



Biodiversity of Cacti, Northeastern Mexico: an Insight

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Abstract

Approximately 563 species, grouped in 50 genera prove a great diversity of cacti in shapes, colors of its flowers in Mexico. Mexican deserts harbor a high number of species of cacti found in groups like the barrel cactus, prickly pear and pitahayas in Durango, Zacatecas, Chihuahua, Coahuila, Nuevo Leon and Tamaulipas; great variety of large *sagueros* in Puebla, Queretaro, Hidalgo and San Luis Potosi. Chandeliers in Sonora and Baja California States are found. In the Mesoamerican region, out of 420 species reported, 118 have at least one use by indigenous peoples. In many regions, it plays an important social role as a source of food for humans, livestock and wildlife, construction, and fuel. At the same time, number of species are under threat due to collection pressure and ecosystem degradation.

1. Introduction

Mexico is considered a country of great cacti diversity, with approximately 563 species, grouped in 50 genera (Hunt, 1999; Guzman et al., 2003). About 78% of the species are endemic, mainly distributed in arid and semiarid ecosystems (Rzedowski, 1978; Rzedowski, 1991; Hernández and Godínez, 1994; Lebgue-Keleng, 2011). Cacti have developed ecological and evolutionary strategies, characterized by reproductive systems allowing them to adapt to different environmental conditions. Cacti vary in size and shape and habitat from columnar species found at sea level in Sonora and Baja California, to Puebla, at 2950 masl, exceeding 10 meters in height and 100 kg in weight. *Selenicereus spinulosus* for instance is adapted to climb in areas of higher humidity, where the roots grow along tree stems and function as anchors and guides to grow through the vegetation. Some species such as *Peniocereus greggii* and *Echinocereus poselgeri* have tuberous roots where water is stored underground that sometimes exceeds the volume of the stems (Velazco-Macías and Alanis-Flores, 2009). Cacti distribution and abundance has been severely affected by human activities such as extraction of construction material (Plate 1), land use changes, urban growth and looting of entire populations of cacti for illegal trade (Jarvis,

1979; Sanchez-Mejorada, 1982; Fuller and Fitzgerald, 1987; Paredes et al., 2000).

2. Diversity and Uses

The diversity of shapes, colors of its flowers, horticultural interest, ornamental and international trade of Cacti is evident (Plates 2 and 3). Many Mexican species are threatened (León de la Luz and Valiente-Banuet, 1994; Hernández y Godínez, 1994; Arias et al., 2005), mainly due to constant habitat loss (Plate 4 and 5). Cacti are characterized by a slow growth rate and long life cycles (Gibson y Nobel, 1986; Mandujano, 1995). Many cacti have extremely limited ranges and are sometimes found in soil conditions with very specific to their survival (Hernández and Godínez, 1994).

There are research centers and government and nongovernment institutions that are dedicated to the reproduction of cacti for sale. This activity is considered unprofitable and time consuming due mainly to bureaucratic procedures required for the establishment and operation of a cacti production business (Barcenas, 2003). In Mexico, some institutions reproduce cacti, for instance the Desert Museum has a nursery dedicated to the production of cacti. Another institution is Cactimex, which is a marketing center for desert plants and seeds, located in Saltillo,



Coahuila (Plate 6). The laws in Mexico, prohibit trade in cacti, parts thereof or seeds obtained from collection.

Mexican deserts harbor a high number of species of cacti found in groups like the barrel cactus, prickly pear and pitahayas in Durango, Zacatecas, Chihuahua, Coahuila, Nuevo Leon and Tamaulipas (Plates 7 and 8). Great variety of large *saguars* in Puebla, Queretaro, Hidalgo and San Luis Potosi. Chandeliers in Sonora and Baja California States are found (Plate 9). The cactus family is characterized by the beauty of its flowers, the variety of shapes and sizes of their stems. Arid and semiarid environments, allow them to store large amounts of water by forming succulent tissue (Plate 10). The leaves are reduced

and disappear in early stages of development in most of the cacti, or are modified in spines to reduce evapotranspiration, although in some species of *Opuntia* mainly these small formations of leaves. There are primitive or ancestral genera such as *Pereskia* and *Pereskopsis*, which are shrubs or small trees and bear leaves (Plate 11). For leafless cacti, photosynthesis occurs on the surface of the stems, the petiole (structure that normally holds the sheet in other plants) transformed into a structure called the tuber and the yolks in the areoles; where thorns grow, flower and fruit (Plate 12). Some species have a type of wooliness (genus *Coryphanta*), fur or felt (genus *Astrophytum*). The function of these structures is protection



Plate 1: Marble mining in Sierra El Sarnoso, Durango, Mexico



Plate 2: *Ferocactus pilosus*, red cactus spine, reaching up to 1.50 m



Plate 3: *Astrophytum myriostigma*, known as bishop's cap or cap appearance of a bishop



Plate 4: *Epithelantha micromeris*, species known as *cotton swabs* or *tassels* for its diminutive size, also of great ornamental value



