

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA



Twenty-fifth meeting of the Plants Committee
Geneva (Switzerland), 17 and 20-23 July 2020

Species specific matters

Maintenance of the Appendices

Periodic Review of species included in Appendices I and II

PERIODIC REVIEW OF *ARIOCARPUS RETUSUS*

1. This document has been submitted by Mexico (Scientific Authority of Mexico – CONABIO).*
2. During the 23rd meeting of the Plants Committee (Geneva, Switzerland, July 2017), in response to Notification to the Parties No. 2017/069, Mexico volunteered to assess *Ariocarpus retusus* as part of the periodic review of species included in the CITES Appendices in accordance with Resolution Conf. 14.8 (Rev. CoP17).
3. *Ariocarpus retusus* is a cactus that is endemic to Mexico. Its distribution is restricted to the Chihuahuan Desert, where it grows on rocky limestone hills with dry shrubland vegetation. The potential area of distribution of the species is about 100,000 km², but its area of occupancy has been estimated to range between 10,490 km² and 12,661.15 km². Only 8.6% of the area of occupancy of *A. retusus* falls within a protected area. The estimated population size was ~ 9,252.36 individuals in 2019. The species has intrinsic biological, reproductive and demographic restrictions which, combined with changes in land use and illegal harvest of wild specimens, pose a threat to the persistence and viability of its wild populations.
4. There is high demand of *A. retusus* in international trade because it is one of the species most appreciated by collectors. Between 2000 and 2018, over 800 exports were recorded in the database of the World Conservation Monitoring Centre (UNEP-WCMC). Between 2019 and 2020, a total of 1,591 individuals of *A. retusus* were recorded to be offered for sale online. Yet, only Germany, Italy and the Czech Republic have registered nurseries that artificially propagate the species.
5. After reviewing the status of the species, Mexico recommends that *Ariocarpus retusus* remain in CITES Appendix I, in accordance with the following criteria of Resolution Conf. 9.24 (Rev. CoP17), Annex 1: A (i, ii, iii, v), B (i, ii, iii, iv), C (i, ii).

* The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.

A. Proposal resulting from the periodic review

Maintain *Ariocarpus retusus* in CITES Appendix I, in accordance with the following criteria of Resolution Conf. 9.24 (Rev. CoP17), Annex 1: A (i, ii, iii, v), B (i, ii, iii, iv), C (i, ii).

B. Proponent

Mexico*

C. Supporting statement

1. Taxonomy

1.1 Class: Magnoliopsida

1.2 Order: Caryophyllales

1.3 Family: Cactaceae

1.4 Genus, species or subspecies, including author and year: *Ariocarpus retusus* (Scheidw 1938)

1.5 Scientific synonyms: See Annex 1

1.6 Common names: English: Wild peyote, living rock, seven stars
French:
Spanish: chaute, chautle, falso peyote, peyote cimarrón, pezuña de venado, cactus estrella, peyote brujo, peyote loco

1.7 Code numbers: 18189

2. Overview

At the 23rd meeting of the Plants Committee (2017, Geneva), Mexico volunteered to assess *Ariocarpus retusus* as part of the Periodic Review in accordance with Resolution Conf. 14.8 (Rev. CoP17) during the period between CoP17 and CoP19.

3. Species characteristics

3.1 Distribution

Ariocarpus retusus is endemic to Mexico; it is the species with the second largest distribution of the genus *Ariocarpus* (Hernández *et al.* 2010) and occurs in the States of Coahuila, Nuevo León, San Luis Potosí, Tamaulipas, Zacatecas and possibly Durango (Bravo-Hollis & Sánchez-Mejorada 1991; Guzmán *et al.* 2003).

The current distribution of *Ariocarpus retusus* was determined by developing a potential distribution map based on georeferenced records of occurrence of the species and abiotic variables (Fig. 1). The resulting model suggests that *A. retusus* has a potential distribution of 113,138 km², which represents approximately 21.2% of the total area of the Chihuahuan Desert, which is 533.660 km² (Hernández *et al.* 2010). However, the distribution of the species may have been overestimated, as the model predicts suitable habitat sites based on environmental factors, without considering biological variables such as biotic interactions or even the life history of the species. According to Hernández and Navarro (2007), the species has an uneven distribution and requires specialized or restricted sites to become established,

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such as rocky hills, which implies that its area of occupancy may in fact range between 10,490 km² and 12,661 km², which represents only 11.2% of its current estimated potential distribution (Fig. 1).

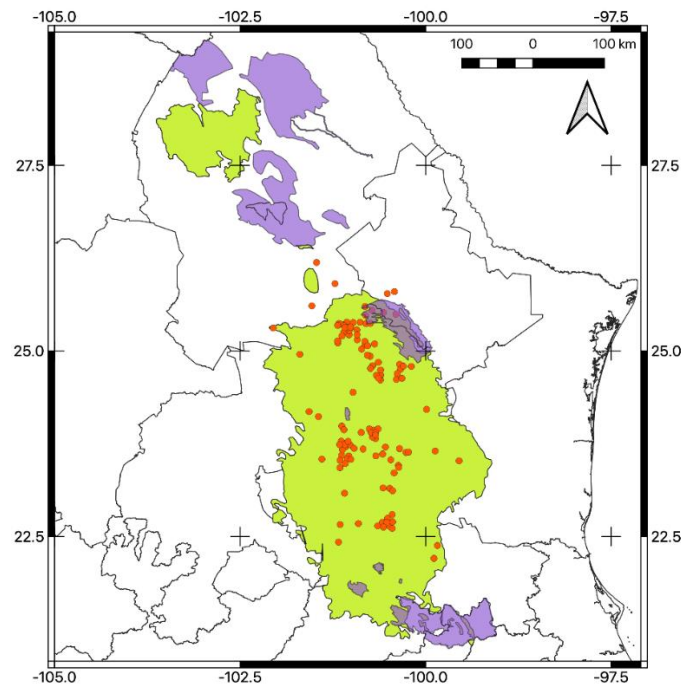


Figure 1. Records of presence (red dots) and potential distribution (in green) of *Ariocarpus retusus* in Mexico in the States of Coahuila, Nuevo León, San Luis Potosí, Tamaulipas and Zacatecas. Areas in purple are protected areas in or near the species' area of distribution.

