

# Cycad 2015

**10th International Conference on Cycad Biology**

Medellín, Colombia

August 16th-21st, 2015

## Schedule and Abstracts



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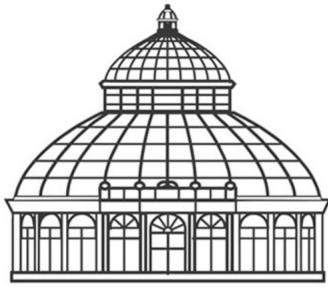
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## August 16th, 2015 (Sunday)

Time	Event
09:00 to 15:20	On-site registration at Plaza Rosa Hotel
15:20 to 16:00	Bus #1 to Medellín Botanical Garden
16:00 to 17:00	Medellín Botanical Garden Tour 1
16:20 to 17:00	Buses #2 and #3 to Medellín Botanical Garden
17:00 to 18:00	Medellín Botanical Garden Tour 2
18:00 to 22:00	Inauguration Banquet

# August 17th, 2015 (Monday)

Time	Event / Talk [Presenter]
09:00 to 10:00	<b>Opening Ceremony</b>
10:00 to 10:40	(1) <b>Plenary talk 1:</b> Cycads of Colombia: status and conservation actions [Cristina López-Gallego]
10:40 to 11:00	<i>Morning break</i>
11:00 to 11:20	(2) Conservation status of the endemic cycads of the Palawan biogeographic region [Esperanza Maribel Agoo]
11:20 to 11:40	(3) An investigation of cycad populations in South Africa using repeat photography [John Donaldson]
11:40 to 12:00	(4) El género <i>Zamia</i> en Cuba: Diversidad, distribución, usos tradicionales y conservación / The genus <i>Zamia</i> in Cuba: Diversity, distribution, ecology, traditional uses, and conservation [Ramona Oviedo Prieto]
12:00 to 12:20	(5) Estado de conservación de poblaciones de Zamiaceae (Cycadales) en Cuba: proyecto de colaboración Cuba-Estados Unidos de América / Conservation status of Zamiaceae (Cycadales) populations in Cuba: a collaborative project between Cuban and American institutions. [Gabriel Brull Puebla]
12:20 to 14:00	<i>Lunch</i>
14:00 to 14:20	(6) Range extension of the endangered Mexican cycad <i>Ceratozamia fuscoviridis</i> : implications for conservation [María T. Pulido-Silva]
14:20 to 14:40	(7) Effect of human perturbation over demographic structure and population dynamics of <i>Ceratozamia fuscoviridis</i> Moore ex R.Osborne, D.W.Stev. & Vovides (Cycadales, Zamiaceae) [Pablo Octavio-Aguilar]
14:40 to 15:00	(8) Assessment of <i>Cycas hoabinhensis</i> [Dennis W. Stevenson]
15:00 to 15:20	(9) The reintroduction of <i>Cycas debaoensis</i> as a pilot project for rescuing the endangered plants in China [Nan Li]
15:20 to 16:00	(10) <b>Plenary talk 2:</b> New roads in, <i>Zamia</i> species out: the case for Isthmian cycads [Alberto S. Taylor B.]
16:00 to 16:20	<i>Afternoon break</i>
16:20 to 16:40	(11) Hypothesizing a relationship between cycads and maize in central Mexico / Hipótesis de relación entre las cicadas y el maíz en el centro de México [Gabriel Espinosa]
16:40 to 17:00	(12) Cycads, maize, and garfish: The representation of ethnoecological systems in Olmec iconography [Gabriel Espinosa]
17:00 to 17:20	(13) Presence of <i>Zamia</i> in the extreme north of Sancti Spiritus, Cuba: Current spatial distribution and possible incorporation in aboriginal diets / La presencia de la <i>Zamia</i> sp. en el extremo Norte de la Provincia de Sancti Spíritus, Cuba. Distribución espacial actual y su posible incorporación a la dieta aborigen [Mark Bonta]
17:20 to 17:40	(14) Food use of <i>Ceratozamia fuscoviridis</i> during the Mexican Revolution and its change between generations in Tlanchinol [María T. Pulido]
17:40 to 18:00	(15) The importance of gender roles and direct oral transmission for cycad detoxification recipes [Mark Bonta]
18:00 to 19:00	<b>Poster session</b>

# August 18th, 2015 (Tuesday)

Time	Event / Talk [Presenter]
09:00 to 09:40	(16) <b>Plenary talk 3:</b> Phylogeography of the Caribbean <i>Zamia</i> clade: testing the “out-of-Cuba” hypothesis [Alan W. Meerow]
09:40 to 10:00	(17) Phylogeography clarifies infrageneric divergence in the genus <i>Dioon</i> (Zamiaceae): implications for taxonomy and conservation [José Said Gutiérrez-Ortega]
10:00 to 10:20	(18) Did climate-driven shifts in habitat elevation lead to speciation in <i>Dioon</i> ? [Brian L. Dorsey]
10:20 to 10:40	(19) Phylogenetic relationships and classification of <i>Cycas</i> [Nathalie S. Nagalingum]
10:40 to 11:00	<i>Morning break</i>
11:00 to 11:20	(20) Programa Integral de Conservación para las especies <i>Zamia incognita</i> y <i>Zamia encephalartoides</i> , en el departamento de Santander – Colombia.[Alicia Rojas]
11:20 to 11:40	(21) Morphological and genetic variation of <i>Zamia prasina</i> in the southern of Mexico and Belize [Miguel A. Pérez Farrera]
11:40 to 12:00	(22) Estimation of heritability and genetic correlations in morphological and physiological traits for a population of <i>Zamia obliqua</i> [Natalia Gomez-Lopera]
12:00 to 12:20	(23) Exploring new approaches for conservation genomics of <i>Cycas</i> L. (Cycadaceae) in Australia [James Clugston]
12:20 to 14:00	<i>Lunch</i>
14:00 to 14:40	(24) <b>Plenary talk 4:</b> A molecular phylogeny of <i>Zamia</i> L.: a multi-gene approach using single-copy nuclear genes [Michael Calonje]
14:40 to 15:00	(25) Molecular and morphological analyses of cycad beetles: what they reveal about cycad evolution in the New World [William Tang]
15:00 to 15:20	(26) Geographically disjunct populations of <i>Macrozamia macleayi</i> : Do they differ in cone volatile chemistry, thermogenic patterns and Cycadothrips pollinator? [Irene Terry]
15:20 to 15:40	(27) Examination of the relationships between respirometry, thermogenesis and volatiles in <i>Macrozamia macleayi</i> and <i>M. lucida</i> pollen cones during their thermogenic events [Robert Roemer]
15:40 to 16:00	(28) Cycad pollination drop composition [Patrick von Aderkas]
16:00 to 16:20	<i>Afternoon break</i>
16:20 to 16:40	(29) Plant-insect communication and specificity of <i>Zamia</i> pollination [Shayla Salzman]
16:40 to 17:00	(30) Pollination in <i>Zamia incognita</i> A.Lindstr. & Idárraga (Cycadales: Zamiaceae) in a natural population from Alicante River Canyon, Maceo, Antioquia [Wendy A. Valencia-Montoya]
17:00 to 17:20	(31) New support for the broodsite visitation hypothesis of female cones from <i>Encephalartos manikensis</i> (Zamiaceae) and allies [Philip Rousseau]
17:20 to 17:40	(32) Does wind play a role in the pollination of <i>Cycas micronesica</i> ? [Irene Terry]
17:40 to 18:00	(33) <i>Eumaeus godartii</i> butterfly: Pest friend or foe? [Alberto S. Taylor B.]
18:00 to 19:00	<b>Forum/mixer (1 hour)</b>

## August 19<sup>th</sup>, 2015 (Wednesday)

Time	Event
09:00 to 12:20	<b>Field trip activities</b>
12:20 to 14:00	<i>Lunch (field trip)</i>
14:00 to 18:00	<b>Field trip activities</b>

# August 20th, 2015 (Thursday)

Time	Event / Talk [Presenter]
09:00 to 09:40	(34) <b>Plenary talk 5:</b> Fieldwork on <i>Encephalartos</i> (Zamiaceae) in Mozambique [Philip Rousseau]
09:40 to 10:00	(35) Rediscovering redback-a <i>Ceratozamia</i> lost and found [Jeff Chemnick]
10:00 to 10:20	(36) Conservation strategy for <i>Zamia incognita</i> A.Lindstr. & Idárraga in the Magdalena Medio region, Colombia [Arturo Aristizábal]
10:20 to 10:40	(37) <i>Cycas pectinata</i> complex of northeast India and southeast Asia [J.S. Khuraijam]
10:40 to 11:00	<i>Morning break</i>
11:00 to 11:20	(38) Cycads from Lao PDR [Hiep Tien Nguyen]
11:20 to 11:40	(39) Morphometrics in <i>Encephalartos</i> (Zamiaceae) [Philip Rousseau]
11:40 to 12:00	(40) Integrative taxonomy of <i>Ceratozamia miquelianiana</i> H. Wendl. (Zamiaceae) and related species [Lili Martínez-Domínguez]
12:00 to 12:20	(41) The meaning of artificial hybridization in cycad phylogenetic studies: The case for populations of <i>Zamia cunaria</i> and <i>Zamia ipetiensis</i> [Alberto S. Taylor B.]
12:20 to 14:00	<i>Lunch</i>
14:00 to 14:40	(42) <b>Plenary talk 6:</b> Anatomy in Zamiaceae: Old techniques solving new problems / Anatomía en Zamiaceae: Técnicas tradicionales resolviendo nuevos problemas [Andrew P. Vovides]
14:40 to 15:00	(43) Leaflet anatomy of plicate leaved South American zamias with emphasis on <i>Zamia roezlii</i> and <i>Zamia wallisii</i> (Zamiaceae) [Walter Marín-Méndez]
15:00 to 15:20	(44) Optical properties, photosynthetic pigments content and anatomical features during leaf development in the seedling of the endangered cycad <i>Dioon edule</i> Lindl. (Zamiaceae) [Laura Yáñez-Espinoza]
15:20 to 15:40	(45) Leaf production rates in <i>Ceratozamia fuscoviridis</i> in Molango, Mexico [María T. Pulido]
15:40 to 16:00	(46) Gelatinous (tension) fibers in the seedling roots of cycads [Tracy M. Magellan]
16:00 to 16:20	<i>Afternoon break</i>
16:20 to 16:40	(47) Reproductive anomalies in <i>Encephalartos</i> (Zamiaceae) [Philip Rousseau]
16:40 to 17:00	(48) Are cycad megasporophylls actually ovulate shoots? [Xin Wang]
17:00 to 17:20	(49) Influence of germination date on <i>Dioon edule</i> (Zamiaceae) seedling tolerance to water stress [Laura Yáñez-Espinoza]
17:20 to 17:40	(50) The first fossil evidence of the genus <i>Zamia</i> L. (Zamiaceae, Cycadales) – implications for the Cenozoic evolution of cycads [Boglárka Erdei]
17:40 to 18:00	(51) Implications of chromosomal fission, fusion, and duplication for cycad evolution and diversity [Root Gorelick]
18:00 to 19:00	<b>Mixer (1 hour)</b>

# August 21st, 2015 (Friday)

Time	Event / Talk [Presenter]
09:00 to 09:40	(52) <b>Plenary talk 7:</b> Integrated Cycad Conservation: collections genetics help close the loop [M. Patrick Griffith]
09:40 to 10:00	(53) Multiplication and popularization of Indian <i>Cycas</i> for ornamental use at CSIR-NBRI Botanic Garden [J.S. Khuraijam]
10:00 to 10:20	(54) Conservación y propagación ex situ de <i>Zamia tolimensis</i> en el Jardín Botánico Alejandro von Humboldt de la Universidad del Tolima, Ibagué, Colombia / Ex situ conservation and propagation of <i>Zamia tolimensis</i> in the Alexander von Humboldt Botanical Garden of the University of Tolima, Ibagué, Colombia [Alfredo Torres]
10:20 to 10:40	(55) Pollination and germination as limiting factors in the propagation of threatened cycads, <i>Encephalartos</i> (Zamiaceae) [Phakamani Xaba]
10:40 to 11:00	<i>Morning break</i>
11:00 to 11:20	(56) The comprehensive cycad collection at the University of Melbourne and its importance to botanical and horticultural education [Tim Uebergang]
11:20 to 11:40	(57) The use of cycads in the landscape [Alvaro Calonje]
11:40 to 12:00	(58) A seven year ravage of Cycad Aulacaspis Scale (CAS) in Panama and a simple method to curtail it [Alberto S. Taylor B.]
12:00 to 12:20	(59) <i>Zamia tolimensis</i> y <i>Zamia huilensis</i> , dos especies vecinas separadas por el Rio Magdalena en Colombia [Hector Esquivel]
12:20 to 14:00	<i>Lunch</i>
14:00 to 14:40	(60) <b>Plenary talk 8:</b> An overview of the world's cycads: current conservation status and trends from 2003-2014 [John S. Donaldson]
14:40 to 15:00	(61) Introducing the online edition of The World List of Cycads [Michael Calonje]
15:00 to 15:20	(62) Cycads coraloid roots as a novel source of biosynthetic gene clusters of specialized metabolites [Francisco Barona-Gómez]
15:20 to 15:40	(63) Ecological genomics of cycads and their root symbionts: insights into a million-yr old association [Angelica Cibrián-Jaramillo]
15:40 to 16:00	(64) South Africa - Hosting Cycad 2018 [Wynand van Eeden & Piet Vorster]
16:00 to 16:20	<i>Afternoon break</i>
16:20 to 17:20	<b>Assembly: Cycad meetings, CSG themes</b>
17:20 to 18:00	<b>Buses to Medellín Botanical Garden</b>
18:00 to 22:00	<b>Closing Ceremony</b>

## Plenary Talk 1

### (1) Cycads of Colombia: status and conservation actions

Cristina López-Gallego\*

**Abstract:** Colombia has 21 recognized species of *Zamia*, with a growing list of new species being discovered. These species are distributed mostly in the Caribbean-Andes (11 species), the Chocó (6 species) and the Amazon (4 species) regions. More than 60% of the species are endemic to Colombia (13 species). These species inhabit extremely wet rainforest to very dry forest and open habitats, from sea level to 2000 meters of elevation. In the last 20 years major advances in taxonomy and ex-situ propagation have been developed by academics and botanical gardens in the country, and a country-level red list was published in 2005. Nevertheless, little direct action has been carried out for in-situ conservation of natural populations. Almost all species in the country are endangered (especially in the Andes and Caribe), mostly because of habitat destruction and degradation, and in some cases by over-exploitation. For the past several years, we have been collaborating with the National Biodiversity Institute and the Ministry of Environment to implement a national Conservation action plan. We are re-evaluating species for the red list with much improved information on their status, building relations with environmental authorities and in some cases working with local land owners to promote several conservation programs, mostly for protecting species in their natural habitats, but also for restoring some extremely endangered populations. We are now preparing to design conservation action plans for each species, and continue to perform research and monitoring to support conservation actions throughout the country.

