

34° Congress of the International Organization for Succulent Plant Study

“Succulent plants in everyone’s life”

Jardín Botánico Regional de Cadereyta
‘Ing. Manuel González de Cosío’
Cadereyta, Querétaro, Mexico
October 23 - 28, 2017

Programme and Abstracts



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Programme

Monday 23

08:00 Registration

09:00 Opening ceremony

09:45 Morning Coffee

10:00 Keynote address

IS DEVELOPMENT, MORPHOLOGY, AND STRUCTURAL SUPPORT OF CEPHALIA
AND PSEUDOCEPHALIA ADAPTIVE?

Root Gorelick

Morning Session: Ecology of Cactaceae

11:00 EFFECT OF HABITAT DISTURBANCE ON THE GENETICS OF
STENOCEREUS QUEVEDONIS (CACTACEAE) IN INFIERNILLO,
MICHOCÁN, MEXICO

José Francisco Paz Guerrero, Alejandro Casas & Hernán Alvarado-
Sizzo*

11:30 DEMOGRAPHY AND REPRODUCTIVE PHENOLOGY OF *ECHINOCACTUS*
PLATYACANTHUS IN TECALI DE HERRERA, PUEBLA

José H. Quiroz Soberanes & Navarro Carbajal, M. C.*

12:00 Lunch

Afternoon Session: Conservation of Cactaceae

13:00 CONSERVATION STATUS OF PERUVIAN CACTACEAE

Carlos Ostolaza Nano

13:30 NATIONAL CONTRIBUTIONS OF THE PERUVIAN CACTUS AND
SUCCULENT SOCIETY – SPECS – TO THE KNOWLEDGE OF
PERUVIAN CACTI

Sidney Novoa

- 14:00 IDENTIFICATION OF PRIORITY AREAS FOR THE CONSERVATION OF
 ENDEMIC CACTI IN THE SONORAN DESERT REGION
Bárbara Larraín-Barrios & Héctor M. Hernández*
- 14:30 Afternoon Coffee
- 15:00 Poster Session
- 16:00 General Meeting (IOS Members only)
- _____ Dinner on your own

Tuesday 24

Keynote address

- 09:00 BRAZILIAN CACTI TODAY
Daniela Zappi

- 10:00 Morning Coffee

Morning Session: Special Topics of Cactaceae

- 10:30 ERUMPENT BUD DEVELOPMENT IN *ECHINOCEREUS* (CACTACEAE)
Daniel Sánchez, Grego-Valencia, D., Teresa Terrazas & Salvador
 Arias*
- 11:00 CHEMICAL ANALYSIS OF SECONDARY XYLEM BY FTIR IN
 CACTACEAE
Agustín Maceda-Rodríguez, Teresa Terrazas, Soto-Hernández, R.M.,
 Reyes-Rivera, J., Salvador Arias, Trejo, C., Peña-Valdivia, C.B. &
 Martínez-Vázquez, M.*
- 11:30 DETERMINATE GROWTH OF CACTOIDEAE PRIMARY ROOT, AND
 BEYOND
Svetlana Shishkova, Gustavo Rodríguez-Alonso, Mayra López-Valle,
 Selene Napsucialy-Mendivil, Marcela Ramírez-Yarza, Marta
 Matvienko & Joseph G. Dubrovsky*
- 12:00 Lunch

Keynote address

- 13:00 A 37-YEAR BALANCE OF THE ACTIVITIES IN CACTUS SYSTEMATICS:
THE ATTRACTIVE CONSERVATION AND THE OSTRACISED
NOMENCLATURE
Rolando Tenoch Bárcenas Luna

Afternoon Session: Systematics of Cactaceae

- 14:00 PHYLOGENY OF *CEPHALOCEREUS* (CACTACEAE) BASED ON
MOLECULAR AND STRUCTURAL DATA
Héctor Tapia & Salvador Arias*
- 14:30 PHYLOGENETIC RELATIONSHIPS OF *ECHINOCACTUS* LINK & OTTO
(CACTOIDEAE, CACTACEAE) INFERRED FROM NUCLEAR DNA
SEQUENCES OF *DODA* AND *5GT* GENES
Mario Vargas-Luna, Patricia Hernández-Ledesma, Raúl Puente,
Lucas C. Majure, Héctor M. Hernández & Rolando T. Bárcenas*
- 15:00 SYSTEMATICS OF THE ENIGMATIC GENUS *APOROCACTUS*
(CACTACEAE)
Isaura Rosas-Reinhold & Salvador Arias*
- 15:30 A PHYLOGENOMICS APPROACH TO TACKLING RELATIONSHIPS IN
SUBFAMILY OPUNTIOIDEAE (CACTACEAE)
Lucas C. Majure, Raul Puente, Andrew Salywon, Shannon Fehlberg
& Marc A. Baker*
- 16:00 INTEGRATIVE TAXONOMY BASED ON GENETIC DELIMITATION:
THE STUDY CASE OF *STENOCEREUS GRISEUS* SPECIES COMPLEX
(CACTACEAE)
Hernán Alvarado-Sizzo, Alejandro Casas & Teresa Terrazas*

- 16:30 Afternoon Coffee
Congress photo

Special address

- 17:00 FERNANDO ALTAMIRANO CARBAJAL: ANAMNESIS OF OUR
REMARKABLE ORIGINS
Emiliano Sánchez Martínez, Beatriz Maruri, Yasmín Hailen Ugalde
& Ma. Magdalena Hernández*

18:00 Cocktail reception at the Botanical Garden
Concert of the Orquesta Típica Makochi-Dulcemelos

Wednesday 25

Mid-congress Tour
(Lunch will be provided)

09:30 Meeting point at Quinta “Fernando Schmoll” nursery

Visit to Quinta “Fernando Schmoll” nursery, Cadereyta
Visit to “Granja GG” nursery, Tequisquiapan
Visit to “La Biznaga Vagabunda” nursery, Ezequiel Montes
Visit to “Casa de Cactus San Martín” nursery, Bernal

16:30 Congress dinner at “El Cuartel”, Bernal
19:00 Return to Cadereyta

Thursday 26

09:00 Keynote address

A CENTURY OF SUCCULENT PLANT TAXONOMY
Len Newton

10:00 Guided tour through the Cadereyta Regional Botanical Garden

Morning Session: Conservation of other succulents

11:00 *IN-SITU* CONSERVATION OF FIVE SPECIES OF CRASSULACEAE AT THE
ÁREA DE PROTECCIÓN DE FLORA Y FAUNA LA PRIMAVERA,
JALISCO
Aarón Rodríguez, Ortiz-Brunel, J.P., Pablo Carrillo-Reyes, &
Ramírez-García, E.*

11:30 DISTRIBUTION AND CONSERVATION OF THE GENUS *Pinguicula*
(Lentibulariaceae) IN MEXICO AND CENTRAL AMERICA
Sergio Zamudio & Julián Hernández Rendón

12:00 Lunch

Afternoon Session: Systematics of other Succulents

13:00 DIVERSITY OF THE GENUS *SEDUM* (CRASSULACEAE) IN THE SIERRA MADRE DEL SUR, MEXICO

Juvenal Aragón-Parada, Pablo Carrillo-Reyes & Guadalupe Munguía-Lino*

13:30 DIVERSITY AND ENDEMISM OF STONECROPS (CRASSULACEAE) IN WESTERN MEXICO

Pablo Carrillo Reyes, Guadalupe Munguía Lino & Juvenal Aragón Parada*

14:00 SYSTEMATICS OF *PORTULACA* (PORTULACACEAE)

Gilberto Ocampo

14:30 INFLORESCENCE ARCHITECTURE, FLOWER DEVELOPMENT AND EVOLUTION IN PORTULACACEAE

Thaíla Vieira Santos, Gladys F. A. Melo-de-Pinna, Gilberto Ocampo & Rejjane Patricia de Oliveira*

15:00 Afternoon Coffee Break

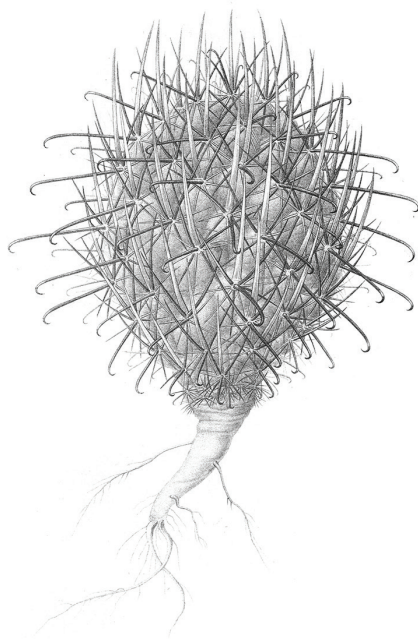
15:30 Keynote address

HECHTIOIDEAE (BROMELIACEAE) A MEGAMEXICAN GROUP

Ivón M. Ramírez-Morillo, Germán Carnevali, Juan P. Pinzón, Katya Romero-Soler, Nestor Raigoza, Claudia Hornung-Leoni, Rodrigo Duno & José Luis Tapia-Muñoz*

_____ Dinner on your own

ABSTRACTS OF ORAL PRESENTATIONS



INTEGRATIVE TAXONOMY BASED ON GENETIC DELIMITATION:
THE STUDY CASE OF *STENOCEREUS GRISEUS* SPECIES COMPLEX
(CACTACEAE)

Hernán Alvarado-Sizzo^{1}, Alejandro Casas¹ & Teresa Terrazas²*

¹Instituto de Investigaciones en Ecosistemas y Sustentabilidad (IIES),
Universidad Nacional Autónoma de México, Morelia, Michoacán,
Mexico

²Instituto de Biología, Universidad Nacional Autónoma de México,
Deleg. Coyoacán, 04510 Ciudad de México, Mexico

* hernanalvaradosizzo@gmail.com

Cactaceae species complexes are often hard to classify because of low-resolution of plastid molecular data and structural characters homoplasy, a consequence of the family's recent origin. Here, we describe a taxonomical multi-evidence taxonomic workflow applied to the *Stenocereus griseus* species complex (SGSC). This method departs from population genetics clustering and then validates the species status of the genetic groups by using ecological and morphological evidence. Nine microsatellite loci over 377 individuals (of three putative species) were used in order to implement population genetics clustering; then, the resulting entities were tested for ecological niche divergence and spination pattern differences. Four species were recovered: three of them correspond to previously recognized species, whereas *S. griseus* turned to be a homonym comprising two species; also, we found that species distribution is strongly associated to biogeographic regions and sympatric zones are unlikely to occur. In this way, we proved that population genetics clustering is a key evidence to be considered in integrative taxonomy, this approach is also a potential tool in order to define species limits in recently diverged species, a common issue in Cactaceae groups.

Key words: Bayesian clustering; ecological niche modelling; integrative taxonomy; microsatellites; species delimitation; spination; SSRs; systematics

DIVERSITY OF THE GENUS *SEDUM* (CRASSULACEAE)
IN THE SIERRA MADRE DEL SUR, MEXICO

Juvenal Aragón-Parada¹, Pablo Carrillo-Reyes^{1, 2*}
& Guadalupe Munguía-Lino^{1,2}

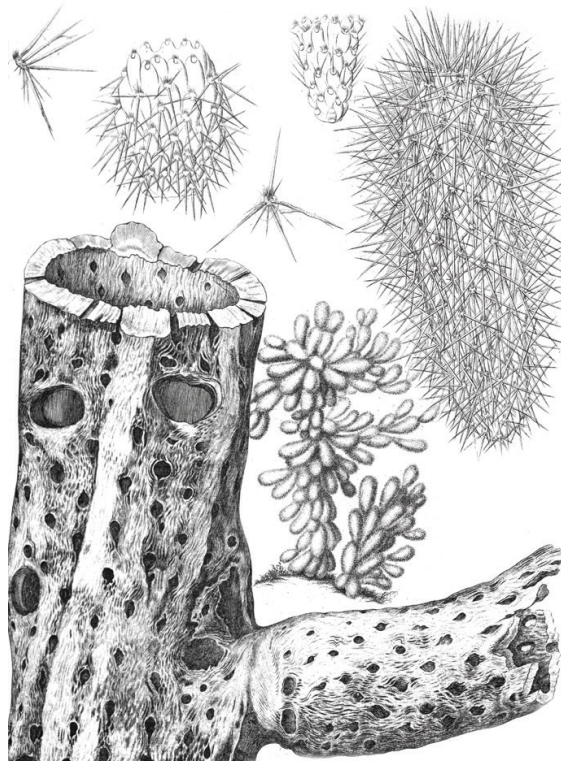
¹Instituto de Botánica, Universidad de Guadalajara, Las Agujas, Zapopan, Jalisco, Mexico

²Laboratorio Nacional de Identificación y Caracterización Vegetal (LANIVEG), Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Zapopan, Jalisco, Mexico

* pcarreyes@gmail.com

Sedum is the largest genus of the Crassulaceae. It groups about 428 species of mostly herbaceous plants, with numerous leaves often arranged in rosettes, and pentamerous flowers with free petals. *Sedum* is distributed in the subtropical and temperate zones, predominantly in the Northern hemisphere. The mountains of southern Mexico, with ca. 130 species, have been recognized as one of the most important centres of diversity for the family. The Sierra Madre del Sur biogeographic province (SMS) runs from southern Jalisco and extends to the states of Oaxaca and part of Puebla and Veracruz. The goals of this work were to analyse the distribution and to identify areas with greater species richness of *Sedum* in the SMS. Fieldwork was done, herbarium specimens were reviewed and a database was generated with 420 records of taxa present in the SMS. With this information, the geographical distribution was analysed in the QGIS program 2.14.3, and the areas with greater richness were estimated with DIVA-GIS. In the SMS there are 46 species of *Sedum*, 12 of which are endemic to Oaxaca and two to Jalisco. Guerrero, Michoacán, Puebla and Veracruz each possess an endemic species. Four major areas were identified that concentrate the richness of species: southern Jalisco, the Miahuatlán region, the Sierra de Juárez, and the Mixteca. In addition, 18 species with restricted distribution to the SMS were registered; of these, there are 12 records at the most. SMS is the region with the greatest diversity of species and endemism of the genus *Sedum* in Mexico. The areas with high richness are in the pine-oak forest, ranging from 2000 to 2500 m altitude. However, there are large unexplored extensions of this region. Exploration of these areas might increase this diversity.

Key words: biogeography, distribution, endemic species, Oaxaca, species richness



A 37-YEAR BALANCE OF THE ACTIVITIES IN CACTUS
SYSTEMATICS: THE ATTRACTIVE CONSERVATION
AND THE OSTRACISED NOMENCLATURE

Rolando T. Bárcenas

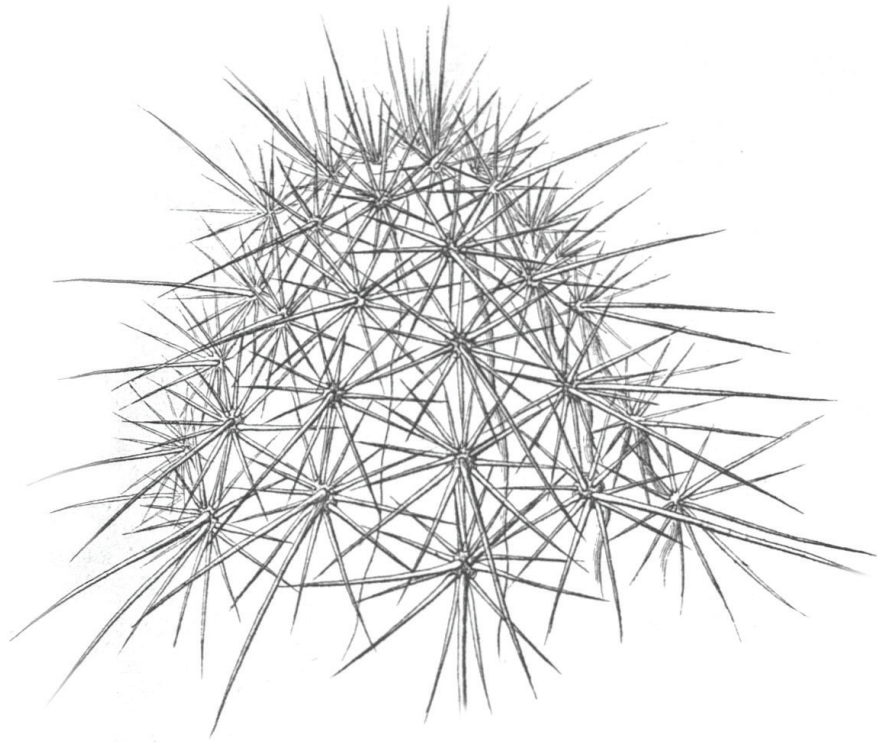
Laboratorio de Genética Molecular y Ecología Evolutiva, Facultad de Ciencias Naturales, Campus Aeropuerto, Universidad Autónoma de Querétaro, Querétaro, Mexico

rtenoch@uaq.mx

Molecular phylogenetic analyses in the cactus family have substantially increased our knowledge of the relationships among these succulent plants. The last two decades of the reign of DNA in phylogenetics have accelerated the characterization and re-delimitation of several groups in the Cactaceae as monophyletic entities. This talk will concentrate on the recent historical balance and tendencies of the three main activities of the systematic enterprise as proposed by some practising systematists: phylogenetics, evolution and (α)-taxonomy in the particular case of the Cactaceae. A review of publications on the Cactaceae from 1980 to 2017 has shown that tendencies in research publications shifted from one or three research topics in the 1980's and early 1990's to up to 13 topics in 2012 and 2013. Few lines of research have survived through time as strong pillars of systematics such as morphology and taxonomy, as taxonomy has not been as popular a line of research as morphology since 1980. Other neglected lines in the Cactaceae are deep morphology, nomenclatural activities and monographic revisions as research subjects, which have been stagnant at least since the 1980's. Conservation of cacti as a topic of research has been the most popular line of study powerfully beating any other topic in the family by a wide margin. The omics era is just starting to have an impact in the family and parallel sequencing is now playing a more important role in the studies of the Cactaceae that will influence the three activities of the systematic enterprise. It is expected that as more groups of the Cactaceae are identified as monophyletic, the evolutionary and α -taxonomic studies could produce more solid and sound evolutionary biogeographic hypotheses or propose more and more synonyms in the next

cactus monograph in order to reduce the excess of names in the family.

Key words: nomenclature, systematics, taxonomy, research enterprise, paradigm



DIVERSITY AND ENDEMISM OF STONECROPS (CRASSULACEAE)
IN WESTERN MEXICO

Pablo Carrillo Reyes^{1, 2}, Guadalupe Munguía Lino^{1, 2}
& Juvenal Aragón Parada¹*

¹Instituto de Botánica, Universidad de Guadalajara, Las Agujas, Zapopan, Jalisco, México

²Laboratorio Nacional de Identificación y Caracterización Vegetal (LANIVEG), Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Zapopan, Jalisco, Mexico

* pcarreyes@gmail.com

The Crassulaceae possess more than 1500 species distributed worldwide. Mexico, with ca. 380 species, is the richest country in the world. The western portion of this country (Aguascalientes, Jalisco, Colima and adjacent parts of Nayarit, Zacatecas, Guanajuato and Michoacán) is located in the confluence six biogeographic provinces. This area has been identified as a secondary centre of diversity of vascular plants in Mexico. The goal of this work was to describe patterns of distribution and diversity as well as to identify centres of endemism for Crassulaceae in Western Mexico. We compiled a database considering both native and naturalized species. Biogeographic analyses were performed using QGIS 2.14.3 and DIVA-GIS. 56 native and 2 naturalized species occur in western Mexico; 31 of them are endemic to this area. *Sedum* (19 spp.) and *Echeveria* (19) are the most diverse genera followed by *Graptopetalum* (7), *Pachyphytum* (6) and *Villadia* (3). The richest biogeographic provinces are the Trans Mexican Volcanic Belt (35 spp.), the Sierra Madre Occidental (13) and the Chihuahuan Desert (9). Southern Jalisco was identified as the main centre of diversity. We consider that the Balsas river Basin and Sierra Madre del Sur have an inadequate representation and additional exploration is required.

Key words: biogeography, Colima, endemism, *Echeveria*, *Graptopetalum*, Jalisco, Nayarit, *Sedum*, *Pachyphytum*

IS DEVELOPMENT, MORPHOLOGY, AND STRUCTURAL SUPPORT
OF CEPHALIA AND PSEUDOCEPHALIA ADAPTIVE?

Root Gorelick

Carleton University, 1125 Raven Road, Ottawa, Ontario,
Canada

RootGorelick@Cunet.Carleton.Ca

Cactus cephalia and pseudocephalia are peculiar structures, with odd development, anatomy, morphology, and structural support. *Discocactus* cephalia are deeply sunken, with a quixotic “W” shaped border between photosynthetic and reproductive parts. Unlike *Melocactus*, *Discocactus* continue growing new photosynthetic tissue after cephalium formation, resulting in the eponymous disk-shape of their photosynthetic parts. *Espostoa* and *Coleocephalocereus* can have precariously leaning lateral cephalia, but their shoots somehow manage to straighten out as they grow, often with disheveled phyllotaxy. Many species with lateral pseudocephalia also have this peculiar temporary leaning of shoot tips, despite lacking cork formation under flowering areoles, but having orderly phyllotaxy. In some species, branches almost never arise from cephalia; whereas in other species, branches almost always arise from cephalia. *Lophocereus* shoots grow slowly before pseudocephalium development, but rapidly once a pseudocephalium is formed. How do their massive shoots not break in the wind, but often bend or break once pseudocephalia form? Is this due to development of woody subdermal thorns? By examining parts of shoots not usually visible because of being covered by epidermal and other tissues, I show how peculiar cactus architectures of cephalia and pseudocephalia sometimes seem adaptive and sometimes do not.

Key words: cephalium, pseudocephalium, anatomy, morphology, ontogeny, non-adaptive, maladaptive

IDENTIFICATION OF PRIORITY AREAS FOR THE CONSERVATION OF ENDEMIC CACTI IN THE SONORAN DESERT REGION

Bárbara Larraín-Barrios^{1} & Héctor M. Hernández²*

¹Instituto de Ecología - Unidad Hermosillo, Universidad Nacional Autónoma de México. Av. Luis Donaldo Colosio s/n, Colonia Los Arcos, 83000 Hermosillo, Sonora, Mexico

²Instituto de Biología, Universidad Nacional Autónoma de México, Ciudad Universitaria, 04510 Ciudad de México, Mexico

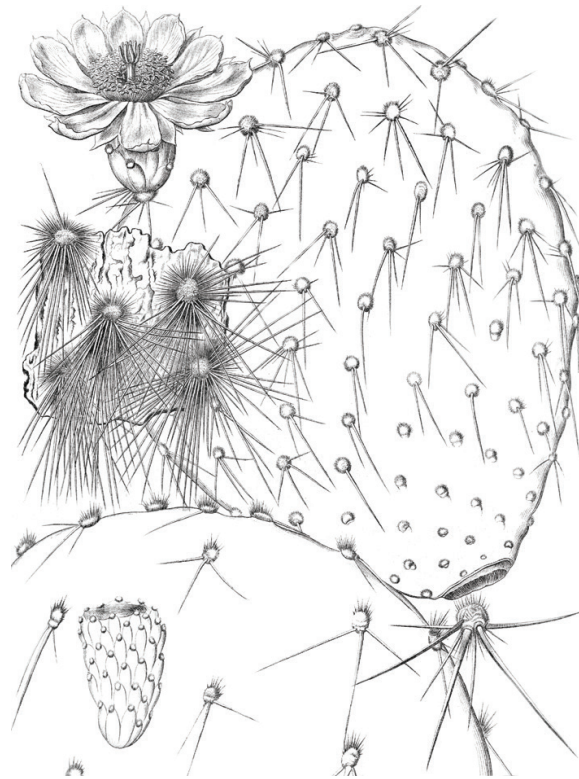
* barbara.larrain@gmail.com

We explored the spatial pattern of endemic cacti in the Sonoran Desert Region (SDR) in order to define priority areas for its conservation and evaluate the effectiveness of the protected area network in Mexico. To pursue this: 1) we defined the endemic species of the SDR using a database and field information, which were analysed in a geographic information system. This allowed us to select endemic species using at least 75% of its records inside SDR as criteria, 2) we evaluated the spatial patterns of the endemic species using 30 minutes latitude by 30 minutes longitude grids, and we obtained maps of richness, rarity and conservation value. A complementarity analysis was performed to optimize the protection of species in a minimum area, 3) we established a consensus map in order to obtain the potential conservation areas by selecting the highest values of the each individual map, and 4) we evaluated the effective protection through: (a) comparison of the consensus map with current protected area network, selecting those potential areas outside the network, and also (b) performing a spatial complementarity index to the species not protected by the current network. Finally, we combined both (a,b) in order to obtain the priority conservation areas.

Seventy-two endemic species were identified and we selected eight potential conservation areas, four in the Baja California Peninsula and four in Sonora. We found that 23 species were not under any official protection, and that eleven complementary cells protect all of endemic species. With this information, we select five priority areas; three located in Baja California and two in Sonora. These areas, considering the priority areas and

the current conservation network, guarantee the protection of 70 species, representing 97.2% of all endemic cactus species in the region.

