species have been described or reviewed. This paper is summary of the recent advances by, and challenges to, the CRBG, which is working to meet the definition of a botanic garden as defined by BGCI.

## Keywords

Botanic Garden, Cadereyta, conservation, flora, Mexico.

## Introduction

The Cadereyta Regional Botanic Garden is a public institution that depends on the Queretaro State Council of Science and Technology (CONCYTEQ, in Spanish). The Council is part of the Ministry of Education of Queretaro State.

The Garden is located in the municipality of Cadereyta de Montes, in the State of Queretaro, central Mexico, at 20°41'12" N, 99°48'15" W. It is close to the semi-arid zone of Queretaro and Hidalgo States (Figure 1), which is considered to be the southern end of the Chihuahuan Desert (Hernández-Oria *et al.*, 2007), and is known world-wide due to its big number of desert flora endemics (Hernández & Bárcenas, 1995, 1996). The State of Queretaro is one of the smallest in Mexico. It represents less than 1% (0.59%) of Mexico's territory but its number of plant species is a little over 4,000 (Rzedowski *et al.*, 2013).

The surface of the Garden belongs to an *ejido*. An *ejido* is land expropriated from large private holdings and redistributed to communal farms. The land is owned by the government, the usufruct by *ejidatarios*. In 1989, members of the Ejido of "Fuentes and Pueblo Nuevo" signed an agreement of bailment with the CONCYTEQ for the Botanic Garden establishment.

The CRBG has developed an integrated scheme of tasks, based on BGCI's definition: "Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education". It also works with other Mexican botanic gardens to participate in the Mexican Strategy for Plant Conservation (EMCV). To achieve these goals, the principal areas at the Garden are *ex situ* Conservation, Scientific Research and Environmental Education. Its main features and achievements are described below.



Figure 1. Location of the CRBG

### ***Ex situ* conservation**

The botanical collection of the CRBG serves as a repository for 303 taxa of 27 botanical families. In recent years, field work and plant collecting have been enhanced, and today four main sections of the Garden keep an important contingent of plants. These sections are:

*Cactaceae of Queretaro*, the main section. This section represents the diversity of Cacti in the centre and north of Queretaro; it includes both cacti and specimens of allied families.

*Mammillaria in Mexico*, a specialized collection of this genus, almost endemic to Mexico. It has more than one hundred of species.

*Agavaceae of Queretaro* is a collection with 38 taxa of the Agavaceae family, including *Agave*, *Manfreda*, *Polianthes*, *Prochnyanthes*, *Beschorneria* and *Yucca* genera.

*Trees of Queretaro Valley*, an interesting group of tropical dry forest trees, whose remains still can be found in the south of the State of Queretaro. Botanical collection sections preserve threatened and microendemic species from the semi-arid zone of Queretaro and Hidalgo.

Specimens at the botanical collections are used as a source of germplasm for the propagation programme, which has propagated more than one hundred species to increase the stock available for replacement, donation, reforestation, and sales.

The CRBG offers advice and training in plant propagation. An interesting example of this was the advisory given to the “Xitales”, a confraternity of persons in charge of the celebration of religious feasts in the municipality of Tolimán. The feast includes the erection of a special structure named “Chimal”, adorned with thousands of leaf bases of sotol (*Dasyliirion acrotrichum* (Schiede) Zucc.) (Figure 2). *D. acrotrichum* is listed in the Mexican NOM-059-SEMARNAT-2010 as “threatened” (A), and permission from the Mexican Ministry of Environment and Natural Resources must be obtained in order to collect it. In 2009, the permission was conditional on the establishment of a propagation place of the species, and the “Xitales” received advice and training at the CRBG for



Figure 2. A “Chimal”, made of leaf bases of *D. acrotrichum*

the legal propagation of *D. acrotrichum*. Recently, they began to reintroduce young plants in their habitat (Figure 3).

### **Environmental education**

The main goal of the garden’s educational programme is to educate individuals to become aware of and take care of the environment and its problems, and to provide them with appropriate tools. This education programme has three essential elements: to promote the Botanic Garden as an attractive place for study, exhibition and cultivation of plants, the Environment as the system where plants and humans coexist, and the sustainable development as a guiding concept.