Plate 5: *Echinocactus platyacanthus*, has great ornamental value



Plate 6: Cacti greenhouse at the desert museum in Saltillo, Coahuila



Plate 7: *Echinocereus pectinatus*, known as rainbow cactus



Plate 11: *Pereskia* sps., a shrub type primitive genus bearing leaves



Plate 8: *Mammillaria* sp., globose cactus, is easily found in the Chihuahuan Desert, northern Mexico



Plate 12: A) Stem of *Echinocactus platyacanthus* B) Cladode of *Opuntia rastrera* C) Fruits of *O. leptocaulis* D) Woolliness of *Coryphantha durangensis*; E) Tassels of *Astrophytum myrionostigma*



Plate 9: *Pachycereus pringlei*, an endemic large cactus of Baja California and Sonora states, Northwest, Mexico



Plate 10: *Echinocereus merkerii*, the carmine red fruits are known as "alicoche", which are used in the preparation of ice creamstage

from predators (herbivores, trampling by livestock, etc.) and solar radiation (Jimenez and Reyes, 2000). The stems of cacti have been adapted to store water in sufficient quantities to survive long periods of drought, with the ability to expand and collapse the inner wall of the tissues to compensate for the loss of water or absorption. The size and shape vary from very small cacti (less than 5 cm) as *Mammillarias*, to the columnar cacti such as *Cereus marginatus* (up to 5 m). There are also species that are half buried in the soil surface as *Ariocarpus* and *Lophophora*, some tree-like *Rhipsalis*. Some species of the genus *Mammillaria*, *Coryphantha* and *Neolloydia* have tubers, which are protuberances with a bottle shape.

Some ethnic groups distributed in different states like the Tarahumara in Chihuahua, the Huichol Indians of Jalisco, the Coras of Nayarit and Tepehuanes of Durango; use certain species of cacti like peyote, peyotl o jiculi (*Lophophora williamsii*) with hallucinogenic properties for use in rituals and religious ceremonies (Plate 13). According to the beliefs and customs of some groups, the species is considered as a divine being (Alanis and Velasco, 2008; Rai et al., 2011).

In a study based focused on species richness, conservation value and complementary information of cacti distribution in Mexico, allowed to identify and determine conservation priorities areas since they harbor the most significant assemblage of



Plate 13: A) *Lophophora williamsii*, known as *peyote* (species known for their hallucinogenic properties of the alkaloids contained in their tissues). B) Flower of *L. williamsii*



Plate 14: Mass production of the cochineal insect (*Dactylopius coccus costa*) in infested prickly pear cladodes of *Opuntia* spp., under greenhouse conditions

endangered species in terms of their numbers, narrow distribution and rarity (Hernandez and Barcenás, 1996).

Many species of cacti are under threat due to collection pressure and ecosystem degradation. In this regard, as an approach to identify conservation areas for the Baja California peninsula, a study was carried based on species richness, endemism, and phylogenetic and morphological diversity using herbarium records and molecular phylogeny. The results indicated that species richness provide solutions to complement the diversity protected, by identifying priority species (endemic species with high contribution to overall plant diversity) (Prado et al., 2010).

It has been suggested that the geographical rarity of cacti species in the Chihuahuan Desert is a natural phenomenon; however, the range of several species has been influenced by human activities (Hernandez et al., 2010).

In the Mesoamerican region of Mexico, there are about 420 species of cacti, of which 118 have at least one use by indigenous peoples (Bravo-Hollis, 1978; Bravo-Hollis and Sánchez-Mejorada, 1991). Cacti species in many regions of Mexico play an important social role as a source of food for humans,

livestock and wildlife, construction, and fuel (Tellez-Valdes and Villa-Aranda, 2003). The fruit known as *garambullos* and *xoconoxtle*, which are usually consumed fresh. The cooking of stems *Ferocactus pilosus* and *Echinocactus platyacanthus* are used to prepare a traditional sweet *biznaga* or commonly known as “*acitron*”. Flower buds of *Ferocactus pilosus* are known as “*cabuche*” and could be eaten either cooked or pickled (Alanís and Velasco, 2008). Fruits from several species of cactus (e.g., *Hylocereus polyrhizus*, *H. undulatus*, *Stenocereus queretaroensis*) are commonly called *pithaya*, *pitajaya*, *pitaya* or similar and prickly pear fruits from some *Opuntia* and *Noplaea* genera are called “*tuna*”. As fodder for animals, contain high nutritional values. Carminic acid production, which is a compound produced by the cochineal insect commonly named “*cochinilla*” (*Dactylopius coccus*) attacking in the form of plague specimens of the genus *Opuntia* (Plate 14), has been used by pre-Columbian cultures for staining of garments and to date is still produced and used in scientific laboratories, or to stain food, textiles, walls and cosmetics (Mendez et al., 1994; Perez and Becerra, 2001). Some extracts from various species of cacti have applications in medicine as antidiabetic agents, diuretics and laxatives. The uses mentioned above, represent a culinary tradition, cuisine, religious and cultural history tied to Mexico from many centuries back.

3. Conclusion

The great diversity of species of cacti in the Mexican Territory, as well as the high number of endemic species, their often restricted distribution, highlight the important of efficient conservation programs. Currently, the National System of Natural Protected Areas in the semi-arid regions in Mexico are experiencing a great problem for not having considering a large number of species in a risk category.

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