Key words: biodiversity conservation, Cactaceae, endemism, richness, rarity, complementarity



CHEMICAL ANALYSIS OF SECONDARY XYLEM BY FTIR
IN CACTACEAE

*Agustín Maceda-Rodríguez^{*1}, Teresa Terrazas²,
Ramón Soto-Hernández¹, Jorge Reyes-Rivera¹, Salvador Arias²,
Carlos Trejo-López¹, Cecilia Beatriz Peña-Valdivia¹
& Mariano Martínez-Vázquez³*

¹Colegio de Postgraduados en Ciencias Agrícolas, Montecillo, Estado de México, Mexico

²Instituto de Biología, Universidad Autónoma de México, Circuito Exterior, Ciudad Universitaria, 04510 Coyoacán, Ciudad de México, Mexico

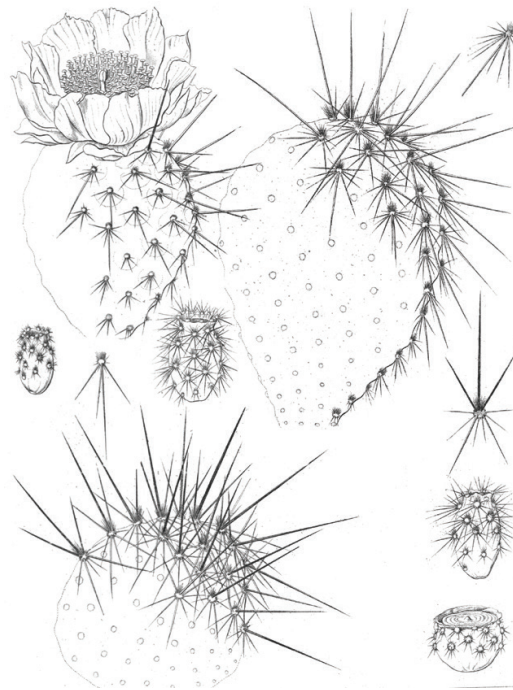
³Instituto de Química, Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad Universitaria, 04510 Coyoacán, Ciudad de México, Mexico

* biologoagustin@hotmail.com

One characteristic of the Cactaceae is its wood diversity and its relation to vascular tissue lignification. The three main types of wood are: non-fibrous (wide band tracheids and vessel elements, wbt-ve), fibrous (ve and fibers, ve-fi) and dimorphic (a transition from wbt-ve to ve-fi). Recent research shows that species with fibrous wood have similar patterns in lignin composition (syringyl or guaiacyl type), whereas in species with non-fibrous and dimorphic woods no pattern in lignin composition is distinguished. Therefore, the aims of this study were to analyse the chemical composition of lignin mainly in species with non-fibrous and dimorphic woods of the Cactoideae and determining their relation to vascular tissue anatomy. We used 26 species of Cactaceae, Pereskioideae (1), Opuntioideae (5) and Cactoideae (20), to remove the vascular cylinder at the base of the stem. Part of this cylinder was dried and milled to make successive extractions and measurements according to TAPPI Standard T207 om-93. Lignin was analysed and characterized by Fourier transform infrared spectroscopy. A slide of the same fresh vascular cylinder (0.5-1.0 cm thick) was fixed, sectioned and stained to characterize the species wood. The results show that lignin percentage in Cactaceae is similar to other families; however, the percentage is higher in species with fibrous wood than

those with non-fibrous and dimorphic wood, due lignification differences. The spectrum shows that species with fibrous wood have a stable pattern of lignin similar to reports in the literature as for other Eudicotyledons; non-fibrous and dimorphic species show a relationship within each genus, but have little differences due abundance of wbt-ve. *Echinocereus* (Echinocereae, tribe with fibrous wood) has a similar lignin composition to other species with dimorphic wood of the Cacteae as for *Echinocactus*. Variation in vascular tissue anatomy has a strong relation to differences in lignin types in the secondary wall.

Key words: spectroscopy, syringyl, guaiacyl, lignin



A PHYLOGENOMICS APPROACH TO TACKLING RELATIONSHIPS
IN SUBFAMILY OPUNTIOIDEAE (CACTACEAE)

Lucas C. Majure^{*1}, *Raul Puente*¹, *Andrew Salywon*¹,
*Shannon Fehlberg*¹ & *Marc A. Baker*²

¹Department of Research, Conservation and Collections, Desert Botanical Garden, Phoenix, Arizona 85008, United States of America

²School of Life Sciences, Arizona State University, P.O. Box 874501, Tempe, Arizona 85287, United States of America

* lmajure@dbg.org

Subfamily Opuntioideae is one of the largest and most important radiations within Cactaceae, including ecologically, economically and medicinally important genera, such as *Cylindropuntia* (chollas) and *Opuntia* (prickly pears), among others. To date, relationships among the three major clades in subfamily Opuntioideae, i.e., Cylindropuntieae, Opuntieae and Tephrocactaeae, have mostly evaded phylogenetic resolution. We used a phylogenomics approach, sequencing nearly entire plastomes for 103 taxa within Opuntioideae and 31 taxa within Cactoideae using the Illumina HiSeq X Ten platform, to build a more robust phylogenetic framework for understanding those relationships. Considering that the structure of the chloroplast genome is highly modified across Cactaceae, we built our dataset out of genic regions rather than using the entire set of sequences for the plastome. We also incorporated 8 taxa from Cactaceae and the outgroup *Portulaca oleracea* with comparable data from GenBank into our dataset. Our results resolve a well-supported Opuntioideae (bs=100), with Opuntieae sister to a Tephrocactaeae+Cylindropuntieae clade. A southern South American origin for the clade Opuntioideae is the most likely according to our analyses. Our results underscore the utility of whole plastome data for phylogeny reconstruction across Cactaceae and its potential usage in other major clades within the family.

Key words: biogeography, morphological evolution, Opuntioideae, phylogenomics

A CENTURY OF SUCCULENT PLANT TAXONOMY

Len Newton

Barking, Essex, UK

ellyen@yahoo.com

In January 1900, the editorial in Walton's *Cactus Journal* suggested that few if any new species were likely to be found. The International Organisation for Succulent Plant Study (IOS) was established in 1950, to facilitate cooperation amongst succulent plant researchers. One of the first publications, in 1951, was *Repertorium Plantarum Succulentarum*, listing new names (new taxa and name changes) published in the year 1950. This has continued as an annual publication to the present day, listing many thousands of new names in the 66 issues published so far. In 1992 the IOS set up a committee to plan the production of an IOS Manual of Succulent Plants. Succulents in families other than Cactaceae appeared in six volumes, *Illustrated Handbook of Succulent Plants*, published between 2001 and 2003. The Cactaceae appeared as a separate publication in two volumes, *The New Cactus Lexicon*, in 2006. Now work is proceeding on a second edition of the *Illustrated Handbook of Succulent Plants*. This presentation will show how our knowledge of two monocot genera has changed during the past century, from 1908 (Berger on *Aloe*) and 1915 (Brown on *Sansevieria*).

Key words: taxonomy, history, lexicon, *Aloe*, *Sansevieria*

NATIONAL CONTRIBUTIONS OF THE PERUVIAN CACTUS
AND SUCCULENT SOCIETY – SPECS – TO THE KNOWLEDGE
OF PERUVIAN CACTI

Sidney Novoa

Sociedad Peruana de Cactus y Suculentas-SPECS, Ca. Rosa Pérez
Liendo 196, Distrito San Miguel, Lima, Peru

sidneynovoa@yahoo.es

The Peruvian Cactus and Succulent Society-SPECS is a non-profit civil society with 30 years of existence, which was formed with the aim of disseminating scientific knowledge, cultivation and conservation of Peruvian cacti and other succulents. The goal of this resume is to present the SPECS contributions to the knowledge of cacti in Peru. For the analysis, we considered the review and classification of bibliographic sources produced by SPECS, or in which it had direct collaboration, since 1987. During this time, the members of SPECS have contributed with more than 350 articles by approximately 100 different authors, covering different topics, including taxonomy, description of new species, travel, ecology, uses, conservation, as well as notes on art, literature, philately, history, referring to this group of plants. During this period of time, we supported the organization of three national congresses (2013, 2015 and 2017), where more than 100 unedited researches on cacti and other Peruvian succulents were presented. Currently, SPECS members are recognized as CITES scientific authorities, to issue binding technical opinions concerning the commercialization of national species, as well as to update the list of threatened species at the national level. In addition, SPECS has collaborated with undergraduate and postgraduate theses, especially between 2002-2006, where various dissertation, scientific articles, and presentations in other national and international events. At the same time, the founder of SPECS, Carlos Ostolaza, has published three books of scientific dissemination with the support from the Ministries of Agriculture and Environment. These results show the valuable contribution of SPECS, for 30 years, to the development of research on cacti and other succulents in Peru.

Key words: SPECS, contributions, research publication, congress

SYSTEMATICS OF *PORTULACA* (PORTULACACEAE)

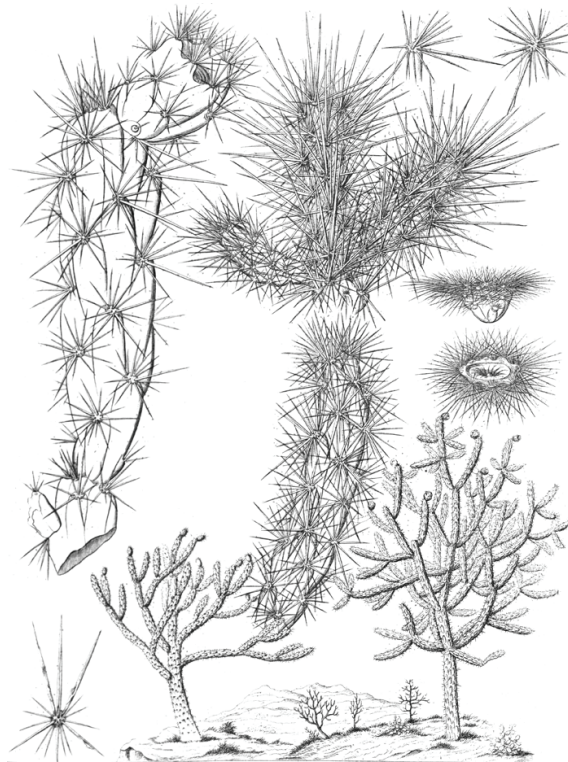
Gilberto Ocampo

Departamento de Biología, Centro de Ciencias Básicas, Universidad Autónoma de Aguascalientes. Avenida Universidad 940, Ciudad Universitaria, 20130 Aguascalientes, Aguascalientes, Mexico

gilberto.ocampo@edu.uaa.mx

Portulaca is the only genus in the Portulacaceae after its recent disintegration into other families (Anacampserotaceae, Montiaceae, and Talinaceae). The genus has ca. 100 species distributed around the world, with important centres of diversification in South America and Africa. The most recent worldwide systematic study was provided by Geesink (Blumea 17(2): 275-301. 1969), who proposed a new, very simple infrageneric classification for *Portulaca*, which is generally employed by most taxonomists; however, Geesink's species sampling was very limited and primarily focused on the Indo-Australian taxa. In this talk, I will show results from phylogenetic analyses employing chloroplast and nuclear DNA sequences to explore the evolutionary relationships within *Portulaca*. Morphological, anatomical, and photosynthetic pathway data were also considered under a phylogenetic framework to study their diversification patterns. In addition, divergence times and historical biogeographical patterns were explored. The phylogenetic analyses recovered *Portulaca* as a monophyletic group and show the existence of two main clades, one with species found in the Old World and another one with taxa distributed around the globe. The resulting clades are in partial agreement with Geesink's classification. Traits that are very variable within the genus (e.g., seed micromorphology) were found to be homoplastic, although a few of them were useful to characterize major subclades within *Portulaca*. The age of Portulacaceae was estimated in 23 million years and the potential area of ancient distribution was found to be in the Southern Hemisphere. The results of this study will be used to propose a new infrageneric classification, which will include two subgenera and six sections.

Key words: Cactineae, classification, leaf anatomy, morphology, *Portulaca*, Portulacaceae, Portulacineae, photosynthetic pathways, phylogeny



CONSERVATION STATUS OF PERUVIAN CACTACEAE

Carlos Ostolaza Nano

Sociedad Peruana de Cactus y Suculentas –SPECS, Ca. Rosa Pérez
Liendo 196, Distrito San Miguel, Lima, Peru

* carlosto36@gmail.com

This contribution deals with the conservation status and IUCN categories of Peruvian cacti taxa (81% of them are endemic) and the measures adopted to minimize the conservation threats with habitat destruction of most of the cacti populations in the valleys surrounding Lima and other coastal valleys because of the inflow of peasants from the countryside to the outskirts of the cities. We are reporting one example of Peruvian cacti species in each of the main IUCN Redlist categories: Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN) and Critically Endangered (CR), and a proposal to include 14 of them in the CITES Appendix I list, following the example of other countries like Mexico, Brazil and the United States. This year the Peruvian Agriculture Ministry approved a list with 91 cacti species categorized, which is an increase, but they represent only 35 % of the whole number. American cacti are exotic and ornamental plants for the rest of the world and that produces a great demand. We must know them well as the only way of preserving the species because of depredation since the discovery of America. We must categorize them to know which species should be protected as a priority. CITES should cover the categorized species even if the commercial demand is not very high, if the country involved asks for it.

Key words: conservation, Redlist categories, CITES, Peruvian Cactaceae

EFFECT OF HABITAT DISTURBANCE ON THE GENETICS
OF *STENOCEREUS QUEVEDONIS* (CACTACEAE) IN INFIERNILLO,
MICHOCÁN, MEXICO

José Francisco Paz Guerrero^{1,*}, *Alejandro Casas*²
& *Hernán Alvarado-Sizzo*²

¹ Universidad Michoacana de San Nicolás de Hidalgo, Gral. Francisco J. Múgica S/N, Ciudad Universitaria, 58030 Morelia, Michoacán, Mexico

² Instituto de Investigaciones en Ecosistemas y Sustentabilidad, Universidad Nacional Autónoma de México, Antigua Carretera a Pátzcuaro 8701, Ex-Hacienda de San José de La Huerta, 58190 Morelia, Michoacán, Mexico

* theramones_bmx@hotmail.com

Stenocereus quevedonis Ortega Buxb. “pitire” is endemic to the Balsas river Basin, where the vegetation is tropical dry forest and xerophytic scrub. The study area is located in Arteaga, Michoacán, in the village of Infiernillo, which is part of the Zicuirán-Infiernillo Biosphere Reserve.

Our aims were to compare the genetic diversity, gene flow, and genetic structure of *S. quevedonis* populations in conserved and disturbed sites, and thus determining if habitat disturbance has negative effects on these cacti populations. Information on population genetics may be useful to designing and establishing proper landscape managing strategies.

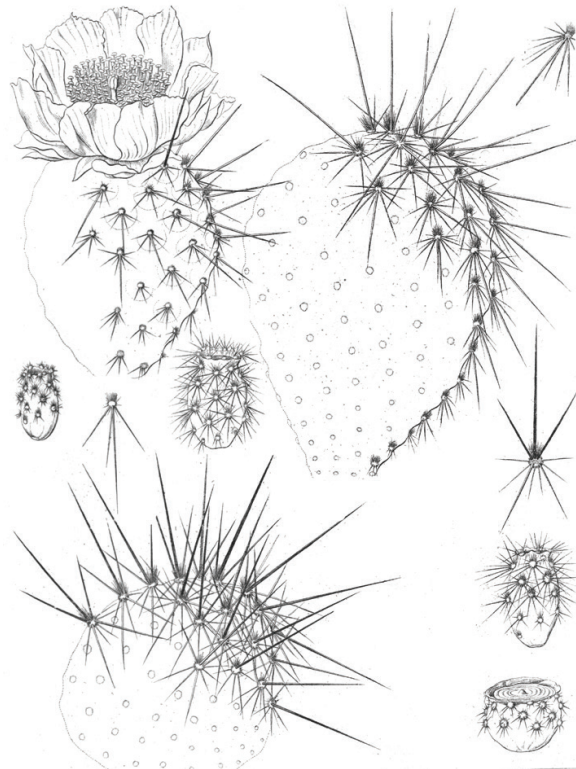
We sampled tissue from 20 adult plants per site in three conserved and three disturbed sites, accomplishing 120 samples. DNA was extracted from tissue samples and we genotyped them through six nuclear microsatellite markers, which, allowed estimating allelic frequencies, genetic diversity, flow and structure through Bayesian cluster analysis. Univariate analyses were performed with all parameters calculated to determine differences according to disturbance.

Expected heterozygosity (H_e) varied 0.437-0.526, similarly to other columnar cacti, with no significant differences among disturbed and undisturbed sites; gene flow (N_m) was 0.163-2.067 ($\bar{x}=1.0974$), indicating overall gene flow and genetic drift equilibrium, with some populations tending to drift. F_{st} values varied between 0.048-0.020, which means low genetic differentiation among populations. However, Bayesian cluster

analysis indicates that one out of four genetic groups is lost in disturbed sites.

Our results indicate that disturbance effect in *Stenocereus quevedonis* genetics is still incipient, apparently because the fragmentation event is relatively recent (nearly 40 years). It may also be buffered by ecological factors previously described (high pollen movement among populations) that may ensure reproductive success, although genetic effects of disturbance might be evident after plants recruited in both site types reach reproductive stage.

Key words: microsatellites, genetic drift, gene flow, genetic diversity, heterozygosity



DEMOGRAPHY AND REPRODUCTIVE PHENOLOGY OF
ECHINOCACTUS PLATYACANTHUS IN TECALI DE HERRERA, PUEBLA

José H. Quiroz Soberanes* & Ma. del Carmen Navarro Carbajal

Plant Ecology Laboratory, Biological Science Faculty, Benemérita Universidad Autónoma de Puebla, Boulevard Valsequillo y Av. San Claudio, Edificio 112-A, Ciudad, Universitaria, Col. Jardines de San Manuel, C. P. 72570, Puebla, Mexico

*josehiram6@hotmail.com

Echinocactus platyacanthus is a Mexican endemic cactus catalogued under special protection by the NOM-059-2010 due to population decline caused by land use change, illegal commerce and acitron (cactus candy) production. Few demographic and phenology studies exist for this species, and there isn't information about the actual state of the populations. The present study describes some demographic and reproductive aspects of *Echinocactus platyacanthus* in the Huexotitlanapa ravine in Tecali de Herrera, Puebla. The results of this study can be used in designing management plans for the species and as a strategy for the *in-situ* conservation of *E. platyacanthus*. The main density of this population was 390.51 plants/ha; the adult category was the most abundant (53.84 adult 1/ha, 142.93 adult 2/ha, 87.65 adult 3/ha and 50.35 adult 4/ha); whereas seedlings and juvenile plants were more scarce (14.84 seedlings/ha and 40.87 juveniles/ha). Of the total plants registered in the area 84.19% (1838 individuals) were solitary and only 15.8% (345 individuals) were colonies. The individuals in this population had a continuous production of reproductive structures from November 2015 to September 2016, with a maximum production of buds and flowers in July and of fruit in August. Fruit volume and weight of *E. platyacanthus* are positively correlated with the number of seeds produced ($F = 179.67$, $P < 0.00$, $r = 0.804$; $F = 103.37$, $P < 0.00$, $r = 0.716$ respectively).

Key words: *Echinocactus platyacanthus*, census, size-category, life-form

HECHTIOIDEAE (BROMELIACEAE) A MEGAMEXICAN GROUP

Ivón M. Ramírez-Morillo^{1*}, *Germán Carnevali*¹, *Juan P. Pinzón*²,
*Katya Romero-Soler*¹, *Nestor Raigoza*¹, *Claudia Hornung-Leoni*³,
*Rodrigo Duno*¹ & *José Luis Tapia-Muñoz*¹

¹Centro de Investigación Científica de Yucatán, A. C. Unidad de Recursos Naturales. Calle 43 # 130 x 32 y 34. Colonia Chuburná de Hidalgo. 97205 Mérida, Yucatán, Mexico

²Departamento de Botánica, Campus de Ciencias Biológicas y Agropecuarias, Universidad Autónoma de Yucatán, Carretera Mérida-Xmatkuil km. 15.5, Apdo. Postal 4-115 Itzimná, 97100 Mérida, Yucatán, Mexico

³Universidad Autónoma del Estado de Hidalgo, Centro de Investigaciones Biológicas, Instituto de Ciencias Básicas e Ingeniería, Km 4.5 Carretera Pachuca-Tulancingo, 42184 Mineral de La Reforma, Hidalgo, Mexico

* ramirez@cicy.mx

Hechtioideae include sympodial to pseudomonopodial rosettes bearing succulent, spiny or serrulate leaves, terminal or lateral inflorescences, unisexual and fragrant flowers with superior or inferior ovary, a sessile stigma, and exhibiting dioecy, a unique combination of characters within Bromeliaceae. Based on DNA sequences (*ycf1*, *rpl32-trnL* intergenic spacer, and *PRK*), as well as morphological characters of 60% of the known taxa in the subfamily, using parsimony and Bayesian Inference, we tested the monophyly of Hechtioideae and study its internal relationships. Results support the monophyly of Hechtioideae and of five groups: (1) a basal clade (the *H. tillandsioides* complex) as the sister group of the rest of Hechtioideae; (2) a clade including the species of the *H. guatemalensis* complex. The remaining taxa of the subfamily are retained in *Hechtia*, which now consists of three well-supported clades: 3) *Hechtia glomerata* complex of species with lateral inflorescence distributed in the Mexican Gulf drainage; (4) a clade of two species that share an inferior ovary and are distributed north of the Tehuantepec Isthmus; and (5) an internally poorly resolved clade (Core *Hechtia*) with the remaining species containing several well-supported, geographically restricted clades. Evidence suggests that Hechtioideae originated in the lowlands of southern Megamexico III biogeographical region,

from where it radiated into restricted geographical areas where they radiated, once more, exhibiting the repeated appearance of particular characters mostly associated with the invasion of dry, seasonal climates up to cooler areas in the Mexican Plateau. Lateral inflorescences, inferior ovary, as well as trochophily have appeared more than once in Hechtioideae.

Key words: dioecy, endemism, *Hechtia*, Megamexico



IN-SITU CONSERVATION OF FIVE SPECIES OF CRASSULACEAE
AT THE ÁREA DE PROTECCIÓN DE FLORA Y FAUNA
LA PRIMAVERA, JALISCO

Aarón Rodríguez*^{1,2}, Juan Pablo Ortiz-Brunel^{1,2}, Pablo Carrillo-Reyes^{1,2}, & Ezequiel Ramírez-García³

¹ Herbario Luz María Villarreal de Puga, Instituto de Botánica, Departamento de Botánica y Zoología, Universidad de Guadalajara, Camino Ing. Ramón Padilla Sánchez 2100, 45200 Las Agujas, Zapopan, Jalisco, Mexico

² Laboratorio Nacional de Identificación y Caracterización Vegetal, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Camino Ing. Ramón Padilla Sánchez 2100, 45200 Las Agujas, Zapopan, Jalisco, Mexico

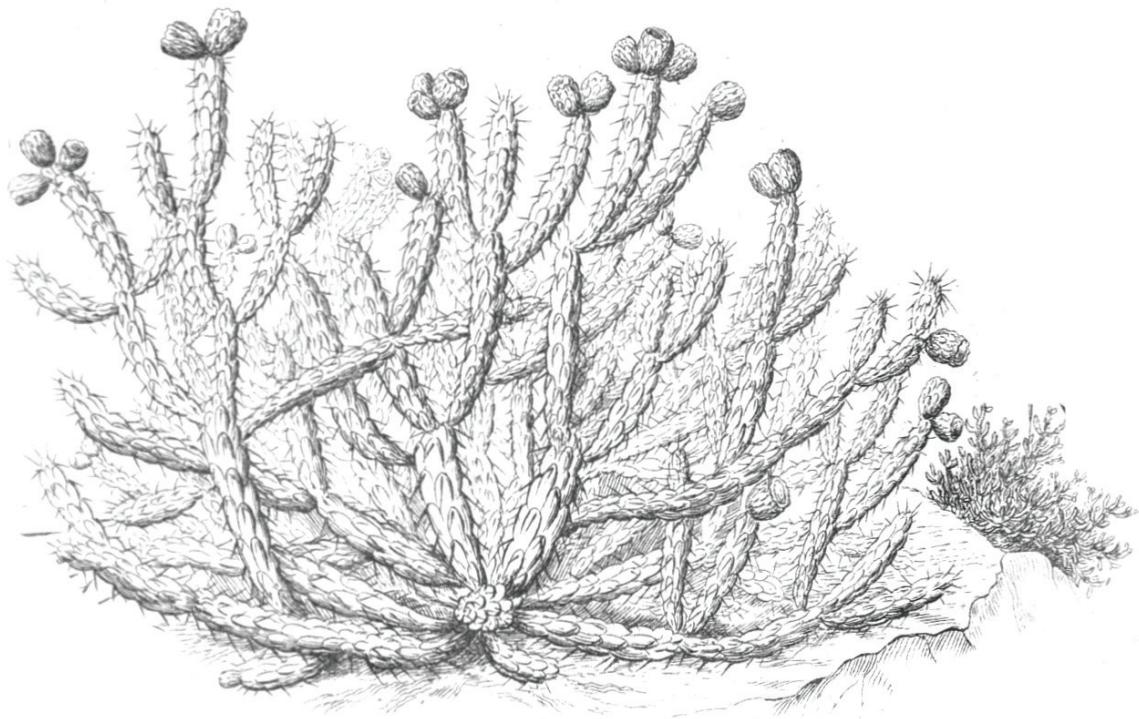
³ Área de Protección de Flora y Fauna La Primavera, Bosque La Primavera, Plaza Comercial Concentro, Av. Vallarta 6503, Local E-38, 45010 Zapopan, Jalisco, Mexico

* aaron.rodriguez@cucba.udg.mx

The Área de Protección de Flora y Fauna La Primavera (APFFLP) was created on March 6, 1980. It covers 30,500 hectares of oak and pine-oak forests, mainly. The nature preserve is located west of Guadalajara Metropolitan Area and partially includes the municipalities of Tala, Tlajomulco de Zúñiga, and Zapopan, in the state of Jalisco. 966 species grouped into 421 genera and 107 families of vascular plants have been registered at the APFFLP. Recent botanical explorations resulted in new records of Crassulaceae for the area. For the first time, we document the presence of *Echeveria colorata* and *Villadia platystyla*. *Echeveria colorata* is endemic to Jalisco and Michoacán. At the APFFLP, it grows on vertical walls along a permanent creek together with *Mammillaria jaliscana*, *Pteridium aquilinum*, *Pitcairnia karwinskyana*, *Opuntia fuliginosa*, and *Epidendron rosilloi*. Similarly, *V. platystyla* is endemic to Jalisco and was known only from three localities. The new population was found on basalt outcrops on the Cerro San Miguel, the second highest point on the APFFLP. *Echeveria colorata* and *V. platystyla* prefer the oak and pine forest. Further, *E. novogaliciana* was described back in 2011 from two populations in Aguascalientes and Jalisco. The Jalisco population is found on the El Colli Volcano within the APFFLP. Numerous adult

and young plants grow on a malpais at the top of the volcano, together with *Agave inaequidens*, *Opuntia atropes*, *Ipomoea intrapilosa*, *Bursera multijuga*, *B. fagaroides*, and *Dahlia coccinea*. Lastly, new populations of *Sedum greggii* and *S. jaliscanum* were located. Both are rupicolous within the oak and pine forest. While, *S. greggii* lives on vertical walls, *S. jaliscanum* prefers horizontal clefts. Both are found among abundant moss but never intermixed. Their presence at the APFFLP increases the probability of survival and conservation.