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\* Speaker

## Session 1: Conservation

### (2) Conservation status of the endemic cycads of the Palawan biogeographic region

Domingo A. Madulid & Esperanza Maribel Agoo\*

**Abstract:** *Cycas wadei*, *C. curranii*, *C. saxatilis* (Sec. Wadeae), and *C. aenigma* (Sec. Cycas) are endemic species found in the Palawan Biogeographic Region in the Philippines. *Cycas wadei* in particular is found in Culion Island, north of Palawan mainland while *C. aenigma*, *C. curranii*, and *C. saxatilis* are found in mainland Palawan. The three species (except *C. aenigma*) are closely similar with their grooved seeds, very broad megasporophyll lamina, and microsporophyll without apical spines. They are however found in different habitats, i.e. grassland, lowland forest, and forest over limestone. The conservation status of the species are assessed based on demographic data, area of occupancy, and extent of occurrence. The threats to the species are also documented.

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\* Speaker

### **(3) An investigation of cycad populations in South Africa using repeat photography**

Desale Y. Okubamichael, Sam Jack, De Wet Bösenberg , Timm Hoffman & John Donaldson\*

**Abstract:** South Africa has 38 cycad species and many of them are sought after world-wide due to their rarity, placing ever more pressure on natural populations. The status of numerous South African cycad species is worrying as their numbers have been declining dramatically. While reports agree that cycads populations are declining, there is nevertheless a lack of broad scale quantitative and systematic studies supporting these views from an historical perspective. The main tool of this study for investigating spatial and temporal change in cycad populations is repeat photography. The current study analyses a set of over 100 photographs taken of cycads in the early to mid-1900s. The photo-collection was first repeated in the mid-nineties and for the second time in the year 2014, 20 years after the initial repeat photos. Analysis of repeat photos shows continuing decline of cycad populations in South Africa where the main cause of reduction is removal of individual plants from the wild. Some populations have also disappeared due to removal of bark for Muthi purposes (traditional medicine). The analysis is linked to detailed demographic data collected at each site to allow ongoing monitoring of changes in population status over time.

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\* Speaker

**(4) El género *Zamia* en Cuba: Diversidad, distribución, usos tradicionales y conservación / The genus *Zamia* in Cuba: Diversity, distribution, ecology, traditional uses, and conservation**

Ramona Oviedo Prieto\*, Lisbet González-Oliva, Michael Calonje, Gabriel Brull Puebla & Javier Francisco-Ortega

**Resumen:** Se presenta información actualizada sobre las poblaciones de *Zamia* en Cuba obtenida en el marco del proyecto ‘Estado de conservación de poblaciones de Zamiaceae en Cuba’, proyecto conjunto entre instituciones Cubanas y Estadounidenses. Los resultados presentados se sustentan en la revisión de literatura especializada y actualizada, la revisión de herbarios cubanos y extranjeros, las prospecciones de campo por todo el país, y el intercambio con técnicos y especialistas de las áreas protegidas. En estos momentos se está articulando una Red de aficionados a las zamias cubanas, que realizan nuevas localizaciones, observaciones de campo y cultivo, tributando información y fortaleciendo los conocimientos sobre este complejo grupo de plantas. Se ilustra la diversidad de las zamias cubanas (actualmente agrupadas en 7 especies) y se discute su distribución, plasticidad ecológica, usos tradicionales, y estado de conservación de las poblaciones nativas y sus hábitats.

**Abstract:** We present new information about native *Zamia* populations in Cuba obtained during a joint research Project between Cuban and American Institutions titled: ‘Conservation status of Zamiaceae populations in Cuba’. The information presented is the result of the review of scientific literature, herbarium specimen study in Cuba and abroad, fieldwork throughout the country, and information exchange with technicians and specialists of protected areas. A network of Cuban cycad specialists and enthusiasts is currently being formed which provides new data to strengthen our knowledge of this complex group of plants by reporting new populations, contributing field data and sharing horticultural knowledge. The diversity of Cuban zamias (currently circumscribed within 7 species) is illustrated, and we discuss the distribution, ecological plasticity, traditional uses, and conservation status of native populations and associated hábitats.

\* Speaker

**(5) Estado de conservación de poblaciones de Zamiaceae (Cycadales) en Cuba: proyecto de colaboración Cuba-Estados Unidos de América / Conservation status of Zamiaceae (Cycadales) populations in Cuba: a collaborative project between Cuban and American institutions**

Gabriel Brull Puebla\*, Javier Francisco-Ortega, Ramona Oviedo Prieto, Michael Calonje & Lisbet González-Oliva

**Resumen:** El proyecto “Estado de conservación de poblaciones de Zamiaceae (Cycadales) en Cuba”, concebido en el marco de una colaboración conjunta entre instituciones de Cuba y Estados Unidos de Norte América; se sustenta en el intercambio de la información existente sobre las poblaciones de *Zamia* y otras especies asociadas, en el Caribe. Se trabaja en una evaluación integral del estado de conocimiento y la situación actual de una muestra representativa de las poblaciones de *Zamia* y algunas especies claves asociadas, en sus ecosistemas nativos en Cuba. El mismo tributa a complementar vacíos de información biológica identificados, su representatividad en herbarios y a la gestión de conservación de cada población y sus hábitats. Los resultados de este proyecto permitirán aclarar la taxonomía del género para las especies cubanas, su ecología, distribución geográfica y su relación filogenética con sus congéneres del Caribe, conocer las incidencias principales en la salud de las poblaciones de *Zamia*, incrementar la información existente sobre ellas; así como el establecimiento de un Plan de Acción Nacional para la mejor efectividad en la gestión de conservación en las áreas protegidas y otras áreas en Cuba.

**Abstract:** The project “Conservation status of Zamiaceae (Cycadales) populations in Cuba” is a joint collaboration between Cuban and U.S. Institutions supported by the exchange of information about *Zamia* populations and associated species in the Caribbean. The team is working on a comprehensive evaluation of current knowledge and the status of a representative sample of the populations of *Zamia* and some key associated species in their native ecosystems in Cuba. The evaluation seeks to complement gaps in knowledge of biological information, in representation in herbaria, and to manage the conservation of cycad populations and their associated habitats. The results of this project will allow the clarification of the taxonomy of Cuban *Zamia*, increase our understanding of their ecology, distribution, and phylogenetic relationship with other Caribbean zamias, evaluate the health of cycad populations, and establish a Conservation Action Plan for the management of species occurring in protected areas and other regions of Cuba.

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\* Speaker

**(6) Range extension of the endangered Mexican cycad *Ceratozamia fuscoviridis*: implications for conservation**

María T. Pulido-Silva\*, Maricela Vargas-Zenteno, Aurelia Vite & Andrew P. Vovides

**Abstract:** *Ceratozamia fuscoviridis* is a recently rediscovered endangered cycad species previously known from only one population in Molango, Mexico. Our recent botanical explorations have uncovered new but scattered populations thus increasing its known geographical range and ecological studies were conducted on six of the 29 populations found. The population structure in general was an Deevey-III curve, while two populations showed Deevey-I curves. Population density varied from 0.358 individuals/m<sup>2</sup> to 0.945 individuals/m<sup>2</sup>. Population structure was statistically significant between populations ( $\chi^2 = 480.7$ ,  $P < 0.05$ ). The large amount of seedlings in all sites was distinctive and indicated the specie's reproductive success even when present in small forest fragments. This research provides the most complete information available to date regarding populations of *C. fuscoviridis*. This study shows that *C. fuscoviridis* is not as restricted in area as previously believed. We suggest the IUCN Red listing category of the species be amended from Critically Endangered to Endangered in view of newly discovered populations, high population size and successful recruitment. Community-based conservation, ex situ conservation and new natural protected areas are suggested.

**Resumen:** *Ceratozamia fuscoviridis* es una especie críticamente amenazada, recientemente redescubierta, donde se ha reportado una única población en Molango, México. Nuestras exploraciones botánicas recientes han encontrado nuevas y dispersas poblaciones, por lo que se ha incrementado notablemente el rango geográfico. Nosotros realizamos estudios en seis de las 29 poblaciones. La estructura poblacional general fue una curva Deevey-III curve, mientras que dos poblaciones mostraron curvas Deevey-I. La densidad poblacional varió de 0.358 individuos/m<sup>2</sup> a 0.945 individuos/m<sup>2</sup>. La estructura poblacional fue distinta entre poblaciones ( $\chi^2 = 480.7$ ,  $P < 0.05$ ). Una característica notable fue la gran cantidad de plántulas en todos los sitios e indica el éxito reproductivo aún en fragmentos pequeños. Este estudio proporciona la información más completa hasta la fecha sobre *C. fuscoviridis*. Nuestro estudio muestra que *C. fuscoviridis* no tiene una distribución tan restringida como me pensó inicialmente. Sugerimos una enmienda en la categoría de la Lista Roja, colocándola en la categoría de Amenazada, debido a las poblaciones descubiertas recientemente, su alta densidad poblacional y éxito en la reproducción. Se sugieren estrategias de Conservación basada en comunidad, conservación ex situ y nuevas áreas naturales protegidas.

\* Speaker

**(7) Effect of human perturbation over demographic structure and population dynamics of *Ceratozamia fuscoviridis* Moore ex R.Osborne, D.W.Stev. & Vovides (Cycadales, Zamiaceae)**

Cuauhtemoc Alaín Rubio-Tobón, Pablo Octavio-Aguilar\*, María Teresa Pulido-Silva & Francisco Núñez de Cáceres-González

**Abstract:** Cycads are long-lived, panchronic and slow growth plants. Persistence of their populations strongly depends on the survival of the adults because younger individuals are more susceptible to environmental changes thus increasing its mortality rate. In this research, the effect of perturbation over the spatial structure and demographic dynamics was evaluated on populations of *Ceratozamia fuscoviridis*, an endemic cycad from Mexico considered by the IUCN Red List as “Critically Endangered”. The main approach was to contrast attributes related with the level of conservation of the studied locations and its effect over the spatial distribution, survival rate, demographic structure and intrinsic rate of population growth. Our results showed that In general human perturbation reduced the amount of individuals per unit of area; it increased the effect of spatial aggregation especially on plantlets; decreased the intrinsic rate of population growth and modified populations’ demographic structure although it doesn’t significantly affected mortality rates.

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**(8) Assessment of *Cycas hoabinhensis***

Khang Sinh Nguyen, Dianxiang Zhang, Hiep Tien Nguyen, Dennis W. Stevenson\* & Leonid V. Averyanov

**Abstract:** *Cycas hoabinhensis* is a typical local paleoendemic with strictly limited distribution in the central part of northern Vietnam. This small, usually unbranched palm-like lithophytic or terrestrial plant grows in evergreen broad-leaved lowland limestone forests to the southwest and south areas of Hanoi at elevations 70-250 m a.s.l. About 130 aboriginal species of vascular plants (from 110 genera and 47 families) are usual associates with *Cycas hoabinhensis* in its typical habitats. Among them 3 species were recognized as a new species for science and 4 species were reported as a new species for the flora of Vietnam. The pollen cone remains about 2 months, female coning cycle of *Cycas hoabinhensis* probably succeeds by years (perhaps 2-3 years a time), seeds become mature from December to January of the following year, possibly dispersed by gravity and rodent (rarely). The variation of morphology of *Cycas hoabinhensis* is studied in a series of individuals from different subpopulations. Low regeneration, progressive decrease of the number of mature individuals in all natural populations (caused by commercial collecting and high market demands) and habitat loss are main threats for the species. The updated global conservation status for this locally endemic cycad is assessed as Endangered A2cd; B1ab(ii, iv, v).

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\* Speaker

**(9) The reintroduction of *Cycas debaoensis* as a pilot project for rescuing the endangered plants in China**

Nan Li\*, Yinghong Jiang & Zaoyan Lu

**Abstract:** *Cycas debaoensis* Y.C.Zhong & C.J.Chen is a typical species in minimum population, which was listed as the first grade of protected plants in China and included in IUCN Red List with status CR B2, mainly caused by the transformation and fragmentation of its habitat as well as the illegal stealing dig. In 2008, 506 seedlings of *C. debaoensis* molecularly detected, had been reintroduced and planted in Guangxi Huanglianshan Nature Reserve, which is less than 8 kilometers from their type locality. The population has grown well since they were planted in reintroduced site. In 2009, over 90% individuals had healthy leaves, with robust root system and abundant coralloid roots. In 2012, the reintroduced population born both female and male cones in the rate 1:3.5 (female : male). By the end of 2013, 485 reintroduced individuals survived with the survival rate of 95.8%. Many young seedlings and seeds moved and scattered by rodents were discovered around the reintroduction site, which indicates that the population has naturally regenerated in the reintroduction site. Investigation of pollination biology indicated the pollinator found in natural habitat in Fupin type locality was lacking in the early blooming stage of the introduced population in 2012. The seed setting rate increased from less than 10% in 2012 to 70% in 2013 through artificially introducing pollinating beetles of the family Languriidae specifically for *C. debaoensis*. Population genetic studies indicated that the reintroduced population has a relatively rich genetic diversity, with the  $H_e=0.254$ , which is close to the native population level ( $H_e=0.307$ ). Genetic analysis of nuclear SSR showed that the reintroduced population has genetically covered 81% of the native populations of *C. debaoensis*. The practice of the reintroduction project showed that the successful reintroduction of rare and endangered plants is not just a pure scientific experimental activity, but also requires the involvement and support of the local communities as well as relevant management departments.

\* Speaker

## Plenary Talk 2

### (10) New roads in, *Zamia* species out: the case for Isthmian cycads

Alberto S. Taylor B.\*

**Abstract:** New roads have been built with quite a frenzy across the Isthmus of Panama in the last 10 years. However, this improvement in government infrastructure has come with a negative cost to the protection of cycad (zamias) population. Roads have been opened, paved or reconstructed from east, central and west Panama, and the populations of *Zamia* in those places have suffered destruction, illegal extraction or both. We give examples of the problem and our conclusion is to once again call the attention of the authorities, especially the National Environmental Authority to monitor all areas with cycads, because they are under threat and, in many places, they are not seen anymore.