3.2 Habitat

The species occurs in desert and semi-desert areas of Mexico, on rocky limestone hills (Bravo-Hollis & Sánchez-Mejorada 1991, Rodríguez-Garza *et al.* 2011), in slopes ranging between 4 and 19° (Villavicencio Gutiérrez *et al.* 2010). It grows at elevations between 1,300 and 2,384 MASL, although in some sites of the State of Nuevo León it can be found in areas below 500 MASL (Flores 2011, Villavicencio Gutiérrez *et al.* 2013). The climate of the areas where *A. retusus* occurs is predominantly of the BSh type (i.e., warm steppe) with warm temperatures all year round and low rainfall, ranging between 250 and 500 mm annually. The soil where it generally grows is lithosol (or leptosol), that is, shallow soils (10 cm) that are rocky with abundant calcareous material. In 94.4% of the sites where *A. retusus* occurs, the predominant vegetation is dry scrub (Rzedowski 1978). It grows among individuals of its same species, rocks, other cacti and also under the canopy of plants such as *Jatropha dioica* and *Dasylium longissimum*; this interaction is known as nursing. These nurse plants or objects can modify environmental conditions and generate a less extreme microclimate, which contributes to the establishment and growth of the species (Valiente-Banuet & Ezcurra 1991; Ramírez Collantes 2011).

3.3 Biological characteristics

Individuals of *A. retusus* start to reproduce once they have reached a diameter greater than 6 cm. Given that the species is slow growing, it can take up to 10 years to reach flowering size in cultivation (Sato & Sugiri 1996; Kessler & Stupp 2006; Cárdenas-Ramos 2015); this delay is probably different in wild conditions. Reproductive individuals of ~ 6 cm in diameter often produce one flower bud per reproductive season (September-November); by contrast, larger, older individuals produce up to five flowers, which allows the development of more fruits and seeds. The species only reproduces sexually (Flores 2011, Martínez-Peralta & Mandujano 2012), so it requires a sufficient number of reproductive individuals to flower at the same time and enough pollinators available (mainly bees; Martínez-Peralta & Mandujano 2012).

Seed release immediately follows the dehiscence of mature fruits. Seeds can be dispersed by water (hydrochory), wind (anemochory) or gravity (barochory; Rodríguez 2008, Flores 2011, Martínez-Peralta 2014c). Seeds are positively photoblastic (i.e., germination is induced by light; Flores & Jurado 2011, Rojas-Aréchiga *et al.* 2013) and exhibit physiological dormancy (i.e., certain conditions are required for maturation of the embryo; Orozco-Segovia *et al.* 2007). Seedlings start to develop secondary roots about 15 days after germination, and the first couple of tubercles grows between the cotyledons about 20 days after radicle emergence. Tubercles have five setose spines (i.e., with stiff hairs) at their tips (Olguín Santos 1994).

3.4 Morphological characteristics

A. retusus is a subglobose cactus that is predominantly solitary and has a geophytic habit, given that its roots or stems can be found below the soil surface (Raunkiaer 1934; Vázquez-Sánchez *et al.* 1982; Bravo-Hollis & Sánchez-Mejorada 1991; Aguilar-Morales *et al.* 2011; Martínez Peralta 2014c). The underground stem has a highly developed system of mucilaginous canals that allows it to store water during the driest months of the year (Anderson 1962; Vázquez-Sánchez *et al.* 1982; Bravo-Hollis & Sánchez-Mejorada 1991). The plant has the shape of a rosette 12 cm high and 10-25 cm in diameter (Fig. 2a). The apex of the plant has numerous long setose white or yellowish trichomes that form a “wool” that grows from the flower areoles. The globose fleshy stem is buried in the soil and composed of numerous triangular tubercles that are attenuated toward the base, arranged in spirals. Tubercles are slightly longer than wide, 1.5-4 cm long and 1-3.5 cm wide. They are glaucous, greyish-green, with a chartaceous texture (i.e., like that of paper or parchment) and a convex or flat surface with shallow undulations or wrinkling, not fissured. Tubercles end in sharp tips, with small, circular, woolly spiniferous areoles 1-5 mm in diameter with or without small vestigial spines (Fig. 2b; Anderson 1962, Bravo-Hollis & Sánchez-Mejorada 1991, Olguín Santos 1994).