Key words: Angiosperms, *Echeveria*, *Villadia*, *Sedum*, nature preserves



SYSTEMATICS OF THE ENIGMATIC GENUS *APOROCACTUS*
(CACTACEAE)

Isaura Rosas-Reinhold^{*1} & *Salvador Arias*¹

¹Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Apdo. Postal 70-614, México 04510 DF, Mexico

*isaurarosar@gmail.com

Lemaire designated the genus *Aporocactus* in the 19th century, although Linnaeus described the first species under the name *Cactus flagelliformis* in 1753. In spite of its popularity the genus is nowadays very enigmatic because the number of species and its phylogenetic relationships are unknown. Botanists such as Britton and Rose and Bravo-Hollis recognized this genus during the 20th century; however, Barthlott synonymized it with *Disocactus* due to the great similarity in flower shape and colour. In this century, Hunt and co-authors and Bauer also argued in favour of recognizing only the genus *Disocactus*, but a first phylogenetic study by Cruz and co-authors did not confirm this classification. Britton and Rose (1920) and Bravo-Hollis (1978) recognized five species within the genus: *A. flagelliformis*, *A. martianus*, *A. conzattii*, *A. flagriformis* and *A. leptophis* but Bauer (2003) and Hunt *et al.* (2006) only accept the first two. Our study aims (1) to determine the relationships of *Aporocactus* within Hylocereeae and (2) to delimit the species that it includes, using a set of four molecular markers of cpDNA (rpl16, trnL-trnF, psbA-trnH and trnQ-rps16) and 51 associated INDELS. A total of 22 *Aporocactus* terminals were included to perform phylogenetic analysis using Bayesian Inference, Maximum Parsimony and Maximum Likelihood methods. Our results indicated that *Aporocactus* is a monophyletic genus and sister to the *Selenicereus* + *Hylocereus* and *Weberocereus* alliance. These results support the delimitation of only two species: *A. flagelliformis* and *A. martianus*. The first one is a species with a zygomorphic magenta flower distributed in Hidalgo, Queretaro, Puebla and Veracruz. The second is represented by an actinomorphic red flower, distributed in Veracruz and Oaxaca. Therefore, we propose that *Aporocactus* should be recognized as an independent genus with two species, and sister to the *Selenicereus* clade.

Key words: molecular phylogenetic, epiphytic cacti, molecular markers, Hylocereae, cacti



ERUMPENT BUD DEVELOPMENT IN *ECHINOCEREUS* (CACTACEAE)

Daniel Sánchez¹, Dalia Grego-Valencia², Teresa Terrazas²
& Salvador Arias²*

¹Conacyt – Laboratorio Nacional de Identificación y Caracterización Vegetal, CUCBA, Universidad de Guadalajara

²Instituto de Biología, Universidad Autónoma de México, Circuito Exterior, Ciudad Universitaria, 04510 Coyoacán, Ciudad de México, Mexico

* dsanchezc29@yahoo.com.mx

In Cactaceae, the areole is the organ that forms the leaves, spines and buds. Peculiarly, species in *Echinocereus* develop erumpent buds, which break through the epidermis of the stem above the areole. However, there is no clarity about how this trait is acquired, nor if the entire genus has it. Therefore, the development of the areole was investigated here in order to understand the anatomical modifications that lead to internal bud development and to supplement anatomical knowledge of plants that do not behave according to classical shoot theory. The external morphology of the areole was documented and the anatomy was studied using tissue clearing, scanning electron microscopy and light microscopy for 50 species including *Morangaya pensilis* (*Echinocereus pensilis*). Results showed that in *Echinocereus*, including those species cited as having non-erumpent buds, the areole is sealed by periderm, and the areole meristem is moved and enclosed by the differential growth of the epidermis and surrounding cortex. The enclosed areole meristem is differentiated in a vegetative or floral bud, which develops internally and breaks through the epidermis of the stem. In *Morangaya pensilis*, the areole is not sealed by the periderm and the areole meristem is not enclosed. The anatomical evidence supports the hypothesis that the enclosed bud represents one synapomorphy for *Echinocereus* and also supports the exclusion of *Morangaya* from *Echinocereus*. The enclosed areole meristem and internal bud development are understood to be an adaptation to protect the meristem and the bud from low temperatures.

Key words: areole meristem, enclosed meristem, enclosed bud, erumpent bud, sealed areole, periderm

FERNANDO ALTAMIRANO CARBAJAL:
ANAMNESIS OF OUR REMARKABLE ORIGINS

Emiliano Sánchez Martínez, Beatriz Maruri,
Yasmín Hailen Ugalde & Ma. Magdalena Hernández*

Jardín Botánico Regional de Cadereyta “Ing. Manuel González de Cosío, Consejo de Ciencia y Tecnología del Estado de Querétaro, Camino Antiguo a Tovaes S/N, Ejido Las Fuentes y Pueblo Nuevo, Cadereyta de Montes, 76500 Querétaro, Mexico

* esanchez@concyteq.edu.mx

In order to pay a profound tribute to all the people who have dedicated their lives to understanding and caring for the succulent flora of our planet, we will use this special presentation to remember and praise Dr. Fernando Altamirano Carbajal (1848-1908), pioneer explorer and quintessential scholar of the flora of the state of Querétaro, Mexico. First, we will review the influence that Querétaro had on the infant Fernando through his grandfather Dr. Manuel Altamirano, who introduced him in the science of Botany: Surely long walks with his grandfather forged his liberal and investigative character. The fruits of this deep relation would be visible later when, having graduated as a Physician, Fernando founded the National Medical Institute, the most important centre of scientific research of Mexico in the transition from the XIX to the XX century. In a second part, we will discuss the influence that Fernando Altamirano had in the then emerging botany science of Querétaro and throughout Mexico. Basically, here, we will nostalgically review the 1905 journey that Dr. Altamirano and Dr. José Rose (Joseph Nelson Rose, 1862-1928; Smithsonian Institution, USA) undertook in the semi-desert zone of our federal state. We conclude that the intellectual example of Fernando Altamirano Carbajal as an inspirational leader should serve to stimulate present-day scientists to fulfil the mission of plant conservation.

Key words: Fernando Altamirano, tribute, Querétaro, Mexico’s Botany, pioneer, intellectual example, plant conservation

INFLORESCENCE ARCHITECTURE, FLOWER DEVELOPMENT
AND EVOLUTION IN PORTULACACEAE

Thaíla Vieira Santos^{1}, Gladys F. A. Melo-de-Pinna²,
Gilberto Ocampo³ & Reyjane Patricia de Oliveira¹*

¹Universidade Estadual de Feira de Santana, Departamento de Ciências Biológicas, Avenida Transnordestina, s/n, Novo Horizonte, 44036-900, Feira de Santana, Bahia, Brazil

²Universidade de São Paulo, Rua do Matão, 321, Butantã, São Paulo, São Paulo, Brazil

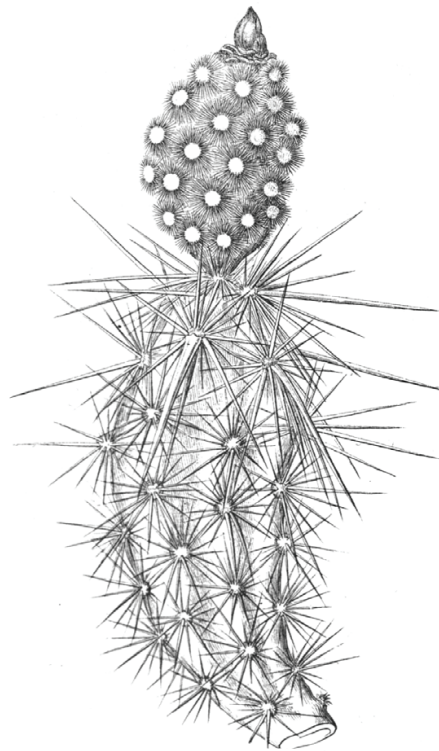
³Universidad Autónoma de Aguascalientes, Av. Universidad 940, Ciudad Universitaria, 20131 Aguascalientes, Mexico

* thailavieira94@gmail.com

Portulacineae (Caryophyllales) is a suborder recognized by grouping succulent families (Anacampserotaceae, Basellaceae, Cactaceae, Didiereaceae, Halophytaceae, Montiaceae, Portulacaceae, Talinaceae). Portulacaceae, as currently understood, is a monogeneric family that comprises ca. 100 species. Phylogenetic studies reconstructed six clades for *Portulaca* (“African-Asian”, “Australian”, “Oleracea”, “Umbraticola”, “Cryptopetala” and “Pilosa”) and this circumscription is corroborated by anatomical and metabolic data. Current knowledge on inflorescence architecture in *Portulaca* classifies them as terminal, cymose but very congested, and head-like. However, this classification is limited, once it does not represent the diversity of inflorescences for this family. The floral structure is inserted into a whorl of leaves forming the head-like inflorescences, whereas solitary flowers have their occurrence limited to some representatives of the “African-Asian” clade, plus *P. pusilla*, from the “Pilosa” clade. The flower parts are formed by two sepals and (4-)5-8 petals, a varied number of stamens and a unilocular carpel. Similar studies focusing on the floral structures of *Portulaca* aren’t very enlightening, most of them aiming at macromorphology analysis with taxonomic applications. Thus, the present project proposes to study morphological and anatomical characters with representatives of the *Portulaca* genus in order to understand evolutionary patterns for inflorescence and flower development within the different genus lineages. The

methodologies chosen for this work were the usual techniques of optical anatomy and scanning electronic microscopy as way to analyse inflorescences and flowers at various stages of their development. Finally, the results obtained will be analysed under the light of evolution, with the goal of understanding the diversification of inflorescences and flowers in the family.

Key words: *Portulaca*, flower, ontogeny, evolution



DETERMINATE GROWTH OF CACTOIDEAE PRIMARY ROOT,
AND BEYOND

Svetlana Shishkova¹, Gustavo Rodríguez-Alonso¹,
Mayra López-Valle¹, Selene Napsucialy-Mendivil¹, Marcela
Ramírez-Yarza¹, Marta Matvienko² & Joseph G. Dubrovsky¹*

¹Instituto de Biotecnología, Universidad Nacional Autónoma de México, Cuernavaca, Morelos, Mexico

²CLC bio, a QIAGEN Company, Davis, CA, USA, present address Tecan Systems, San Jose, California, United States of America

* sveta@ibt.unam.mx

Determinate root growth involves the root apical meristem (RAM) exhaustion and differentiation of root tip cells. Determinate growth of the primary root (PR) was first reported in a few desert Cactaceae species.

With the objectives (i) to survey the incidence of determinate growth of the Cactaceae primary root, we analysed PR growth pattern in species from this family; and (ii) to explore the mechanisms of the RAM exhaustion, we *de novo* assembled the transcriptome of the *Pachycereus pringlei* PR tip and characterized differential expression of the transcripts and microRNAs in developmental stages with RAM present and exhausted.

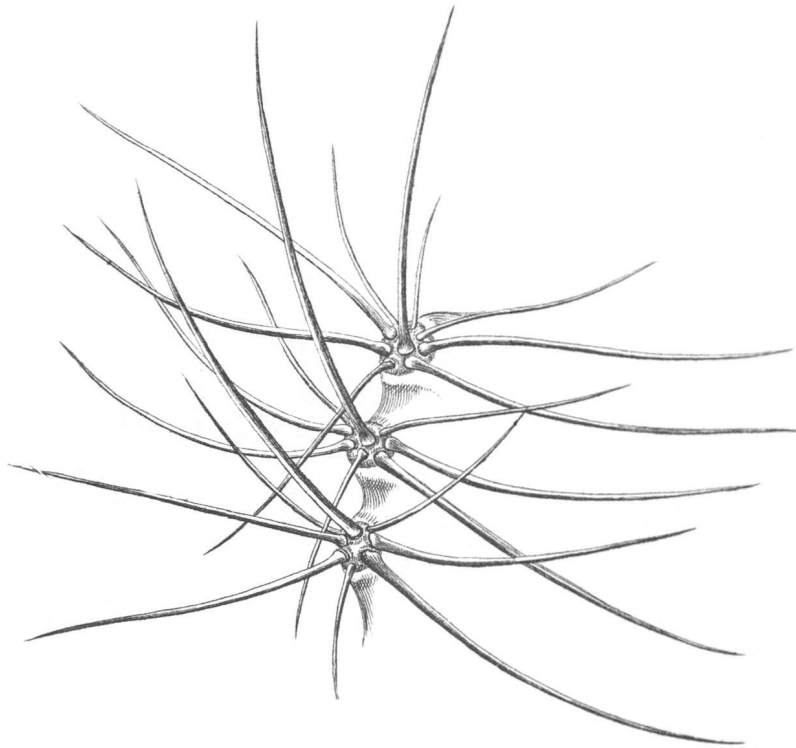
Methods: PR growth was analysed in seedlings cultivated *in vitro*. *De novo* transcriptome assembly; differential expression, miRNA and degradome analyses were performed using CLC-Genomics-Workbench, miRDeep and CleaveLand4 software.

Results: PR exhibits determinate root growth in all analysed species from five non-epiphytic Cactoideae tribes. Moreover, our preliminary results suggest that (a) seedlings of two epiphytic Cactoideae tribes either do not develop PR or could exhibit determinate or indeterminate PR growth, and (b) the PR growth pattern of Opuntioideae is also variable. Analysis of the *P. pringlei* PR transcriptome, microtranscriptome, and gene regulatory network (GRN) based on the published *Arabidopsis* GRN, suggest that the transcriptional programs operating in the PR tip of Cactoideae and *Arabidopsis* are similar. However, many lineage specific transcripts were found using published and unpublished Cactaceae transcriptomic data.

Conclusions: Determinate PR growth in Cactoideae matches their arid and semi-arid environment, while epiphytic Cactoideae that can also inhabit mesic environments, exhibit determinate or indeterminate PR growth. Cactaceae PR tip with exhausted RAM performs functions of root differentiation zone. In addition to the conserved molecular mechanisms of PR development in angiosperms, lineage specific genes might be involved in the regulation of determinate PR growth in Cactaceae.

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Key words: adaptation, Cactoideae, degradome, determinate root growth, meristem exhaustion, microtranscriptome, *Pachycereus pringlei*, transcriptome



PHYLOGENY OF *CEPHALOCEREUS* (CACTACEAE)
BASED ON MOLECULAR AND STRUCTURAL DATA

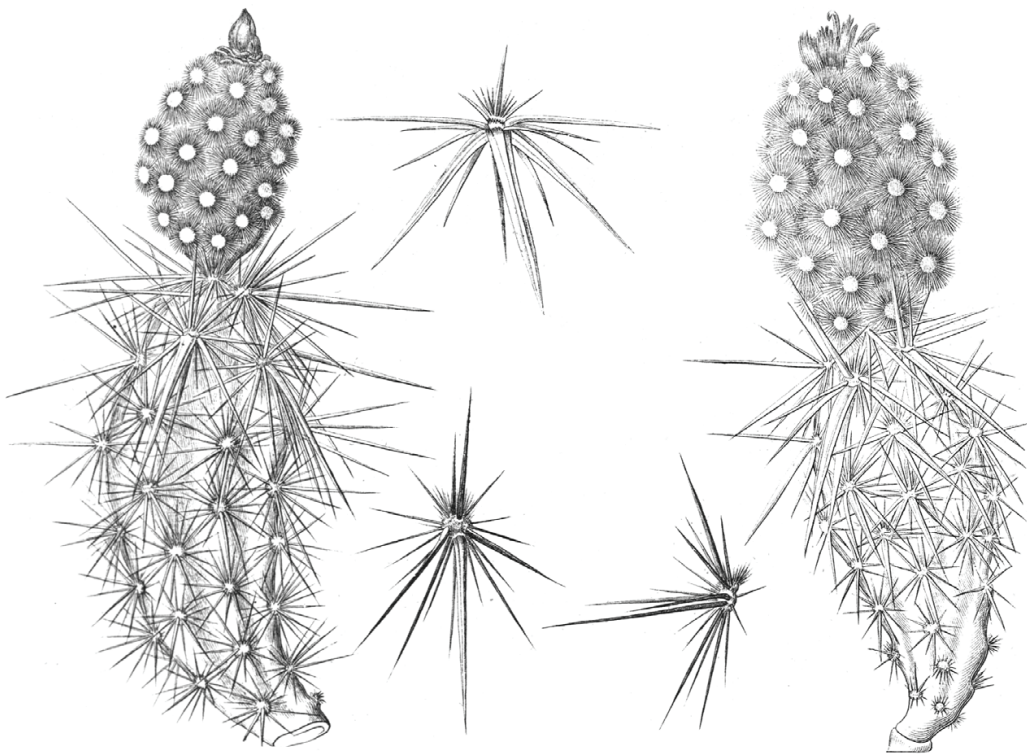
Héctor Tapia & Salvador Arias*

Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Apdo. Postal 70-614, 04510 Mexico City, Mexico

* hectorts@unam.mx

Several authors have sustained the recognition of *Neobuxbaumia* as a genus separated from *Cephalocereus* since the past century, relying on the absence or the presence of a differentiated flowering region, respectively. Recent phylogenetic studies based on molecular and morphological evidence have recovered the monophyly of the “*Cephalocereus* group”, including *Neobuxbaumia* and the monotypic *Pseudomitrocereus*, but the monophyly of each genus has not been resolved yet. The aims of this study were to evaluate the monophyly of these genera, and to re-assess the circumscription of the “*Cephalocereus* group”. We explore two phylogenetic methods, maximum parsimony and Bayesian inference, to recognize the relationships among the species and genera from “*Cephalocereus* group”. The data employed was gathered from seven molecular chloroplast markers (*petL-psbE*, *psbA-trnH*, *rpl16*, *rpl32-trnL*^{UAG}, *trnL-F*, *trnQ-rps16*, and *ycf1*), simple coded indels, and 46 structural characters. Two different datasets were constructed for: 1) molecular data alone, and 2) combined (molecular + structural) data. The different molecular and combined analyses were mostly congruent in topology and support values. Our results support the monophyly of the “*Cephalocereus* group”, including all the species of *Neobuxbaumia* and *Pseudomitrocereus fulviceps*, and the distinction from other genera as *Carnegiea*, *Pachycereus* and *Lemaireocereus*. The genus *Cephalocereus* is resolved as polyphyletic because their species appeared nested in different clades with several species of *Neobuxbaumia*, which is recovered as paraphyletic, and *Pseudomitrocereus fulviceps* appeared in a derived position, instead of diverging early. We suggest grouping all the species in a natural taxon, which has priority over the name *Cephalocereus*. A combined set of molecular and morphological characters that support the circumscription of *Cephalocereus* as defined here, and internal clades are discussed.

Key words: combined analyses, morphology, *Neobuxbaumia*,
Pseudomitrocereus, taxonomy



PHYLOGENETIC RELATIONSHIPS OF *ECHINOCACTUS* LINK
& OTTO (CACTOIDEAE, CACTACEAE) INFERRED FROM
NUCLEAR DNA SEQUENCES OF *DODA* AND *5GT* GENES

Mario Vargas-Luna*,¹ Patricia Hernández-Ledesma,²
Raúl Puente,³ Lucas C. Majure,³ Héctor M. Hernández⁴
& Rolando T. Bárcenas¹

¹Laboratorio de Genética Molecular y Ecología Evolutiva, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Campus Aeropuerto, Querétaro, Querétaro 76140, Mexico

²Instituto de Ecología A.C., Centro Regional del Bajío, Pátzcuaro, Michoacán, Mexico

³Research, Conservation and Collections Department, Desert Botanical Garden, 1201 N. Galvin Parkway, Phoenix, Arizona 85008 USA

⁴Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, 3er Circuito de Ciudad Universitaria, Del. Coyoacán, Ciudad de México, 04510 Mexico

* mvargas23@alumnos.uaq.mx

We tested the phylogenetic utility of DNA sequences of the *DODA* and *5GT* betalain synthesis related nuclear genes to reconstruct evolutionary relationships in *Echinocactus*. Maximum parsimony (MP), maximum likelihood (ML) and Bayesian analyses (BA) were performed to 34 generated sequences for *5GT* and 19 for *DODA*. The analyses included 42 terminals, representing all taxa of *Echinocactus* and other outgroup taxa of the Cactoideae, Phyllocacteae and Opuntioideae. Results with *5GT* and with a concatenated matrix including *DODA* and *5GT* recovered the Cactaceae as monophyletic with strong support. *5GT* analyses recovered two internal clades within the Cactaceae, one including all the *Ferocactus* species, *Echinocactus grusonii* and one accession of *E. polycephalus* var. *polycephalus*, here called the *Ferocactus* clade, the other including *A. ornatum* and the rest of the accessions of *Echinocactus* here called the *Astrophytum-Echinocactus* clade. These results suggest that *Echinocactus* as currently circumscribed is not monophyletic. Although, one accession of *E. polycephalus* var. *polycephalus* was nested in the *Ferocactus* clade, the other two accessions of this taxon were retrieved among the species of *Echinocactus*. In order to circumscribe a monophyletic genus we

propose to recognise five species in *Echinocactus* and to exclude *E. grusonii*. Also, we propose to formally recognise the two internal clades in *Echinocactus*: the *Echinocactus* clade, including *E. platyacanthus* and *E. horizonthalonius* and the *Homalocephala* clade comprising *E. parryi*, *E. texensis* and the two varieties of *E. polycephalus* (var. *polycephalus* and var. *xeranthemoides*). Results with 5*GT* support the recognition of *E. polycephalus* var. *xeranthemoides* as a distinct species. Estimations of divergence times with 5*GT* suggest that the *Echinocactus* and the *Homalocephala* clades diverged during the Pliocene at 2.8 and 4.9 mya, respectively. We thank the International Organization for Succulent Plant Study for economic support to develop some of the molecular analyses.

Key words: *Echinocactus*, *Homalocephala*, *DODA*, 5*GT*, betalains



DISTRIBUTION AND CONSERVATION OF THE GENUS *Pinguicula*
(Lentibulariaceae) IN MEXICO AND CENTRAL AMERICA

Sergio Zamudio¹ & Julián Hernández Rendón²

¹Apartado Postal 293, 61600 Pátzcuaro, Michoacán, Mexico

²Instituto de Investigación de Zonas Desérticas, Calle Altair 200, Colonia del Llano, 78377 San Luis Potosí, San Luis Potosí, Mexico

* szamudioruiz@gmail.com

The genus *Pinguicula* is distributed in the temperate regions of the Northern Hemisphere, with some representatives in the West Indies and the South American Andes. It consists of ca. 90 species, of which 45 are known in Mexico and Central America; one is endemic to Central America, six are shared between Central America and Mexico and 38 are endemic to Mexico. In addition to these, we have seven new species from Mexico and one from Honduras in preparation. The occurrence in Mexico of ca. 50% of the known species in the world points to the conclusion that this country is the main centre of diversification of the genus.

In Mexico and Central America the butterworts are distributed along the mountainous regions in a discontinuous pattern. They grow in cliffs, slopes, ravines, rocky walls and along streams; preferentially in sites with north or northeast face, protected from direct sunlight, with high environmental humidity and frequently dripping wet.

The extraordinary variation in the ecological conditions in the Mexican and Central American mountains has stimulated the ample radiation of these plants, which have diversified extraordinarily and occupied cloud forest, tropical deciduous forest and arid tropical scrub as well as the coniferous forest.

None of the Mexican and Central American species are included in the Mexican Official List of Endangered Species, nor in the IUCN Red List. Accelerating environmental destruction in the region, increasing collection and illegal trade could, in the future, cause the extinction of some of these plants, mainly the micro-endemics known only from one locality. It is necessary to take action for the protection and conservation of these beautiful plants.