**Resumen:** Durante los últimos diez años se han construido carreteras con gran entusiasmo a través del Istmo de Panamá. Sin embargo, este mejoramiento de infraestructura de gobierno ha llegado con un costo negativo para la protección de poblaciones de cícadas (zamias). Carreteras han sido inauguradas, pavimentadas o reconstruidas desde el este, el centro y el oeste de Panamá, y las poblaciones de *Zamia* en esos sitios han sufrido destrucción, extracción ilegal o ambas cosas. Presentamos ejemplos de este problema y nuestra conclusión es llamarles la atención otra vez a las autoridades, especialmente a la Autoridad Nacional de Ambiente para monitorear todas las áreas con cícadas, porque están bajo amenaza y, en varios sitios, ya no se ven.

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\* Speaker

## Session 2: Ethnobotany

### (11) Hypothesizing a relationship between cycads and maize in central Mexico / Hipótesis de relación entre las cicadas y el maíz en el centro de México

Gabriel Espinosa\*, María T. Pulido, Aurelia Vite, Mark Bonta & Andrew P. Vovides

**Abstract:** In Mexico, vestiges exist of the historically close relationship between cycads and maize. Through comprehensive interdisciplinary research employing interviews, etymological analysis and historical sources, in this paper a hypothesis is posed of close relationship between cycads and maize, which emerges in the present territory of Hidalgo state. Cycads in Hidalgo include eight species with at least seven common names that make close reference to maize. Cycads have historically had various uses in the region, including for food, ritual, construction, medicine, and poison. Though several of these uses have been lost in the last century, ritual use is still widespread. The analysis accomplished by a multidisciplinary research team supports proposing a cultural proximity between cycads and maize in relation to use, etymology, morphology, and legends, among others. Extending ideas initially proposed by M. Bonta, additional evidence of cultural proximity between cycads and maize is provided. Also hypothesized is that cycads may have been conceived as deities with a certain degree of sacrality. What is needed is a larger body of evidence to support this hypothesis, to reconstructing a symbolic world existent several centuries ago, but of which only remnants persist.

**Resumen:** Existen vestigios del vínculo histórico entre las cícadas y el maíz teniendo en cuenta aspectos como su utilización, datos arqueológicos y otros aspectos. Mediante entrevistas, análisis etimológicos y fuentes históricas, en este trabajo se planteó una hipótesis de relación estrecha entre las cícadas y el maíz, que emerge al menos en el actual territorio de Hidalgo. Las cícadas en Hidalgo corresponden a ocho especies que reciben siete nombres comunes que aluden al maíz. Históricamente las cícadas han tenido usos como el alimenticio, el ritual, el de construcción, medicinal, venenoso. Varios de estos usos se han perdido en el último siglo, permaneciendo de forma más generalizada el uso ritual. El análisis permite proponer una cercanía cultural entre las cícadas y el maíz. Se aportan evidencias adicionales a lo sugerido inicialmente por M. Bonta. Se propone la hipótesis que el conjunto de las cícadas como entidad pudieron ser concebidas como una deidad con cierto grado de sacralidad. Se requiere de un mayor cuerpo de evidencias que soporte esta hipótesis, puesto que se busca reconstruir un mundo simbólico vigente hace varios siglos, donde parecen permanecer sólo vestigios complejos de interpretar.

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\* Speaker

**(12) Cycads, maize, and garfish: The representation of ethnoecological systems in Olmec iconography**

Michael D. Carrasco (Presented by Gabriel Espinosa\*)

**Abstract:** Interpretations of phytomorphic deities in the iconography of the Olmec and other Mesoamerican peoples have often turned to maize as a source for such imagery. While the Maize God is a clearly definable figure in Maya art, Olmec imagery is less specific and possibly draws from a number of taxa, a fact which complicates explanations that posit a direct correspondence between maize and specific deities. Ethnographic, archaeological, and art historical data suggest that Formative period (1200 ~ 400 BCE) Mesoamericans placed maize, cycads, garfish, caimans, and a variety of other things into similar conceptual categories. In art these analogies were expressed in the form of composite beings the most famous of which was the “child maize god.” In Teneek (Huastec Mayan) this deity is known as Thipaak a term cognate to the alligator god Cipatli of the Mexica. Janis Alcorn (1984) and Mark Bonta (2007, 2010; Bonta et al. 2006) have demonstrated that Thipaak and a range of other maize-related terms also refer to cycads. This paper brings these lines of information together with the corpus of Formative period iconography to suggest that cycads played a more prominent role in Olmec art and culture than has previously been thought.

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\* Speaker

**(13) Presence of *Zamia* in the extreme north of Sancti Spiritus, Cuba: Current spatial distribution and possible incorporation in aboriginal diets / La presencia de *Zamia* sp. en el extremo Norte de la Provincia de Sancti Spíritus, Cuba**

José Eusebio Chirino Camacho, Armando Falcón Méndez & Mark Bonta\*

**Abstract:** This presentation discusses populations of *Zamia* encountered by the authors in the study area. Yaguajay, in the extreme north of Sancti Spiritus province, Cuba, has a karstic geomorphology in the highlands northeast of Las Villas (crossing the region from east to west) in the Sierras of Jatibonico, Meneses and Cueto, of Matahambre and Bamburanao. Also included in the study area is the archipelago Cayos de Piedra, with 11 islands containing more than 90 caves. On the coastal plain, the same karst formation is found in the hills of Guayaruez and Judas. In this region, 120 archaeological sites are known, of which 85% were inhabited, representing all the groups that existed in the aboriginal history of Cuba in an area of 200 square kilometers. In the surrounding forest, *Zamia* populations are encountered. Even if they did not constitute an item in the everyday aboriginal diet, due to their slow rate of reproduction and uncommon status, zamias very likely constituted a food source. In our presentation, we demonstrate the present-day distribution of the plant and its geographical relationship to the sites.

**Resumen:** Se presenta un análisis a partir de la localización por parte de los autores de poblaciones de *Zamia* sp. en la zona objeto de estudio. Yaguajay, extremo Norte de la provincia de Sancti Spíritus Cuba, presenta una geomorfología en que resaltan las áreas cársicas de Las Alturas del Nordeste de Las Villas (que le atraviesa de Este a Oeste) y que se conforma por las Sierras de Jatibonico, Meneses y Cueto, de Matahambre y Bamburanao; también se encuentran Los Cayos de Piedra, grupo insular cercano a la costa con once islas que se describen en el trabajo (con más de noventa cuevas). En La Llanura Costera, se encuentran con la misma formación las lomas de Guayaruez y Judas. En estas locaciones y La Llanura, se encuentran ciento doce sitios arqueológicos, de los que más del 85% fueron habitacionales, representativos de todos los grupos que existieron en la Historia aborigen de Cuba, lo que singulariza la zona con unos 200 Km<sup>2</sup>. En los bosques se encuentran poblaciones de *Zamia* que si bien no debió constituir una dieta cotidiana por su lenta reproducción y no mayoritaria representación, debió constituir una fuente de alimento. La distribución actual de la planta y su relación geográfica con los sitios se muestra en nuestro trabajo.

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\* Speaker

**(14) Food use of *Ceratozamia fuscoviridis* during the Mexican Revolution and its change between generations in Tlanchinol**

Karina Piedra-Reynoso, María T. Pulido\* & Andrew P. Vovides

**Abstract:** *Ceratozamia fuscoviridis* Moore ex R.Osborne, D.W.Stev. & Vovides is widely used for traditional purposes. Some decades ago, they were an important food source that is not fully understood. By means of participatory techniques we studied the changes in uses and perceptions of this species in “Bienes Comunales de Tlanchinol”, working with 24 persons of different age groups. Our results suggest that in this region, cycads represented an important food source during the Mexican Revolution, because their seeds were mixed with corn to make tortillas. However, since 1960 cycads are not consumed; this change in uses and perception are related with governmental and economic drivers that changed the local economic activities. Currently young people do not know this plant and its historical importance, while the adult generation knows the plant but rarely consumes it for food; in contrast the older people know, managed and used this resource, although some persons become nostalgic when they remember that epoch. They claimed that populations of *C. fuscoviridis* were “ruined” during the Revolution, while currently they have recovered. Traditional ecological knowledge is significant.

**Resumen:** *Ceratozamia fuscoviridis* Moore ex R.Osborne, D.W.Stev. & Vovides es una especie críticamente amenazada que es ampliamente usada para fines tradicionales. Hace algunas décadas esta fue un importante recurso alimenticio. Por medio de técnicas participativas nosotros estudiamos cómo ha cambiado los usos y la percepción de esta especie en Bienes Comunales de Tlanchinol, trabajando con 24 personas de distintas generaciones. Nuestros resultados indican que en la región las cícadas representaron un alimento muy importante durante la Revolución Mexicana porque sus semillas se mezclaban con la masa de maíz para hacer tortillas. Desde 1960 las cícadas no son consumidas regularmente; este cambio en los usos y percepción se correlacionan con factores gubernamentales y económicos que cambiaron las actividades económicas de la gente. Actualmente la gente joven no conoce la planta ni su importancia histórica, mientras que los adultos la conocen pero pocos la comieron; en cambio la gente vieja manejaron y comieron este recurso, aunque algunos lloran al recordar esa época. Ellos mencionan que las poblaciones de *C. fuscoviridis* se “arruinaron” durante la Revolución y ahora se están recuperando. El conocimiento ecológico tradicional aún es notable.

\* Speaker

**(15) The importance of gender roles and direct oral transmission for cycad detoxification recipes**

Mark Bonta\*

**Abstract:** In almost all documented cases in the Americas, continuity of cycads as dietary staples over the last several millennia has depended almost solely on inter-generational, oral transmission of detoxification recipes between women. Probably due to its complexity and inherent risks, no case of detoxification being discovered without being taught has been recorded (though plenty of poisonings by the desperately hungry are documented in the literature), thus hinting at the great longevity of detoxification knowledge. The difficulty of discovering detoxification recipes by accident or trial and error suggests not only the cultural value that such recipes would have had, but also the reason why some cultures abandon cycad consumption altogether. The case of Hispaniola vs. Cuba is demonstrative: in the latter, no transmission of detox knowledge occurred between indigenous and African peoples in the 1500s before the former were wiped out; the opposite happened in Hispaniola, and the knowledge is retained to this day. The heritage preservation process is ongoing in Honduras, where cycad detox knowledge (*tiusinte*, *Dioon mejiae*) that was being rapidly lost is now being transmitted via demos at the Cycad Heritage Festival, videotaped, photographed, and written down.

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\* Speaker

## Plenary Talk 3

### (16) Phylogeography of the Caribbean *Zamia* clade: testing the “out-of-Cuba” hypothesis

Alan W. Meerow\*, Dayana E. Salas-Leiva, Javier Francisco-Ortega, M. Patrick Griffith, Michael Calonje, Dennis W. Stevenson, Kyoko Nakamura

**Abstract:** The *Zamia pumila* L. complex (Cycadales: Zamiaceae) is a monophyletic, diploid ( $2n = 16$ ) and distinctive assemblage of cycad populations restricted to the West Indies and southeastern U. S. that has been treated as comprising one to nine species. It appears to represent the first branch in the *Zamia* tree of life. Over the past four years, we have been simultaneously investigating patterns of microsatellite DNA and single copy nuclear gene sequence variation in the complex. In this paper we present the results of our analysis of ten single copy nuclear genes across the entire distribution of the clade, comprising 135 populations, and a total of 932 samples. Microsatellite genetic distance analyzed with principle coordinate analysis was used to select 10 samples from each population that represented the spectrum of genetic diversity in each. Alignments will be analyzed with the programs BEAST and EDENetworks, with *Microcycas* as outgroup. We hypothesize that Cuban populations have been the source of all populations elsewhere in the Caribbean, with perhaps as many as three radiations. We anticipate that a resolute picture of the phylogeographic history of the clade will result from the analyses that allows us to pinpoint the origins of the clade.

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## Session 3: Genetics / Systematics 1

### (17) Phylogeography clarifies infrageneric divergence in the genus *Dioon* (Zamiaceae): implications for taxonomy and conservation

José Said Gutiérrez-Ortega\*, Yoshiaki Tsuda, Andrew Vovides, Miguel Ángel Pérez-Farrera, Francisco Molina-Freaner, Tadashi Kajita

**Abstract:** The genus *Dioon* comprises 14 endangered species from Mexico and Central America. The distribution ranges of most of the *Dioon* species consist of few small populations, mainly scattered in mountains. This distribution pattern is attributed to demographic expansions/shrinks and short distance dispersal, but the resulting genealogical connections among populations/species are still unclear. Our aim is to reveal the phylogeographic patterns of the genus *Dioon*; in particular, to test whether the phylogeny of *Dioon* recognizes clades geographically structured, and to test whether the phylogeography reflects species delimitation. Three intergenetic regions of the chloroplast DNA were analyzed for 27 individuals, representing the whole distribution ranges for all the species. The maximum likelihood analyses suggested that clade composition of *Dioon* corresponds to a geographic structure in which two main clades and two subclades are recognized. Also, the variation of the trnL-F region for 115 individuals from 56 populations of all the 14 *Dioon* species reveals 32 haplotypes grouped on 17 haplogroups. Two shared haplotypes between species were commonly found. This study suggests that clade divergence of *Dioon* corresponded to geographic limitations correlated with the expansion of the Neotropical flora. Also, it points to a redefinition of conservation and taxonomic status of several populations.

**Resumen:** El género *Dioon* agrupa a 14 especies en peligro de extinción de México y Centroamérica. Los rangos de distribución de la mayoría de las especies de *Dioon* consisten en poblaciones pequeñas localmente restringidas en las montañas. Este patrón de distribución se atribuye a las expansiones/contracciones demográficas y dispersión a corta distancia, pero las conexiones genealógicas resultantes entre poblaciones/especies no están claras. Nuestro objetivo es revelar los patrones filogeográficos del género *Dioon*; en particular, evaluar si la filogenia de *Dioon* reconoce clados geográficamente estructurados, y evaluar si la filogeografía refleja delimitación de especies. Se analizaron tres regiones intergenéticas del ADN del cloroplasto de 27 individuos, representando los rangos de distribución de todas las especies. Los análisis de máxima similitud sugirieron que la composición de clados corresponde a una estructura geográfica donde se reconocen dos clados y dos subclados. Además, la variación de la región trnL-F en 115 individuos de 56 poblaciones de todas las especies reveló 32 haplotipos agrupados en 17 haplogrupos. Se encontraron comúnmente dos haplotipos compartidos. Este estudio sugiere que la divergencia de *Dioon* correspondió a limitaciones geográficas relacionadas con la expansión de la flora Neotropical. También, sugiere una redefinición de estatus taxonómicos y de conservación de muchas poblaciones.