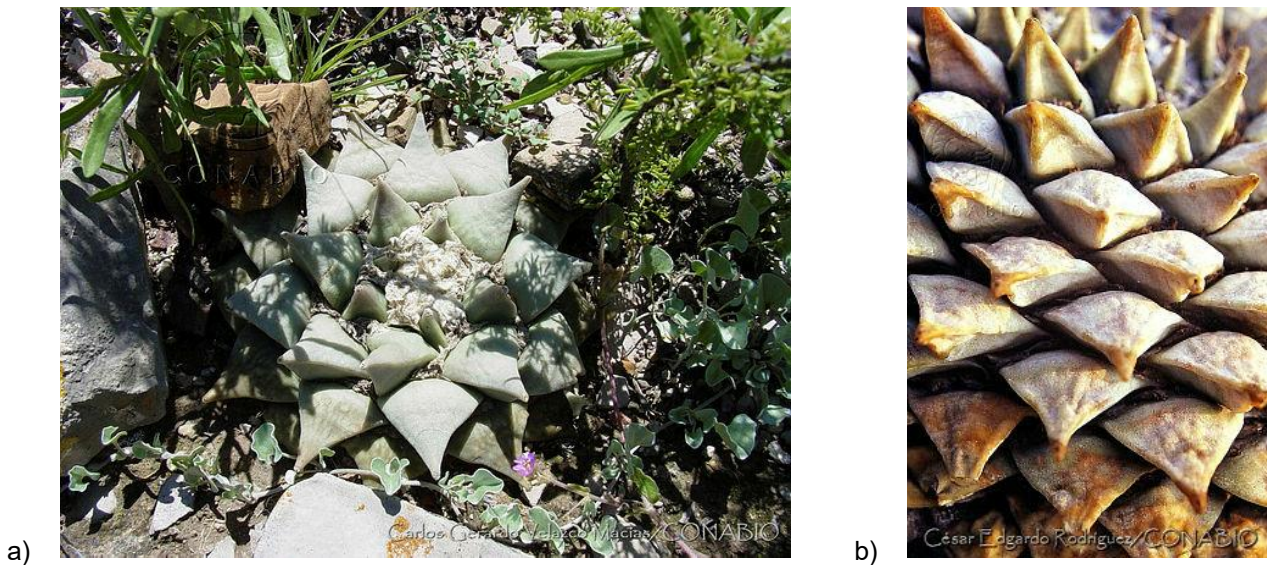


Figure 2. a) Upper view of a specimen of *Ariocarpus retusus* (Photo: Carlos Gerardo Velazco Macías); b) Close-up view of the tubercles of *A. retusus* (Photo: César Edgardo Rodríguez Ortega; both images taken from the image bank of CONABIO <http://bdi.conabio.gob.mx/fotoweb/>)

Flowers are hermaphrodite, campanulate or infundibuliform (i.e., funnel shaped), and grow from the centre or the sides of the apex (Villavicencio Gutiérrez *et al.* 2013). They are white, sometimes tinged with pink (Martínez-Peralta & Mandujano 2012). Pollen is tricolpate (i.e., with three grooves on each grain); there are 5-130 pollen grains per anther in flowers exposed to pollinators, and up to 249,572 pollen grains in an entire flower; grain size is 80-85 microns (Bravo-Hollis & Sánchez-Mejorada 1991, Martínez-Peralta *et al.* 2014b, Cárdenas-Ramos 2015).

The fruit is ovoid, emerges from the apex and measures 20-25 mm long; it is greenish white or light pink, with dry floral remains at its apex. Seeds are tuberculate, black with a small aril; they have a diameter not exceeding 1.5 mm, weigh 0.911 mg and are 1.458 mm long and 1.163 mm wide on average. One fruit can bear 6-136 seeds (76 seeds per fruit on average; Bravo-Hollis & Sánchez-Mejorada 1991, Kessler & Stupp 2006, Rojas-Aréchiga *et al.* 2013, Martínez-Peralta *et al.* 2014b, Martínez-Peralta 2014c).

3.5 Role of the species in its ecosystem

Flowers are a refuge, a mating site and a source of food for other species (Annex 2). Pollinators seeking pollen or nectar are mainly solitary native bees of several families and some beetles that can be florivorous. Grasshoppers (Orthoptera) feed on the tubercles of the plant. Ants (Formicidae) collect wool from the apical area and also the stamens and petals of plants close to anthills (Cárdenas-Ramos 2015, Martínez-Peralta & Mandujano 2012). When predated upon, the plant can exude a sticky white substance (Flores 2011). Spiders use the flowers as sites to hunt insects such as bees.

4. Status and trends

4.1 Habitat trends

Of the potential area of distribution estimated for *A. retusus* (113,138 km²) in 2009, 16% (18,107.45 km²) was undergoing changes in land use towards agriculture, livestock farming, forest plantations and urban areas. By 2017, 26.24% (29,690.55 km²) of the potential area of distribution of the species had been modified to conduct economic activities. Considering these data, the rate of habitat loss (Th) was calculated as a ratio between the area (km²) used for economic activities in 2017 and the area (km²) that experienced changes in land use in 2009. The value obtained was Th = 1.4740, which suggests that in a period of eight years (2009-2017) changes in land use increased by 47.40% in areas with natural vegetation.

Potential distribution models do not consider the influence of anthropic activities, although these variables play a key role in the establishment of *A. retusus*. Dr. Mandujano, from the National Autonomous University of Mexico (UNAM), who conducted the study supporting this review (Mandujano, M. C., in prep.), reported that, by 2017, 29,657.83 km² of areas with plant cover had shifted to agriculture, livestock farming (intensive or extensive) and forest plantations, and 32.72 km² had become urban areas. This represents a loss of 26.24% (29,690.55 km²) of the current potential area of distribution. If we consider the influence of anthropic activities on the persistence of *A. retusus*, it can be inferred that the current potential area of distribution of the species is 83,447.45 km²; yet, the decrease in the area may be even greater, considering that the projection was based on information on land use and vegetation dating from 2017.

4.2 Population size

In a wild population of *A. retusus*, it is possible to find 1-233 individuals in 50 m²; a population has 79.08 (\pm 20.20) individuals on average. If we consider the average number of individuals per population and the number of populations found (i.e., 117 records of presence), it can be inferred that 9,252.36 individuals of *A. retusus* still remain in small wild populations in the States of Coahuila, Nuevo León, San Luis Potosí, Tamaulipas and Zacatecas.

4.3 Population structure

The population structure of *A. retusus* has the following size classes:

Size category	Diameter (cm)
Seedlings	< 3
Juveniles	3.1-6
Adults 1	6.1-9
Adults 2	9.1-12
Adults 3	12.1-15
Adults 4	15.1-18
Adults 5	18-21

Twelve sites of occurrence of *A. retusus* of which there were previous herbarium records were surveyed (Aguilar-Morales et al. 2011); in all of them, the least represented size class was Adults 5 (18.1-21 cm in diameter), that is, the specimens that contribute the most to the fecundity of the population and can potentially produce the largest amount of fruits and seeds per reproductive period (Cárdenas-Ramos 2015).