The education programme is based in a conceptual framework that proposes constructivism as its pedagogic approach (Sánchez & Galindo, 2009). Individuals live and experience real situations and activities, and learn directly from their interactions with the environment. The interaction becomes a unique phenomenon for every single individual, who should change his behavior towards the environment after information process. An essential part of the programme is the “37 concepts” list, an integrated learning scheme to guide pupils towards nature interpretation and social awareness (Sánchez *et al.*, 2012) (Figure 4).

The programme is oriented to elementary schools pupils from the municipality of Cadereyta de Montes. The sessions are developed outdoors, in an informal atmosphere, and pupils take the leadership of activities. At the end of each session, a time for reflection and interchange is given, and students are encouraged to analyze their behavior and attitudes, to identify the learning achieved. The programme started in 2009; since then, an increasing number of elementary school pupils have come every year to participate. In 2013, 4 419 pupils participated.



Figure 3. Reintroduction of *D. acrotrichum*, propagated by the “Xitales” (Photographs courtesy of the Cadereyta de Montes municipality).

### Scientific Research

Since 2003, the CRBG has been developing scientific research. The objective of this area is to generate and disseminate scientific knowledge about plant resources, with the main emphasis on flora and vegetation of the semi-arid zone of Queretaro and Hidalgo.

The main lines of scientific research are: the study of useful plants, optimization of growth factors of useful plants inside a greenhouse, documentation of regional plants collections, the study of conservation status of key species and ecological restoration.

The CRBG is enhancing this area, establishing key partnerships with local, national and international educational institutions. The Autonomous University of Queretaro, the National Autonomous University of Mexico, the Autonomous Metropolitan University and the Université Laval in Canada are some examples of these partners.

A brief resume of the Scientific Research at the CRBG is summarized in the following list, including the project name, date, source of funds and main results, besides scientific and divulgation papers:

- *In situ* ecological evaluation and propagation of threatened species of the Cactaceae family at the semi-arid zone of Queretaro. (2003-2006). Funded by the FOMIX (acronym for “mixed funds”) Programme, with participation of the National Council of Science and Technology (CONACYT) and the CONCYTEQ. (FOMIX-QRO-2003-CO1-10152). A book was published (Sánchez *et al.*, 2006) and nineteen propagation protocols were standardized. Mother plants collected during this project are sources of germplasm at the Garden.
- Technical notes about the conservation status of the Cactaceae species in Queretaro. (2004-2006). Funded by the National Commission for Knowledge and Use of Biodiversity (CONABIO). (CONABIO-CK016).
- "The three R's that you are." Cacti conservation with participation of local communities. (2005-2006). Funded by HSBC, through BGCI. A prototype of a ‘training’ greenhouse was installed at the small town of El Arbolito, in a key location of the municipality of Cadereyta, in terms of cactus biodiversity. Five local boys and girls were trained in the appreciation of endangered species, and its sustainable propagation.
- Evaluation of the conservation status of *Echinocereus schmollii* (Weing.) N. P. Taylor, at Cadereyta de Montes, Queretaro. (2005). Partially funded by the National Autonomous