Key words: carnivorous plants, Lentibulariaceae, *Pinguicula*

BRAZILIAN CACTI TODAY

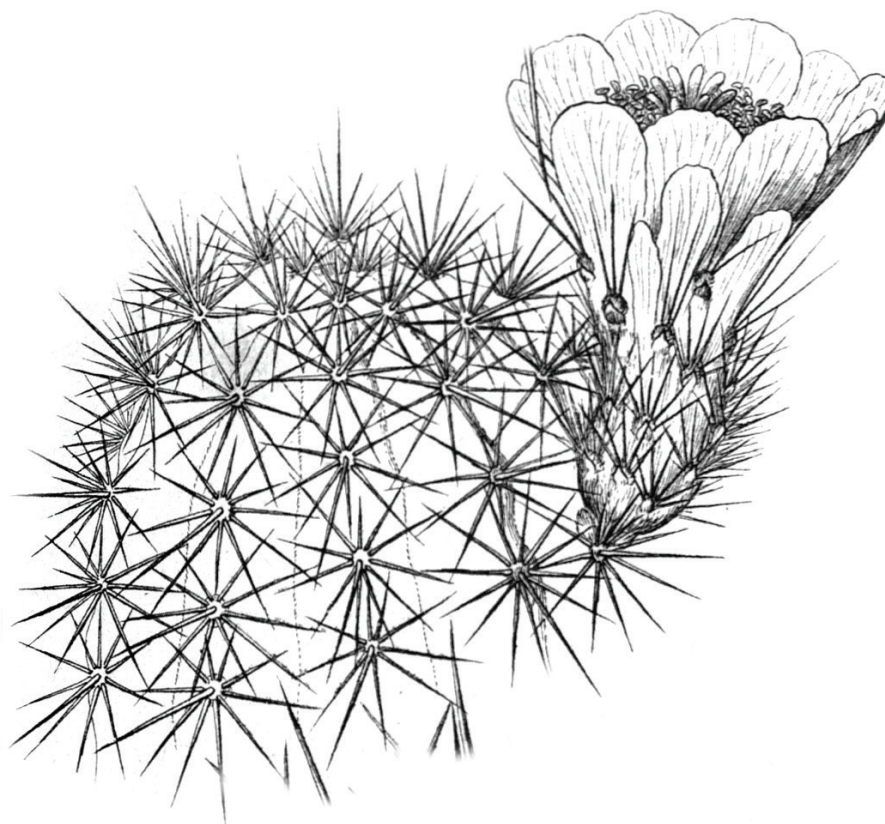
Daniela Zappi

Coordenadoria Botânica, Museu Paraense Emílio Goeldi & Instituto Tecnológico Vale. MPEG, Av. Perimetral 1901, CEP 66077-830, Belém, Pará, Brazil

danielazappi14@gmail.com

The taxonomy and systematics of Brazilian cacti has changed dramatically in the last 20 years. We provide a review of these developments and present several of the most iconic and enigmatic species that share a diversity centre in Eastern Brazil. These studies continue through the Brazilian Flora Online 2020 project, which provides a dynamic platform to record the distribution of the family throughout the country, which is considered today home to the highest plant diversity. On the other hand, the provision of a detailed alpha taxonomy for the family in the country has fostered recent genetic studies that show interesting (and intriguing) patterns regarding the distribution, diversification and speciation of key genera (*Pilosocereus*, *Cereus*). Brazilian cactus species may thus be used as a model group to study wider questions regarding arid lands biodiversity and speciation. Allied to those, in-depth studies of pollination biology are providing subsidies to the conservation of this knowingly highly endangered group of plants in Brazil and in the Americas.

Key words: Brazil, cacti, Brazilian Flora Online, taxonomy



ABSTRACTS OF POSTER PRESENTATIONS

GLOBAL FIGHT! HOW CLOSE IN MORPHOLOGICAL SPACE
ARE THE CONVERGENT GLOBAL SUCCULENTS OF THE AMERICAS
AND AFRICA?

Leonardo O. Alvarado-Cárdenas^{1}, Mark E. Olson²,
Angélica Cervantes² & Laura Trejo³*

¹Laboratorio de Plantas Vasculares, Departamento de Biología Comparada, Facultad de Ciencias, Universidad Nacional Autónoma de México, Apartado Postal 70-282, 04510 Ciudad de México, Mexico

²Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Apartado Postal 70-233, 04510 Ciudad de México, Mexico

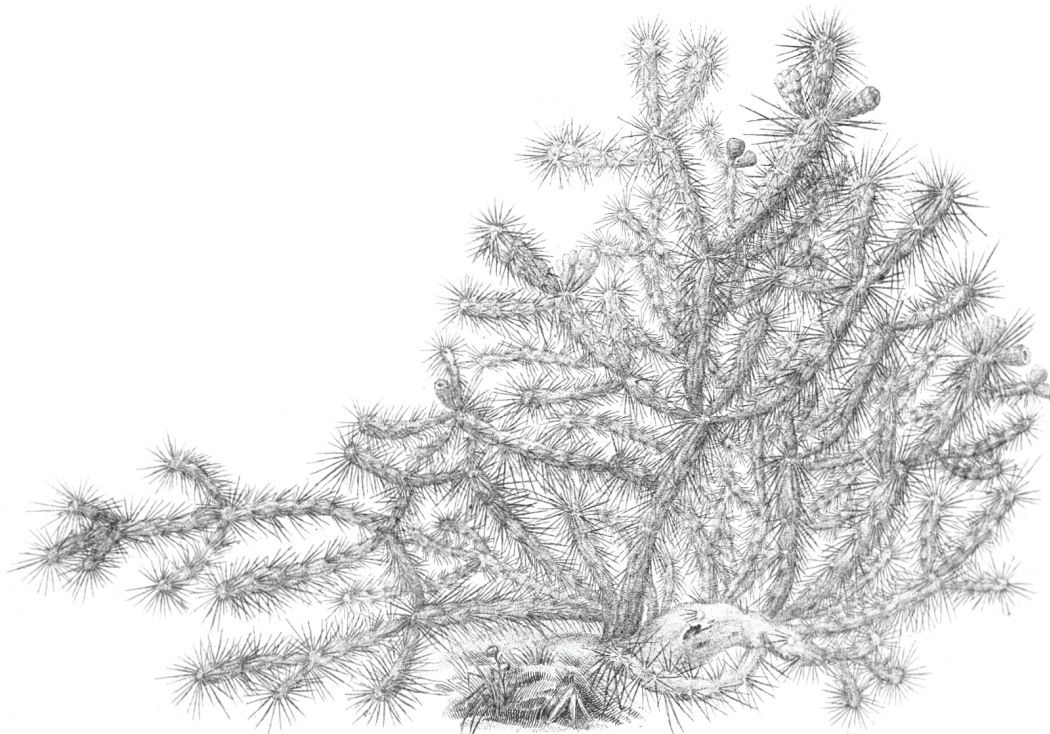
³Laboratorio Regional de Biodiversidad y Cultivo de Tejidos Vegetales, Instituto de Biología, Universidad Nacional Autónoma de México, Tlaxcala, Mexico

* leonardo.oac77@gmail.com, leonardoac@ciencias.unam.mx

Convergent evolution is a central phenomenon in biology. However, many proposals of morphological convergence are based on qualitative assessments of the attributes. To test quantitatively similarity in shape, we applied a geometric morphometrics analysis to the classic example of convergence between globular succulents of Cactaceae from the Americas and the African Aizoaceae, Apocynaceae, and Euphorbiaceae. We included *Astrophytum asterias* and *A. myriostigma* (Cactaceae), *Conophytum calculus* (Aizoaceae), *Euphorbia meloformis*, *E. obesa*, and *E. valida* (Euphorbiaceae), and *Pseudolithos migiurtinus*, and *P. cubiformis* (Apocynaceae) to evaluate their shape in the apical and lateral views using the method of semi-landmarks. We also included a spherical shape to observe whether the globular succulents are close to the theoretically optimal form in terms of surface/volume ratios. The apical view analysis generated a morphospace with four main groups: 1) *A. asterias*-*C. calculus*-*E. obesa*-*P. migiurtinus*, 2) *E. meloformis*-*E. valida*, 3) *A. myriostigma*, and 4) *P. cubiformis*. The analysis of the longitudinal view generated a cloud of points describing a morphological continuum of shapes. When the circle was included, in both comparisons (apical/lateral), the globular species were distant from the sphere in axis 1, but in axis 2 some shapes had partial similarities with the sphere. This work allowed us to suggest that the convergence is far from being a question of all or nothing, instead describing a broad

continuum in which similarity can be total or partial depending of the analytical tools. The use of geometric morphometrics corroborated the similarity in globular succulents, as well as a strong association between the form and the environment. We highlight the potential role of natural selection acting at different stages of development or dimensions (transversal or longitudinal) of the body plant to lead them to areas adjacent to theoretically optimal configurations of surface/volume ratio.

Key words: Apocynaceae, Cactaceae, convergence, Euphorbiaceae, morphometrics



THE PHOTOPROTECTIVE ROLE OF PIGMENTS ON THE
PHOTOSYNTHETIC PERFORMANCE OF *AGAVE TEQUILANA* UNDER
INDUCED GLOBAL WARMING: ASSESS IN EARLY DEVELOPMENT PHASES

*José Luis Aragón-Gastélum¹, Hugo Magdaleno Ramírez-Tobías¹,
Joel Flores Rivas², Ariadna Balderas¹*, Evelyn Méndez Guzmán¹,
Claudia González-Salvatierra¹ & José Pablo Lara-Ávila¹*

¹Facultad de Agronomía y Veterinaria, Universidad Autónoma de San Luis Potosí, Km 14.5 Carretera San Luis Potosí-Matchuala, Ejido Palma de la Cruz, 78321 Soledad de Graciano Sánchez, San Luis Potosí, Mexico

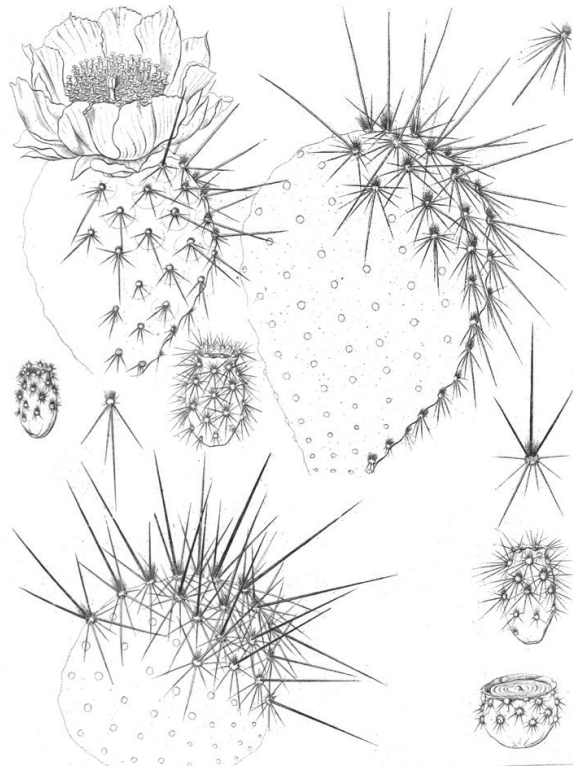
²Instituto Potosino de Investigación Científica y Tecnológica, División de Ciencias Ambientales. Camino a la Presa San José No. 2055, Colonia Lomas 4a. Sección, 78216 San Luis Potosí, Mexico

* ariadna.balderas.m@gmail.com

Agave tequilana is a native Mexican plant associated with tequila production for several centuries. *Agave* species do not seem threatened by climatic warming projections; however, this assumption only considers adult plants; neglecting the potential impact of warming in early development phases. Climate change models in the Chihuahuan Desert indicate an increase in temperature of 1–2 °C by 2030. We assessed the photosynthetic performance [maximum quantum efficiency of photosystem II (F_v/F_m); effective quantum yield of photosystem II (F_{PSII}); electron transport rate (ETR) and non-photochemical quenching (NPQ)] and pigment content (chlorophylls *a*, *b*, total chlorophyll, carotenoids and anthocyanins) in *A. tequilana* under induced warming. Open-top chambers (OTCs) were used to simulate the effect of global warming on two-year old seedlings and five-year old individuals. OTCs had higher mean temperature (2°C) and lower relative humidity (3.3%) than control plots. Induced warming affected the photosynthetic performance and pigment content of *A. tequilana*. F_v/F_m values changed differently among seedlings and young plants under induced warming; values dropped on F_v/F_m but were more pronounced on controls and stability observed on OTC. Low F_{PSII} values were registered in both development phases and conditions. ETR values were higher on young plants than in seedlings and changed over the time but not by warming treatment. Neither warming nor the age affected the NPQ values; Chlorophylls *a* and *b* were higher (until a 40% more) in seedlings than young individuals, but young

plants presented more carotenoids and anthocyanins than seedlings. It might be a major ability for photoprotection of young plants than in seedlings. Therefore, under a global warming scenario, photosynthetic performance and pigment content are altered, but photoprotective pigments play an important role on sexual reproduction in the wild population of *A. tequilana*. This is the first experimental study focused on the potential impact of climate warming on photosynthetic performance of a succulent species with high economic value.

Key words: Asparagaceae, Chihuahuan Desert, global warming, photosynthetic performance, pigment content



REPRODUCTIVE PHENOLOGY AND FLOWER COLOUR VARIATION
IN *LOPHOPHORA DIFFUSA* (CACTACEAE)

Ma. Isabel Briseño & Ma. del Carmen Mandujano*

Laboratorio de Genética y Ecología, Departamento de Ecología de la Biodiversidad, Instituto de Ecología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Deleg. Coyoacán, 04510 Ciudad de México, Mexico

* Isabel.brisenosanchez@gmail.com

The beginning and length of reproductive phases in plants is subject to environmental variables and biotic interactions. For globose cacti, the flowering period usually lasts several weeks, and a positive association with precipitation and temperature has been proposed. In order to describe the reproductive phenology in a population of *Lophophora diffusa*, monthly censuses were carried out to record the presence of reproductive structures from September 2014 to November 2015 ($N = 420$ individuals). To know the degree of floral synchrony we performed the Marquis index. We also measured the frequency of the flowers according to their colour. The flowering period lasted from March to July, with a maximum production of open flowers in March and May. We determined that the population is asynchronous, which means that the flowering differs in duration time and it does not occur at the same time in all of the individuals. 42% of the plants were reproductive, but only 28% produced fruits. The fruiting began about two months after the first flowering peak and extended until the end of the year. Most of the flowers were white, only 4% of individuals were pink. The difference in floral traits may have implications in the activity of pollinators and florivores. The asynchrony in flowering has been explained as a strategy to minimize the risk of exposure to adverse conditions, which may be an advantage to the movement of the pollinators and seed dispersers. Our population of *Lophophora diffusa* presents a period of reproduction lasting several months, with more than one peak of flowering. These characteristics could generate different opportunities for the success of the pollination, fruiting, and seed dispersal.

Key words: flowering, asynchrony, floral traits, reproductive success

NECTARIES IN THE GENUS *STROMBOCACTUS* (CACTACEAE)

Aldebarán Camacho-Velázquez^{1*}, *Salvador Arias*²,
*Emiliano Sánchez-Martínez*³ & *Sonia Vázquez-Santana*¹

¹Laboratorio de Desarrollo en Plantas, Departamento de Biología Comparada, Facultad de Ciencias, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

²Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

³Jardín Botánico Regional de Cadereyta 'Ing. Manuel González de Cosío', 76500 Cadereyta de Montes, Querétaro, Mexico

* aldebis84@yahoo.com.mx

Floral nectaries are nectar-secreting structures, which are offered by the plant to its pollinating agents, promoting outcrossing. The objective of this study was to describe and compare the floral nectaries morphology and anatomy of the taxa in the genus *Strombocactus* (*S. disciformis* subsp. *disciformis*, *S. disciformis* subsp. *esperanzae* and *S. corregidora*), all of which are threatened. Flowers of the three taxa were collected at anthesis; a portion of the material was processed for observation under a scanning electron microscope or embedded in paraplast to perform histological sections and histochemical tests. The results show that the anatomical characteristics of the nectaries are similar among the three studied taxa. The nectarial tissue is located below the insertion of the innermost stamens and reach the upper part of the ovary, along the basal portion of the hypanthium, in the form of a ring. The nectaries are constituted of a simple almost flat epidermis (in *S. disciformis* subsp. *esperanzae*) to papillose (in *S. corregidora*), a nectariferous parenchyma of small cells very active metabolically and a subnectariferous parenchyma of larger cells, associated with vascular bundles. The nectar is secreted by nectarostomes. Based on the floral characteristics of this genus (flowering time, shape, colour, rewards and nectar guide) and preliminary field observations it can be presumed that they are pollinated by bees.

Key words: floral nectaries, nectar, nectarostomes, *Strombocactus*

DISTRIBUTION AND SPECIES RICHNESS OF THE CACTACEAE IN THE STATE OF TABASCO, MEXICO

Manuel Jesús Campos Díaz^{1,2} & Carlos Manuel Burelo Ramos²*

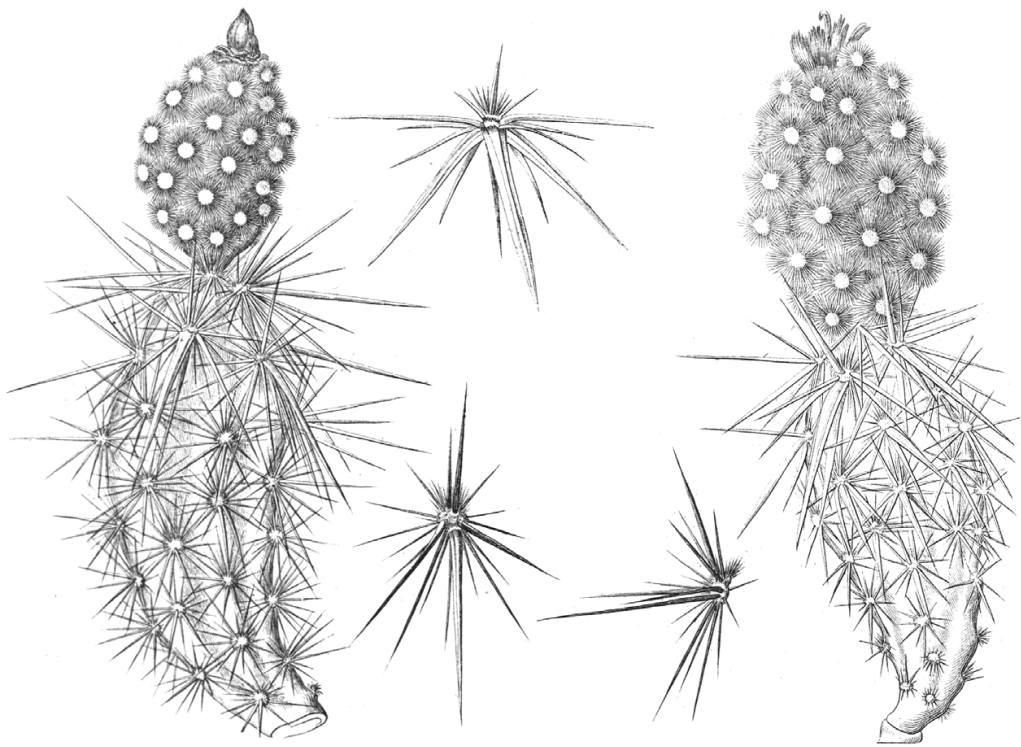
¹Licenciatura en Biología, División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco, 86150 Villahermosa Tabasco, Mexico

²Herbario UJAT, División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco, 86150 Villahermosa, Tabasco, Mexico

* biolcamposm@gmail.com

Studies on the Cactaceae in Mexico are primarily focused on the species that inhabit arid zones, with little knowledge about the species which have epiphytic habits and that inhabit the rain forest areas of Mexico. In the State of Tabasco it has been documented the presence of Cactaceae; however, the knowledge generated about their biology, ecology, ethnobotany and systematics are very low. The development of the project “Diversity and species richness of the Cactaceae in the State of Tabasco” aims at: 1) determining the species diversity, 2) generating descriptions of each of the genera and species, 3) establishing their geographic distribution, and 4) developing dichotomous keys for the genera and species of the family in the state. By consulting the CSAT, MEXU, UJAT and XAL herbaria, and the collection of specimens throughout the state, it is established that in Tabasco there are 20 native species, grouped into 8 genera. The genera with the greatest diversity are *Epiphyllum* and *Selenicereus*, with 6 and 5 species respectively. The most diverse municipalities are: Tacotalpa and Teapa with 9 species for both of them and Centro with 8 species. The existence of the genera *Nopalea* and *Opuntia* are reported as introduced. *Selenicereus chrysocardium* (Alexander) Kimnach (*molecular evidence suggests *S. chrysocardium* is in fact a species of *Epiphyllum* as originally proposed by Alexander), a species that was considered endemic of Chiapas and is currently protected by Mexican regulations, is reported for the first time for the flora of the State of Tabasco. This work allowed us to know the richness of Cactaceae that inhabit Tabasco and is the basis for the development of studies aimed to establishing the conservation status of cacti populations to generate conservation and management strategies in the state. It will also help the development of research in the fields of reproduction, floral biology, associations, anatomy and physiology of Cactaceae species.

Key words: Cactaceae, *Epiphyllum*, *Selenicereus*, species richness, Tabasco



FLORIVORY ON *OPUNTIA CANTABRIGIENSIS* LYNCH IN CADEREYTA DE MONTES, QUERÉTARO, MEXICO

Diana Cárdenas-Ramos & Ma. del Carmen Mandujano*

Instituto de Ecología, Universidad Nacional Autónoma de México,
Departamento de Ecología de la Biodiversidad. Apartado postal 70-275,
04510 Ciudad de México, Mexico

* diana_cr92@ecologia.unam.mx

Florivory is the consumption of buds, ovules, pistils, stamens or any part of the flower before seed formation. This interaction may impact plant reproductive output, reduce seed formation, change mating systems, plant fitness and floral traits that drive the evolution of sexual systems. In extreme cases florivory can decrease birth rate and deplete populations. The effects of florivory on reproductive output are indirect when florivores affect visitation rates or behaviour of pollinators modifying crossing rates, while direct effects reduce seed production in damaged flowers. We aimed to determine the effects of florivory on the reproductive output of *Opuntia cantabrigiensis* by assessing the association of florivory with floral synchrony, and experimentally simulating the effects of florivory on floral visitors and fruit set. Our hypothesis was that high floral synchrony will decrease florivory and damaged flowers would have reduced fruit set. We counted reproductive structures on 35 plants every other day during the flowering period and measured frequency of floral buds, flowers or fruits and damage by florivores. Effects of florivory were assessed with an experimental design with 20 replicates (plants) and four treatments: intact flowers (control), damaged flowers with removal of 50% of perianth, 50% of stamens or all stamens. Floral visitors were registered every two hours for 30 min in experimental flowers. Fruit set of all treatments was evaluated and mature fruits collected, weighed and seeds counted. Floral visitors were captured and their activities described. Florivory was found in 26% of reproductive structures. Florivores consumed more buds (22%), which precluded reproduction as no fruits were formed (damaged flowers lack stigma) and the removal of stamens decreased floral visitors.

Key words: direct effect, floral synchrony, florivory, indirect effect, pollination

CONSERVATION STATUS OF *BEAUCARNEA INERMIS* (S. WATSON)
ROSE IN MEXICO

Hugo Alberto Castillo Gómez & Luis Hernández-Sandoval*

LANIVEG, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Av. de las Ciencias s/n, Juriquilla, Querétaro, Mexico

* hbetocg@hotmail.com

One of the ponytail palm species, *Beaucarnea inermis*, is endemic to northeastern Mexico. It is included in the Mexican species conservation list NOM-059, recognized as an endangered species. Most species of the genus are endangered or under the risk of extinction, and are illegally collected from natural populations to trade in both, domestic and international markets. The goal of this work is to evaluate the conservation status of *B. inermis* by means of the Mexican Risk Assessment for Wildlife Species Method (MER). The information for the MER criteria was obtained directly from the study sites, and from literature for: a) distribution amplitude, b) habitat status with respect to the natural development of the taxon, c) intrinsic biological vulnerability, and d) human activity impacts. This information showed that *B. inermis* has a restricted distribution in Mexico, comprising less than 5% of the country. The habitat status is considered intermediate or restricted. So, even that the species is found in both, primary and secondary tropical deciduous forest, and its humidity and temperature ranges are ample, stochastic factors such as prolonged droughts and hurricanes, threaten the natural populations recruitment. The intrinsic biological vulnerability of the taxon has significant differences in population structure, random recruitment events, and phenology, which is strongly associated with climatic variability. Large natural areas have *B. inermis* populations in good conservation status; however, human direct impact over the taxon is considerable as well as the strong biological communities alteration. The score obtained with the integration of the criteria, supports the maintenance of *B. inermis* under the endangered category in the Mexican NOM-059.