Researchers observed an irregular frequency of individuals among the various size classes (Mandujano et al. 2001). The class “Seedlings” as well as the largest size classes had a very low frequency of individuals, whereas the intermediate size classes had a high frequency of individuals. This population structure is also found in other species of the genus *Ariocarpus* (Mandujano et al. 2007, Mancilla 2012). This population pattern is due to the fact that extreme environmental conditions prevent the establishment of new individuals and the growth of individuals in intermediate classes, which suggests that remaining in the same size class or development stage is common in the populations. The low frequency of individuals in the largest size classes may reveal that there is low survival of adult individuals or that such individuals are continuously harvested (Mandujano et al. 2007; Mandujano et al. 2001).

4.4 Population trends

The projected potential distribution of the species in 2050 (see Section 4.5) applying climate change scenarios developed for this review yields an estimated loss of 18 populations by 2050. Also considering that about 117 individuals of the species are illegally harvested every year, it is estimated that by 2050 the population will have dropped to 5,030.64 individuals, which represents a potential loss of 45.62% of individuals compared to the estimated population size. However, population size may be even smaller, given that the projected potential distribution does not consider changes in land use, which determine the persistence of wild populations of *A. retusus*.

4.5 Geographic trends

Future potential distribution maps were developed for the year 2050 based on the French CNRM-CM5 model tested for Mexico (Fernández Eguiarte *et al.*, 2015), considering two climate change scenarios or representative concentration pathways (RCPs). In an RCP 4.5 (i.e., conservative) climate change scenario, the projected distribution of *A. retusus* is 106,938 km²: this implies a decrease of 6,200 km² compared to the current projected distribution. Considering the changes in land use recorded until 2017 (29,690.55 km²), the potential area of distribution in 2050 would be 77,247.45 km² (Annex 3, a) compared to the current distribution. By contrast, in an RCP 8.5 (i.e., extreme) climate change scenario, the species' potential area of distribution would be 108,496 km², that is, 4,642 km² less than the current distribution; considering the same changes in land use, the area of distribution would be 78,805.45 km² (Annex 3, b).

5. Threats

A. retusus is overexploited due to its growing offer and demand because it is one of the cactus species most appreciated by collectors (see Section 6.4).

Changes in land use are another of the main causes of the loss of this species. For example, in 2013 a wild population of *A. retusus* was found in an area close to the town of Miquihuana (Tamaulipas). It had 1,605 individuals and a density of 5.33 ind/m², so the conservation status of the population was good. However, the land where the population occurred was cleared to build a watering hole for livestock. This anthropic event caused the loss of up to 2,000 individuals (Cosultchi *et al.* 2014, Cárdenas-Ramos 2015). Following the change in land use, it was observed that the remnants of natural vegetation were unable to recover in the short term: the cleared area was colonized by onion weed, an invasive species (*Asphodelus fistulosus*; Guerrero-Eloisa 2019). In fact, the areas where *A. retusus* occurs are constantly subjected to anthropic pressures.

Livestock farming is the economic activity that contributes the most to the decline in the habitat and the death of individuals of *A. retusus*. In some places where exotic pastures have been introduced for the livestock, the death of some individuals of the species has been recorded, which suggests that *A. retusus* is sensitive to changes in plant composition. Livestock not only compacts the soil but also damages the vegetative structures of individuals or causes the death of certain plants by trampling (Cárdenas-Ramos 2015). Areas where the species grows are also used to dump waste or to build urban areas or roads. Road construction causes the fragmentation of populations and facilitates access to wild populations, which leads to the illegal harvest of specimens.

6. Utilization and trade

6.1 National utilization

In Mexico, several species of the genus *Ariocarpus*, including *A. retusus*, have been used to make glue and other adhesives for traditional – not industrial – purposes with the mucilage produced in the stem (Bravo-Hollis & Sánchez-Mejorada 1991, Batis & Royas 2002). Communities in the neighbouring areas of Cumbres de Monterrey National Park, in the State of Nuevo León, use *A. retusus* as a remedy against body pains and headaches. This requires using the entire plant, which is eaten or prepared in infusions (Cantú *et al.* 2013). In the Huichol indigenous communities of Durango and Zacatecas, the plant is known as “false peyote”, as it is considered to have magical properties similar to those of peyote (*Lophophora williamsii*). It causes hallucinations because secondary metabolites of the alkaloid group (hordenine, N-methyl-3, 4-dimethoxyphenethylamine, N-methyl-4-methoxyphenethylamine) and phenols (N-methyltyramine, retusin 5-hydroxy-3,3,4,7-tetramethoxyflavone) are synthesized in the vegetative structures (i.e., tubercles) of the plant (Batis & Royas 2002).

A. retusus has been used in traditional medicine as a remedy against fever (Bruhn & Bruhn 1973) and to fight skin diseases caused by fungi. Various secondary metabolites such as phenols (coumarins, flavonoids, leucoanthocyanins, phenolic hydroxyls), terpenes (sterols, methyl sterols, saponins, sesquiterpenelactones) and alkaloids that act as antifungal agents are synthesized in the stem and roots. A study found that the saponins synthesized in the stem inhibited growth of the fungi *Microsporium cookei* and *Trichophyton tonsurans* (Rodríguez-Garza *et al.* 2011).

