More than half of Mexico is arid and semi-arid. There are three main desert regions in Mexico – the Chihuahuan Desert, the Sonoran Desert and the Tehuacán Valley – each of which is distinctive but in different ways. In these regions, plants and animals have undergone a profound evolutionary process, which has led to a wide variety of specialized life forms adapted to desert conditions.

With an estimated flora of 3,000 species and an interesting assemblage of animals, the Chihuahuan Desert in northern Mexico is one of the most extraordinary deserts in the world. The region is bordered by two large mountain ranges, the Sierra Madre Occidental and the Sierra Madre Oriental. Some half a million km² in size, it is the largest desert in North America, extending from central Mexico north into parts of southeastern Arizona, and southern New Mexico and Texas. Adjacent to the main part of the Chihuahuan Desert are several disjunct, dry, inter-montane valleys, canyons and depressions that contain an important part of the region’s biodiversity; these desert fragments are home of a considerable number of cactus species and even contain endemic genera, of which Aztekium, Geohintonia and Obregonia are examples.

The hottest, driest and lowest areas of this desert are in the Rio Grande and Trans-Pecos regions of Texas (600 m elevation at the valley bottom), in the Bolaón de Cuatro Ciénegas, Coahuila (740 m), and in the Bolaón de Mapimi, Durango (1075 m). As elevation increases so too does the rainfall. The northernmost areas receive some snow during the winter months but, as the elevation decreases and as one moves south, average temperatures rise and the seasons without frost become longer.

An amazing diversity of cacti

The cactus family (Cactaceae) occurs throughout the Americas, mainly in dry or highly seasonal regions in Mexico, southern United States, eastern Brazil, and parts of Bolivia, Peru and Argentina. It comprises about 100 genera and 1500 species worldwide. Its highest diversity is in Mexico, where about 50 genera and 550 species have been recorded. A reflection of their uniqueness and representa-
Conservation strategies

In Mexico, as well as in several other countries, cacti are a highly endangered group of plants. It has been estimated that at least one third of the Mexican species are threatened species. In the Chihuahuan Desert, natural populations of a number of species have been considerably affected by the collection of plants for use as ornamentals or as collectors’ items. Although Mexican environmental authorities have developed a legal framework to prevent illegal collecting of flora and fauna, there is evidence that plants and seeds of Mexican cacti are still being illegally collected in the field. An additional factor affecting the conservation status of Chihuahuan Desert cacti is the deterioration of the habitat. Agricultural development, goat and cattle raising, mining, road construction, dam building, and other human activities have modified large parts of this desert, in cases dramatically.

These forms of disturbance have had a tremendous impact on cactus populations because these plants usually have slow growth rates, long life cycles, and tend to exist in low population numbers. All of these factors make Chihuahuan Desert cacti extremely vulnerable to disturbance.

The entire cactus family is included in Appendix II of the Convention on International Trade of Endangered Species (CITES). Specifically, 33 of the species in the Chihuahuan Desert are on Appendix I. Similarly, 257 Mexican Cactaceae are included in Mexico’s official list of threatened species, of which 116 are found in this desert. Many species of which has over 100 cactus species of which have been recorded throughout the Chihuahuan Desert, including Arizona, New Mexico and Texas, and elsewhere well beyond the desert.

A recent study of cactus diversity in the Chihuahuan Desert shows that almost 70% of the species are endemic to the region. If we analyze their distribution pattern shows that species diversity is not distributed evenly. Diversity is concentrated towards the eastern and southeastern fragments of the region, in the Mexican states of San Luis Potosí, Coahuila, Nuevo León and Tamaulipas, each containing more than 100 cactus species. It is in this portion of the Chihuahuan Desert that most of the best known, cactus-rich localities are located; these include El Huizache, Mixteco Ortejo, Doctor Arroyo, Matahuila, Tula, Jaumave and Cuatro Ciénegas.

A recent study of cactus diversity in the Chihuahuan Desert, including the region, we can ask where the geographically persistent species are located. If we consider only the 79% species restricted to one state, we find that the Mexican states of Coahuila, San Luis Potosí, Nuevo León and Tamaulipas are the richest, with 14, 13, 10, and 9 endemic species respectively. Of these four Mexican states, only the Chihuahuan Desert, but also have the most endemic species.

If we repeat the analysis on a smaller scale, we discover that some cactus species have extremely small areas of distribution, which we can map with a high degree of precision. The most extreme examples are of species that are known only from one or a few localities, such as Arrojocactus brauneri, A. scaphirhizus, Aztekium hintonii, Echinocereus waddii, Mammillaria carmenae, Opuntia cheffeyi and Turbinicarpus subterraneus.