\* Speaker

**(18) Did climate-driven shifts in habitat elevation lead to speciation in *Dioon*?**

Brian L. Dorsey\*, Tim Gregory, Chodon Sass, Chelsea Specht, Silvia Salas-Morales, Gonzalo Juárez García

**Abstract:** Recent studies indicate that extant cycad clades are roughly 12 my old. This suggests that rather than comprising ancient “living fossils” extant cycad diversity is the result of processes since the late Miocene. During this time frame climate fluctuations and a general cooling trend have changed habitats across the globe and likely played a role in the diversification of lineages, including cycads. We test this hypothesis in the genus *Dioon*, a group of ca. 14 species all but one of which are endemic to Mexico. Several *Dioon* species occur along the Sierra Madre Oriental or Sierra Madre Occidental but the greatest species diversity is south of the Transvolcanic Range. Most species are restricted to dry localities in a thin elevational band between major forest types. Climate change would have moved this habitat, separating populations by topology. If so, we would expect the timing of this to coincide with speciation events. We have brought together a number of emerging techniques, including RNAseq and targeted sequence capture, with high throughput sequencing to produce a robust phylogenetic dataset. From this data we estimated the species tree of *Dioon* and the timing of speciation as a first test of this climate fluctuation hypothesis.

**Resumen:** Estudios recientes indican que los clados existentes de cíadas tienen aproximadamente 12 millones de años. Esto sugiere que la diversidad de cíadas existente es el resultado de procesos desde el Mioceno tardío. Durante este tiempo, las fluctuaciones del clima y una tendencia general de enfriamiento han cambiado hábitats en todo el mundo. Ambas probablemente jugaron un papel en la diversificación de los filos, incluyendo las cíadas. Probamos esta hipótesis en el género *Dioon*, un grupo de aprox. 14 especies, de las cuales todas menos una son endémicas de México. La mayoría de las especies se encuentra al sur del Eje Volcánico Transversal y están restringidas a una estrecha franja de elevación que está situada entre los principales tipos de bosques. El hábitat se habría movido con el cambio climático y, a su vez, separaría las poblaciones por la topología. Si es así, esperamos encontrar que ese cambio climático coincide con eventos de especiación. Hemos reunido una serie de técnicas emergentes que incluyen “RNAseq” y captura de secuencias diana, para producir una base de datos filogenética robusta. Utilizamos estos datos para estimar la filogenia de *Dioon* y el momento de la especiación como una primera prueba de esta hipótesis fluctuación climática.

\* Speaker

### (19) Phylogenetic relationships and classification of *Cycas*

Nathalie S. Nagalingum\*, Lorena Endara, Hong Cui & J.Gordon Burleigh

**Abstract:** *Cycas* is the most diverse and widespread of all the cycad genera, and it is currently segregated into five sections (Asiorientales, Wadeanae, Indosinenses, Stangerioides, and Cycas), with an additional three subsections in section Cycas. This classification was erected using on a phylogeny that sampled about half of species diversity, and using a single DNA region and 30 morphological characters. In the 10 years since, there have been significant advances in the availability of molecular data, and even more recently, in our ability to generate morphological datasets. Here we test the classification using a phylogeny incorporating more species diversity, and with a greater number of molecular markers and morphological characters. While it is relatively straightforward to obtain additional markers from Genbank, the acquisition of morphological characters is time-consuming and laborious. We have developed a new method to extract morphological data (phenomic data) from species descriptions, ultimately converting this information into taxon/character matrices for phylogenetic analysis. Using this newly generated phylogeny we test the current classification, and also evaluate the morphological characters used to define the various sections.

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\* Speaker

**(20) Programa Integral de Conservación para las especies *Zamia incognita* y *Zamia encephalartoides*, en el departamento de Santander – Colombia.**

Alicia Rojas\*, Raquel Sofía Gómez-Parra, Jeffrey Vega Aguilar, Jhon Alexander Mantilla Carreño, Juan Diego Ramírez Román.

Resumen: Dentro de las especies del género *Zamia*, con distribución en el departamento de Santander, encontramos a *Zamia encephalartoides* y *Z. incognita*, la primera categorizada como VU en la Lista Roja de la IUCN y para la segunda los autores de la especie recomiendan una categorización de VU. Desde el Jardín Botánico Eloy Valenzuela – CDMB, se adelanta hace nueve años, el Programa integral de conservación para la *Z. encephalartoides* y desde hace un año, para la *Z. incognita*, para lo cual se han desarrollado diferentes estudios como; Descripción de la demografía, el hábitat y la variabilidad en rasgos funcionales de tres poblaciones de *Zamia incognita* en Bosques secos de Santander, Descripción demográfica del hábitat de una población de *Zamia encephalartoides* y comparación de rasgos funcionales en dos especies del genero *Zamia*: (*Z. encephalartoides* y *Z. incognita*) y Caracterización demográfica, rescate y reubicación de una población de *Zamia incognita*, en un bosque seco tropical de Santander (Colombia), adicionalmente se han desarrollado talleres comunitarios, se ha estandarizado el protocolo de germinación y propagación , se han construido dos viveros comunitarios en las áreas de influencia directa en las poblaciones registradas y uno en el Jardín Botánico Eloy Valenzuela , para la propagación y posterior reintroducción de las plantas, en su hábitat natural.

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\* Speaker

**(21) Morphological and genetic variation of *Zamia prasina* in the southern of Mexico and Belize**

Miguel A. Pérez Farrera\*, Andrew P. Vovides, Sergio Lopez Mendoza, Brenda Y. Velasco Martinez, Christian Ruiz Castillejos, Hector Gomez Dominguez

**Abstract:** The morphological and genetic variation of six populations *Zamia prasina* were evaluated in southern Mexico (Chiapas, Tabasco, Campeche, Yucatan and Quintana Roo) and Belize. The morphological variation of these populations was analyzed for 12 variables among 119 individuals for the six populations by means of principal component analysis (PCA) and discriminant analysis (DA). The genetic variation was analyzed from 120 leaflets taken from mature individuals using ten primers by the microsatellite method. The ANOVA indicated all variables were significant between populations. The PCA showed that the first two factors explained about 67.1% of variation; rachis length and inter leaflet distance, being the highest between populations. EL PCA and DA classified all populations into three groups: (Wilks' Lambda: 0.049; F (60,481) = 7.246; p < 0.000). The genetic analysis showed a significant genetic differentiation among populations AMOVA (Fst = 0.076, p < 0.001). The major variation was found within populations about 92%, and approximately 8% among populations. Low levels of genetic diversity within and among the populations were found. The average genetic differentiation among populations was also low (Fst = 0.083). The cluster analysis using genetic distance (Nei's) indicated three groups.

**Resumen:** La variación morfológica y genética de seis poblaciones *Zamia prasina* fueron evaluados en el sur de México (Chiapas, Tabasco, Campeche, Yucatán y Quintana Roo) y Belice. Se analizó la variación morfológica de estas poblaciones con 12 variables y 119 individuos por medio de análisis de componentes principales (PCA) y el análisis discriminante (DA). La variación genética se analizó con 120 foliolos tomadas de individuos maduros utilizando diez cebadores por el método de microsatélites. El ANOVA indicó que todas las variables fueron significativas entre poblaciones. El PCA mostró que los dos primeros factores explican aproximadamente el 67,1% de variación; largo del raquis y la distancia entre foliolos explicaron la mayor variación. EL PCA y DA clasifican todas las poblaciones en tres grupos: (Wilks 'Lambda: 0.049; F (60,481) = 7,246; p <0,000). El análisis genético mostró una diferenciación genética significativa entre las poblaciones AMOVA (Fst = 0,076, p <0,001). La mayor variación se encontró dentro de las poblaciones con 92%, y aproximadamente el 8% entre las poblaciones. Se encontraron bajos niveles de diversidad genética dentro y entre las poblaciones. La diferenciación genética entre las poblaciones promedio también fue baja (Fst = 0,083).

\* Speaker

**(22) Estimation of heritability and genetic correlations in morphological and physiological traits for a population of *Zamia obliqua***

Natalia Gomez-Lopera\* & Cristina Lopez-Gallego

**Abstract:** The response to natural selection of quantitative traits in a natural population depends on the magnitude of genetic variability and genetic correlations between traits, and these genetic parameters can differ between trait categories. In this study we characterized the patterns of phenotypic variance and covariance and estimated heritability and genetic correlation of morphological and physiological traits in a population of *Zamia obliqua*. We tested the hypothesis that variance and heritability values are higher for morphological than for physiological traits, and that phenotypic and genetic correlations are larger within than between trait categories. Phenotypic variance values were higher for physiological traits than for morphological characteristics. Heritability estimates suggested that morphological traits had a higher genetic variance than physiological traits. On the other hand, significant estimates of genetic correlations among traits were not obtained. Nevertheless, phenotypic correlations show a higher correlation within morphological traits than within physiological traits or among physiological and morphological traits. These kinds of estimates for genetic parameters can help generate hypotheses about the evolution of phenotypic traits in natural populations, and represent important contributions to the study of evolutionary ecology in non-model species and their populations in natural habitats.

**Resumen:** La respuesta a la selección natural en caracteres cuantitativos en una población natural depende de la magnitud de variabilidad genética y las correlaciones genéticas en los rasgos, y estos parámetros genéticos pueden diferir entre categorías de rasgos. En este estudio se caracterizaron los patrones de varianza y covarianza fenotípica y se realizaron estimaciones de heredabilidad y correlaciones genéticas de rasgos morfológicos y fisiológicos en una población de *Zamia obliqua*. Se probaron las hipótesis de que la varianza y la heredabilidad de rasgos morfológicos son mayores que las de rasgos fisiológicos, y que las correlaciones fenotípicas y genéticas son mayores dentro que entre las categorías de rasgos. Los valores de varianza fenotípica fueron mayores en los rasgos fisiológicos comparados con los caracteres morfológicos. Los estimativos de heredabilidad sugieren que los caracteres morfológicos presentan mayor varianza genética que los rasgos fisiológicos. Por otro lado, no se obtuvieron correlaciones genéticas significativas entre los rasgos. Sin embargo, las correlaciones fenotípicas muestran mayor correlación dentro de los caracteres morfológicos que dentro de los fisiológicos o entre rasgos morfológicos y fisiológicos. Estas estimaciones de parámetros genéticos permiten construir hipótesis sobre la evolución de caracteres fenotípicos en poblaciones naturales, y son aportes importantes al estudio de la ecología evolutiva de especies no modelo y sus poblaciones en hábitats naturales.

\* Speaker

**(23) Exploring new approaches for conservation genomics of *Cycas* L. (Cycadaceae) in Australia**

James Clugston\*, Gregory Kenicer, Richard Milne & Nathalie S. Nagalingum

**Abstract:** Many cycads exist as small populations, and so understanding the genetic variation in cycads is imperative for conserving the remaining populations and ensuring their survival. Genetic data play a fundamental role to help conserve multiple genotypes and also the populations with the greatest genetic diversity. Although, Australia represents a significant biodiversity hotspot for cycads, their genetic diversity has yet to be explored in detail. Next generation sequencing (NGS) and restriction associated DNA sequences (RADseq) produce thousands of small stretches of the genome, which can be used for population genotyping by identifying potentially thousands of polymorphisms. The application of RADseq has been successful in many non-model angiosperms for examining ancestral hybridisation, adaption and genomic differentiation in populations, as well as the role of natural species barriers. This research applies NGS technologies for conservation genetic research using RADseq for three species of *Cycas* in the Northern Territory, Australia. The NGS data will be used to: understand intraspecific and interspecific genetic variation in populations of species; identify putative hybrids; recognize populations of conservation priority; and determine if botanic garden collections successfully represent existing genetic diversity found in the wild.

\* Speaker

## Plenary Talk 4

### (24) A molecular phylogeny of *Zamia* L.: a multi-gene approach using single-copy nuclear genes

Michael Calonje\*, Alan Meerow, Patrick Griffith, Dayana Salas-Leiva, Javier Francisco-Ortega & Andrew Vovides

**Abstract:** The genus *Zamia*, with approximately 70 species, is the most morphologically and ecologically diverse genus in the Cycadales. We present the preliminary results of a multi-gene phylogenetic analysis of the genus *Zamia* including over 90% of the currently accepted species in the genus. Maximum parsimony, maximum likelihood, and a gene tree/species tree reconciliation analyses are presented. Major clades and novel phylogenetic relationships are discussed within the context of biogeography and comparative macromorphology. The genus *Zamia* appears to have originated in the Caribbean basin and dispersed through Central America into South America. Major clades are strongly congruent with geographic distribution, agreeing with the limited gene flow and dispersal ability of the Cycadales. In addition, convergent evolution of macromorphological characters appears to be common in the genus.

\* Speaker

## Session 3: Ecology / Interactions

### (25) Molecular and morphological analyses of cycad beetles: what they reveal about cycad evolution in the New World

William Tang\*, Guang Xu, Charles W. O'Brien, Michael Calonje, Alberto S. Taylor B., Andrew P. Vovides, Miguel Angel Pérez-Farrera, Silvia H. Salas-Morales, Julio C. Lazcano-Lara, Anders Lindström, Nico Franz, Paul Skelley & Cristina López-Gallego

**Abstract:** Two major lineages of beetles inhabit cycads in the New World: weevils (Curculionoidea) in the subtribe Allocorynina and beetles in the family Erotylidae including the genus *Pharaxonotha*. Analysis of the 16S rRNA mitochondrial gene as well as cladistic analysis of morphological characters of the weevils indicate ancient associations with New World cycads as well as recent radiations and exchange of pollinators between cycad genera. Analysis of the weevils indicate at least five major radiations on *Dioon* and *Zamia* and suggest *Dioon mejiae* is the oldest host lineage and that there has been a relatively recent host shift onto *Zamia*. Analysis of the erotylid beetles indicate that a lineage in *Ceratozamia* is the most basal and shows affinity with erotylid beetles on Asian *Cycas*, supporting fossil evidence of an Eurasian origin for *Ceratozamia*, and that there have been three recent and separate host shifts of beetles from *Zamia* onto *Dioon* and *Ceratozamia*. Analysis of beetles also support current models of continent drift in the Caribbean basin, support some proposed species groupings of cycads, but not others, and suggest that pollinator type may impact population genetic structure in their host cycads.