6.2 Legal trade

The UNEP-WCMC database contains records of 817 exports and 16 re-exports of *A. retusus* between 2000 and 2018. Most exports (687; 84%) were reported to be for commercial purposes (T); they all involved artificially propagated live plants or seeds (using both source codes D, which refers to exports of Appendix-I plants artificially propagated for commercial purposes, and A, used wrongly). Only four re-exports with source code W (wild) were reported, three of which had Mexico as country of origin. These transactions took place in 2000, with the following purposes: G (botanical garden), L (law enforcement/judicial/forensic) and N (reintroduction or introduction into the wild). Slightly over half of all the exports were exports of seeds (411 exports, equivalent to ~ 239,564 seeds) and fewer exports involved live plants (404 exports, equivalent to ~ 11,261 individuals). The greatest exporters during this period were the United States of America, with 348 exports, followed by Thailand, with 238 exports; neither the USA nor Thailand – which together represent 78% of the transactions – have nurseries registered with the CITES Secretariat that artificially propagate specimens of Appendix-I plant species for export purposes (https://www.cites.org/esp/common/reg/s_nu.html), as established by Resolution Conf. 9.19 (Rev. CoP15). During the above-mentioned period (2000-2018), 66 countries imported plants or seeds of this species. Switzerland was the main importer and reported 92 imports involving a total of 1,436 live plants and 21,390 seeds.

During that 18-year period, Mexico only reported one legal export in 2018 of one live artificially propagated plant for personal purposes (P), 8 imports of seeds and 3 imports of live plants re-exported from other countries but whose country of origin was Mexico.

To date (April 2020), only Germany (2), Italy (4) and the Czech Republic (4) have operations included in the Register of nurseries that artificially propagate specimens of Appendix-I plant species for export purposes (https://www.cites.org/esp/common/reg/s_nu.html).

In Mexico there are 26 intensive Wildlife Management and Conservation Units (UMAs, Spanish acronym), that is, nurseries that deal with conservation aspects of the wild species they manage, six botanical gardens and 19 other nurseries that are authorized to use *A. retusus*; none of them are registered in the CITES Secretariat in accordance with Res. Conf. 9.19 (Rev. CoP15).

In the nursery called La Biznaga Vagabunda, located in the town of Ezequiel Montes in the State of Querétaro, it is possible to acquire a seedling of *A. retusus* for about \$3 USD, which is between \$0.20 and \$15 USD less than its sale price in the illegal market. Economic competition between cactus producers and cactus poachers could be an advantage in combating the illegal harvest of wild specimens.

6.3 Parts and derivatives in trade

Specimens are sold at various stages of their life cycle and different sizes. There is continuous offer and demand of seeds or whole plants, and other parts and derivatives of the plant – tubercles, buds, flowers, fruits or wool – are also traded (see next section).

6.4 Illegal trade

In the period between 2000 and 2018, the WCMC-UNEP database recorded 6 illegal exports from and to several countries, involving about 52 live plants of *A. retusus*, and one illegal re-export (in 2000) of 4 plants originating from Mexico.

Arroyo-Quiroz and Wyatt (2019) reported that, between 1980 and 2017, there was a record of an illegal export of 4 plants and seeds (quantity unknown) of *A. retusus* to the Czech Republic and up to 89 plants whose final destination was not specified. At the 11th meeting of the Plants Committee (Malaysia, 2001), the Scientific Authority of Mexico reported that *A. retusus* was the cactus species most frequently offered for sale online, with 79 records (PC 11 Doc 21.2). According to a survey of online trade of the species, conducted by Dr. Mandujano (Mandujano, M. C., in prep.) between 2019 and 2020, in a period of four months 326 illegal online transactions were recorded, involving more than 1,500 plants and over 5,000 seeds, quantities four times higher than those recorded in 2001. Of the total records, 6.8% involved websites in Mexico, and 93.2% involved websites in other countries. The survey revealed 26 online shops offering plants and/or seeds for sale, and 114 private individuals offering the species for sale in platforms such as AliExpress, Amazon, bidorbuy (South Africa), eBay, ETSI, Facebook and Mercado Libre.

Dr. Mandujano also found a high frequency of specimens offered for sale illegally online in several countries, such as China, the United States and Italy, where it is possible to acquire seedlings and even adults with flowers, whereas in India and Canada the sale of seeds is more common. Of the 140 web pages in which *A. retusus* was offered for sale, four shops and 51 private individuals offered one specimen of *A. retusus* for sale, five shops and 12 private individuals offered two to ten specimens for sale, and three shops offered more than 100 individuals of the species for sale. Of the total records, it is worth highlighting five shops established in China that offered 100-445 seedlings for sale, with individual prices for each specimen ranging between \$14 and \$28 USD approximately (Mandujano, M. C., in prep.).

Mexican online shops do not specify whether they have any permits for the propagation and/or sale of the species. Moreover, in most cases they offer for sale adult plants with flowers which, considering their size, were probably wild harvested. The price of adult plants ranges between \$10 and \$285 USD. Seedlings of *A. retusus* can be purchased online for about \$3.25-\$18.25 USD, and on many occasions no sales note is produced.

In Germany, the sale price of an adult individual is \$21.6-\$103 USD, juveniles are sold for \$9.75-\$39 USD and a package of 10 seeds costs \$2.15 USD. Canadian websites only offer seeds of *A. retusus* for sale; a package of 10 seeds costs \$7 USD and a package of 100 seeds costs \$14.20-\$29 USD; none of these shops report having any permits to sell the species. Finally, between 2019 and 2020, a total of 1,591 individuals of *A. retusus* were recorded to be offered for sale online: 8.7% were adult individuals without flowers, 2.1% were individuals with flowers, 7.7% were juvenile individuals and 81.3% were seedlings; in addition, over 5,000 seeds were offered for sale.