Key words: ponytail palm, MER, endangered species

RESPONSES TO DIFFERENT CONCENTRATIONS OF AUXINS AND
CYTOKININS IN *AGAVE GUIENGOLA* AND *A. POTATORUM*

*Lucía Isabel Chávez-Ortiz**, *Eugenio Pérez-Molphe-Balch*,
José Francisco Morales-Domínguez, *Araceli Rodríguez-Sahagún*,
Alejandra Palomeque-Carlín, *Ma. de Lourdes de la Rosa Carrillo*,
Martha Evelia Pérez-Reyes & *Adilene Dávila-Galván*

Universidad Autónoma de Aguascalientes, Av. Universidad 940, Col. Cd.
Universitaria, 20131 Aguascalientes, Mexico

* lichavez@correo.uaa.mx

The genus *Agave* holds great biological, economic and cultural importance in Mexico. *Agave guiengola* is a microendemic species from the Guiengola region in the Tehuantepec Isthmus, in Oaxaca; it is greatly appreciated as an ornamental plant, but it is considered threatened. *Agave potatorum* is endemic of the Tehuacán-Cuicatlán valley located between Puebla and Oaxaca; it does not present asexual reproduction, and its natural populations have been subjected to intense exploitation, mostly for mezcal production. In consequence, its numbers are decreasing rapidly and the species is now considered threatened. In order to avoid the extinction of natural populations of these and other *Agave* species it is crucial to develop comprehensive management strategies with the purpose of recovering natural populations, and to help domesticate them for rational exploitation that could result in very much needed economic benefit for people of impoverished communities. *In vitro* plant tissue culture is a vital tool in these management schemes, therefore the goal of this work is to assess the response of *A. guiengola* and *A. potatorum* to auxins, cytokinins and combinations of both. In general terms, in both species the use of cytokinins alone increases adventitious shoot formation, while auxins alone or combined with cytokinins induce callus formation; in some treatments the combination of auxins and cytokinins appears to induce embryogenic callus. Based on these results it will be possible to elaborate specific protocols, particularly those of micropropagation via organogenesis or somatic embryogenesis, that later could be used in the management strategies of these species.

Key words: *Agave guiengola*, *A. potatorum*, auxins, cytokinins, micropropagation

HISTORIC DEMOGRAPHY OF *CEPHALOCEREUS COLUMNA-TRAJANI*
(CACTACEAE) IN THE TEHUACÁN-CUICATLÁN VALLEY, MEXICO

Amelia Cornejo-Romero^{1*}, *Carlos Fabián Vargas-Mendoza*²,
*Gustavo Fabián Aguilar-Martínez*² & *Javier Medina-Sánchez*³

¹Departamento de Botánica, Escuela Nacional de Ciencias Biológicas,
Instituto Politécnico Nacional, Ciudad de México, Mexico

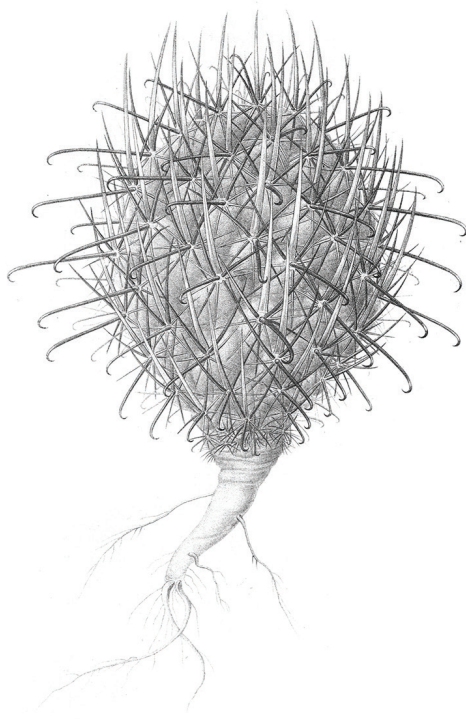
²Departamento de Zoología, Escuela Nacional de Ciencias Biológicas,
Instituto Politécnico Nacional, Ciudad de México, Mexico

³Department of Geography, University of Leicester, Leicester, UK

*ameli.cornejo@gmail.com

Historic demography changes of plant species adapted to New World arid environments could be consistent with either the Glacial Refugium Hypothesis (GRH), which posits that populations contracted to refuges during the cold-dry glacial and expanded in warm-humid interglacial periods, or with the Interglacial Refugium Hypothesis (IRH), which suggests that populations contracted during interglacial and expanded in glacial times. In order to determine if the historic demography of the giant columnar cactus *Cephalocereus columna-trajani* in the intertropical Mexican drylands is consistent with either hypothesis, sequences of the chloroplast regions *psbA-trnH* and *trnT-trnL* from 10 populations comprising the full distribution range of this species were analysed. The demographic dynamic was analysed using an Approximate Bayesian Computation (ABC) and the palaeodistribution of Late Quaternary was derived from ecological niche modelling to determine if, in the arid environments of south-central Mexico, glacial-interglacial cycles changed the distribution area of this species. ABC demographic analyses suggest a population expansion, which could have taken place in the Last Interglacial (123.04 kya, 95% CI 115.3±130.03). The estimated population size of the *C. columna-trajani* before the expansion was $N_b = 996,000$ individuals (95% CI 327,000±1,840,000), increasing up to an estimated size of $N_1 = 1,680,000$ individuals (95% CI 702,000±2,370,000). The species palaeodistribution is consistent with the ABC analyses and indicates that the potential area of palaeodistribution and climatic suitability were larger during the Last Interglacial and Holocene than in the Last Glacial Maximum. Overall, these results suggest that *C. columna-trajani* experienced an expansion following the warm conditions of interglacials, in accordance with the GRH.

Key words: Quaternary climatic changes, historic demography, palaeodistribution



DEVELOPMENT OF BIOTECHNOLOGICAL METHODS FOR THE
PROPAGATION AND CONSERVATION OF *FEROCACTUS* SPECIES

*Ma. de Lourdes de la Rosa-Carrillo**, *Lucía Isabel Chávez-Ortiz*,
Alejandra Palomeque-Carlín, *Eugenio Pérez-Molphe-Balch*
& *Víctor Ángeles-Galván*

Universidad Autónoma de Aguascalientes, Av. Universidad #940, Ciudad
Universitaria, 20131 Aguascalientes, Aguascalientes. Mexico

* lmdelaro@correo.uaa.mx

Species of the genus *Ferocactus* (Cactaceae) are characterized by their large size and globose or cylindrical shape. These plants are called biznagas and have many uses. Their stems, flowers and fruits are edible and the plants have great ornamental value. However, they are very often over-collected in their natural habitats, so some (*F. cylindraceus* var. *cylindraceus*, *F. pilosus* and *F. haematacanthus*) are subject to special protection; according to NOM-059-ECOL-2010. An alternative to propagate and conserve these species is through the use of biotechnological tools. The objective of this work was to test different treatments with plant growth regulators to propagate massively eight species of this genus (*F. flavovirens*, *F. cylindraceus* var. *cylindraceus*, *F. haematacanthus*, *F. hamatacanthus*, *F. glaucescens*, *F. hystrix*, *F. latispinus* var. *latispinus* and *F. pilosus*). The first step was to establish the *in vitro* culture from seed or part of the plant, which were subjected to a disinfection process and placed in a culture medium. Then, for each species different treatments were tested by varying the plant growth regulator and its concentration for the purpose of generating shoots, to quantify them and to be able to establish the best treatment. The number of shoots per explant ranged from 4.4 to 7.5. Only *F. flavovirens* gave a good response with 2-isopentyladenine at a concentration of 4.0 mg/L, the other species did so with benzyladenine at concentrations of 0.5, 1.0 and 2.5 mg/L. Therefore, it can be concluded that the use of plant growth regulators allows the massive propagation of these species and is a viable methodology, since it gives better results and in a shorter time than propagation by conventional methods.

Key words: *Ferocactus*, *in vitro* culture, plant growth regulators

ENVIROMENTAL PREFERENCES AND NICHE SIMILARITY
IN FOURTEE CRASSULACEAN SPECIES OF OAXACA

César Damián-Jiménez¹ & Carlos Martorell Delgado²

¹Benemérita Universidad Autónoma de Puebla, 4 sur 104, Centro Histórico, 72000 Puebla, Mexico

²Facultad de Ciencias, Universidad Nacional Autónoma de México, Av. Universidad 3000, Universidad Nacional Autónoma de México, Ciudad Universitaria, 04510 Ciudad de México, Mexico

* cd_ed@hotmail.com / cesar.damian@posgrado.ecologia.edu.mx

The aim of the present work was to determinate the environmental preferences and environmental similarities in 14 species of Crassulaceae from Concepcion Buenavista, Oaxaca, for which fundamental biological variables were registered. The point-centered quarter method was used for sampling an area of 13,740 m². The variables were: nurse plants, soil depth, biotic/abiotic soil cover, canopy, solar radiation on May 15th, annual solar radiation, vegetation, bedrock and altitude. We estimated if the different species had environmental preferences and which one was the specific condition preferred through different indices. Principal Components Analysis (PCA) was used to obtain a visual examination of the environment distance between species; thus, we estimated their similarity in the environmental space. The results showed that the Crassulaceae family was widely distributed, covering most of the conditions; nevertheless, the species exhibited well-defined preferences. The PCA showed that the species could be classified into three groups, each one being characteristic of a specific environmental condition; however, they are paraphyletic. Thereby, closely related species are considerably distant in the environment space, while others, which they are not so phylogenetically related, are often close. Sedum species had very distant preferences and only the Villadia group and part of the Echeveria group (*E. setosa* and *E. derenbergii*) had greater similarity (11/14 and 10/14 similar preferences, respectively). Moreover, we observed a phylogenetic structuring pattern of the communities where they are conformed by species belonging to different taxonomic groups. This could be due to their low competitive capacity resulting in the exclusion of less competitive related species.

Key words: niche similarity, abiotic niche, phylogenetic structure, life strategies

MACRO AND MICROSTRUCTURAL EPIDERMAL CHARACTERS
OF *TURBINICARPUS S.L.*

Alejandro de la Rosa Tilapa A.^{1}, Teresa Terrazas¹
& Monserrat Vázquez-Sánchez²*

¹Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Apartado Postal 70-233, 04510 Ciudad de México, Mexico

²CONACyT-Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Instituto Politécnico Nacional, Unidad Michoacán, 59510 Jiquilpan de Juárez, Michoacán, Mexico

* alexdrosa17@gmail.com

The taxonomic history of *Turbinicarpus* is complex and its generic limits are not yet resolved. Molecular evidence suggests that the recognized species of *Turbinicarpus s.l.* are grouped into three clades, here named as *Turbinicarpus s.s.*, *Rapicactus* and *Kadenicarpus*. With the aim of supporting this phylogenetic hypothesis we studied the epidermis-hypodermis of 34 species belonging to *Turbinicarpus s.l.* of the tribe Cactaeae, Cactaceae. The dermal tissue was prepared for light microscopy (paraffin embedding) and for scanning electron microscopy –MEB- (critical point) observations. The results showed that most species of *Turbinicarpus s.l.* have a smooth cuticle, except for four species with striated cuticle. Epidermal cells, view on the surface MEB, are polygonal elongated (19 spp.) or polygonal isodiametric (14 spp.) and projections of the periclinal wall occurred particularly in the clade of *Turbinicarpus s.s.* Stomata are paracytic or parallelocytic. All species, viewed in cross section, have a simple epidermis, where the outer periclinal wall thickness varies among clades: *Turbinicarpus s.s.* ($1.66 \pm 0.69 \mu\text{m}$), *Rapicactus* ($3.06 \pm 1.39 \mu\text{m}$) and *Kadenicarpus* ($1.17 \pm 0.46 \mu\text{m}$). The hypodermis is composed of one to four strata mostly collenchymatous with two crystal types in their cell lumina: prisms in *Kadenicarpus* and *Turbinicarpus s.s.* and concentric druses in *Rapicactus*. It is concluded that there are epidermal characters that can contribute to support the recognition of three clades in *Turbinicarpus s.l.* However, some epidermal characters as the shape or the projections are shared with other members of Cactaeae, as well as the number and thickness of the layers of the hypodermis and the shape of the crystals.

Key words: hypodermis, prismatic crystals, druses, *Rapicactus*, *Kadenicarpus*

DIVERSITY OF GLOMEROMYCOTA SPECIES IN SOILS OF CACTACEAE
PLANT COMMUNITIES OF THE TEHUACÁN VALLEY, MEXICO

Nancy Andrea García, Lucía Yolanda Varela, Claudia Barbosa
& Leticia Ponce de León*

Departamento de Biología, División de Ciencias Biológicas y de la Salud,
Universidad Autónoma Metropolitana-Iztapalapa, San Rafael Atlixco 186,
Col. Vicentina, 09340 Ciudad de México, Mexico

* clbm@xanum.uam.mx

The Tehuacán Valley has been reported as a centre of origin and diversification of Cactaceae, but studies of mycorrhizal associations are not yet available. Arbuscular mycorrhizal fungi are able to establish mutual symbiosis with the roots of about 75% of terrestrial plants. The general purpose of this research is to explore the diversity of Glomeromycota species in soils of plant communities with a high frequency of cacti in the Tehuacán Valley. Spores of Glomeromycota were extracted from soil samples obtained at three sites located in the Municipality of San Juan Joluxtle and Santiago Chazumba, Oaxaca, Mexico. The technique of wet sieving and decantation followed by centrifugation in sucrose was used. The extracted spores were mounted in fixed preparations in Polyvinyl alcohol-Lactoglycerol with and without Melzer reagent. We identified 18 species in the genera: *Acaulospora*, *Ambispora*, *Claroidioglomus*, *Entrophospora*, *Gigaspora*, *Glomus* and *Scutellospora*. Some of the genera found in this work have been reported as forming mycorrhizal associations with globose Cactaceae and *Pachycereus pecten-aboriginum* in the deciduous forest in Mexico. In this study a mycorrhizal association with *Coryphantha radians* was observed, which is in the process of identification. Mycorrhizal associations improve the production of plants of agricultural interest and have been used for purposes of restoration and species conservation. This work confirms the abundant presence of Glomeromycota spores in soils of the studied area and suggests it would be of interest to confirm the establishment of mycorrhizal associations in cacti.

Key words: arbuscular mycorrhiza, xerophytic shrub, *Coryphantha radians*

DEVELOPMENT AND DIFFERENTIATION OF UNISEXUAL FLOWERS
IN FUNCTIONALLY DIOECIOUS POPULATIONS OF *ECHINOCEREUS* IN
NORTHERN MEXICO

Rocío Hernández-Cruz^{*1}, Fátima Brenda Barrón-Pacheco¹, Daniel
Sánchez-Carbajal², Salvador Arias³ & Sonia Vázquez-Santana¹

¹Laboratorio de Desarrollo en Plantas, Departamento de Biología Comparada, Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad Universitaria, Deleg. Coyoacán, 04510 Ciudad de México, Mexico

²CONACYT, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Guadalajara, Jalisco, Mexico

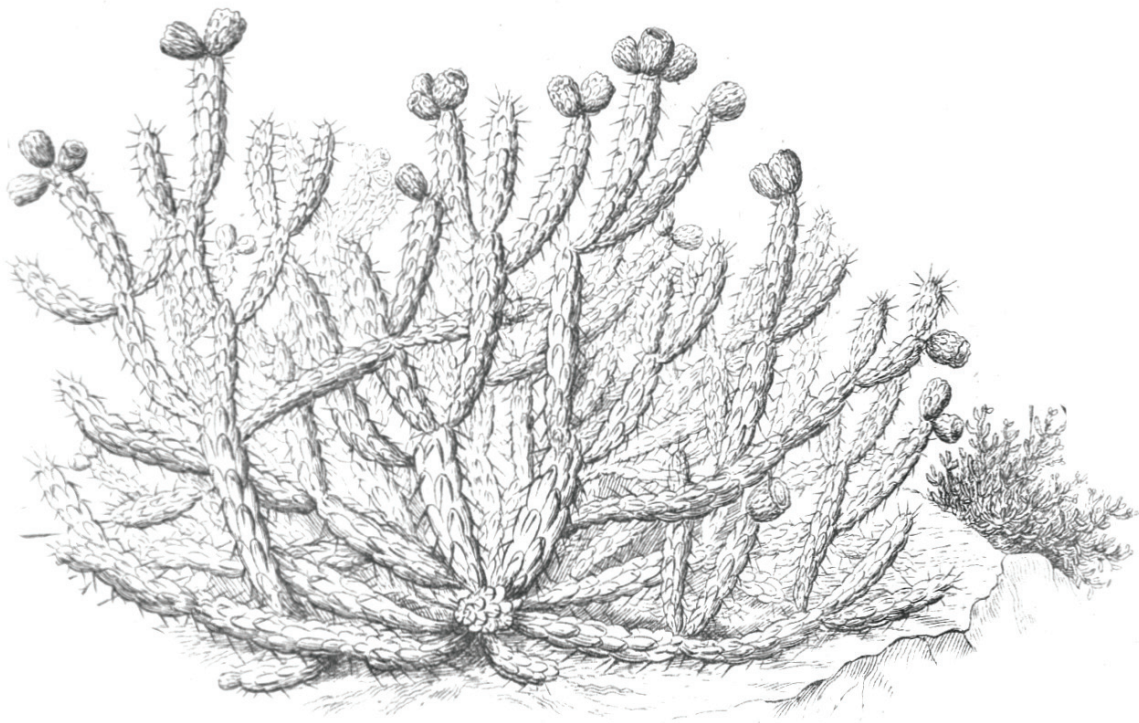
³Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Deleg. Coyoacán, 04510 Ciudad de México, Mexico

* rosio.hc@gmail.com

In the Cactaceae, dioecy has evolved numerous times in unrelated taxa. Changes in the ontogenetic patterns determine the final floral morphology and define its breeding system. The genus *Echinocereus* includes hermaphrodite and dioecious taxa, which make it a good study model to determine how hermaphrodite to unisexual flower transition occurs. *E. coccineus*, *E. polyacanthus*, *E. pacificus* and *E. mombergerianus* are distributed in high and rocky areas of northern Mexico and southwestern United States. In this study, the sexual system in four *Echinocereus* taxa was determined through controlled pollination and field observations. Flowers and seed development were analysed through histological observations and scanning electron microscopy. TUNEL assays were used as an indicator of DNA fragmentation to corroborate programmed cell death during flower and seed development. Here we present how differentiation of unisexual flowers occurs late in development in the four species of *Echinocereus*. Their sexual system is functionally dioecious. Male flowers produce pollen grains and exhibit an atypical fully developed and functional gynoeceum in which, after fertilization, the seeds are aborted at early stages of post-zygotic development. Female flowers do not form pollen grains in any of the species. Programmed cell death is shown to mediate both seed and pollen abortion. We propose that heterochrony, as an evolutive pattern, controls male sterility by accelerating the process of programmed cell death in tapetal cells

during anthers development in female flowers. The four related taxa of *Echinocereus* have functionally dioecious populations. They share the differentiated ontogenetic pattern from bisexual to unisexual flowers and male and female sterility are stable.

Key words: dioecy, heterochrony, homoplasy, male sterility, programmed cell death, seed abortion



*Héctor M. Hernández** & *Carlos Gómez-Hinostrosa*

Departamento de Botánica, Instituto de Biología, UNAM, Cd. Universitaria,
04510 Mexico City, Mexico

* hmhm@ib.unam.mx

In this presentation we describe the second product of a project aimed at mapping the geographic distribution of all the Mexican species of Cactaceae (*Mapping the cacti of Mexico. II. Mammillaria. Succulent Plant Research* 9: 1-189, 2015). We mapped the global distribution of all the 155 species of *Mammillaria*, the largest genus in the cactus family, and one of the largest and most emblematic in the Mexican flora. A total of 4397 geographically referenced *Mammillaria* records was used. The northern limit of distribution of the genus occurs in southern California, Arizona, New Mexico and western Texas, with few, marginal records in Nevada and Utah. Southwards, *Mammillaria* species occur in almost every major Mexican region and in parts of Central America. In addition, three species occur sporadically in the West Indies and in a few localities in the northern Andean regions of Venezuela and Colombia. Species primarily inhabit areas with arid or semi-arid climates covered by desert scrub, although they may also be found in tropical deciduous or thorn forest, and even in more mesic areas, from sea level to 3250 m, although they tend to grow primarily at moderate elevations (1000– 2000 m). The great majority (98.7%) of the species occur in Mexico, 88.2% being endemic to this country. Six major areas of high species richness exist in Mexico: one in the Sonoran Desert (Baja California Sur), four in the Chihuahuan Desert (Jaumave, Guadalcázar, San Luis Potosí and Meridional subregion), and another one in the Tehuacán-Cuicatlán Valley. Twelve unique, microendemic species, which are extremely important from the conservation perspective, are located within these species-rich areas. Two thirds of the species (102 or 65.8%) are partially or totally protected inside Natural Protected Areas in Mexico. However, unfortunately 28, out of the 53 unprotected species, are threatened according to IUCN criteria.

Key words: Cactaceae, *Mammillaria*, biogeography, micro-endemics, conservation

MORPHOLOGICAL AND ANATOMICAL EVIDENCE FOR THE SPECIES
CIRCUMSCRIPTION OF NOLINOIDEAE (ASPARAGACEAE) FROM
THE BAJÍO AND ADJACENT REGIONS, MEXICO

Luis Hernández-Sandoval

LANIVEG, Facultad de Ciencias Naturales, Universidad Autónoma de
Querétaro, Av. de las Ciencias s/n, Juriquilla, Querétaro, Mexico

luishs@uaq.mx

The Nolinoideae is a subfamily of Asparagaceae distributed in North and Central America, with most of its diversity in Mexico (ca. 86%). The group is composed of four genera (*s.l.*), and *ca.* 70 species: *Beaucarnea* with 13 spp., *Calibanus* probably three spp., *Dasyllirion*, about 24 spp., and *Nolina* ca. 30 spp. However, species circumscription has been complicated due to character similarity. For the Flora of the Bajío and adjacent regions, Nolinoideae species have been studied using a critical approach for species morphological character definition, as well as leaf anatomical characters (fibers, vascular bundles, stomata and epidermis composition) when species separation is not clear. As a result, seven species have been detected in the area, one for each of the genera *Beaucarnea*, *Calibanus*, *Nolina* and four for *Dasyllirion*. One species was found to be new to science. The geographical distribution of the Nolinoideae in the region leaves five species for the state of Guanajuato, five for Querétaro and one for Michoacán, leaving the region as one of the richest areas in Mexico for Nolinoideae.

Key words: *Beaucarnea*, *Calibanus*, *Dasyllirion*, *Nolina*

ABOVEGROUND BIOMASS AND WATER AND CARBON STORAGE IN
NEOBUXBAUMIA TETETZO (CACTACEAE) FROM TEHUACÁN INTER-
TROPICAL DESERT, MEXICO

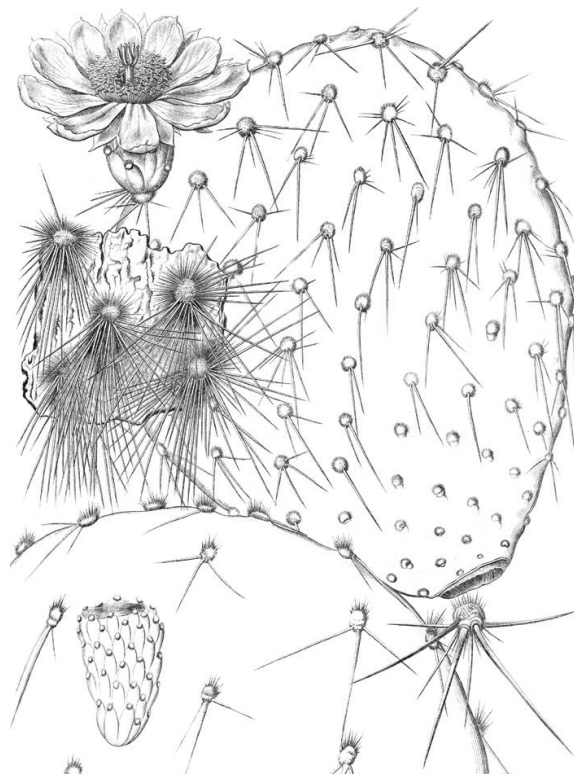
*Valeria Huerta-Saavedra**, *Alejandra Martínez-Ramírez*
& *Noé Manuel Montaña*

Departamento de Biología, División de Ciencias Biológicas y de la Salud,
Universidad Autónoma Metropolitana, Unidad Iztapalapa, San Rafael
Atlixco 186, Vicentina, Iztapalapa, 09340 Ciudad de México, Mexico

* chimalse31@gmail.com

In Mexico, the C stock in the aboveground biomass has been reported for plant species of tropical and temperate environments. However, in plant species of desert ecosystems the C stock has been scarcely studied, especially in those succulent plants such as the cacti that are representative of these environments. The objective of this study was to estimate the aboveground biomass of *Neobuxbaumia tetetzo* and its ability to store water and C in the Tehuacán inter-tropical Desert, Mexico, where this cactus is endemic and dominant within the scrubby vegetation. The density of *N. tetetzo* was estimated by marking 10 (10×10 m) squares, where three adult individuals were randomly selected (total 30 plants) during the dry season. The height, basal diameter, number of branches, length and diameter of each branch were measured for each plant. The aboveground biomass was estimated based on the volume of stems and branches. The water content and C concentration per plant were estimated in tissue samples by gravimetric method and a C auto-analyser, respectively. These data were extrapolated to the volume of each plant and per area unit. The sampled cacti had an average height of 5.54 m, average basal diameter of 27.8 m, and the number of branches per plant ranged from 1 to 10. Average aboveground biomass per plant was 337.3 kg. Water content per plant was 964.9 L, equivalent to 71% of its volume; while C content per plant was 83.5 kg, equivalent to 24.7% of C concentration in aboveground biomass. The plant density was 810 individuals ha^{-1} , and it indicated an average of 8,851.36 ton C ha^{-1} , and 101,634 703.3 L of water ha^{-1} . Our study highlights the importance of this endemic cactus in the storage of water and C in its biomass, two ecosystem services critical for functioning of the scrubs in this Mexican inter-tropical Desert.