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\* Speaker

**(26) Geographically disjunct populations of *Macrozamia macleayi*: Do they differ in cone volatile chemistry, thermogenic patterns and Cycadothrips pollinator?**

Irene Terry\*, Dean Brookes, James Hereward, Gimme Walter & Robert Roemer

**Abstract:** *Macrozamia macleayi* is disjunctly distributed throughout southeastern Queensland, Australia, from Mt. Colosseum near Miriam Vale in the north to just southwest of Brisbane, a distance of over 400 km. Throughout this species' distribution, *Cycadothrips chadwicki* is the only pollinator. We examined the volatile chemistry and thermogenic patterns of pollen cones of three allopatric *M. macleayi* populations: two populations near the northern tip of the distribution, one from the Dawson Highway near Biloela and the other from Blackman's Gap Rd near Miriam Vale; and the third from the most southern population at Moggill Conservation Reserve southwest of Brisbane. We report on the differences we found in the cone traits as well as in the thrips' molecular genetics, CO1 mitochondrial gene, 28s nuclear gene and microsatellite data. Cones from all three populations have a similar day-time thermogenic event, but those from the two northern populations have distinctly different volatile profiles from the southern population. Likewise, distinct differences were found in the *Cycadothrips* between the northern and southern Qld *M. macleayi* populations. The implications of these patterns for understanding local adaptation and divergence among obligate mutualists are discussed.

\* Speaker

**(27) Examination of the relationships between respirometry, thermogenesis and volatiles in *Macrozamia macleayi* and *M. lucida* pollen cones during their thermogenic events.**

Robert Roemer\*, Irene Terry, David Booth, Chris Moore & Gimme Walter

**Abstract:** Excised cycad pollen cones exhibit a daily thermogenic event for up to two weeks, as do intact cones. We devised a respirometry chamber and system for concurrently measuring the respiratory oxygen uptake, CO<sub>2</sub> release, thermogenic temperature rise, relative humidity and chemical volatiles of these cones and examined the effects of different temperature regimens on these metabolic activities. We placed each excised cone into a sealed glass respirometry chamber. Instrument grade or filtered ambient air was supplied to and removed from the chamber via separate swage-lock attached tubing traversing through holes in a stainless steel lid. To capture cone volatiles, a subset of the exiting air was suctioned first through a water trap and then through a tube of chemical adsorbent and were later eluted and analyzed by gas chromatography. The remaining air went over a RH meter, and a second sub-sample of air went to oxygen and CO<sub>2</sub> analyzers. Ambient and cone temperatures were measured by thermocouples placed in four chamber locations and in four sporophylls, and recorded every minute. We report on the relative timing of cone metabolic activity, temperatures and volatile emissions during the thermogenic events under different temperature regimens and then explore the basic biophysics and metabolic activity of this system.

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\* Speaker

**(28) Cycad pollination drop composition**

Patrick von Aderkas\*, Natalie Prior, Stefan Little & Massimo Nepi

**Abstract:** We analyzed pollination drops of a number of Cycadophyta. Amino acid and sugar composition of *Zamia furfuracea* was measured using high pressure liquid chromatography. Protein composition of *Ceratozamia hildae*, *Cycas rumphii*, and *Zamia furfuracea* was assessed using tandem mass spectrometry. The drops were compared with compositional analysis of the other three extant clades of gymnosperms, Gingkophyta (*Ginkgo biloba*), and Coniferophyta (10 species) Gnetophyta (7 species of *Ephedra*, male and female plants of *Gnetum gnemon*; male and female plants of *Welwitschia mirabilis*). Insect-pollinated species such as cycads and gnetophytes differed from wind-pollinated species with entomophilous species having a lower total amino acid proportion, but with a higher non-protein amino acid proportion, particularly the percentage of  $\beta$ -alanine compared to that of anemophilous taxa. Gymnosperms that develop a deep pollen chamber as the nucellus degrades, e.g., cycads, *Ginkgo*, *Ephedra*, generally contained higher proportions of proteins localized to intracellular spaces. These proteins represent the pollination drop degradome. Gymnosperms that either lack a pollen chamber, e.g. *Taxus*, or have a shallow pollen chamber, e.g. *Gnetum*, had greater proportions of secreted extracellular proteins in their profiles.

\* Speaker

**(29) Plant-insect communication and specificity of *Zamia* pollination**

Shayla Salzman\*

**Abstract:** It is becoming increasingly evident that pollinator interactions are important for driving and maintaining plant diversity. The recent diversification of cycad lineages coupled with increasing knowledge of insect pollination suggests that investigating plant-pollinator interactions is vital for understanding cycad diversification. *Zamia* pollination by *Rhopalotria* weevils appears to be species-specific. The specialization of *Rhopalotria* pollinators may be due to attraction to host plant volatile profile. If this is so, and both plant and insect lineages have undergone change in response to the other, we have a classic case of co-diversification. This hypothesis is approached in two ways. First volatile profiles of Caribbean *Zamia* were gathered with headspace collection methods and analyzed with gas chromatography mass spectrometry. Second, using electroantenograms, weevil antennal response to host plant volatiles were tested in two species pairs; *Rhopalotria slossoni* on *Zamia integrifolia* and *R. mollis* on *Z. furfuracea*. Caribbean *Zamia* species produce an array of distinct volatile profiles. The volatile component that each weevil responds to was positively identified and were found to be unique to each host plant. These combined results show phenotypic specialization of both the plants and their pollinators and lays important ground work for further study of the co-diversification of this group.

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\* Speaker

**(30) Pollination in *Zamia incognita* A.Lindstr. & Idárraga (Cycadales: Zamiaceae) in a natural population from Alicante River Canyon, Maceo, Antioquia**

Wendy A. Valencia-Montoya\*, Dino J. Tuberquia Muñoz & Juliana Cardona-Duque

**Abstract:** The genus *Zamia* (Zamiaceae: Cycadales) reaches its greatest diversity in Colombia and its species are highly threatened by different factors. One of the most relevant and frequently ignored aspects for establishing conservation programs is its highly specialized pollination process. Despite the importance of pollination for the *Zamia* populations' viability, there are no studies about the pollination process for these cycads in Colombia. Herein we describe the pollination process of *Zamia incognita* A.Lindstr. & Idárraga, in a population from the Magdalena Medio valley in Colombia. We found *Pharaxonotha* beetles in the male cones where they complete all phases of their life-cycle; beetles are attracted to the cones by an increment in the cone temperature. Heat production generally follows a circadian pattern, and its magnitude and extent are positively correlated with the elongation of the cones and the pollen shedding. We confirmed that *Pharaxonotha* sp. is the effective pollinator by following marked beetles with fluorescent dyes. We suggest that the cones may have volatiles that could be acting as an attractant and that the pollination droplets may serve as reward for the pollinators. We also discuss the relationships with other insects like butterflies, ants, flies and bees.

**Resumen:** El género *Zamia* (Zamiaceae: Cycadales) alcanza su mayor diversidad en Colombia y sus especies están altamente amenazadas por diferentes factores. Uno de los aspectos más relevantes y frecuentemente ignorados para el establecimiento de programas de conservación es la polinización altamente especializada. A pesar de la importancia de la polinización para la viabilidad de las poblaciones de *Zamia* no hay estudios sobre el proceso de polinización para estas cícadas en Colombia. En el presente trabajo, describimos el proceso de polinización de *Zamia incognita* Lindström & Idárraga, en una población del Valle del Magdalena Medio en Colombia. Encontramos escarabajos del género *Pharaxonotha* en los conos masculinos donde ellos completan todas las fases de su ciclo de vida; los escarabajos son atraídos por un incremento en la temperatura del cono. La producción de calor generalmente sigue un patrón circadiano y su magnitud y duración está positivamente correlacionada con la elongación de los conos y la liberación del polen. Confirmamos que *Pharaxonotha* es el polinizador efectivo siguiendo escarabajos marcados con tintes fluorescentes. Sugerimos que los conos pueden tener volátiles como atractantes y la gota micropilar podría ser la recompensa para los polinizadores. También discutimos las relaciones con otros insectos como mariposas, hormigas y abejas.

\* Speaker

**(31) New support for the broodsite visitation hypothesis of female cones from *Encephalartos manikensis* (Zamiaceae) and allies**

Philip Rousseau\*, Piet J. Vorster, O.J. Baptista, I. Waters & A.E. van Wyk

**Abstract:** Since the pioneering work on *Zamia furfuracea*, all cycad genera have either been definitively shown, or inferred from circumstantial evidence, to be insect-pollinated. Members of the Coleoptera (beetles) are the main pollinators in all cases, except for *Cycas* species which may be partly wind-pollinated, *Cycas micronesica* which is putatively moth-pollinated, and some *Macrozamia* species which are wholly or partly thrip-pollinated. Information on pollinator ecology is only available in very few cases. Within *Encephalartos* (67 infrageneric taxa) only four have been definitively shown to be beetle-pollinated, though members of known pollinator genera have been collected from most other southern African taxa. Outside of South Africa very little is known of the pollination of the group. Information on the ecology of pollinators is only known for *E. villosus*. Pollinators are known to complete their life cycles in male cones, feeding on sporophyll tissue and/or pollen. Hypotheses for visitation to female cones vary from duping/mimicry, broodsite, resources, and refuge. Currently data seems to favour the rewardless mimicry hypothesis. Here we present field observations on pollinator ecology from a previously uninvestigated phylogenetic group within *Encephalartos*, the *E. manikensis* complex from Zimbabwe and Mozambique, that supports the broodsite hypothesis.

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\* Speaker

**(32) Does wind play a role in the pollination of *Cycas micronesica*?**

Irene Terry\*, Trent Hamada, Claudia Calonje, Robert Roemer & Thomas Marler

**Abstract:** *Cycas micronesica* is an endangered species native to the Pacific islands of the Mariana islands, Guam and Rota, and of the Caroline Islands, Palau and Yap. This species is a member of *Cycas* section Cycas and subsection Rumphiae species complex distinguished by having floating seeds that disperse to new locations by water. Because Guam is located in the northern trade wind zone, and this cycad grows in habitats that vary in their exposure to winds, we conducted different experiments to examine the potential role of wind in the pollination of this species. Some ovules of the outer whorl of megasporophylls are exposed to air as the ovules receptive, and more become exposed at later receptive stages. We found dramatic differences in pollen drift associated with wind directional strength and velocity across different cycad habitats. At Montgomery Botanical Center (MBC), Miami, Florida, many *C. micronesica* plants that were started from seed in 2007 are now reproductive. Because MBC is also situated within trade wind zone with winds commonly from the east to northeast, and the native insect pollinators from Guam are not present at this site, we examined open pollinated plants for pollination. We found that open pollinated plants do produce viable seed but the percentage of ovules pollinated is lower than in hand pollinated plants. The results strongly suggest that wind is a pollen vector in some locations; however, this is not true across all habitats on Guam indicating the presence of ambophily.

\* Speaker

**(33) *Eumaeus godartii* butterfly: Pest friend or foe?**

Alberto S. Taylor B.\*

**Abstract:** *Eumaeus godartii* butterfly larvae, similar to those of the coontie atala butterfly, have been observed in almost all *Zamia* populations in the Isthmus of Panama to date on 11 of the 17 described species for Panama. Small plants and young cones have been completely destroyed, but larger plants and older cones have withstood the attacks of the larvae. A recent study of the butterfly, from eggs to adults took 6 weeks. However, most of the time, the eggs are parasitized by an unknown predator. There is some evidence of very little or no harnessing of plant toxins by young larvae or some toxin tolerance by birds or insects predators. This could explain the low incidence of attacks of plants in the wild, most of which are sporadic. Larvae are easy to remove mechanically from plant parts.. In some instances, as has been witnessed before, the damage to mature cone, simply free maturing seeds before natural cone disarticulation and these germinate prematurely, making possible an increase in population size.

**Resumen:** Las larvas de la mariposa *Eumaeus godartii*, similares a las de la mariposa atala de coontie, han sido observadas en casi todas las poblaciones de *Zamia* del Istmo de Panamá hasta la fecha sobre 11 de las 17 especies descritas de Panamá. Las plantas pequeñas y conos jóvenes han sido completamente destruidos, pero plantas más viejas y conos más maduros han soportado los ataques de las larvas. Un estudio reciente de la mariposa, desde huevos a adultos tomó 6 semanas. Sin embargo, en la mayoría de las veces los huevos son parasitados por un depredador desconocido. Hay alguna evidencia de poca o ninguna absorción de toxinas de la planta por larvas jóvenes o alguna tolerancia a las toxinas por aves e insectos depredadores. Esto podría explicar la baja incidencia de ataques, también esporádicos, de plantas en poblaciones naturales. Es fácil de eliminar las larvas mecánicamente de partes de las plantas. En algunos casos, como se ha visto antes, el daño a los conos maduros, sencillamente libera las semillas en maduración antes de la desarticulación natural del cono y éstas germinan en forma prematura, dando la posibilidad de un aumento poblacional.

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\* Speaker

## Plenary Talk 5

### (34) Fieldwork on *Encephalartos* (Zamiaceae) in Mozambique

Philip Rousseau\*, Piet J. Vorster, Abilio V. Afonso, Obety J. Baptista, Ian R. Waters & Abraham E. van Wyk

**Abstract:** Mozambique has seen much political strife leading to its independence (1964) and the subsequent civil war (~1992). Much of the country remains remote due to a lack of infrastructure, the language barrier for English speakers, and periodic civil unrest. The amount of indigenous cycad species remains speculative, and is currently accepted as three endemic (*E. mitchii*, *E. pterogonus*, *E. turneri*) and seven indigenous species (*Cycas thouarsii*, *E. chimanimaniensis*, *E. ferox*, *E. gratus*, *E. lebomboensis*, *E. manikensis*, *E. umbeluziensis*). Reports of other taxa at both the southern and northern extremes are rife. Population sizes estimates are significantly dissimilar between workers with Red List statuses in some cases based on anecdotal claims. Here we present firsthand accounts on the state of several cycad populations. Additionally we focus on two species complexes: *E. ferox*, and *E. manikensis* and allies. In the first case we assess the stability of some character states and explore the distribution limits, culminating in the introduction of a new subspecies: *E. ferox* subsp. *emersus*. In the latter case we assess the specific validity of allied taxa and the taxonomic status of other populations, providing preliminary conclusions. The presentation also gives a practical look at explorative cycad work in Africa.

\* Speaker

## Session 4: Genetics / Systematics 2

### (35) Rediscovering redback-a *Ceratozamia* lost and found

Jeff Chemnick\*

**Abstract:** *Ceratozamia* “Redback” has been known for years in cultivation though its origin in Mexico had never been established until a recent field trip finally found this enigmatic cycad. Details of its morphology, and ex situ distribution will be presented as well as the story of the search and ultimately successful rediscovery of this taxon which is now under formal investigation as a new species. *Ceratozamia* “Redback” is most significant perhaps because it represents a missing link in the distribution of the genus in Mexico.