In Mexico, the CITES law enforcement authority, known as PROFEPA (Procuraduría Federal de Protección al Ambiente) is in charge of conducting inspections and ensuring compliance with environmental protection legislation in the country. Since 2010, PROFEPA has seized two specimens of *A. retusus* at Mexico City International Airport. In 2010, an operation conducted on the federal road between San Luis Potosí and Matehuala led to the arrest of two people who had illegally harvested 87 plants, products and by-products of wild plants and animals, including specimens of *A. retusus* and other cactus species (PROFEPA 2010).

6.5 Actual or potential trade impacts

See sections 4.4. and 6.4.

7. Legal instruments

7.1 National

A. retusus is included in the Mexican list of species considered to be at risk on a national level (Anexo Normativo III, modificado en 2019, de la Norma Oficial Mexicana NOM-059-SEMARNAT-2010; DOF 2019, SEMARNAT 2010) in the category “Subject to Special Protection” (Pr), which refers to species that could become threatened by factors that have a negative influence on their viability, justifying the need to promote their recovery and conservation; this category is equivalent to the categories of lower risk of the IUCN Red List. According to Article 420, Section IV of the Mexican Federal Penal Code (CPF), the inclusion of *A. retusus* in the list of species at risk (NOM-059-SEMARNAT-2010) implies that any illegal activity for the purpose of trafficking, possession, transportation, storage, import or export is punishable with a fine equivalent to 300-3,000 days and a maximum of nine years’ imprisonment (CPF 2020). There is an additional penalty of three years’ imprisonment and a fine equivalent to up to 1,000 days if these illegal activities take place in or affect a protected area or are conducted for commercial purposes. The harvest and use of the species are also regulated by the Mexican General Wildlife Act (Ley General de Vida Silvestre).

7.2 International

There have been attempts to regulate international trade of *A. retusus* for several decades now; in 1975 the species was included in CITES Appendix II; in 1992 it was transferred to Appendix I, where it is currently included. It is also listed in Annex A of the Regulation (EU) of the European Parliament. In accordance with this regulation, trade of *A. retusus* with and within the European Union is monitored (Official Journal of the European Union 2019).

8. Species management

8.1 Management measures

Given that the species is included in the Mexican list of species at risk (NOM-059-SEMARNAT-2010) in the category “Subject to Special Protection” (Pr), the Department of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT) is responsible for its management, under the provisions of the General Ecological Balance and Environmental Protection Act (Ley General de Equilibrio Ecológico y Protección al Ambiente) and the General Wildlife Act (Ley General de Vida Silvestre) and their respective regulations. According to the General Directorate for Wildlife (Dirección General de Vida Silvestre, SEMARNAT), 124 authorizations for harvesting the species were recorded in the period between 2005 and 2018; all of them involved nurseries legally registered in the country.

8.2 Population monitoring

There are no particular measures in place for monitoring the population of the species.

8.3 Control measures

8.3.1 International

See Section 7.2.

8.3.2 Domestic

See sections 6.4 and 7.1.

8.4 Captive breeding and artificial propagation

In Mexico there are 26 intensive Wildlife Management and Conservation Units (UMAs, Spanish acronym), that is, nurseries that deal with conservation aspects of the wild species they manage, six botanical gardens and 19 other nurseries that are authorized to use *A. retusus*; none of them are registered in the CITES Secretariat in accordance with Res. Conf. 9.19 (Rev. CoP15).

To date (April 2020), only Germany (2), Italy (4) and the Czech Republic (4) have operations included in the Register of nurseries that artificially propagate specimens of Appendix-I plant species for export purposes (https://www.cites.org/esp/common/reg/s_nu.html).

8.5 Habitat conservation

Some wild populations of *A. retusus* occur in two protected areas: Parque Nacional Cumbres de Monterrey in Nuevo León and Área de Protección de Recursos Naturales Bajo Río San Juan, in the States of Coahuila and Nuevo León (Fig. 1). The habitat of *A. retusus* is directly protected in both areas. However, the percentage of the area of occupancy of the species that lies in protected areas is only 8.68%.

8.6 Safeguards

Protected areas are one of the protection measures implemented by the Mexican government to safeguard priority or endangered species, including *A. retusus* (see previous section).

Another way to safeguard the species is through botanical gardens, which enable the conservation and in some cases the propagation of species outside their natural habitat. Although there is no certainty about the number of specimens that are housed in botanical gardens, most of their living collections are composed of specimens donated by universities, the local, regional or national community or wild-harvested plants that were seized (Parra Suárez et al. 2017). For example, PROFEPA recovered 149 cactus plants, including one plant of *A. retusus*, which were handed over by SEMARNAT to the botanical garden of the National Autonomous University of Mexico (UNAM) in 2016 to take care of them (PROFEPA 2016).b

9. Information on similar species

Species of the genus *Ariocarpus* look very similar to each other. The differences lie mainly in the size of individuals; *A. retusus* and *A. trigonus* are the largest species of the genus (in diameter), and the remaining species measure less than 15 cm in diameter. The colour of the flower is another distinctive trait: in *A. kotschoubeyanus*, flowers may be pink, magenta or white, so they can be confused with those of *A. retusus*, but the arrangement and colour of the tubercles is a trait that can be used to distinguish both species. The tubercles of *A. fissuratus* have many fissures on the surface, and those of *A. bravoanus* are erect, unlike those of *A. retusus*, which are attenuated toward the base, with a flat surface (Anderson 1967, Bravo-Hollis and Sánchez-Mejorada 1991).

Other genera and species of the Cactaceae family may be confused with *A. retusus* or with other species of the genus *Ariocarpus* (Annex 4). Such is the case of the species *Aztekium ritteri*, *Obregonia denegrii*, *Strombocactus disciformis*, *Turbinicarpus alonsoi* and species of the genus *Lophophora*. The main trait that distinguishes them is the spines, which are absent or vestigial and thus imperceptible in *Ariocarpus*. In the genus *Lophophora*, spines are present in seedlings but not in adult plants; despite this similarity with *Ariocarpus*, both genera have different shapes: in *Lophophora*, the stem is composed of fused ribs and tubercles are absent (Anderson 1967, Bravo-Hollis & Sánchez-Mejorada 1991).