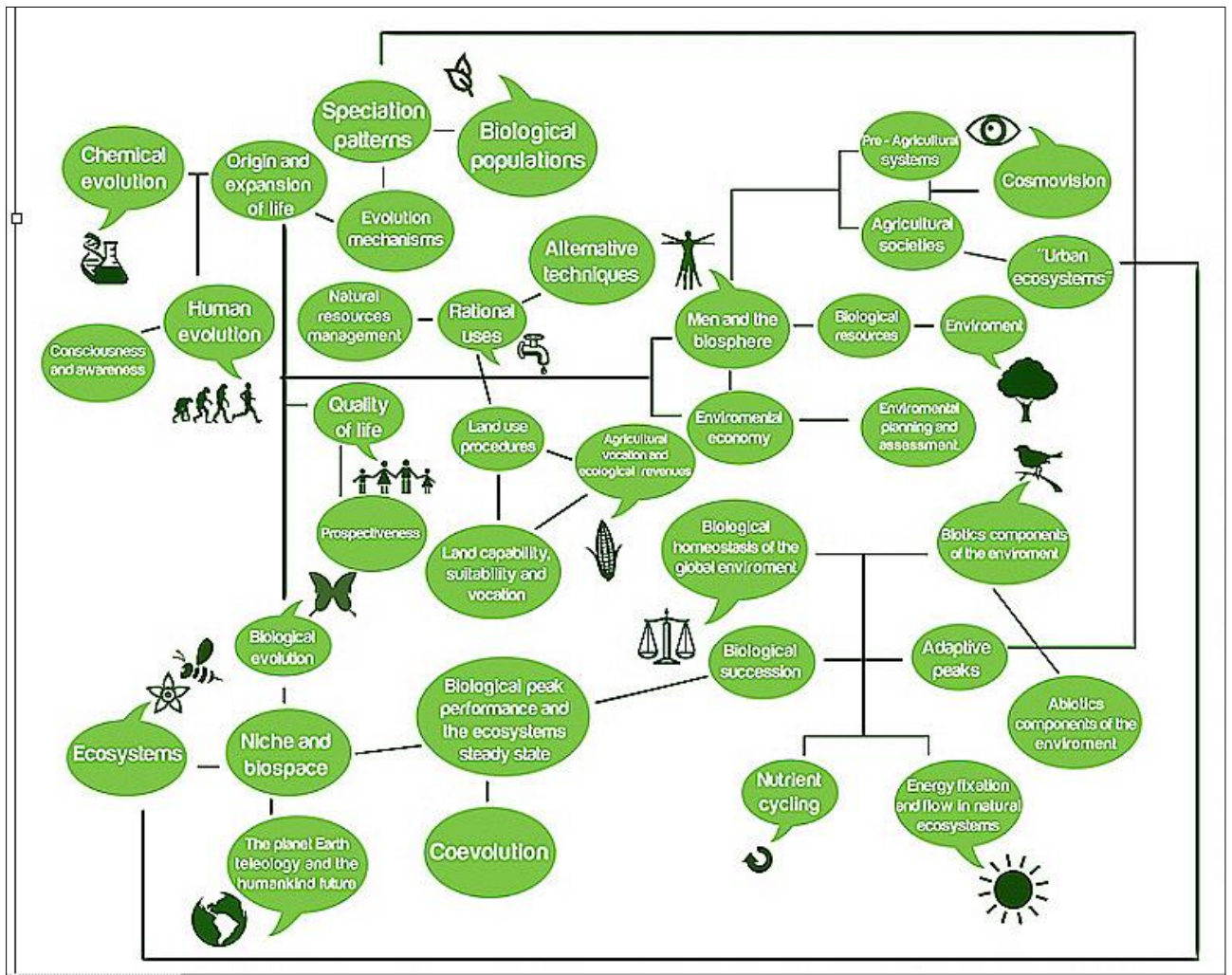


Figure 4. "37 key concepts", foundation of the Educational Programme

University of Mexico (UNAM). A special issue of the Mexican journal *Cactáceas y Suculentas Mexicanas* was published with the information of this project.

- Key species propagation, for their use in reforestation and restoration in the municipality of Queretaro, and its area of influence. (2007-2011). Funded by the FOMIX Programme (CONACYT-CONCYTEQ). (FOMIX QRO-2006-C01-54300). A book was published (Sánchez *et al.*, 2011). Thirty five propagation protocols for key species of the tropical dry forest were developed. A pool of 3,000 young plants was delivered to the Queretaro Trust for Environment (FIQMA). The CRBG has participated in regional workshops for the use of native flora in urban areas.
- *Mammillaria herrerae* Werderm. A conservation project at Cadereyta de Montes, Queretaro. (2009-2011). Funded by the British Cactus and Succulent Society (BCCS). An inventory of this extremely threatened species was made. It was possible to collect seeds. A plot for the propagation of the species was established at the CRBG.
- Evaluation of the conservation status, uses and threats of *Yucca queretaroensis* Piña (Agavaceae). Evaluation of its relevance for inclusion in the CITES Appendices. (2011-2013). Funded by the CONABIO. (CONABIO-JE005). The species was listed in the Appendix II of CITES during 2013, thanks to the information generated.

## A colophon

The Cadereyta Regional Botanic Garden has evolved, increasing its tasks, commitments and responsibilities. However, much work is still needed to enhance key areas. The administration of the Garden is aware of this and is strengthening new partnerships and seeking creative ways to ease educational and research activities, and to collaborate with national and international organizations for the conservation of flora.

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