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\* Speaker

**(36) Conservation strategy for *Zamia incognita* A.Lindstr. & Idárraga in the Magdalena Medio region, Colombia**

Arturo Aristizábal, Dino Tuberquia, María José Sanín, Wendy A. Valencia-Montoya & Juliana Cardona-Duque

**Abstract:** *Zamia incognita* is distributed within the Magdalena Medio region, in the Antioquia and Santander departments, Colombia. Since 2009 various activities like research, exploration and cultivation have been executed with the aim of obtaining the greatest amount of possible information, in order to elaborate an effective conservation strategy for this species. To date, a total of six populations in the Magdalena Medio have been reported and georeferenced, herbarium specimens have been collected, live material has been taken for horticultural purposes and its visitor and possible pollinators have been recorded. The greatest density was reported for the Maceo population, from census of a permanent monitoring parcel. In addition, two research projects that are being executed, are seeking to document the reproductive biology and to characterize the genetic diversity of the known populations.

**Resumen:** *Zamia incognita* se distribuye en la región del Magdalena Medio en Colombia, en los departamentos de Antioquia y Santander. Desde 2009 se han realizado diversas actividades como exploración, investigación, y cultivo, con el fin de recopilar la mayor cantidad de información posible, para elaborar una estrategia de conservación efectiva de esta especie. A la fecha, se han reportado y georeferenciado poblaciones naturales, colectado especímenes de herbario, se ha obtenido material vivo para propósitos horticulturales y se han documentado sus visitantes y posibles polinizadores, en seis localidades de la región del Magdalena Medio. La mayor densidad poblacional se registró en el municipio de Maceo, a partir de un censo en una parcela permanente de monitoreo. Además, dos investigaciones en ejecución, pretenden documentar la biología reproductiva y caracterizar la diversidad genética de las poblaciones conocidas. Se han identificado diversas amenazas para esta especie en la zona de estudio, donde destacan como las más importantes, la alteración y destrucción del hábitat por expansión de la frontera agropecuaria y otras actividades como la minería para extracción de material calcáreo. Esta última constituye una amenaza especialmente importante para las poblaciones de Maceo, consideradas las más importantes a conservar. Sin embargo, ya se tiene conocimiento relativamente amplio sobre el manejo horticultural de *Z. incognita*, que junto a la información obtenida sobre historia natural, esperamos contribuyan a su conservación ex situ e in situ.

\* Speaker

**(37) *Cycas pectinata* complex of northeast India and southeast Asia**

J.S. Khuraijam\* & Rita Singh

**Abstract:** The *Cycas pectinata* complex is a taxonomically confused entity distributed naturally in North East India, Bhutan, Bangladesh, Nepal, South West China, Myanmar, Thailand and Vietnam. A detailed morphometric analysis of taxonomically distinct vegetative and reproductive structures of *Cycas pectinata* from several populations of Sikkim, Assam, West Bengal and Manipur in North East India revealed a marginal intra-populational difference but among the populations in these states are quite distinct and supports their separation into at least three species. A comparison based on the previously published data on the vegetative and morphological characters of *Cycas pectinata* from China, Thailand and Vietnam further suggests that the Indian populations are morphologically distinct from South East Asian populations. The similarity between *Cycas pectinata* of these Southeast Asian countries suggest the common ancestry and Indian populations which appear to be three distinct species have evolved through allopatric speciation, however, this ancestral theory can only be established through a collaborative comprehensive morphological and molecular *C. pectinata* populations in South and South East Asian countries.

\* Speaker

**(38) Cycads from Lao PDR**

Hiep Tien Nguyen\*, Khang Sinh Nguyen & Leonid V. Averyanov

**Abstract:** Distribution data for only two species (*C. siamensis* and *C. simplicipinna*) was recorded from Laos in previous publications (Nguyen et Vidal 1996, Newman et al. 2007, Thomas et al. 2007). The present review includes keys for identification and summary data on the nomenclature, morphology, ecology and distribution for all 9 species of cycads hitherto recorded in the flora of Laos. One species, *Cycas laotica* Aver., T.H.Nguyễn & S. K. Nguyen is described as new species for science. Eight species as *Cycas dolichophylla* K.D.Hill, T.H.Nguyễn & P.K.Lôc, *C. inermis* Lour., *C. macrocarpa* Griff., *C. micholitzii* Dyer, *C. nongnoochiae* K.D.Hill, *C. petraea* A.Lindstr. & K.D.Hill, *C. simplicipinna* (Smitinand) K.D.Hill and *C. siamensis* Miq. are found in Laos and represent new records for the flora of the country. Important additions to previous data were obtained in the course of two field trips during 2009– 2013 when we studied 10 local floras within 8 provinces of country (Borikhamxai , Attapeu, Se Kong, Champasak, Saravan , Khammoun, Vientiane and Louang Prabang). In this work, 14 new localities for 9 Cycads were discovered. Maps of the distribution and illustrations for the newly discovered cycad species are provided. All observations, records and discoveries are based on reliable scientific literature and collected voucher herbarium specimens housed in main regional herbaria.

\* Speaker

**(39) Morphometrics in *Encephalartos* (Zamiaceae)**

Philip Rousseau\*, Piet J. Vorster & A.E. van Wyk

**Abstract:** Although morphologically well known, the African endemic genus *Encephalartos* (Zamiaceae) is still difficult to identify to species level, especially when geographic data is discounted. Moreover, much of the morphological variation known within the genus stems from cultivated specimens, which limits the interpretation in terms of prevalence and stability of character states. Additionally many diagnostic characters based on reproductive structures, the latter which are infrequently present as the genus has slow growth rates, long juvenile periods and are known to mast with intermittent periods up to decades long. In our continued studies into the systematics of the genus, we present results based on in situ (except where impossible) observations. Data are from more than 60 vegetative and 40 reproductive characters, including quantitative and qualitative measurements, of 180 specimens representing 16 taxa. This encompasses both phylogenetically distant and sister taxa. We used principal component analysis to determine: stability of characters within and between populations of the same species, usefulness of characters for distinguishing among species, various ratio's and interactions between traits, how distances between taxa could be interpreted in terms of ranking, and how these results compare phylogenetically with other sources of taxonomic evidence.

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\* Speaker

**(40) Integrative taxonomy of *Ceratozamia miqueliana* H.Wendl. (Zamiaceae) and related species**

Lilí Martínez-Domínguez\*, Fernando Nicolalde-Morejón, Francisco Vergara-Silva & Dennis W. Stevenson

**Abstract:** Species circumscription in an integrative taxonomy (IT) setting implies the analytical incorporation of multiple sources of evidence directed towards robust taxonomic-nomenclatural decision-making. We use a combination of geographic and morphological qualitative and quantitative sources of evidence as criteria for species delimitation in the *Ceratozamia miqueliana* (Zamiaceae) species complex utilizing the ‘taxonomic circle’ operational procedure. Our results indicate that none of the species analyzed can be distinguished in morphometric terms. However, morphological data (mainly qualitative-) and molecular sequences (character-based ‘DNA barcoding’ diagnostics) provide support for the following taxa: (1) *C. subroseophylla*, a new *Ceratozamia* species herein described from the montane Los Tuxtlas region (Veracruz, Mexico) and sympatric with the morphologically divergent *C. miqueliana*; (2) *C. euryphyllidia*, which is diagnosable both in terms of morphology and molecules; (3) a scenario of potential cryptic species for *C. zoquorum* and *C. santillanii* given their molecular diagnosability but morphological similarity; and (4) the proposed synonymy of *C. becerrae*, due to complete lack of diagnostic characters for the entire set of evaluated morphological and molecular data.

**Resumen:** La circunscripción de especies enmarcada en la taxonomía integrativa requiere la incorporación analítica de múltiples fuentes de evidencia para la toma de decisiones taxonómico-nomenclaturales, permitiendo obtener estimaciones robustas de los límites entre especies. Aquí, usamos una combinación de criterios geográficos, morfológicos –cuantitativos y cualitativos– y moleculares (DNA-Barcoding) acorde a los postulados del marco-teórico organizador del círculo taxonómico –“break out”– para analizar el complejo de especies *Ceratozamia miqueliana*. Los resultados indican que la afinidad morfométrica entre las especies analizadas no permite su identificación; sin embargo, los patrones de variación morfológica –principalmente cualitativos– y molecular, revelan interesantes patrones que plantean la existencia de: (1) una especie nueva, *C. subroseophylla*, la cual se describe e ilustra desde la región montañosa de Los Tuxtlas en el estado de Veracruz, misma que es simpátrica con *C. miqueliana*, donde particularmente *C. miqueliana* no posee sitios diagnósticos moleculares pero morfológicamente está bien diferenciada, (2) *C. euryphyllidia* diferente tanto a nivel morfológico como molecular, (3) un escenario potencial de especies crípticas debido a que *C. zoquorum* y *C. santillanii* son diagnosticables molecularmente pero morfológicamente indistinguibles y (4) la sinonimia de *C. becerrae*, debido a que esta especie no es diagnosticable mediante las fuentes de evidencia evaluadas.

\* Speaker

**(41) The meaning of artificial hybridization in cycad phylogenetic studies: The case for populations of *Zamia cunaria* and *Zamia ipetiensis***

Alberto S. Taylor B.\* & Michael Calonje

**Abstract:** Interspecific crosses of species or genera can, in many cases, help in the análisis of relationship between species or groups. With this in mind, and because various cladistic analisies based on the sequencing of the ITS2 gene of the nuclear ribosomal DNA with or without combination with morphological data sets, caryological analysis, an ANOVA of various populations adscribed to the species in question, have all left doubts on relationship between *Zamia cunaria* and *Z. ipetiensis*, we have made interspecific reciprocal crosses of plants obtained from two natural populations. Two plants of *Z.cunaria* as pollen and ovulate parent respectively and three plants of *Z. ipetiensis*, one as pollen parent and two as ovulate parent respectively. Only two seeds, of the few formed, germinated from a mother plant of *Z. ipetiensis* crossed with pollen from a *Z. cunaria* plant. Preliminary results point toward genetic isolation of the two species, in spite of their great morphological similarity and, because of this, we consider that they should still be considered separate species , unless we obtain different future evidence on this matter.

**Resumen:** Los cruces interespecíficos de especies o géneros pueden, en muchos casos, ayudar en la elucidación de parentesco entre especies o grupos. Con eso en mente y porque varios análisis cladísticos basados en la secuencia del gen del ADN ribosomal nuclear ITS2 con o sin combinación con conjuntos de datos, análisis de cariología, un ANOVA de varias poblaciones han dejado muchas incertidumbres sobre el parentesco entre *Zamia cunaria* y *Z. ipetiensis* hemos realizado cruces interespecíficos recíprocos en plantas obtenidas de dos poblaciones naturales. Dos plantas de *Z. cunaria* respectivamente como padre polínico y madre ovulada y tres de *Z. ipetiensis*, dos como madres ovuladas y una como padre polínico. De las pocas semillas formadas, solo hubo germinación de dos de la planta madre de *Z. ipetiensis* cruzada con polen de una planta de *Z. cunaria*. Los resultados preliminares señalan hacia un aislamiento genético de las dos especies, a pesar de su gran similitud genética y, por ello, estimamos que se deben considerar todavía como especies diferentes a menos que haya más evidencia futura sobre el particular.

\* Speaker

## Plenary Talk 6

### (42) Anatomy in Zamiaceae: Old techniques solving new problems / Anatomía en Zamiaceae: Técnicas tradicionales resolviendo nuevos problemas

Andrew P. Vovides\*, Miguel Angel Pérez-Farrera, José S. Gutiérrez Ortega, Dennis W. Stevenson, Dolores González, Sergio Avendaño, María Ydelia Sánchez-Tinoco & Sonia Galicia

**Abstract:** Species delimitation in cycads has largely been dependent on macro-morphological characters such as shape and size of various organs such as leaves, leaflets, stems, cones, color and indumentum. However many of these characters are lost during the voucherizing process. The use of documented living material held in botanic gardens is of great usefulness since phenotypic plasticity can be investigated over long periods of time enabling the comparison of field collected and cultivated material. Studies on leaflet anatomy and epidermis have shown that micro-morphological characters are generally stable and interpretations have potential for complementing molecular work. In this study the micromorphology of leaflets and epidermis of some species of *Ceratozamia*, *Dioon* and *Zamia* is explored from contrasting ecological conditions to determine taxonomically useful characters as well as comparing these structures from a habitat/ecological viewpoint.

**Resumen:** La delimitación de las especies de cíadas depende mayormente sobre caracteres macro morfológicos tales como forma y tamaño de varios órganos como hojas, foliolos, tallos, estróbilos, color e indumenta. Sin embargo muchos de estos caracteres se pierden durante el proceso de herborización. El uso de material vivo, documentado en los jardines botánicos es de gran utilidad dado que se puede investigar plasticidad a lo largo del tiempo permitiendo la comparación de material colectado del campo con lo cultivado. Estudios sobre anatomía de foliolos y epidermis han mostrado que los caracteres micromorfológicos son generalmente estables y las interpretaciones tienen potencial en complementar los trabajos moleculares. En este estudio se explora la micromorfología de foliolos y epidermis de algunas especies de los géneros *Ceratozamia*, *Dioon* y *Zamia* de condiciones ecológicas contrastantes con el objetivo de distinguir caracteres útiles para la taxonomía del grupo así como comparar estas estructuras desde los puntos de vista ecológico y de plasticidad.

\* Speaker

## Session 5: Anatomy / Morphology / Physiology

### (43) Leaflet anatomy of plicate leaved South American zamias with emphasis on *Zamia roezlii* and *Zamia wallisii* (Zamiaceae)

Rafael Acuña-Castillo & Walter Marín-Méndez\*

**Abstract:** The genus *Zamia* is morphologically and ecologically the most diverse of the Cycadales especially in Southern Central America and Northwestern South America where the genus is most speciose. As with the remaining Cycadales, the genus *Zamia* shows several unusual anatomical traits in the leaflets. The objective of this research was to describe the leaflet anatomy of *Zamia roezlii* and *Z. wallisii*, native to northwestern South America, and establish possible relationships between the anatomical traits and their habitats. The studied species showed traits like the thick epidermal cuticle, sunken stomata and hypostomatic leaf blades that are usually considered adaptations for xeric environments and that could be remnants from an ancestor adapted to that environment. Some other adaptations in common with other *Zamia* species include the large air chambers formed by parenchyma, that could increase the rate of gas exchange with the atmosphere, and the plicate texture of the leaflets that could allow the plants to eliminate the excess of rainwater from the adaxial surfaces of their leaflets, typical of the very wet habitats where the species are native. On the other hand the presence of fiber clusters just at the vein areas could account for the longevity.