Key words: cactus, C concentration, semiarid ecosystems, tropical scrubs, water content



DEMOGRAPHIC ASPECTS OF A POPULATION OF SAGUAROS IN EL
PINACATE AND GRAN DESIERTO DE ALTAR BIOSPHERE RESERVE

Cecilia Jiménez Sierra^{*1}, *Daniel Torres-Orozco*², *Ma. Loraine Matias Palafox*^{1,3}, *Abel Gasca*¹, *Ángeles González Adán*¹, *Erika Arroyo Pérez*¹
& *Benito Vázquez Quesada*²

¹Departamento de Biología, CBS, Universidad Autónoma Metropolitana-Iztapala, Ciudad de México, Mexico

²Facultad de Ciencias, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

³Dirección General de Análisis y Prioridades. CONABIO, Ciudad de México, Mexico

* ceci_jsierra@hotmail.com

Carnegiea gigantea (Engelm.) Britton & Rose, is an emblematic columnar cactus of the Sonoran Desert, commonly known as saguaro. The species is considered at risk (A) by the Mexican law (Nom-059-SEMARNAT-2010), and it is included in the Appendix II of CITES and in the IUCN Red List (LC). The aim of this work was to describe the demographic characteristics of a population of saguaro found within El Pinacate and Altar Great Desert Biosphere Reserve. For this, we established a plot of 8.5 hectares and recorded the location of all individuals of saguaro, as well as the following variables per individual: total height, diameter, number of ribs, number of arms, reproductive structures and type of damage. We found 203 individuals, so the density was 29 ind/ha, in an aggregated spatial distribution. The minimum height recorded was 0.23 m and the maximum 9.15 m, with an average population height of 2.92 m and a distribution of multimodal values with individuals between 3.5 and 4 meters being more abundant. The number of ribs per individual varied between 12 and 28. Most of the saguaros were monopodic, with only 2.8% of them presenting from 1 to 4 branches. The minimum height of the reproductive individuals was 2.5 m. The percentage of reproductive individuals increased with height and the range from 3 to 4 m in height provided the greatest number of reproductive structures (buds, flowers and fruits). Our data are similar to those reported for other populations of saguaro, although it is interesting that the mean heights of individuals are lower than those reported for other sites.

Key words: demography, saguaro, Sonoran Desert

EVOLUTIONARY DIVERGENCE OF *MAMMILLARIA* TESTED BY GENETIC
AND ECOLOGIC PERSPECTIVES

Nelly López-Ortiz^{*1}, *Salvador Arias*², *Antonio González-Rodríguez*³,
*Oswaldo Téllez*¹, *Francisco López-Galindo*¹, *Patricia Dávila*¹ & *Sofía*
*Solórzano*¹

¹Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México. Av. de los Barrios No. 1, Los Reyes Iztacala, Tlalnepantla, Estado de México, Mexico

²Instituto de Biología, Universidad Nacional Autónoma de México. Circuito Zona Deportiva 53, Ciudad Universitaria, Deleg. Coyoacán, 04510 Ciudad de México, Mexico

³Instituto de Investigaciones en Ecosistemas y Sustentabilidad, Universidad Nacional Autónoma de México. Antigua Carretera a Pátzcuaro 8701, Col. Ex Hacienda de San José de la Huerta, Morelia, Michoacán, Mexico

* nlopezortiz@outlook.com

In Cactaceae, *Mammillaria* is the richest genus with 163 species. In order to elucidate the evolutionary processes that have driven the evolutionary divergence in this genus, we analysed the molecular variation under, the phylogeographic and ecologic niche perspectives. *Mammillaria crucigera*, *M. huitzilopochtli*, and *M. supertexta* of the Supertextae series were sampled with a total of 10 cpSSR and 12 regions of cpDNA in five populations for each of these species. The hypotheses of divergence and conservatism of niche were tested with Ecological Niche Modelling (ENM) and PCA procedures. For doing so, we analysed a total of 19 climatic and two topographic variables, and 18 edaphic variables. The results showed that two cpSSR and seven cpDNA were polymorphic, and they recorded a molecular polymorphism < 2 % within and among the species analysed. It was not possible to identify phylogeographic structure in each of the three species. A total of three, five and one haplotypes were identified in *M. crucigera*, *M. huitzilopochtli*, and *M. supertexta*, respectively. The results of ENM revealed a geographic overlapping between *M. supertexta* with *M. crucigera* and *M. huitzilopochtli*, which supports niche conservatism hypothesis. The PCA results identified the niche differentiation hypothesis is supported by the temperature seasonality, and the levels of precipitation during the coldest and driest months. This analysis showed that the density, humidity and phosphor contained in soils,

as well as, soil conductivity could drive the niche differentiation among the species studied. We concluded that the low molecular variation might have been caused by a recent evolutionary divergence and low mutation rates in DNA regions of these species. Later, the ecologic interactions (competition) could have promoted the niche differentiation that shaped the current geographic distribution of these species.

Key words: phylogeography, cpDNA, ENM, *Mammillaria*, Tehuacán–Cuicatlán Valley



MICROPROPAGATION OF *ECHINOCACTUS GRANDIS*

Miriam S. Lozano Gamboa, Eugenio Pérez-Molphe-Balch
& Yenny A. Gómez-Aguirre*

Cátedras CONACyT, Universidad Autónoma de Aguascalientes, Av.
Universidad 101, Ciudad universitaria, Aguascalientes, Mexico

* yagomez@correo.uaa.mx

Echinocactus grandis is a Mexican endemic species growing mainly in the Tehuacán-Cuicatlán Valley. In this investigation, we established a methodology for the micropropagation of this species using different concentrations of BAP (0.5, 1, 1.5 y 2 mgL⁻¹), activated charcoal (1 mgL⁻¹), and three different explant types (shoot tip, longitudinal section and basal shoot) were used. Shoots were sectioned to obtain apical, lateral and basal explants and three explants of each type were inoculated in Murasigue and Skoog (1962) medium containing BAP at different concentrations. Each glass jar (3 per treatment) was incubated in photoperiod conditions (16/8 dark/light) at 25° C during 7 weeks. Differences (P<0.05) were found. The apical section, when cultured on MS medium supplemented with 1.5 mgL⁻¹ and 2 mgL⁻¹ BAP, gave maximum axillary shoot proliferation (4.5 shoots), in contrast to the control (2 shoots per explant). Activated charcoal treatment showed no significant differences with respect to the control (1.58 shoots per explant). The shoots obtained from the different treatments were acclimatized to the greenhouse by placing samples in pots containing a mixture of peat moss and tezontle (1:1). Each plant was covered with a plastic bag, gradually opened weekly during the irrigation stage. After 8 weeks, the bag was removed and the percentage of survival corresponding to 100% was evaluated. Micropropagation offers a tool for multiple shoot induction and proliferation in 15 weeks.

Key words: micropropagation, *Echinocactus platyacanthus*, shoot

PHOTOSYNTHETIC RESPONSES IN YOUNG PLANTS
OF *Yucca queretaroensis* PIÑA (ASPARAGACEAE)

*Judith Gabriela Luna Zúñiga**, *Mónica Queijeiro Bolaños*
& *Luis Hernández-Sandoval*

LANIVEG, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Av. de las Ciencias s/n, Juriquilla, Querétaro, Mexico

* metzliju77@gmail.com

Yucca queretaroensis is an endemic plant from the semiarid region in Querétaro, Mexico. Its leaf anatomic characters suggest the presence of crassulacean acid metabolism (CAM). However, no studies on the plant species photosynthetic capacity or day length variation have been carried out. The study goal was to test if *Yucca queretaroensis* presents CAM photosynthesis. Plant CO₂ assimilation (*A*) and its day length variation in young plants leaves were recorded every 3 h up to 24 h, for three leaves per plant up to 20 individuals by using a Li-6400XT portable photosynthesis system. The photosynthetic activity observed for most of the measurements (24 h), showed a decrement tendency through the daylight, and an increase through the night-time. The highest *A* observed values were found at 7:00 am (4.27 μmol CO₂ m⁻² s⁻¹) and at 01:00 am (3.47 μmol CO₂ m⁻² s⁻¹), whereas the lowest values were found at 13:00, 16:00, 19:00 and 22:00 h (0.61, -0.39, -0.81 y -0.55, respectively). Results indicate that the evaluated plants have a facultative CAM system, being active throughout day and night-time as a probable response to non-stable environmental conditions. Further systematic long-term observations will help to assess the photosynthetic system of *Yucca queretaroensis*.

Key words: photosynthesis, CAM, Querétaro, Mexico

UTILITY OF SUCCULENT FLORA OF SANTO DOMINGO TONALÁ, OAXACA, MEXICO

Magali Martínez C.¹, Gladys Manzanero² & Hermes Lustre Sánchez²*

¹Universidad del Mar, Campus Puerto Escondido, Ciudad Universitaria, Carretera Vía Sola de Vega, C.P. 71980 Puerto Escondido, Oaxaca, Mexico

²Jardín Botánico, Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Unidad Oaxaca, Instituto Politécnico Nacional, C.P. 71230 Santa Cruz Xoxocotlán, Oaxaca, Mexico

* manzanerogladys70@gmail.com

An ethnobotanical study of succulent plants was carried out in Santo Domingo Tonalá, Oaxaca. The aim was to keep record of traditional knowledge and to identify the most culturally important plants. Species record was performed by monthly tours for one year on important sites where these species grew. To know about the traditional use and management, semi-structured interviews (2 events) were applied to 20 key informants. For analysis of ethnobotanical data, the ethnographic method of free listing and the value of use index were used. There were 44 useful succulent plant species, which were included in 21 anthropocentric categories; based on the quantitative ethnobotanical analysis, *Agave angustifolia*, *Mammillaria albilanata*, *Stenocereus pruinosus*, *S. griseus*, *Pachycereus weberi*, *Neobuxbaumia mezcalaensis* and *Dasyllirion serratifolium*, were the species recognized, as those of greatest cultural value to the community. It was observed that in this region people had a wide traditional knowledge, of these plants, since they used them in a great variety of ways. Succulent flora represents an important plant resource, often used to cover part of the basic and cultural needs in the community. It is essential to continue the documentation of traditional knowledge and thereby contribute to its reassessment and rescue.

Key words: succulent plants, uses, traditional knowledge, cultural value

HOW COMMON IS INTERSPECIFIC POLLEN TRANSFER IN *OPUNTIA TOMENTOSA*?

Linda Mariana Martínez-Ramos & Ma. del Carmen Mandujano*

Laboratorio de Genética y Ecología, Departamento de Ecología de la Biodiversidad, Instituto de Ecología, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

* lindam.mtz@gmail.com

Most plant species grow and flower at the same time in a community. Co-flowering species can interact by affecting each other's visitation rate during pollination or through interspecific pollen transfer, via pollen-pistil interactions. These mechanisms alter reproductive success of the focal species through competition or facilitation, and may promote hybridization. Our aim was to assess pollen-pistil interactions of *Opuntia tomentosa* with three other *Opuntia* spp. that co-flower. Flowers are diurnal with longevity of one day, solitary bees are the main pollinators and fruit set is very high in all four species. Our hypothesis was that plants would reduce their fruit and seed set when receiving interspecific pollen. The pollen of a focal plant of *O. tomentosa* (OTPD-experiment) was marked with fluorescent dye at anthesis. The frequency and qualitative quantity of marked pollen on stigmas of *O. cantabrigiensis*, *O. robusta* and *O. streptacantha* was registered at flower closure. In addition, we measured pollen transfer from the other three species towards *O. tomentosa*. We targeted one species per day for two days each one species of *Opuntia* other than *O. tomentosa*. The presence of marked pollen from the other species (OXPD-experiment) was quantified on stigmas of *O. tomentosa*. We found in OTDP that the dye was absent or found in low quantities, 48.27% *O. cantabrigiensis*, 24.19% *O. robusta* and 26.67% *O. streptacantha* of the flowers had marked pollen. In the OXDP experiment most of the flowers of *O. tomentosa* did not have dye, and if there was, it also in low quantities. The interspecific pollen transfer was scarce. Co-flowering promotes facilitation by the increased availability of resources. Furthermore, floral constancy by pollinator foraging may reduce of the flow of heterospecific pollen.

Key words: co-flowering, facilitation, floral constancy

EFFECT OF PHYTOHORMONES AND LIGHT ON THE EARLY
DEVELOPMENT OF FIVE CACTUS SPECIES FROM THE SOUTHERN
CHIHUAHUA DESERT

*Ernesto Mascot Gómez**; *Nguyen E. López Lozano* & *Joel Flores Rivas*

Instituto Potosino de Investigación Científica y Tecnológica A.C., Camino a la Presa San José 2055, Colonia Lomas, 4ta Sección, 78216 San Luis Potosí, Mexico

* ernesto.mascot@ipicyt.edu.mx

Seed germination is a process regulated by environmental variables such as light, temperature and humidity. Germination can be controlled by the action of different plant growth regulators, also called phytohormones. In the early stages of plant development, the action of different phytohormones has been described, especially gibberellins (GA_3), which stimulate seed germination and auxins (AAI), that promote root development, although AAI also promote seed germination in some species. For several species, GA_3 promotes germination under darkness, thus this phytohormone can overcome the light stimulus. In Cactaceae species, there are very few studies that deal with the effect of phytohormones on seed germination and seedling growth. No response pattern has been found. In this research, our objective was to evaluate the effect of two phytohormones (GA_3 and AAI) on seed germination and seedling growth of five species of cactus. The studied species were *Stenocereus queretaroensis*, *Echinocactus platyacanthus*, *Ferocactus latispinus*, *F. pilosus*, and *Coryphantha maiz-tablasensis*. Seeds from these species were germinated under two light conditions (12 h light : 12 h darkness and 24 h darkness), and six concentrations of each phytohormone: 0, 50, 100, 250, 500 and 1000 ppm. Our results suggest that, in general, light did promote seed germination without GA_3 effect. In darkness, GA_3 at 500 and 1000 ppm did promote seed germination for *S. queretaroensis*, *F. latispinus* and *E. platyacanthus*. Seedling growth was evaluated at the end of the germination experiment and, in general, not effect of the phytohormones was found.

Key words: Phytohormones, Chihuahuan Desert, *Stenocereus queretaroensis*, *Echinocactus platyacanthus*, *Ferocactus latispinus*, *F. pilosus*, *Coryphantha maiz-tablasensis*

ANALYSIS AND IDENTIFICATION OF INFORMATION GAPS
OF MEXICAN CACTI SPECIES AT RISK

Ma. Loraine Matias-Palafox, Esther Quintero & Angélica Cervantes*

Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Liga
Periférico - Insurgentes Sur 4903, Parques del Pedregal, 14010 Ciudad de
México, Mexico

* lmatias@conabio.gob.mx

Currently the Official Mexican Standard NOM-059-SEMARNAT-2010 identifies the wild flora and fauna species or populations that are in danger in Mexico. In it, 30% of Mexican cactus taxa are categorized into one of the following categories of extinction risk: En riesgo de extinción (P), Amenazada (A) and Sujeta a protección especial (Pr). In this study we estimated the Index of Completeness of known information (IC), through the analysis of a matrix of completeness with the information contained in fact sheets made by CONABIO, of the cactus species listed in NOM-059. These fact sheets include information regarding their classification and description, geographical distribution, biology (habitat, reproduction and dispersion), ecology, demography, genetics, biological importance, economic, culture and their conservation status. Of the 276 cactus taxa in NOM-059, only 45% have an information sheet. The average IC is 0.63 ± 0.08 . Only seven species (*Ariocarpus kotchoubeyanus*, *Cephalocereus senilis*, *Lophophora diffusa*, *Lophophora williamsii*, *Mammillaria gaumeri*, *Mammillaria humboldtii* and *Turbinicarpus pseudomacrochele* subsp. *minimus*) presented an IC greater than 0.79. What is best known about cacti are aspects of their geographical distribution (0.69), its importance in terms of commercialization and some aspects of its conservation status (0.67 respectively). The least known, although there are numerous relevant studies, are the aspects related to its ecology, demography and genetics. This work detects the information gaps of the Mexican cacti species at risk and reflects the urgency to increase the investigation of the aspects not studied, with the purpose of generating useful information to carry out more robust risk assessments that enable the true conservation status to be assessed, and thus to implement management plans appropriate to each species.

Key words: NOM-059-SEMARNAT-2010, cacti in danger, information gaps, Index of Completeness

RESULTS FROM 5 YEARS OF GROWING AND FRUITING PITAHAYA
(‘DRAGON FRUIT’, *HYLOCEREUS HYBR.*) IN DAVIS, CALIFORNIA,
USDA ZONE 9B

Marta Matvienko

Davis, California, USA

matvienko@gmail.com

Introduction and Methods: This hobby project started in early 2012. Cuttings were rooted in potting soil in 1 gal. pots, then replanted to larger pots as needed. Most plants are still growing in relatively small containers, with ~1 cubic foot of soil. Pitahaya is a tropical cactus, and our winter frosts can easily kill young plants. For the first two winters, all plants were placed in heated greenhouses. As the plants grew, moving them in and out of protected environment became impractical. For the last three winters, on frosty nights, the plants were just protected with fabric.

Results: In the summer of 2017, nine out of twelve plants started in 2012 are still alive and well. A dozen additional plants were added to the collection between 2013-2017. The winter of 2016-2017 brought 212% of average winter precipitation, as well as many nights below freezing point. This claimed a few plants. The lowest temperature observed was -3.5C. Some varieties seem to be more tolerant to low temperatures than others. ‘Sugar Dragon’, ‘Physical Graffiti’, ‘Haley’s Comet’, ‘Thompson G2’, ‘Purple Haze’, ‘Condor’, and ‘Vietnamese Giant’, are more wet-cold tolerant than ‘Delight’, ‘Pink Panther’, ‘Seoul Kitchen’, ‘Valdivia Roja’, ‘El Grullo’, ‘Tricia’, and ‘Paisley’. These are just observations on small (1-4 plants) samples, and should be taken as a preliminary result, not a definite finding. As for fruit production, the most productive variety turned out to be ‘Sugar Dragon’, followed by ‘Physical Graffiti’. In the summer of 2015, flowering and fruiting data were collected for all plants. A total of 124 fruits were produced from 142 flowers.

Conclusions: For home growing purposes, *Hylocereus* can be grown and fruited in zone 9B. Adequate protection is needed for the first two years of plant development, and occasional protection may be required on frosty nights in later development.

Key words: pitahaya, dragon fruit, *Hylocereus*, fruiting Cactaceae

NEGATIVE FLORAL INTERACTIONS IN *NEOBUXBAUMIA MEZCALAENSIS*
(CACTACEAE)

Pactli Fernando Ortega-González, Rocío Hernández-Cruz
& *Sonia Vázquez-Santana*

Laboratorio de Desarrollo en Plantas, Departamento de Biología Comparada,
Facultad de Ciencias, Universidad Nacional Autónoma de México, 04510
Ciudad de México, Mexico

* pfogl2@ciencias.unam.mx

We studied the effect of florivores on floral and seed development in the columnar cactus *Neobuxbaumia mezcalaensis* from the Tehuacán Valley. In the 1990's *N. mezcalaensis* was mentioned as androdioecious species, but at present it is recognized as hermaphrodite, where some unidentified parasites consume ovules, stigmas, styles and seeds. In order to know the impact of florivory in this species, field research was conducted in two locations (Zapotitlán Salinas and San Juan Raya, Puebla) during the stages of flowering and fruiting. Flowers and fruits were collected in different developmental stages to determine the amount of healthy *versus* affected flowers/fruits by florivores. We compared the averages of healthy *versus* damaged styles and the number of seeds in healthy *versus* infested fruits using the non-parametric U-Mann Whitney test. Research findings showed that carpenter ants (*Camponotus* sp.) consume the style and stigma, leaving the hermaphrodite flower to a male appearance. Thus it is confirmed that *N. mezcalaensis* is hermaphrodite and not androdioecious, as previously was mentioned. Other florivorous ants were also detected, such as *Camponotus rubrithorax* (Formicinae), *Crematogaster opaca* (Myrmicinae) and *Atta mexicana* (Myrmicinae), which consume total or partially the flowers of *N. mezcalaensis*; as well as larvae of the families Muscidae (Diptera) and Pyralidae (Lepidoptera). These develop in different places in the flower, depending on the developmental stage, forming tunnels and galleries inside the ovary, consuming the ovules and funiculus. This causes a reduction of up to 23% in the number of *N. mezcalaensis* seeds available for dispersal.

Key words: androdioecy, florivory, Formicidae, hermaphrodite, Muscidae, Pyralidae

REPRODUCTIVE ASPECTS AND ETHNOBOTANY OF A WILD *OPUNTIA*
IN THE MIXTECA REGION, OAXACA, MEXICO

Luis Eder Ortiz^{1}, Gladys Manzanero¹, Ma. del Carmen Mandujano²,
Jordan Golubov³ & Marco Antonio Vásquez⁴*

¹CIIDIR Oaxaca, Instituto Politécnico Nacional, Hornos 1003, Col. Noche Buena, Santa Cruz Xoxocotlán, 71230 Oaxaca, Mexico

²Laboratorio de Genética y Ecología, Depto. Ecología de la Biodiversidad, Instituto de Ecología, UNAM, Ciudad Universitaria, 04510 Ciudad de México, Mexico

³Canal de Miramontes 3855, Ex de San Juan de Dios, 14387 Ciudad de México, Mexico

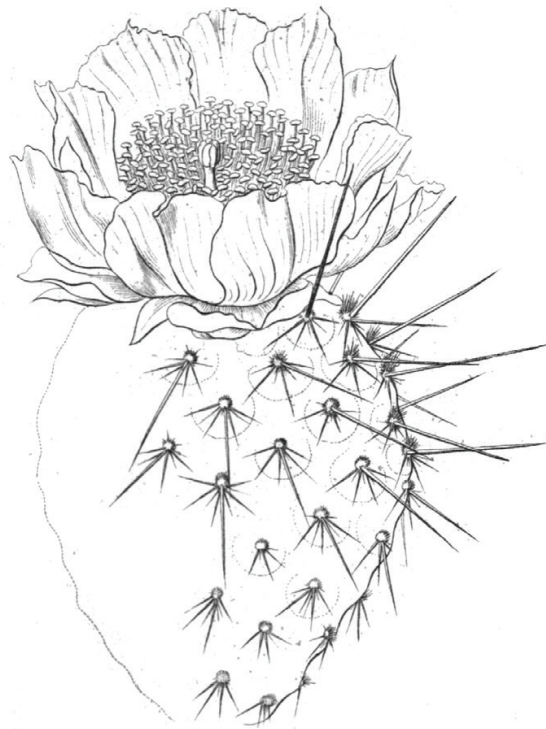
⁴Instituto Tecnológico del Valle de Oaxaca, De Guerrero s/n, Nazareno, 71230 Santa Cruz Xoxocotlán, Oaxaca, Mexico

* dean_0409@gmail.com

Biological diversity of succulent plants from arid regions has recently become of interest to ecologists and ethnobotanists. These plants have played an important role in the development of numerous ancient civilizations as they are nowadays. In Mexico there is a long tradition of use and management of succulent plants. Prickly pear cactus species, genus *Opuntia*, are among the most frequently used. In a small rural community from the Mixteca region in Oaxaca, *Opuntia decumbens* is a useful wild cactus that is currently facing a decline in its population due to habitat loss. This study aims to describe the sexual reproduction processes of the species as well as its use value for the local community. The breeding system was determined by pollination experiments (obligate self-pollination, natural self-pollination, outcrossing and control). The success of each pollination treatment was evaluated through the fruit set, seed set, and outcrossing rate. The outcrossing system was determined through floral morphometry and the Cruden Index. For the ethnobotanical research, semi-structured interviews were performed with local collaborators, by which information about the uses of this and other native cacti species was gathered. The Phillips & Gentry Index was employed to estimate the use value of the species and then used to compare with other native cacti species. Although all treatments produced fruits, outcrossing treatments were more successful (fruit set = 0.78). The outcrossing rate was 0.66, which indicated the presence of a mixed mating system in

the species and the pollen-ovule ratio (226:1), which corresponded to a facultative xenogamy system. The fruit is the only part utilized, mainly as a natural source of pigment. The use value of the species is inferior to that of other native species that have a market and economic value, but its properties as a source of pigment and the amount of fruit it produces, give this succulent species a great utilitarian potential.

Key words: *Opuntia*, reproductive biology, ethnobotany



CONSERVATION OF PLANTS ADAPTED TO ARID ENVIRONMENTS
IN AN *IN VITRO* GERMPLASM BANK

*Alejandra Palomeque-Carlín**, *Lucía Isabel Chávez-Ortiz*,
Ma. de Lourdes de la Rosa-Carrillo, *Yenny A. Gómez-Aguirre*
& *Eugenio Pérez-Molphe-Balch*

Universidad Autónoma de Aguascalientes, Departamento de Química, Av.
Universidad 940, Ciudad Universitaria, 20131 Aguascalientes, Mexico

* alejandra_palomeque@yahoo.com

Arid and semi-arid zones cover an important part of Mexico, which makes water scarcity a common problem in a good part of the country, including the state of Aguascalientes. One of the measures we should take in order to adapt to this environmental problem has to do with the type of plants used in different realms, ranging from reforestation to gardening and agriculture. Mexico has a great variety of plants that are capable of developing and maturing under arid conditions, all of which have many uses that have been forgotten or displaced. Unfortunately, many of these plants face different levels of threat, so we cannot rely on wild populations to obtain the required specimens. Also, conventional propagation methods of these types of plants are generally not efficient, thus we need options that will allow an extensive harnessing of these species while reassuring the conservation of their natural populations. We propose the application of biotechnological methods (micropropagation), which allow the conservation and rational use of native plants adapted to low water availability through the creation of an *in vitro* Germplasm Bank. The Germplasm Bank developed in our institution comprises viable tissues of 127 species of plants adapted to limited water availability, of which 37 belong to the Agavaceae, 77 to the Cactaceae and 13 to the Nolinaceae. Of the Agavaceae, 31 of the species belong to genus *Agave*, and six to the genus *Yucca*. The 77 species of cactus in the bank include 24 different genera which represent three of the four cactus subfamilies: Opuntioideae, Pereskioideae and Cactoideae. Finally, it contains 13 Nolinaceae species representing the four genera that integrate this family. These plants are available for research and for education purposes, which focus on how they can be used in an intensive yet sustainable manner.