The genus *Ariocarpus* differs from the genus *Obregonia* in the reproductive season, particularly in the point from where the flower develops and also in the colour and shape of the flower. However, the seedlings of both genera are very similar to each other, and also the seeds, which have the same colour, shape and size (Anderson 1967, Bravo-Hollis & Sánchez-Mejorada 1991). The genus *Turbinicarpus* has flowers of the same colour as *A. retusus*, but flowering occurs at different times of the year and adult individuals have a different size – they are smaller in the genus *Turbinicarpus*. Adult individuals of the genus *Strombocactus* reach similar sizes to those of *A. retusus* and their flowers can have similar colours, but they differ in the reproductive season and the shape of the tubercles, which are triangular in *A. retusus* and rhomboid or pyramidal in *Strombocactus*. The genus *Aztekium* has tubercles of a similar shape and colour to those of *A. retusus*, but both genera differ in the colour of the flowers, the flowering season and the size. *Leuchtenbergia principis* has triangular tubercles that are similar to those of *A. retusus*, but differs in the colour of the flowers, the size of the individuals and the reproductive season.

10. Consultations

No other countries were consulted because the species is endemic to Mexico.

11. Additional remarks

12. References

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Annex 1

Synonyms or scientific names that have been accepted over the years to refer to the species (Bravo-Hollis & Sánchez-Mejorada 1991):

Anhalonium prismaticum Lemaire, Cact. Gen. Nov. Sp. 1, 1839.

Anhalonium retusum Salm-Dyck, Cact. Hort. Dyck. 1849 5 et 77, 1850.

Anhalonium elongatum SD. Cact. Hort. Dyck. 1849 5 et 77, 1850.

Mammillaria aloides Monville ex Labouret, Monogr. Cact. 153, 1853, nom. nud.

Anhalonium areolosum Lem., Illustr. Hort. 6, Misc. 35, 1859.

Anhalonium pulvilligerum Lem., Illustr. Hort. 16: 72, 1869.

Mammillaria aloides pulvilligera Monv. ex Lem., Illustr. Hort. 16: 72, 1869.

Mammillaria areolosa Hemsley, Biol. Centr. Amer. Bot. 1: 503, 1880.

Mammillaria elongata Hemsl., Biol. Centr. Amer. Bot. 1: 509, 1880.

Mammillaria prismatica Hemsl., Biol. Centr. Amer. Bot. 1: 519, 1880.

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Ariocarpus pulvilligeris Schumann ex Engler, Bot. Jahrb. 24: 550, 1898.

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Ariocarpus furfuraceus (S. Wats.) Thomps. var. *rostratus* Berger, Kakteen 334, 1929.

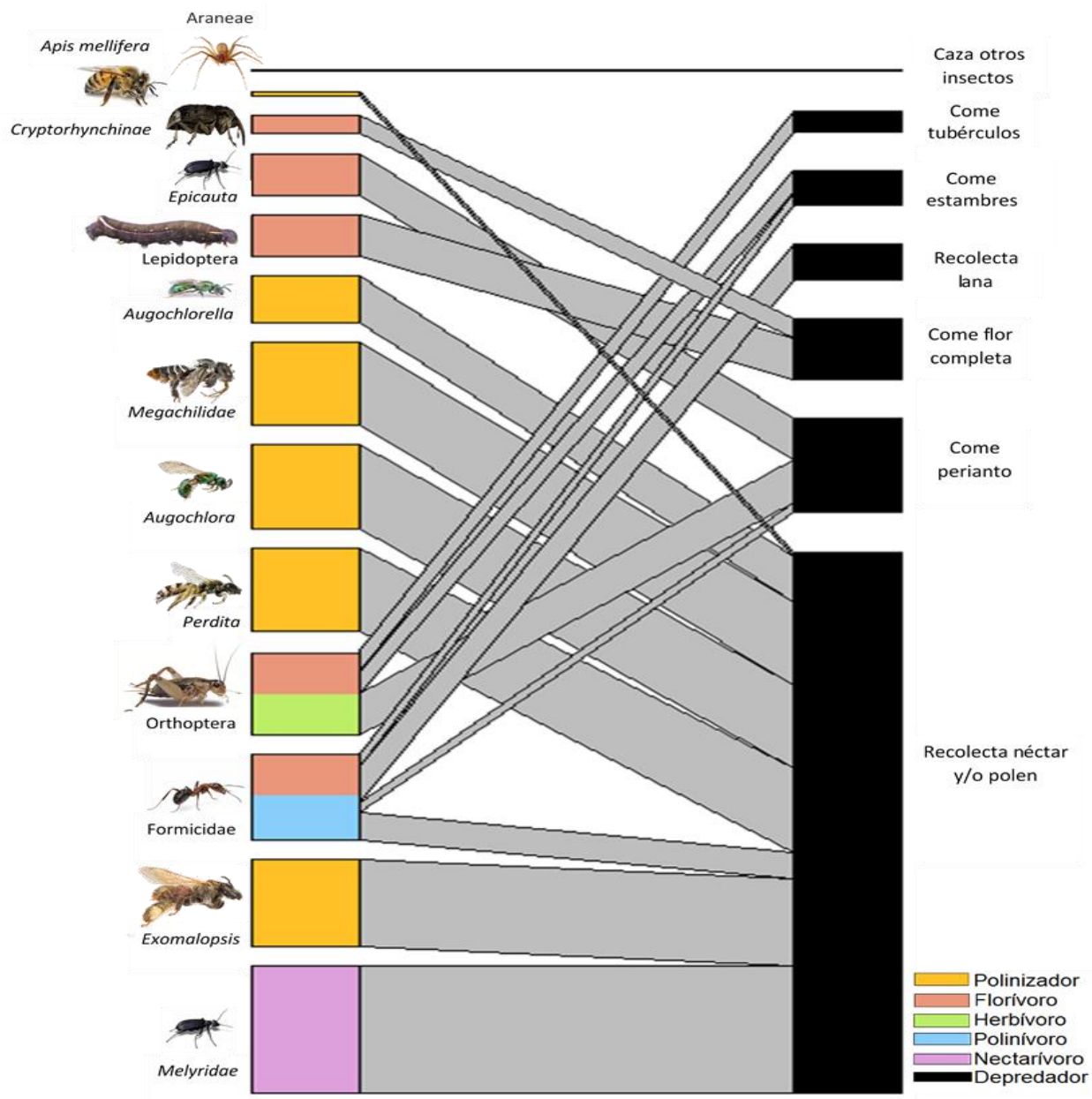
Ariocarpus elongatus (SD.) Wittstein, Kakteenkunde, 13, 1933.