**Resumen:** El género *Zamia* es morfológica y ecológicamente el más diverso de los Cycadales, especialmente en la parte sur de América Central y Nor-occidente de América del Sur donde el género presenta más especies. Al igual que el resto de Cycadales, el género *Zamia* muestra varias características anatómicas inusuales en los foliolos. El objetivo de esta investigación fue la de describir la anatomía de los foliolos de *Zamia roezlii* y *Z. wallisii*, especies nativas del Nor-occidente de América del Sur, y establecer posibles relaciones entre las características anatómicas y sus hábitats. Las especies estudiadas mostraron características como una gruesa cutícula epidérmica, estomas hundidos y láminas foliares hipoestomáticas que usualmente se consideran adaptaciones a ambientes xéricos y que podrían ser remanentes de un ancestro adaptado a ese ambiente. Otras adaptaciones comunes con otras especies de *Zamia* incluyen grandes cámaras aéreas formadas por parénquima, que podría aumentar la tasa de intercambio gaseoso con la atmósfera, y la textura plicada que podría permitir a las plantas eliminar el exceso de agua de lluvia de las superficies adaxiales de los foliolos, típico de los hábitats muy húmedos donde estas especies son nativas. Por otra parte la presencia de agrupamientos de fibras justo en las áreas de las venas podría explicar la longevidad de las hojas de *Zamia*.

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\* Speaker

**(44) Optical properties, photosynthetic pigments content and anatomical features during leaf development in the seedling of the endangered cycad *Dioon edule* Lindl. (Zamiaceae)**

Laura Yáñez-Espinosa\*, Javier González, Joel Flores, R. Isaac Muñoz-Álvarez & Aurora R. Almanza-Piña

**Abstract:** *Dioon edule* seedlings characteristically have a single leaf that change in texture and color during development, from soft and flexible pale red-brown when emerging to coriaceous and rigid dull green when mature, and soft yellow when senescent. The anatomical characters, photosynthetic pigments content and optical properties of the leaf were assessed to determine the sequence of changes during its development. One year old seedlings ( $n=20$ ) grown in a glasshouse were used. They were classified at five developmental consecutive leaf stages along one year. Leaflet anatomical characters: cuticle, epidermis, hypodermis and blade thickness (light microscopy) and epicuticular wax (scanning electron microscopy) were evaluated. Photosynthetic pigments: chlorophyll a, chlorophyll b, total chlorophyll and carotenoids were extracted and quantified. Optical properties absorbance and reflectance were measured in intact leaf (reflection probe). Leaflet develops anatomical traits along development related to physical irradiation screen (cuticle) and promoting blue light absorption (hypodermis). The pigments content increased along maturation and declined to senescence, similar to other shade tolerant cycads. Gradual development of photosynthetic pigments corresponds to slow leaf development characteristic of evergreen species. *Dioon edule* is a shade tolerant species similar to other cycads and presents leaf xeromorphism and photosynthetic shade features simultaneously.

**Resumen:** Las plántulas de *Dioon edule* característicamente tiene una sola hoja que cambia de textura y color durante su desarrollo: de suave y flexible rojo-marrón pálido cuando emerge a coriácea y rígida verde mate cuando madura, y suave-amarilla cuando senescente . Los caracteres anatómicos, contenido de pigmentos fotosintéticos y propiedades ópticas de la hoja se evaluaron para determinar la secuencia de cambios durante su desarrollo. Se utilizaron plántulas de un año ( $n = 20$ ) cultivadas en un invernadero. Se clasificaron en cinco etapas de desarrollo de hojas consecutivas a lo largo de un año. Los caracteres anatómicos del foliolo: cutícula, epidermis, hipodermis y espesor de la hoja (microscopio de luz) y cera epicuticular (microscopía electrónica de barrido) se evaluaron. Los pigmentos fotosintéticos: clorofila a, clorofila b, clorofila y carotenoides totales fueron extraídos y cuantificados, las propiedades ópticas absorbancia y reflectancia se midieron en hoja intacta (sonda de reflexión). Se forman a lo largo del desarrollo rasgos anatómicos relacionadas con un filtro físico a radiación (cutícula) y promueve la absorción de luz azul (hipodermis). El contenido de pigmentos se incrementó durante la maduración y disminuyó en la senescencia. *Dioon edule* es una especie tolerante a la sombra en etapas iniciales de crecimiento.

\* Speaker

**(45) Leaf production rates in *Ceratozamia fuscoviridis* in Molango, Mexico**

Silvia Y. Vargas-Roldán, María T. Pulido\*, Andrew P. Vovides & Miguel A. Pérez-Farrera

**Abstract:** *Ceratozamia fuscoviridis* Moore ex R.Osborne, D.W.Stev. & Vovides is a critically endangered species, with only one known population endemic to the Molango region; their leaves are widely used currently for traditional purposes. Leaves of this species and many cycads are commonly used throughout the world, therefore the understanding of their foliar dynamics is relevant. Leaf production rate (LPR) as well as leaf abscission (LA) were quantified in 142 individuals (seedlings to adults) over 1.5 years. LPR was 0.57 leaves/individual/year, while LA was 0.98 leaves/individual/year through the study period. A quarter of individuals do not produce leaves. LPR was higher during the dry season, and was highly variable between semesters. LPR is significantly correlated with stem width, the number of initial dead leaves and their interaction. We highlight the importance of these studies over longer periods as well as future studies of experimental defoliation, aimed at achieving a better management of the species.

**Resumen:** *Ceratozamia fuscoviridis* Moore ex R.Osborne, D.W.Stev. & Vovides es una especie críticamente amenazada, con una única población conocida en la región de Molango; sus hojas se emplean ampliamente para propósitos tradicionales. Las hojas de esta y otras cícadas son usadas en varias partes del mundo, por lo que es importante entender su dinámica foliar. La tasa de producción de hojas (LPR), así como su abscisión (LA) fue cuantificada en 142 individuos (plántulas a adultos) durante 1.5 años. LPR fue 0.57 hojas/individuos/año, mientras que LA fue de 0.98 hojas/individuo/año durante el tiempo de estudio. Una cuarta parte de los individuos no produjeron hojas. LPR fue mayor en la estación seca y fue altamente variable entre semestres. LPR está correlacionado significativamente con el diámetro del tallo, el número de hojas muertas iniciales y su interacción. Sobresale la importancia de estos estudios por largos períodos de tiempo , así como estudios de defoliación, para lograr un mejor manejo de esta especie.

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\* Speaker

**(46) Gelatinous (tension) fibers in the seedling roots of cycads**

Tracy M. Magellan\*, M. Patrick Griffith &amp; P. Barry Tomlinson

**Abstract:** Gelatinous (tension) fibers (GFs) are distinctive cells that occur widely in angiosperms and have considerable mechanical significance in tree architecture. Where they occur they produce a considerable pulling force because they shorten subsequent to maturation by a little understood mechanism of wall contraction. Gelatinous fibers have only been described for gymnosperms in the Gnetales. A recent discovery based on material cultivated at Montgomery Botanical Center shows that GFs occur in the roots of cycads. Initially observed in seedling roots of *Cycas* and *Zamia* they have been more recently observed in varying degrees in all genera of cycads, i.e., they seem to be a synapomorphy for the whole order. They apparently function in the normal way for GFs, i.e., induce a contraction within the organ where they develop. This observation sheds novel light on the well-known phenomenon of root contraction in cycads. This behavior of cycad roots seems necessary for the successful establishment of the developing plant and is of importance in horticultural practice. Overall the observations we have made raise interesting evolutionary questions. It seems as if a cell type of known function in highly derived seed plants may actually have originated in a particularly ancient group.

**Resumen:** Las fibras gelatinosas (FG) son células distintivas que existen ampliamente en las angiospermas y que tienen una gran importancia mecánica en la arquitectura de los árboles. Cuando ocurren producen una considerable fuerza de tracción debido a que se acortan posterior a la maduración por un mecanismo poco entendido de contracción de las paredes celulares. Las fibras gelatinosas sólo se han descrito para gimnospermas en los Gnetales. Un descubrimiento reciente basado en material cultivado en Montgomery Botanical Center muestra que las FG se producen en las raíces de las cícadas. Inicialmente se observaron en raíces de plántulas de *Cycas* y *Zamia* y más recientemente se han observado, en mayor o menor grado en todos los géneros de cícadas, es decir, que parecen ser una sinapomorfía para todo el orden. Aparentemente funcionan en la forma normal para las FG, es decir, inducen una contracción dentro del órgano donde se desarrollan. Esta observación trae nueva información sobre el conocido fenómeno de la contracción de la raíz en las cícadas. Este comportamiento de las raíces de cícadas parece necesario para el éxito del establecimiento del desarrollo de la planta y es de importancia en la práctica de la horticultura. En general, las observaciones.

\* Speaker

**(47) Reproductive anomalies in *Encephalartos* (Zamiaceae)**

Philip Rousseau\*, Piet J. Vorster & A.E. van Wyk

**Abstract:** Cycads have undergone little morphological change over their extensive evolutionary history, with all extant and fossil taxa strictly dioecious. Reproductive structures are hypothesised to be derived from modified leaves with *Cycas* representing the ancestral state of uncompacted euphyllous megasporophylls. The mechanism of sex determination is speculative, though currently epigenetic methylation is the most supported hypothesis. Sex changes documented ex situ are seemingly due to stress. Sex thus seems to be determined at cone initiation, though this process is still poorly understood. Reproductive events in most species also follow strict phenological patterns for both sexes. Here we present four departures from normal reproductive events in the genus *Encephalartos*, at least some of which may be atavisms. Firstly, the well-documented phenomenon of sporophyll tissue in both sexes sprouting leaves. Secondly, adventitious nonfunctional cones produced ex situ in *E. lebomboensis*. Thirdly, miniature, phenologically asynchronously produced—but fully functional—microstrobili (*E. laevifolius* ex situ and *E. middelburgensis* in situ). Lastly, we present the first known case of a bisexual cone in the Cycadales, represented by a male strobilus of *E. cerinus* ex situ, in which several sporophylls bear numerous ovules with various degrees of functionality.

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\* Speaker

**(48) Are cycad megasporophylls actually ovulate shoots?**

Nan Li & Xin Wang\*

**Abstract:** Among all gymnosperms, ovulate parts of *Cycas* demonstrate by far the greatest resemblance to leaves. Meeuse (1963) was probably the first to challenge the foliar in nature of ovulate parts in Cycadales. Recent developmental experiment suggests that the foliar appearance of ovulate parts in *Cycas* is probably due to the mechanical pressure. Various independent research indicate that the female parts in other gymnosperms (Ginkgoales, Coniferales and Gnetales) are axial in nature. However, it seems generally accepted to term all female parts of seed plants “megasporophylls” since the latin suffix “-phyll” means “leaf” and Goethe said “all is leaf”. Arber and Parkin (1907) even correlate carpels with “megasporophylls” of *Cycas*. And this conception was adopted by most botanists. It is apparent that the nature of *Cycas* ovulate part is hinged with interpretation of female parts of all seed plants as well as the origin of carpels in angiosperms. To elucidate the situation, here we document the morphology of ovulate parts of *Cycas rumphii* and *Zamia furfuracea*. The extant cycads and fossil cycads seem to suggest that cycad ovulate parts are actually axial in nature, and should be termed “megasporocladodes”. All information together brings the former controversial seed plant systematics in order.

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\* Speaker

**(49) Influence of germination date on *Dioon edule* (Zamiaceae) seedling tolerance to water stress**

Laura Yáñez-Espinosa\*, Joel Flores, Paulina S. Rodríguez-Millán & Gabriel Rubio-Méndez

**Abstract:** *Dioon edule* seedling mortality is mostly attributed to dehydration by prolonged drought, even when they present xeromorphic characteristics like the adult plants. The effect of germination date and soil water deficit on seedling tolerance to water stress was assessed. The seedlings grown from seeds with developed embryos and germinated every month (GD) from December to April were selected to evaluate the leaf area, photosynthetic pigment content, crassulacean acid metabolism (CAM) activity, stomatal conductance (gs) and leaflet anatomy at soil water potential ( $\Psi_s$ ) of 0.0 MPa (day 1), -0.1 MPa (day 40), -1.0 MPa (day 90), -1.5 MPa (day 130), and a control (0.0 MPa at day 130) to recognize differences due to leaf development. The seedlings shift from C3 to CAM-cycling when water stress is activated at  $\Psi_s$  of -1.0 MPa, like adult plants. The March-April GD seedlings with undeveloped sclerified hypodermis and stomata, presented reduced leaf area, lower Chlorophyll a/b ratio, higher CAM activity and midday partial stomatal closure when reached  $\Psi_s$  of -1.0 MPa. These have higher probability of dehydration during severe drought (February-April) than those of the December-February GD with similar  $\Psi_s$ . Plants used for restoration purposes must have full leaf development to increase the survival.

**Resumen:** La mortalidad de las plántulas de *Dioon edule* se atribuye a la deshidratación por sequía prolongada, aun cuando presentan características xeromórficas como las adultas. Se evaluó el efecto de la fecha de la germinación y déficit de agua en la tolerancia al estrés hídrico en plántulas. Las plántulas germinaron cada mes (GD) de diciembre a abril y se seleccionaron para evaluar el área foliar, contenido de pigmentos fotosintéticos, metabolismo ácido de las crasuláceas actividad (CAM), conductancia estomática (gs) y anatomía de los foliolos con potencial hídrico del suelo ( $\Psi_s$ ) de 0,0 MPa (día 1), -0.1 MPa (día 40), -1.0 MPa (día 90), -1.5 MPa (día 130), y un control (0.0 MPa en el día 130) para reconocer diferencias debidas al desarrollo de las hojas. Las plántulas cambian de C3 a CAM de reciclaje cuando el estrés hídrico se activa a  $\Psi_s$  de -1.0 MPa, como en las plantas adultas. Las plántulas de marzo-abril con hipodermis esclerificado y estomas subdesarrollados, presentaron una reducción de área foliar, baja relación de clorofila a / b , una mayor actividad CAM y cierre parcial de los estomas ( $\Psi_s$  de -1,0 MPa). Estos tienen mayor probabilidad de deshidratación durante la sequía prolongada.

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\* Speaker

## Session 6: Evolution

### (50) The first fossil evidence of the genus *Zamia* L. (Zamiaceae, Cycadales) – implications for the Cenozoic evolution of cycads

Boglárka Erdei\*, Michael Calonje, Austin Hendy & Nicolas Espinoza

**Abstract:** The first fossil evidence of the genus *Zamia* L. supported by epidermal traits is discussed and the fossil record of the genus is reviewed based on the reinvestigation of fossil specimens and the relevant literature. The fossil foliage assigned to *Zamia* is preserved partly as compression in sediments of the Gatuncillo Formation, near Buena Vista, Colon Province, Central Panama. Nannoplankton and foraminiferal biostratigraphy at this locality indicate a late Eocene to earliest Oligocene age (P14-P17 and NP18- NP21 zones). Epidermal characters were studied using light microscopy and scanning electron microscopy. Gross epidermal structure shown by the fossil cuticles is comparable to traits displayed by modern species of *Zamia*. The majority of fossil foliage assigned formerly to *Zamia* were also revisited and are critically discussed. Morphometric analysis was adopted for the comparison of the fossil epidermal features with those of modern *Zamia* species. Results suggest a higher epidermal similarity with Caribbean *Zamia* species than other Mesoamerican or South American species. The first fossil evidence of *Zamia* proved by micromorphology may shed new light on the paleobiogeography of the genus and former conceptions on its evolution. Research was supported by the Hungarian-American Enterprise Scholarship Fund and the Hungarian Scientific Research Fund (108664).