Key words: micropropagation, germplasm bank, Cactaceae, Agavaceae, Nolinaceae, conservation

SEED INVIGORATION BY HYDROPRIMING OF TWO CACTI SPECIES

*Dulce Ivonne Pérez-Lozano & Mariana Rojas-Aréchiga**

Departamento de Ecología de la Biodiversidad, Instituto de Ecología,
Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad
Universitaria, 04510 Ciudad de México, Mexico

* mrojas@ecologia.unam.mx

Seed hydropriming is a pre-treatment that allows seeds to imbibe water and continue to the first stage of the germination process whilst preventing radicle protrusion through the testa. This method has shown - mainly in cultivated plants - that it can have positive effects on some germination parameters such as germination percentage, germination speed and uniformity and may also invigorate old seeds. Particularly with cactus species, some germination parameters have been tested with priming methods, but not the effect of it on old seeds. So we tested the effect of hydropriming cycles on the germination of old seeds of *Carnegiea gigantea* (10 years) and *Obregonia denegrii* (11 years). First, we determined the hydration-dehydration curves to define the hydration (HD) and dehydration (DH) cycles to test and assess initial germination capacity. After each hydropriming cycle (1, 2 and 3 cycles) of 24h HD and 12h DH, we sowed five replicates with 20 seeds for each species in petri dishes with 1% agar and incubated at 25 °C with a 12h photoperiod, plus a control. Germination was counted daily for 31 days. Initial seed germination was 15 % for *O. denegrii* and 28.7% for *C. gigantea*. Results from the one factor ANOVA showed that hydropriming significantly improved germination for *C. gigantea* ($F_{(3,16)} = 16.774$; $p < 0.05$), with the two cycles treatment giving us the highest germination percentage (75%). For *O. denegrii* marginally significant differences among treatments were found ($F_{(3,16)} = 2.8903$; $p = 0.06781$) but germination was increased with three cycles (29 %). Hydropriming results demonstrated that it is a suitable, easy and cheap invigoration method that can be used in conservation programs to recover seeds that have been in storage for a long time under sub-optimal conditions and have lost their viability.

Key words: *Carnegiea gigantea*, germination capacity, *Obregonia denegrii*, seed priming

TRANSFORMED ROOTS AS AN ALTERNATIVE FOR OBTAINING
METABOLITES OF INTEREST IN THREATENED CACTI

*Eugenio Pérez-Molphe-Balch**, *Alejandra Palomeque-Carlín*,
Noé Israel Contreras-Ovalle, *Shantal Suárez-Mercado*,
Yenny Adriana Gómez-Aguirre, *Lucía Isabel Chávez-Ortiz*
& *Ma. de Lourdes de la Rosa-Carrillo*

Unidad de Biotecnología Vegetal, Universidad Autónoma de Aguascalientes,
Av. Universidad 940, 20131 Aguascalientes, Mexico

* eperezmb@correo.uaa.mx

One of the most interesting aspects of the Cactaceae family is its biosynthetic capacity. These plants can produce various types of secondary metabolites such as alkaloids, phenolic compounds, betalains and others. Many of these compounds could be useful in fields such as pharmacology, food industry and cosmetics. However, currently, the study and exploitation of these compounds is very difficult. This is because many of the species that produce them are of very small size, slow-growing and threatened. These factors make it impossible to obtain the plant tissue necessary for the extraction of the metabolites of interest. The generation and *in vitro* culture of transformed roots can be a solution to this problem, as their biosynthetic capacity is very similar to the entire plant and can produce biomass at a higher rate than a cactus growing in natural conditions. The objective of this study was to produce and cultivate transformed roots of several cacti species by tissue infection with *Agrobacterium rhizogenes*. Up to now, 118 species of cacti native of Mexico, South America and the Caribbean have been tested. The response has been positive in 71 of the tested species (28 different genera), achieving the emergence and growth of transformed roots. Stable transformed roots cultures have already been generated in genera of great phytochemical interest like *Ariocarpus*, *Coryphantha*, *Epithelantha*, *Mammillaria* and *Turbinicarpus*. The biosynthetic capacity of transformed roots has already been analysed in many of the species included in the project. It has been found that its biosynthetic capacity in terms of the production of alkaloids, phenolic compounds and betalains is very similar to that of the whole plant. This suggests that transformed roots are a viable option to produce metabolites of the cacti without the need to collect plants from their natural habitat.

Key words: *Agrobacterium rhizogenes*, cacti, transformed roots



RICHNESS AND DISTRIBUTION PATTERNS OF ECHEVERIOIDEAE
(CRASSULACEAE) ENDEMISMS IN THE STATE OF OAXACA

*Aminta Pérez-Noroña**, *Eloy Solano-Camacho* & *Ramiro Ríos-Gómez*

Unidad de Investigación en Sistemática Vegetal y Suelo, Herbario FEZA, Carrera de Biología, Facultad de Estudios Superiores Zaragoza, Universidad Nacional Autónoma de México, 09230 Iztapalapa, Ciudad de México, Mexico

* amintaperez@hotmail.com

The richness of endemic species of Echeverioideae (Crassulaceae) was determined and their geographical distribution patterns were analysed in relation to the physiographic subprovinces, protected natural areas and priority terrestrial regions of the state of Oaxaca. From a state map divided into 15 x 15' grids and information from herbarium specimens, virtual collections, databases and field gathering, a presence/absence matrix was generated with 219 records. The Wealth and Corrected Index of Weighted Endemism were calculated for each cell. A total of 67 taxa were recorded: *Echeveria* was the most diverse genus, followed by *Thompsonella*. Of the 164 cells in which the state of Oaxaca was divided, at least one species was recorded in 62. The cells with the greatest richness contained between 10 and 14 species, others 6 to 9; 37% of the cells one species only. Five cells with high endemism were located. Of the 67 taxa recorded, 34 are endemic to Oaxaca and more than 90% are distributed in the physiographic subprovinces Montañas and Valles del Occidente, Sierra Madre de Oaxaca and Sierra Madre del Sur. Almost 60% of the endemic species are distributed in oak-pine forest and approximately 40% in low deciduous forest. 6.46% of these taxa are found in the Reserva de la Biósfera del Valle de Tehuacán-Cuicatlán and 54.72% in the Priority Terrestrial Regions: Sierra del Norte de Oaxaca-Mixe, Sierras Triqui-Mixteca, Sierra sur and Costa de Oaxaca. As most of the endemic taxa are distributed outside the Biosphere Reserve and indicated Priority Terrestrial Regions, it is recommended to extend the boundaries of this reserve to the southwest. In addition, these Priority Terrestrial Regions should be declared protected natural areas to help conserve the endemic species.

Key words: *Echeveria*, *Graptopetalum*, diversity, physiographic subprovinces, *Thompsonella*

PRICKLY PEARS (*OPUNTIA* spp. CACTACEAE) AS HOSTS OF CARMINE
COCHINEALS

Liberato Portillo & Ana Lilia Viguera*

Departamento de Botánica y Zoología, CUCBA-Universidad de Guadalajara,
Apartado postal 1-139, 45101 Zapopan, Jalisco, Mexico

* portillo@cucba.udg.mx

Cochineal (*Dactylopius* spp.) is an American group of Hemipteran insects thriving on *Opuntia* cactus plants. They show four remarkable attributes relevant to man: 1. Carminic acid extracted from fine cochineal (*D. coccus* Costa) serves for colouring food, cosmetics, drugs, fabrics, and many other products. 2. Some *Dactylopius* species are biological control agents against invasive *Opuntia* plants. 3. Cochineals can become invasive to *Opuntia* plants where they are non-native. 4. Carminic acid is being studied for other potential applications. Due to these and other points, several *Opuntia* species have been and still are introduced from America to different regions in the world, mainly from Mexico, where the most important cochineals and *Opuntia* plants (from the commercial point of view) are native.

This paper aims to show the situation of *Opuntia* species known as hosts of cochineals. A literature review of Dactylopiidae family taxonomy as well as that of their hosts (*Opuntia* spp.) was the base for the present study. Also, from 1988 to 2017, the main cacti regions in North and South America have been surveyed to collect cochineals from wild and cultivated *Opuntia* plants, and from other regions of the world. All *Opuntia* and cochineal taxa were determined.

Opuntia ficus-indica (L.) Miller is the most common species used as host for fine cochineal rearing in several parts of the world, including Argentina, Bolivia, Chile, Ecuador, Ethiopia, Peru, Mexico, Spain (Canary Islands) and other countries. However, recently wild cochineal (*D. opuntiae* Cockerell) has become an insidious plague in several countries of America and the Mediterranean basin. Tolerant and resistant *Opuntia* species, as well as biological control by predators are the focal points to solve this situation. However controversial issues have arisen, since in some regions introduced *Opuntia* species are considered invasive plants, which are controlled by means of cochineals; but in other-regions, cochineals are considered pests.

Key words: nopal, *Dactylopius*, cactus pear, carminic acid

ANDROCECIUM AND GYNOCECIUM DEVELOPMENT OF DIOECIOUS
LEUENBERGERIA ZINNIIFLORA (DC.) LODÉ (PERESKIOIDEAE)

Adriana Puente Aguirre^{1*}, *Duniel Barrios Valdés*²
& *Sonia Vázquez-Santana*¹

¹Laboratorio de Desarrollo en Plantas, Facultad de Ciencias, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

²Grupo de Ecología y Conservación, Jardín Botánico Nacional, Universidad de La Habana, Cuba

* paradina_tenue@ciencias.unam.mx

Leuenbergeria zinniiflora (Pereskioideae) is a dioecious species of the family Cactaceae, endemic to Cuba. The aim of this work was the study of androecium and gynoecium development in male and female flowers of this species in a comparative way. This study was carried out with flowers collected from individuals growing in the National Botanical Garden, in Havana, Cuba. Flowers were collected at different developmental stages and processed by different techniques of microscopy and histology. The results showed that male and female flowers begin their development being bisexual and later, by abortion of one of the sexual whorls, specialize in developing ovules (in the case of the female) or pollen grains (in the male ones). The female flower has a gynoecium whose ovary has numerous campylotropous, bitegmic and crassinucellate ovules, and well-developed style and stigma. In the female flowers, the stamens do not produce pollen grains, since the anthers stop their development at a young stage and there is no differentiation of tissues inside the microsporangium. In the male flowers there is a non-functional gynoecium, with a reduced ovary cavity, as well as a multistaminate androecium that produces many pollen grains and anthers with longitudinal dehiscence. The pollen grains, released at tricellular stage, are pericarpate; the sculpture exine is echinate. Two male floral morphs were observed. The first one initiates the development of ovules, but tissue differentiation is arrested; and in the second the ovary cavity is empty.

Key words: Cactaceae, dioecy, embryology, female sterility, *Leuenbergeria*, male sterility

ONTOGENY OF THE SEED APPENDAGES IN CACTACEAE

Sandra Ríos-Carrasco^{*1}, *Aldebarán Camacho-Velázquez*¹,
*Silvia Espinosa-Matías*² & *Sonia Vázquez-Santana*¹

¹Laboratorio de Desarrollo en Plantas, Departamento de Biología Comparada, Facultad de Ciencias, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

²Laboratorio de Microscopía Electrónica de Barrido, Facultad de Ciencias, Universidad Nacional Autónoma de México, 04510 Ciudad de México, Mexico

* src18@ciencias.unam.mx

Seed appendages are outgrowths of the seed and come from tissues of different parts of the ovule. What they are called depends on the tissue from which they originate. In Cactaceae the presence of wings, wool, arils, caruncles, and strophioles on the seeds has been mentioned. In order to list all the species with seed appendages in the Cactaceae, a bibliographic review was made. Based on this, eight species from different clades were chosen to study the development of its appendage. In order to ascertain the ancestral character, we performed an ancestral character reconstruction. The results indicated that 31 genera of the Cactaceae have seed appendages. Of these, we selected *Ariocarpus kostchoubeyanus*, *Aztekium ritteri*, *Blossfeldia liliputana*, *Gymnocalycium mihanovichii*, *Lophophora williamsii*, *Parodia ottonis*, *Rebutia minuscula* and *Thelocactus leucacanthus* to study the ontogeny of the seed appendage. Our research showed that only seeds with an aril or arillode are present in the Cactaceae. The ancestral character reconstruction estimates that the aril is the ancestral character since it is presented in the Pereskioideae subfamily. The arillode has four different origins in the phylogeny, more frequently present in the Core Cactoideae. Moreover, the subfamily Opuntioideae does not have an aril like the others, but exhibits a modification in the funiculus that is initiated after the ovule develops. After fertilization, one part is differentiated in lignified tissue, while the other is differentiated in parenchymal tissue. This peculiar structure is termed the ‘funicular envelope’ (Stuppy 2002), in order to avoid the general and misleading term ‘aril’. Finally, the presence of caruncles and strophioles in Cactaceae seeds is discounted.

Key words: aril, arillode, funicular envelope, seed ontogeny

PHOTOBLASTIC RESPONSE AND SEED SIZE IN SPECIES BELONGING TO
TRIBE PACHYCEREAE (CACTACEAE)

Mariana Rojas-Aréchiga^{1*}, *Jordan Golubov*²,
*Ma. del Carmen Mandujano*¹ & *Salvador Arias*³

¹Instituto de Ecología, Departamento de Ecología de la Biodiversidad, Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad Universitaria, 04510 Ciudad de México, Mexico

²Universidad Autónoma Metropolitana-Xochimilco, Calzada del Hueso 1100, Col. Villa Quietud, Ciudad de México, Mexico

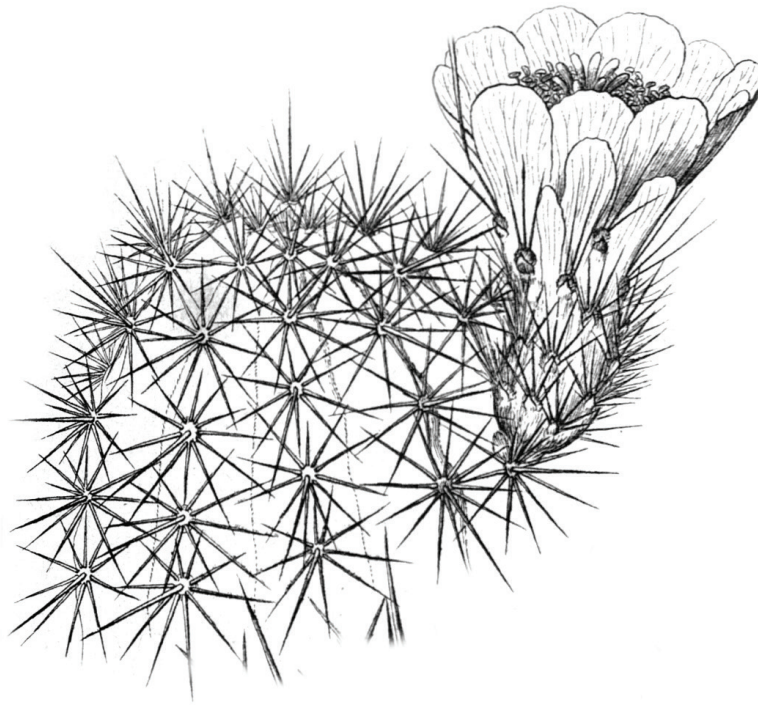
³Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad Universitaria, 04510 Ciudad de México, Mexico

* mrojas@ecologia.unam.mx

Photoblastic response has been related to seed size by many authors mainly for species inhabiting tropical forests, where broadly the light requirement increases as seed size decreases. This is well understood as small seeds have less reserves to overcome the physical barrier imposed by soil. This relationship has been barely tested in plants inhabiting xeric environments, as in species of the family Cactaceae. We collected seeds from 42 species from tribe Pachycereae (Cactaceae) throughout Mexico and according to their phenology, to test photoblastic response under controlled conditions and to obtain seed length and mass of 50 seeds per species. We used the sequences of 41 species with *rpl16* in GenBank to generate phylogenetic relatedness through RAxML and mapped the morphologic and physiologic seed traits to test patterns among species. We used phylogenetically independent contrasts (PIC) and tested phylogenetic signal *K* for seed length and mass and *D* for photoblastism. Also, we determined the ancestral and derived character states for seed length and for the photoblastic response to propose hypotheses of character evolution. Seeds showed two types of photoblastic response: positive photoblastic and indifference to light. Seeds of subtribe Stenocereinae consistently showed a positive photoblastic response and those of subtribe Pachycereinae were neutral photoblastic, with the exception of *Carnegiea gigantea*, which has the smallest seed size in its subtribe. We found a significant phylogenetic signal for seed length, and photoblastic response. In both subtribes, we found seeds in the mass categories from

4 to 7, and in the length categories from medium to extremely large, a trait that was not correlated with photoblastic response. We found that neutral photoblastism is the ancestral character and it remained in subtribe Pachycereinae but may evolve to positive photoblastism as in *C. gigantea* within this subtribe or as in subtribe Stenocereinae.

Key words: germination, photoblastism, seed length, seed mass



TO NURSE OR NOT TO NURSE: *MAMMILLARIA CARNEA* SEEMS
TO PREFER MICROSITES WITH HIGHER RADIATION INCIDENCE
BENEATH NURSE-PLANTS CANOPY

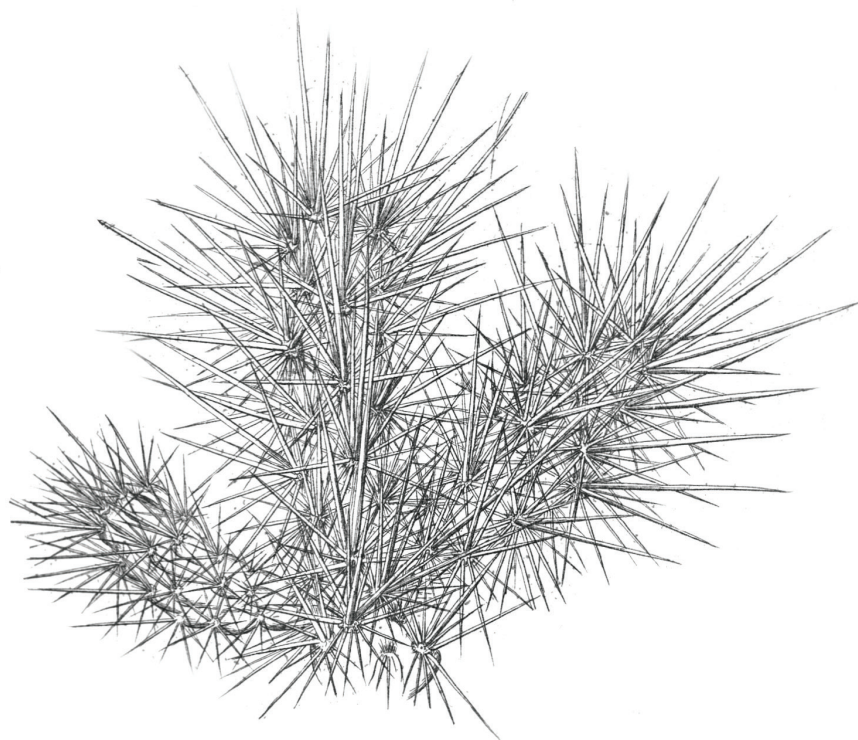
Marcela Lizbeth Rojas-López, Cindy Gisela González-González,
Ma. de Jesus Montserrat Jiménez & Alejandro Zavala-Hurtado*

Department of Biology, Universidad Autónoma Metropolitana-Iztapalapa,
Apartado Postal 55-535, 09340 Ciudad de México, Mexico

* marce_rl56@hotmail.com

Mammillaria carnea is a globose cactus with a restricted distribution in the Tehuacán-Cuicatlán Valley, Mexico. Although it has been reported that this species requires nurse-plants for its establishment, it is common to find individuals in the open. We analysed the relationship between the spatial distribution pattern of *M. carnea* individuals, and the solar radiation regime under the nurse-plants canopy. Due to the heterogeneity of the architecture of the tree and shrub cover, a preference in the establishment of *M. carnea* in sectors where radiation is less was expected. All individuals under the canopy of 15 plants of five species of nurse-plants were mapped and their spatial distribution pattern was estimated. Each shrub was divided into 4 sectors (North, South, East and West), the surface of the canopy was measured and radiation (direct, indirect and total) and leaf-area indices were estimated from the analysis of hemispheric photographs. A Rayleigh Uniformity Test was performed to evaluate a possible preferential orientation of the cacti beneath the canopy. From a circular statistical analysis we found random and aggregate distribution patterns of *M. carnea* individuals, as well as a southern preferential orientation pattern. Although the larger class sizes had more individuals, we did not find significant differences in the radiation variables. Contrary to what we expected, the higher abundance of *M. carnea* was found where the opening of the canopy was greater; this coincides with a negative relation with the leaf-area index and positive with the indirect solar radiation. Our results suggest the existence of some fine-tuned threshold of radiation incidence where a successful establishment of *M. carnea* individuals is facilitated by the nurse-plant. Further research is needed to investigate if the presence of *M. carnea* individuals beneath the canopy responds to a facilitation process or if this is due simply to the seeds' dispersal process.

Key words: Tehuacán Valley, nurse-plants, facilitation, hemispheric photographs, crown architecture



SYSTEMATIC AND PHYLOGENY OF THE *HECHTIA GUATEMALENSIS*
MEZ AND *HECHTIA TILLANDSIOIDES* (ANDRÉ) L.B. SM. COMPLEXES
(HECHTIOIDEAE: BROMELIACEAE)

Katya Romero-Soler^{1*}, *Ivón Ramírez-Morillo*¹, *Germán Carnevali*¹,
*Juan P. Pinzón*², *Claudia Hornung-Leoni*³ & *Nestor Raigoza*¹

¹Herbario CICY, Unidad de Recursos Naturales, Centro de Investigación Científica de Yucatán, A. C., Calle 43 # 130 x 32 y 34, Colonia Chuburná de Hidalgo, 97205 Mérida, Yucatán, Mexico

²Departamento de Botánica, Campus de Ciencias Biológicas y Agropecuarias, Universidad Autónoma de Yucatán, 97200 Mérida, Yucatán, Mexico

³Universidad Autónoma del Estado de Hidalgo, Centro de Investigaciones Biológicas, Instituto de Ciencias Básicas e Ingeniería, Km 4.5 Carretera Pachuca-Tulancingo, 42184 Mineral de La Reforma, Hidalgo, Mexico

* katya_romero@cicy.mx

The Megamexican genus *Hechtia* is composed of several species complexes, two of which are remarkable for their morphological, ecological, and biogeographical characteristics, namely, the *H. guatemalensis* complex and the *H. tillandsioides* complex.

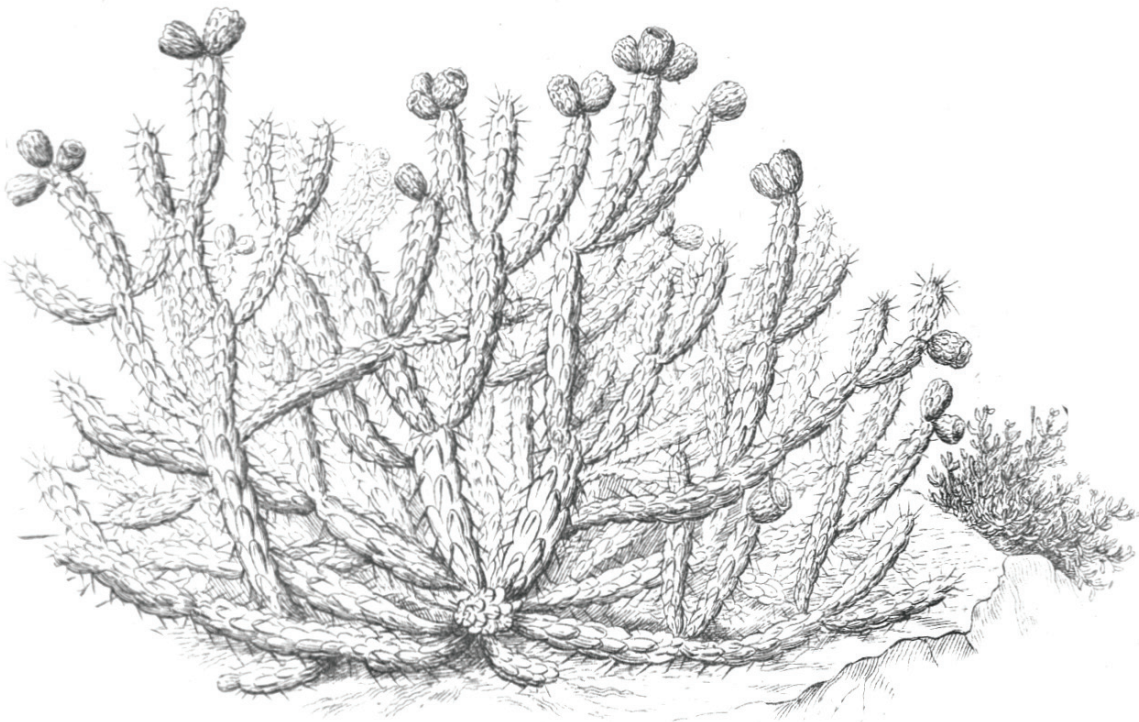
Objectives: the main goals of this project are to test the following hypotheses: Due to their intrinsic morphological features and geographically coherent distribution, both species complexes are monophyletic entities; based upon its distinctive morphology, the *H. guatemalensis* complex is sister to the remaining species of the genus; and because most *Hechtia* species feature narrow ecological and geographical ranges, the few members of the genus that have been circumscribed as widely ranging and morphologically variable, will be composed of several, more narrowly distributed and circumscribed (cryptic) taxa.