Ariocarpus retusus Scheidw. var. *furfuraceus* (S. Wats.) Frank in Krainz, Die Kakteen CVIIIb, 1. 10. 1975.

Annex 2

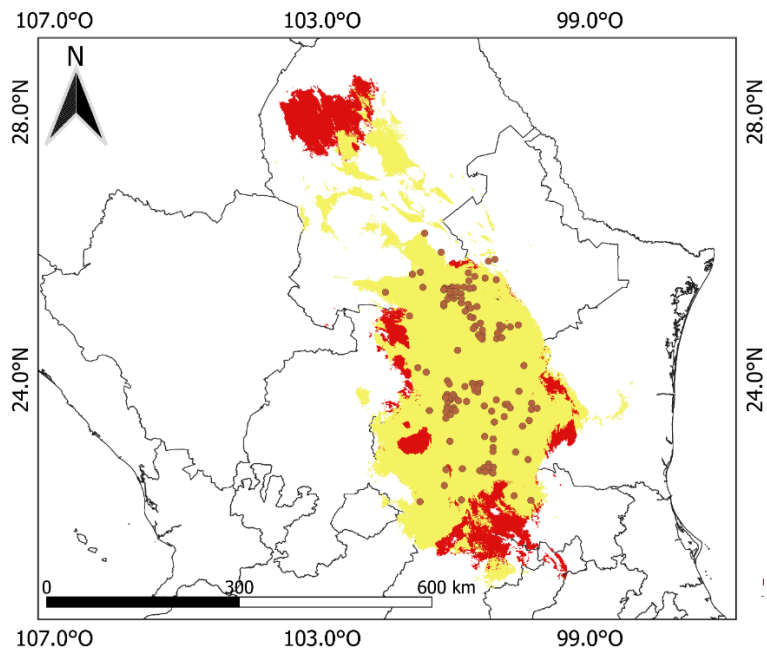
Interaction network of *Ariocarpus retusus*.

Based on data reported by Cárdenas-Ramos 2015 and Cárdenas-Ramos & Mandujano 2018.

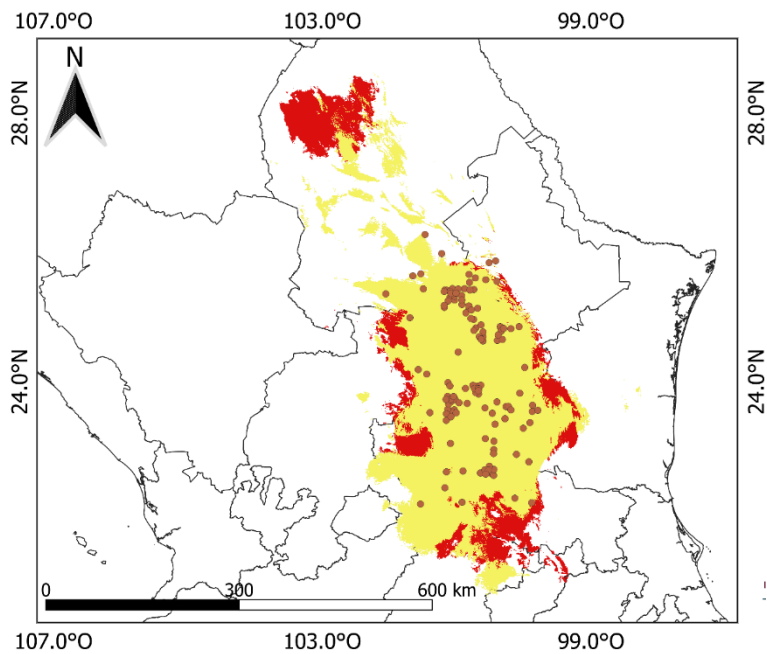


Annex 3

a) Potential distribution map of *Ariocarpus retusus* in an RCP 4.5 climate change scenario based on the CNRM-CM5 model. In yellow, potential distribution predicted for 2050; in red, current potential distribution that would be lost in this scenario.



b) Potential distribution map of *Ariocarpus retusus* in an RCP 8.5 climate change scenario based on the CNRM-CM5 model. In yellow, potential distribution predicted for 2050; in red, current potential distribution that would be lost in this scenario.



Annex 4

Similar species: 1) to 6) Based on data reported by Anderson 1967, Bravo-Hollis & Sánchez-Mejorada 1991.
7) Carlos Gerardo Velazco Macías, image bank of CONABIO.



1) *Aztekium ritteri*



2) *Leuchtenbergia principis*



3) *Lophophora*



4) *Obregonia denegrii*



5) *Strombocactus disciformis*



6) *Turbinicarpus alonsoi*



7) *Ariocarpus retusus*