Another form of rarity is when the population numbers of a species are low. Turbinicarpus subterraneus, for example, is known only from two populations in southern Nuevo León; in one of the populations only a handful of individuals have been found. An even more extreme example is that of Opuntia cheffeyi, also known only from two disjunct localities in Zacatecas. Extensive searching at the two known populations of this species has revealed no more than 20 individuals in total. Examples such as these portray cactus species that are both geographically and ecologically rare. Such examples are not uncommon in the Chihuahuan Desert.

A different form of rarity in cacti is exemplified by Sclerocactus uncinatus, a widespread species in the Chihuahuan Desert, with numerous populations recorded from central Mexico to southern Texas. We have made over 100 counts of this species along 2–3 km transects, and in most of the samplings we found that this species is extremely rare in terms of numbers of individuals. Species such as this one – geographically widespread but locally rare – abound in the Chihuahuan Desert. Indeed, it is likely that rarity is a natural phenomenon among cacti in the Chihuahuan Desert. It may be a result of past ecological factors, such as climate changes, including to minimum and maximum temperatures and to rainfall, that have affected plant distributions in the past. However, during the last century, human activities have caused these plants to become even more rare.

The conservation challenge

Conservation strategies

Cacti are perhaps the group of organisms that most justify conservation activities within the Chihuahuan Desert. However,
I travel widely in Europe and elsewhere, often with tour groups in search of flowers. It was on my return to England from one such trip to Greece, where I had been waxing lyrical to a group of British naturalists about the superb displays of flowers, that no-one had produced an illustrated book to show just how attractive our native (and some introduced!) wildflowers can be en masse; and that most people in Britain are probably entirely unaware of what is there to be seen and enjoyed, often on the doorstep. This was the genesis of the book *Flowers at my feet*, produced in collaboration with, and partly in aid of, the UK charity Plantlife, to try to raise awareness of how much floral richness our flora is, and that most people in Britain are probably entirely unaware of what is there to be seen and enjoyed, often on the doorstep.

There is no denying that the native flora of the British Isles is not a rich one. Thanks to the destruction of our flora during last Ice Age, and the re-flooding of the North Sea and English Channel before full re-colonization had been achieved, we have never recovered the full complement of plant species that other European countries possess. So our flora is now poorer than that of equivalent areas of northern Europe. We have few endemic species either, perhaps due to the short time of isolation, and a cool climate which lengthens generation times. Many high profile British ‘rarities’, such as the orchid Red Helleborine (*Cephalanthera rubra*), or the sage Meadow Clary (*Salvia pratensis*), to which considerable conservation efforts are understandably devoted, are common, even abundant, not far away on mainland Europe. Yet there is more to wild plants, and their conservation, than biodiversity, endemism and rarity. Britain, despite an impoverished flora, vast areas of intensively managed agricultural land, and a high human population density, still retains some wonderful displays of flowers in superb and varied scenery, and this is a difficult task due to the extraordinarily high beta-diversity in this region.

There are several important protected areas in the Chihuahuan Desert. On the U.S. side the most important ones are La Jornada Experimental Range, Big Bend National Park and White Sands National Monument. During the last 30 years, several protected areas have been created in Mexico and these have contributed in various degrees to the conservation of the region’s flora and fauna. Outstanding among these are the Mapimí Biosphere Reserve, the Cántaros de San Juan de los Lagos Reserve, the Maderas del Carmen Wildlife Refuge, and the Metztitlán and Sierra Gorda Biosphere Reserves. However, most of these still are exposed to negative pressures and some of those on the Mexican side lack sufficiently trained personnel and adequate budgets. Also, only about 2.5% of the Chihuahuan Desert area is under any kind of protection, far too low a proportion for such an important area of plant diversity. Moreover, due to the lack of comprehensive knowledge on these areas, regarding, for example, their flora and fauna, the physical environment (geology, soils, climate) and ecological interactions, we have not been able to propose alternative forms of land use that would conserve the flora and be sustainable. In countries such as in Mexico, the degree of knowledge of these basic elements is very low compared to that in developed countries.

A significant addition to the previously existing protected areas within the Chihuahuan Desert was the creation of the ‘Real de Guadalcázar Protected Natural Area’. Based on knowledge from our studies on the Cactaceae of El Huizache, a few years ago, the Government of San Luis Potosí passed a decree creating this protected area. Covering 188,758 hectares, it was designed not only to preserve the diversity of cactus species from El Huizache and surrounding areas, but also the range of vegetation types found in the area, and several other plant and animal groups whose diversity and degree of endemism is comparatively greater than there in other parts of the Chihuahuan Desert. Without doubt, the creation of this protected area is a good example of the marriage between science and conservation practice.

Despite this and other conservation achievements, many of the critical areas of high cactus species richness and endemism are not yet protected. The number of areas under formal protection in the Chihuahuan Desert definitely needs to be increased. The selection of these should be based on a thorough analysis of variables such as species richness, degree of endemism, taxonomic uniqueness, and habitat diversity. Undoubtedly, conservation efforts in this region should be intensified, through the consolidation of the already existing natural protected areas and the creation of new ones.

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