Methods: this research was carried out using phylogenetic analyses using all possible evidence, sequence information from several regions of plastid (*matK-trnK*, *rpl32-trnL*+ indels, fragments 4 & 6 of *ycf1*) and nuclear DNA (the PRK region), and structural characters. The several data matrices were analysed under Maximum Parsimony and Bayesian Inference.

Results and conclusions: The analyses recovered three strongly supported clades, one composed of all outgroup *Hechtia* spp. and one each for the *H. guatemalensis* and *H. tillandsioides* species complexes. The *H. tillandsioides* complex, is readily diagnosed by leaves with serrulate

margins, central inflorescences bearing hundreds of flowers on thin pedicels, narrow, membranaceous petals and sepals, superior ovaries; this clade is composed by five species restricted to Mexico, one of which will be formally proposed. The *H. guatemalensis* complex, composed of three species ranging from Guatemala in northern Nicaragua, is defined by its soft, slightly succulent leaves, non-pungent spines, sessile, epigynous flowers, capsules loculicidal, erect to pendent capsules.

Key words: Megamexico, monophyly, cryptic species



MICROMORPHOLOGICAL PATTERNS IN POLLEN GRAINS
OF THE GENUS *PORTULACA* IN BRAZIL

*Thaíla Vieira Santos, Alexa Araújo de Oliveira Paes Coelho,
Marcos da Costa Dórea, Francisco de Assis Ribeiro dos Santos,
Kelly Regina Batista Leite, Reyjane Patricia de Oliveira*

¹Universidade Estadual de Feira de Santana, Departamento de Ciências Biológicas, Avenida Transnordestina, s/n, Novo Horizonte, 44036-900 Feira de Santana, Bahia, Brazil

²Universidade do Estado da Bahia, Campus II-Alagoinhas, Departamento de Ciências Exatas e da Terra, Rodovia Alagoinhas/Salvador, BR 110 – Km 03 s/n, 48040-210 Alagoinhas, Bahia, Brazil

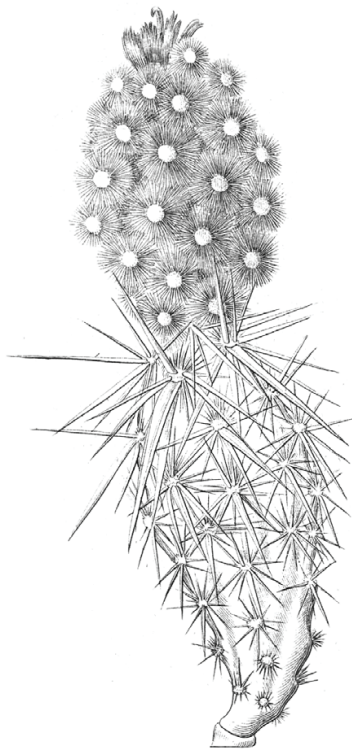
³Universidade Federal da Bahia, Instituto de Biologia, Rua Barão de Geremoabo, 147, 40170-290 Salvador, Bahia, Brazil

* thailavieira94@gmail.com

The main goal of this study was to report the variation in pollen micromorphology as a potential tool for taxonomy within the Portulacaceae. Additionally, a second aim was to provide useful information for morphological studies of the family as a whole. Pollen grains from all *Portulaca* species that occur in Brazil were sampled from flower buds in dried material from various herbaria (ALCB, HUEFS and RB). Three specimens per species were sampled. Following this procedure the pollen was then treated by acetolysis and mounted in permanent slides. Optical microscopy was used for measuring the following features: pollen diameter (N=25); exine, nexine and sexine thickness (N=10); and sculptural elements' length. These measurements were taken within seven days after the preparation of the slides. Other pollen samples were analysed with Scanning Electron Microscopy - SEM (ME-CPqGM-FIOCRUZ). Pollen grains were classified as apolar, medium (only *Portulaca halimoides*) to large (other species) sized, and the exine's ornament was observed to be spiny and annulate perforations. Variations regarding organization and type of aperture of pollen grains allowed us to separate the species into three basic pollen types: a) Type 1: pantocolpate; recorded as the only *Portulaca* type; b) Type 2: pantocolpate; seen only in two endemic species, *P. hatschbachii* (Paraná state) and *P. goiasensis* (Goiás state); c) Type 3: pantoporate, exclusively found in *P. hirsutissima*, an endemic species from Minas Gerais state. New aperture patterns reported here

for Portulacaceae pollen grains shed new light over micromorphology and its taxonomic implications. Portulacaceae is a family with wide morphological variation, and the absence of diagnostic characters for many species is often reported, which hinders taxonomic identification. Based on the combination of pollen data, morphology of the seeds' testa cells, plus species geographical distribution, two new Brazilian species from the *P. hirsutissima* complex were recently described, thus showing the potential for using a combination of these traits for taxonomical purposes.

Key words: Portulacaceae, palynology, taxonomy, Brazil



EFFECTS OF THE EXPRESSION OF MAYEHUELIN, A TYPE 1 RIP OF
AGAVE TEQUILANA, ON THERMOTOLERANCE OF *SACCHAROMYCES*
CEREVISIAE

Eric Sosa Jiménez^{1*}, *Jesus Gutiérrez Cruz*^{1*}, *Sandi Reyes Hernández*¹,
*Aída Martínez Hernández*², *Fernando Lledías Martínez*³
& *Jorge Nieto Sotelo*¹

¹Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Deleg. Coyoacán, 04510 Mexico City, Mexico

²ColPos, Unidad Campeche, Carretera Haltunchén-Edzá km 17.5, Champotón, Camp. 24450, Mexico

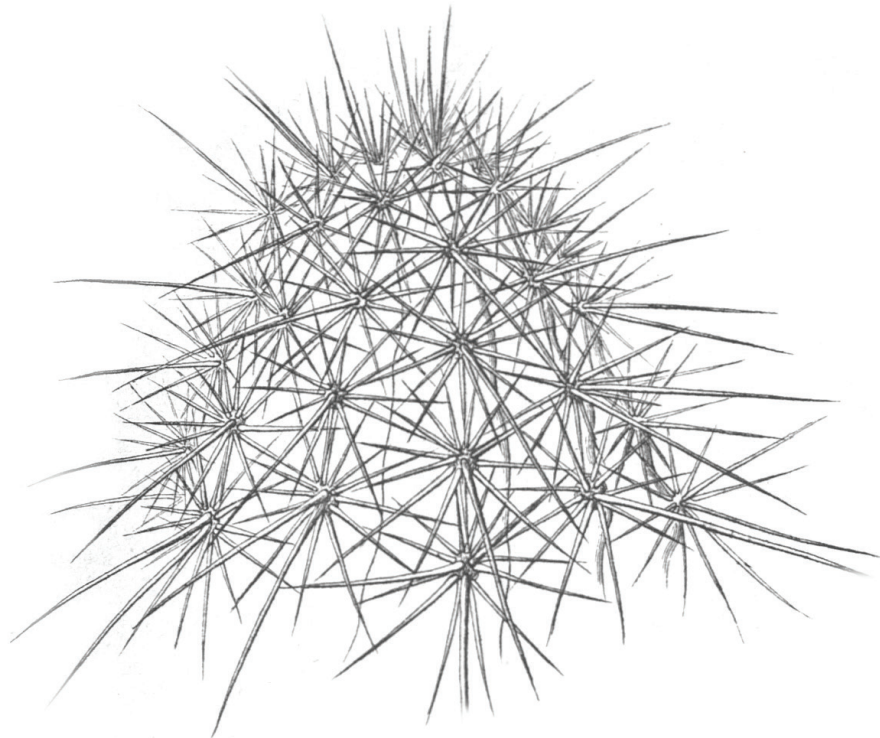
³Departamento de Biología Molecular de Plantas, Instituto de Biotecnología, Universidad Nacional Autónoma de México, Av. Universidad 2001, Cuernavaca, Mor. 62210, Mexico

* efsosaj@ciencias.unam.mx

The genus *Agave* is composed of succulent plants of great cultural, scientific and commercial interest in Mexico. They present great resistance to drought and to heat stress, primarily in the unfolded leaves found in the *cogollo* (bud with leaves forming a long tapering cone), where it has been observed that different morphological and molecular adaptations allow it to resist up to 55°C in the case of *Agave tequilana*. Mayehuelin is a protein found only in the folded leaves of the tapering cone of *A. tequilana*, and is also present in other species of the genus. Its amino acid sequence identifies it as a protein of the type 1 RIP family. Because mayehuelin accumulates in the structure with highest heat resistance of the plant, we assumed that its function might be related with stress resistance. In this work, we evaluated the effect of expressing mayehuelin on the growth and heat tolerance of *Saccharomyces cerevisiae*. Using the expression vector pYES-DEST52 of the Gateway system we built two versions of the recombinant protein: 1) the mature protein only and 2) the mature protein fused to the epitope V5 and a tag of histidines. The vectors were introduced to the W303-1a strain and the expression of the recombinant protein in the transformants was induced with galactose. Thereafter, cell liquid cultures were subjected to heat shocks to evaluate their basal and induced thermotolerance. The recombinant protein did not affect significantly the growth of the yeast cultures. Moreover, we observed a statistically significant increase in basal thermotolerance, whereas

induced thermotolerance levels were similar to the control. Our data demonstrates that mayehuelin function is involved in heat stress resistance, however its mechanism of action remains to be studied.

Key words: *Agave*, cogollo, RIPs, *Saccharomyces*, thermotolerance



A NUMERIC INDEX TO ASSESS THE LEVEL OF PROTECTION
OF THREATENED, PRIORITY SUCCULENTS IN MEXICO

Yasmín Hailen Ugalde, Beatriz Maruri, Israel Carrillo,
Emiliano Sánchez & Ma. Magdalena Hernández*

Jardín Botánico Regional de Cadereyta “Ing. Manuel González de Cosío,
Consejo de Ciencia y Tecnología del Estado de Querétaro, Camino Antiguo
a Tovaes S/N, Ejido Las Fuentes y Pueblo Nuevo, Cadereyta de Montes,
76500 Querétaro, Mexico

*jhugalde@concyteq.edu.mx

The main objective is to diagnose the effectiveness and coherence of a group of national and international conservation instruments, covering the succulents of the “List of species and priority populations for conservation”. This list acts as a complementary strategy to reach international commitments of biodiversity conservation, and includes 123 species of plants, many of them already present in the NOM-059-SEMARNAT-2010, which is the first Mexican list regarding threatened species.

A group of seven instruments was selected. Three of them are lists (Mexican NOM-059-SEMARNAT-2010, IUCN Red List, CITES Appendices) and four are practical approaches (Natural Protected Areas, Management Units for Wildlife Conservation, Botanic Gardens and Conservation of Genetic Resources). A numerical matrix was constructed and served as the basis for the development and application of two indexes of attention priority, as well as for the design of a visual indicator, traffic light-type.

The analysis provides a comprehensive overview of the current status of the succulent species (Cactaceae, Agavaceae and Nolinaceae) included in the list, and identifies gaps, coherence and incoherence in conservation priority, according to the instruments analysed. On that basis, it establishes conservation priority. This work is an objective contribution for decision makers for future conservation activities. Data provided by the analysis will help to redefine the attention priorities, actions and directions of environmental policy and conservation.

Key words: priority species, conservation instruments, attention index, prospective actions

MORPHOMETRIC VARIATION AND FLORAL BIOMASS AMONG NATURAL
POPULATIONS OF *OPUNTIA CARACASANA* SALM-DYCK (CACTACEAE)
IN ARID ZONES OF VENEZUELA

Carlos W. Varela Romero[†]

Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro,
Querétaro, Mexico

anfirrox@gmail.com

Multivariate statistical analyses have been increasingly used among morphological and reproductive morphometric characteristics to corroborate species characterization, analyse patterns of intra and interpopulation variation and interpret correlations of related groups. The morphometric variation, floral biomass and production of reproductive structures were evaluated in two populations of *Opuntia caracasana* located in the arid areas of Mangle Lloroso (Falcón state) and La Bocaina (Carabobo state), located in the western and central Venezuelan coast, respectively. The following variables were analysed: number of flower buds, number of open flowers, number of unripe fruits, number of ripe fruits, outer floral diameter, inner floral diameter, floral length, pericarpel length and dry biomass of floral whorls (tepals, androecium, gynoecium and pericarpel + receptacle). A multivariate analysis of principal components was conducted (CPA) to evaluate the affinities between the populations. No differences were found between the production of flowers and fruits, while the dimensions and floral biomass changed significantly between populations. The flowers of La Bocaina population were larger and heavier compared to those of Mangle Lloroso, showing segregation of the two populations, with an explained variance of data 66.96%, according CPA. The variables associated with biomass and floral length were the factors that contributed most to the interpopulational variation found in this species on the Venezuelan coast.

Key words: multivariate analysis, floral biology, reproductive biology, *Opuntia caracasana*, interpopulation variability, Venezuela

IMPORTANCE OF THE DOBA IN THE ZAPOTEC CULTURE
OF THE OCOTLÁN DISTRICT, OAXACA, MEXICO

*Patricia Vásquez Luis, Claudia López Sánchez & Felipe Palma Cruz**

Instituto Tecnológico de Oaxaca, Estudios de Posgrado y División de Investigación, Av. Ing. Víctor Bravo Ahuja 125, esquina Calzada Tecnológico, 68030 Oaxaca, Mexico

* felipepalmacruz@gmail.com

The diversity of “doba or dub” present in the Zapotec territory of the district of Ocotlán manifests itself in a multiplicity of uses, emphasizing its medicinal and food use. The present study recognizes the importance of doba in the daily life of this indigenous culture of Oaxaca. The study was divided into two phases; the first consisted in locating and identifying the representative populations of the doba; while in the second phase 36 semi-structured interviews were held with key informants to recognize names in the local native language, as well as the importance and usefulness of each of the species studied. Two species of Bromeliads, locally called Doba kuelda (*Hechtia* sp.) and Doba xiidxu (*Bromelia pinguin*) were identified, along with nine species of the genus *Agave*: Doba biya’ (*A. potatorum* and *A. nussaviorum*), Doba dxia (*A. convallis* and *A. angustiarum*), Doba ziiz (*A. karwinskii* f. *miahuatlan*), Doba daa’n (*A. karwinskii*), Doba naxh (*A. angustifolia*), Doba nupi (*A. americana*) and Doba beew (*A. marmorata*), as well as two species of *Yucca*: Doba baadu’ (*Y. mixteca* and *Y. guatemalensis*). They were classified into eight use categories: medicinal, food, fermented beverages, distilled beverages, construction, ornamental, agricultural and domestic use; of which the category with greater number of uses was construction, the inflorescence being the most important part of the plant. The Zapotec classification for doba is not exclusive to species of the genus *Agave* as it places more emphasis on the coarsely shaped plants.

Key words: doba, zapotec culture, use categories

SOME SUCCULENT NOVELTIES FROM QUERÉTARO, MEXICO

Sergio Zamudio^{1*} & *Ulises Guzmán*²

¹Apartado Postal 293, 61600 Pátzcuaro, Michoacán, Mexico

²Facultad de Estudios Superiores Zaragoza, UNAM, Batalla 5 de mayo s/n esquina Fuerte de Loreto, Colonia Ejército de Oriente, Deleg. Iztapalapa, 09320 Ciudad de México, Mexico

* szamudioruiz@gmail.com

During the development of the Flora of the Bajío and Adjacent Regions project, directed since 1985 by Dr. Jerzy Rzedowski and Dra. Graciela Calderón, 121 new taxa have been discovered and described, corresponding to 118 species, two subspecies and one genus. Among the new species there are some outstanding succulent plants of *Agave*, *Echeveria*, *Hechtia*, *Pinguicula* and *Sedum*. Additionally, we are proposing six more new species, collected recently in Querétaro and San Luis Potosí: *Agave mixii* Zamudio in prep., *Mammillaria occulta* Zamudio & U. Guzmán, *Mammillaria rzedowskiana* Zamudio & U. Guzmán, *Pinguicula robertiana* Zamudio in prep., *Pinguicula rzedowskiana* Zamudio in prep., and *Yucca pinophila* Zamudio in prep. All these are narrow endemics, from the southern part of the Sierra Madre Oriental in Querétaro and San Luis Potosí, known locally as Sierra Gorda. These discoveries reaffirm the importance of the region in the flora of the state.

Key words: new species, *Agave*, *Pinguicula*, *Mammillaria*, *Yucca*

Post-Congress Tour

THE QUERETARO-HIDALGO SEMI-DESERT BIODIVERSITY HISTORICAL ROUTE October 27-28



Thomas Coulter



Joseph Nelson Rose



Fernando Altamirano C.

The Queretaro-Hidalgo Semi-desert biodiversity historical route pays homage to those national and foreign botanists and explorers that have contributed to the knowledge of the flora of this region, and whose effort has been crucial for the understanding of succulents in Mexico. The route is designed for a two-day field trip, visiting the locations of Cadereyta de Montes that Joseph N. Rose and Fernando Altamirano Carbajal explored in the early XX Century, along with other sites of distribution of emblematic species collected by Thomas Coulter, around 1825.

The journey includes the recognition of a wide variety of species of Cactaceae, many of them linked to prominent names in botany as De Candolle, Ehrenberg, Hildmann, Werdermann, Glass and Hunt. It is a unique opportunity to see the semiarid landscape of Central Mexico in a journey of scientific knowledge, culture and history.

ITINERARY

SITE 1 (FRIDAY 27TH).

PUERTO DEL SALITRE TO “FERNANDO HIRIART BALDERRAMA”, ZIMAPÁN DAM

The meeting point will be at the Cadereyta Regional Botanic Garden, to leave at 09:00 A.M. At Puerto del Salitre we will stop to look at the Crassicaulous scrub (*Opuntia*, *Zaluzania*, *Yucca*); at El Junquillal we will see the Rosetophyllous scrub (*Dasyllirion longissimum*, *Flourensia resinosa*, *Agave striata*); and at the Dam, in “El Arbolito” community, we will have a look at the Submontane scrub. We will sleep at “El Arbolito” Hotel, at Mesa de León.

SITE 2 (SATURDAY 28TH).

VIZARRÓN-PEÑA BLANCA-BERNAL

We will leave Mesa de León to the Higuerilla-Peña Blanca site to see the Desert Microphyllous scrub (*Prosopis*, *Myrtillocactus*, *Larrea*). At Barranca del Río de la Noria, we will identify another type of Crassicaulous scrub (*Isolatocereus-Myrtillocactus*). At Bernal, we will see the Microphyllous shrub and the arid grasslands. Lunch will be provided at Peña Blanca and we will return to Cadereyta at 18:00.

The following species of interest are expected to be found: *Agave striata*, *Ariocarpus kotschoubeyanus*, *Astrophytum ornatum*, *Dasyllirion longissimum*, *Echinocactus grusonii*, *E. platyacanthus*, *Echinocereus schmollii*, *Ferocactus hystrix*, *F. latispinus*, *Isolatocereus dumortieri*, *Mammillaria compressa*, *M. herrerae*, *M. longimamma*, *M. sempervivi*, *M. uncinata*, *Myrtillocactus geometrizans*, *Opuntia kleiniae*, *O. leucotricha*, *O. stenopetala*, *Thelocactus hastifer*, *Turbinicarpus pseudomacrochele*, among others.

Please note that Mexican law prohibits the collection of specimens, parts or samples of flora or fauna, unless there is a collection permit.

Monday 23		Tuesday 24	
08:00	Registration	08:00	Registration
	Opening ceremony		
09:45	Morning Coffee Break	09:00	Keynote address by Daniela Zappi
10:00	Keynote address by Root Gorelick	10:00	Morning Coffee Break
11:00	Morning Session: Ecology (Cactaceae)	10:30	Morning Session: Special Topics (Cactaceae)
12:00	Lunch	12:00	Lunch
13:00	Afternoon Session: Conservation (Cactaceae)	13:00	Keynote address by Rolando Bárcenas
14:30	Afternoon Coffee Break		
15:00	Poster Session	14:00	Afternoon Session: Systematics (Cactaceae)
16:00	General Meeting (IOS Members)	16:30	Afternoon Coffee Break
		17:00	Special Address by Emiliano Sánchez Martínez

Wednesday 25**Thursday 26**

		08:00	Registration
09:30	Mid Congress Tour.	09:00	Keynote address by Len Newton
		10:00	Guided tour CRBG
		11:00	Morning Session: Conservation (Other families)
	Visiting: Quinta "Fernando Schmoll", "Granja GG" Nursery, "La Biznaga Vagabunda" Nursery, "Casa de Cactus San Martín" Nursery	12:00	Lunch
		13:00	Afternoon Session: Systematics (Other families)
		14:30	Afternoon Coffee Break
		15:00	Afternoon Session continues: Systematics (Other families)
		15:30	Keynote address by Ivón Ramírez- Morillo
16:30	Dinner at El Cuartel (Bernal)	16:30	Closing remarks and farewell
19:00	Bus departs to Cadereyta		

IMPORTANT NUMBERS

The Botanic Garden:

Jardín Botánico Regional de Cadereyta: (441) 2760647

Hotels:

Hotel “Esperanza” (441) 276 0357

Posada “Las Vegas” (441) 276 0526

Hotel “Rancho Hacienda San Antonio” (441) 276 2292

Hotel “Viña del Cielo” (441) 276 0140

Hotel “Del Lago”, Hacienda Tovares (442) 109 1218, (442) 403 0576

Taxis (Cabs):

(441) 100 7790 (Don Coreano)

(441) 101 7902 (Don Gregorio)

(441) 109 0598 (Don Jesús)

(441) 107 9387 (Doña Mari)

(441) 118 0770 (El Chino)

(441) 119 0478 (Por la noche-At nights)

(441) 109 9328 (En la Central de autobuses-At the bus station)

Servicios (Public services):

Coordinación Municipal de Turismo (Tourism Office): (441) 276 0880

Cruz Roja (Red Cross): (441) 276 1609

Hospital General (General Hospital): (441) 276 0886, (441) 276 0887

Dirección de Seguridad Pública (Public Security): (441) 276 0938

Bomberos de Cadereyta (Fire brigade)

(Comandante María Gloria): (441) 116 4700

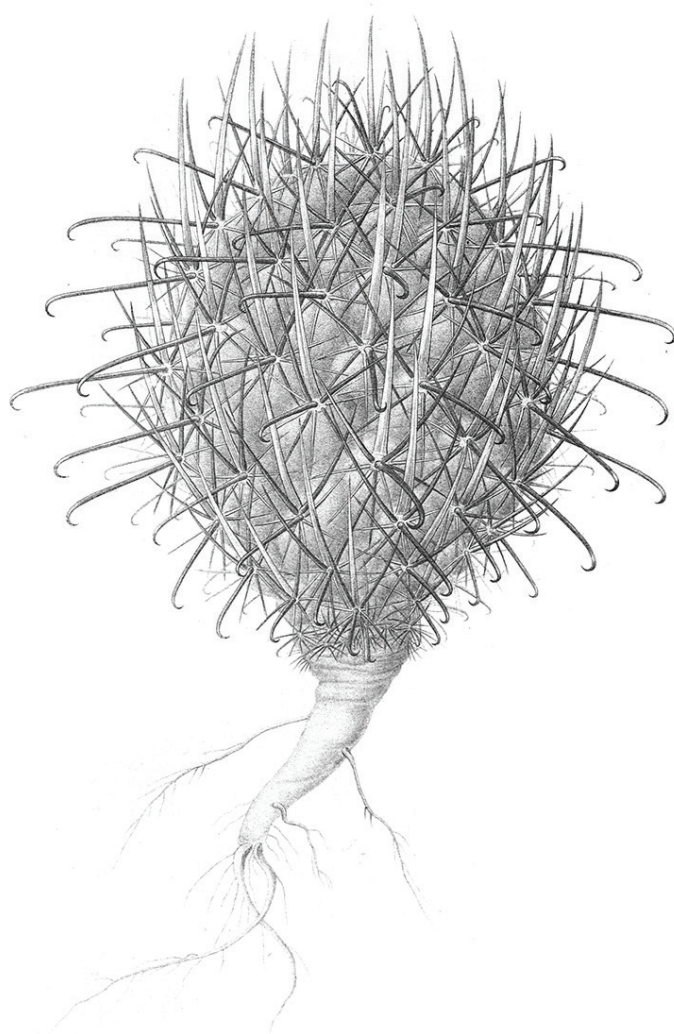
Protección Civil (Emergencies): (441) 276 0939

Números del Comité Organizador. (Organizing Committee contacts)

(55) 1333 1542 Héctor M. Hernández

(442) 139 3349 Ma. Magdalena Hernández

(442) 141 7655 Beatriz Maruri



Edition: Héctor M. Hernández
Design: Julio César Montero