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\* Speaker

**(51) Implications of chromosomal fission, fusion, and duplication for cycad evolution and diversity**

Root Gorelick\*, Krystle Olson, Danielle Fraser & Damon Little

**Abstract:** Unlike angiosperms and monilophytes, cycads show no evidence for whole genome duplication (polyploidy) nor simultaneous chromosomal fissioning (pseudopolyploidy). Therefore, in cycads, we do not expect substantial radiations associated with polyploidy nor adaptations associated with pseudopolyploidy. *However, Zamia* has a proclivity for fissioning of individual pairs of homologous chromosomes, which may have allowed for adaptation to different ecological niches. Comparison of genome size versus chromosome number across all extant genera of cycads did not yield a significant correlation, even when accounting for phylogeny. Lack of correlation is consistent with chromosomal fissions and fusions, not large-scale genomic duplications or deletions. Given the small number of large chromosomes in cycads, cycad evolution has probably been mostly driven by chromosomal fusions, except maybe in *Zamia* + *Microcycas*.

\* Speaker

## Plenary Talk 7

### (52) Integrated Cycad Conservation: collections genetics help close the loop

M. Patrick Griffith\*, Michael Calonje, Alan W. Meerow, Javier Francisco-Ortega & Abby Hird

**Abstract:** Genetic data can help manage cycad conservation collections. Direct assay of collections' genetic diversity, measured against wild plant populations, offers insight for conservation efforts. Here we present two carefully selected case studies, *Zamia decumbens* and *Zamia lucayana*, which offer examples of different life histories, population sizes, collections management needs, as well as cultural contexts. By systematic comparisons of the genetic data within and among these case studies, and with another non-cycad collection, we developed basic recommendations. These are presented in straightforward metrics to answer the basic question: "which plants should I grow, and how many?" Careful consideration of the target species is essential when planning for capture of genetic diversity; i.e. biology informs strategy. Differences in species, accessions, populations, and time all play a role in selecting which plants to grow. Integrating this type of precise ex situ conservation assessment with in situ management, monitoring, and community outreach can "close the loop," ensuring these living treasures do not go extinct.

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\* Speaker

## Session 7: Conservation / Horticulture

### (53) Multiplication and popularization of Indian *Cycas* for ornamental use at CSIR-NBRI Botanic Garden

J.S. Khuraijam\* & R.K. Roy

**Abstract:** Cycads are an ancient group of plants which have several cultural, ornamental and economical values. They are in great demand and have high commercial value in horticultural trade as they are used as pot plants and landscape purpose. In India, only one genus, *Cycas* is found and it is distributed mainly in the Western Ghats, the Eastern Ghats and Northeast region. Unlike other cycads, Indian species are not in exclusive use for horticultural and landscaping purpose. Though Indian *Cycas* species have equal potential, lack of knowledge on the cultivation techniques and low availability in nurseries have restricted their use as well as commercial value. Since propagation through tissue culture is not successful in cycads, conventional multiplication techniques through seeds and vegetative propagation are adopted in the Cycad Conservation Centre, CSIR-NBRI Botanic Garden. Out of the 9 species of *Cycas* reported in India, three species namely *Cycas sphaerica*, *Cycas beddomei* and *Cycas pectinata* are multiplied and planted in the thematic way to exhibit their landscape use for popularization.

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\* Speaker

**(54) Conservación y propagación ex situ de *Zamia tolimensis* en el Jardín Botánico Alejandro von Humboldt de la Universidad del Tolima, Ibagué, Colombia / Ex situ conservation and propagation of *Zamia tolimensis* in the Alexander von Humboldt Botanical Garden of the University of Tolima, Ibagué, Colombia**

Alfredo Torres\*, Eloísa Aldana & Héctor Eduardo Esquivel

**Resumen:** La especie *Zamia tolimensis*, endémica de los municipios de Rioblanco y Planadas en el Departamento del Tolima, se registra entre los 1300 y 1900 msnm y actualmente se encuentra catalogada En Peligro Crítico debido a que las pocas poblaciones están amenazadas por agricultores, ganaderos y madereros. Con el propósito de adelantar estudios de propagación ex situ para posteriormente hacer la caracterización citogenética, en el año 2014 se colectaron seis conos en bosques del municipio de Planadas, de los cuales solo un cono con 120 semillas que presentaban la sarcotesta de color rosado, dio resultados positivos en el proceso de germinación que se llevó a cabo en el invernadero del Jardín Botánico de la universidad. Para tal efecto, se emplearon tres clases de sustratos, arena negra, suelo-arena (50/50) y suelo gravilla (50/50). Se aplicaron cuatro tratamientos por cada sustrato así: Semillas lavadas superficiales, semillas lavadas profundas (3cm), semillas sin lavar superficiales y semillas sin lavar profundas. En este proceso de germinación se obtuvo un rendimiento del 90% con una mayor efectividad en el tratamiento con semillas sembradas sin lavar superficiales, en los sustratos arena negra y suelo arena. En el tratamiento uno (semillas en arena negra-sin lavar-superficiales), se evidenció un proceso de germinación con mayor rapidez (88 días) frente al tratamiento tres (semillas en arena negra-lavadas-superficiales) donde la germinación ocurrió más lenta (130 días). Las plántulas desarrolladas presentan una altura promedio de 12,35 cm y se encuentran trasplantadas en bolsas de polietileno ubicadas en condiciones de umbráculo.

**Abstract:** *Zamia tolimensis* is endemic to the municipalities of Rioblanco and Planadas in the Department of Tolima, Colombia. It occurs between 1300 and 1900 masl and is currently catalogued as Critically Endangered due to the fact that the few extant populations are threatened by agriculture, cattle ranching, and logging. With the purpose of advancing studies of ex situ propagation to later due the cytogenetic characterization for the species, in 2014 6 seed cones were collected in forests of the Planadas municipality of which only a single cone with 120 seeds showed pink colored seeds and gave positive germination results in the greenhouse of the University's Botanic Garden. Three substrates were tried: black sand, soil-sand (50/50) and soil-gravel (50/50). Four treatments were applied for each substrate: cleaned seeds on the surface of the substrate, cleaned seed buried in the substrate, uncleaned seeds on the substrate, and uncleaned seeds buried in the substrate. Treatment 1 (uncleaned seeds in black sand on the substrate) germinated the fastest (88 days) compared to treatment 3 (cleaned seeds in black sand on the substrate) where germination was the slowest (130 days). The seedlings developed have an average height of 12.35 cm and have been transplanted to polyethylene bags in a shady area.

\* Speaker

**(55) Pollination and germination as limiting factors in the propagation of threatened cycads, *Encephalartos* (Zamiaceae)**

Phakamani Xaba\*, John S. Donaldson & Jayanthi Nadarajan

**Abstract:** This study focuses on the Critically Endangered cycad *Encephalartos latifrons*, which exhibits low seed viability (< 10%) in ex situ living collections at Kirstenbosch National Botanical Garden (KNBG). This is the largest known ex situ collection of *E. latifrons*, and the conservation of this species is negatively affected by the unknown cause of low seed germination. Low seed germination in *E. latifrons* at KNBG was hypothesised to be caused by low pollen viability artificial pollination method used; and, seed handling methods. Wet and dry artificial pollination methods resulted in significantly different seed germination. The duration of dry seed storage had an impact on vigour (mean time to germination) and (time taken for 50% of seeds to germinate. Wet pollination resulted in low pollen germination and in turn caused low seed germination. Seeds required a storage period of 12 months before attaining full germination potential and seed pre-treatments on fresh seeds to overcome dormancy do not have significant effect on germination as these species undergoes deep simple morphophysiological dormancy. In conclusion, dry pollination in the afternoon and dry seed storage for 12 months is recommended for *E. latifrons* to achieve maximum germination.

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\* Speaker

**(56) The comprehensive cycad collection at the University of Melbourne and its importance to botanical and horticultural education**

Tim Uebergang\*

**Abstract:** The University of Melbourne's System Garden was born with learning and education at its heart. Established just after the university in 1856 it was the brain child of the first professor of Natural Sciences, Frederick McCoy. The objective was to showcase plant relationships through planting schemes based on taxonomic groups. Recently we have been committed to providing a comprehensive cross section of cycad diversity in the System Garden. We currently have 35 species from 8 genera on display. Such a display allows students studying general horticulture, taxonomy or systematic research, as well as public visitors the opportunity to understand the diversity of cycads, and to appreciate their varied shapes, foliage and colour. Being located in the southern hemisphere our developing collection has a distinct number of cooler growing specimens. We are particularly proud to display numerous taxa with multipinnate foliage including *Cycas multipinnata*, *C. debaoensis* and *Macrozamia stenomera* that highlights homoplasy of this form amongst the cycads. We also have several threatened species represented including *Cycas debaoensis*, *Encephalartos sclavoi* and the extinct in the wild *E. nubimontanus* extending the collection's importance also possibly to future conservation efforts.

\* Speaker

**(57) The use of cycads in the landscape**

Alvaro Calonje\*

**Abstract:** Since the introduction of *Cycas revoluta* and *Zamia furfuracea* as mass-propagated plants in the nursery trade for use as house plants or landscape elements, the use of different cycad species in the landscape trade continues to increase. Cycads are remarkably varied in their architecture, texture, colors, climate preferences, growth rates, and drought resistance and thus can be used as elements of landscape design for many different purposes under many different environmental conditions. The use of cycads as elements of landscape garden design is illustrated, and several species with unique characteristics for specific purposes are discussed. Cycads constitute a very important part of modern landscape design and the availability of seeds of new species in the trade is increasing the possibilities for their use as landscape design elements.

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\* Speaker

**(58) A seven year ravage of Cycad Aulacaspis Scale (CAS) in Panama and a simple method to curtail it**

Alberto S. Taylor B.\*

**Abstract:** Cycad Aulacaspis Scale (CAS) infestation was seen in Panama City in 2008 and large numbers of imported species of cycad growing in the cycad garden of the University of Panama, and practically all *Cycas* species on the Pacific slope up to many parts of eastern Panama, but not on the Atlantic coast nor mountainous grounds, covering hundreds of plants (basically *C. revoluta* and *C. rumphii*) were lightly or intensely infested with CAS. Taking in account availability, cost and non-toxicity, non-pesticide methods, especially including the use of remade coffee extract from coffee grounds and insecticidal oil, pure or emulsified, were tried by the author. The coffee extract method appeared to give good results when repeated many times weekly due the long rainy season and rain wash-out from treated plants. Businesses and Institutions, although informed and warned did nothing to continue the treatment, and all plants eventually died during a seven year period. Ecology also plays a part in CAS infestation as *C. revoluta* growing near the sea was not infested, but the same species growing less than 2km away somewhat separate from the sea, was infested with CAS.

**Resumen:** La infestación por la Escama Aulacaspis de Cícada (EAC) fue observada en la Ciudad de Panamá en 2008, y casi todas las especies importadas de cíadas que crecían en el jardín de cícada de la Universidad de Panamá y prácticamente todas las especies de *Cycas* en la vertiente pacífica, hasta varias partes de Panamá este, salvo en la costa atlántica y áreas montañosas, con una cobertura de cientos de plantas (fundamentalmente *Cycas revoluta* y *C. rumphii*) fueron levemente o intensamente infestadas con EAC. Tomando cuenta de la disponibilidad, costo y no-toxicidad, el autor practicó métodos sin el uso de pesticidas, especialmente el uso de extracto de café a partir de su afrecho reutilizado y aceite insecticida solo o en emulsión. El método de extracto de café parecía dar buenos resultados, cuando se repetía varias veces por semana debido a la época lluviosa prolongada y el lavado por la lluvia de las plantas tratadas. Los negocios y las instituciones, aunque fueron informados y advertidos no hicieron nada para continuar con el tratamiento, y todas las plantas murieron durante un período de siete años. La ecología también juega un papel en la infestación por EAC ya que *C. revoluta* que crece cerca del mar no está infestada pero la misma especie a menos de 2 km de distancia y algo alejada del mar sí está infestada con EAC.

\* Speaker

**(59) *Zamia tolimensis* y *Zamia huilensis*, dos especies vecinas separadas por el Rio Magdalena en Colombia**

Héctor Eduardo Esquivel\* & Michael Calonje

**Resumen:** En los años 2010 y 2011 como resultado de expediciones realizadas en los departamentos del Tolima y Huila, con el apoyo de la Universidad del Tolima y el Montgomery Botanical Center de Miami, se lograron encontrar en relictos de bosques algunas poblaciones de *Zamia* que al ser estudiadas se comprobó que pertenecían a dos especies nuevas para la ciencia: *Zamia tolimensis* y *Z. huilensis*. *Zamia tolimensis* se encuentra en los Municipios de Rio Blanco y Planadas en Tolima a elevaciones entre 1500 y 1900 msnm. Llamada “palma de yuca” por los campesinos de la región, que tienen tallos erguidos hasta de 5 m de alto y hasta 34 hojas pinnadas por tallo de más de 3 m de largas con foliolos falcados y pocos dientes en el borde (de 10 a 15).

*Zamia huilensis* se encuentra en los Municipios de Algeciras, Garzón y El Hobo, Huila, a elevaciones entre 1000 y 1850 m. Llamada “palma de monte” por los campesinos de la región, la mayoría de los ejemplares tienen alturas inferiores a 1 m, sin embargo se registraron individuos hasta de 1.90 m, con hasta 17 hojas pinnadas por tallo de hasta 1.60 m de largas, con foliolos elíptico – lanceolados con (20 a 60) dientes a lo largo del borde.

Se recomendaron al UICN categorías de CR para ambas especies por la deforestación extensa que ocurre en sus hábitats naturales.

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\* Speaker

## Plenary Talk 8

### (60) An overview of the world's cycads: current conservation status and trends from 2003-2014

John S. Donaldson\*, De Wet Bösenberg, Anders Lindström, Michael Calonje, Jeff Chemnick & Andrew Vovides

**Abstract:** The Global Cycad Assessment provides a comprehensive assessment for all cycads up to 2014 and allows an analysis of current status and trends from 2003-2014. The 341 assessments were based on the latest accepted World List of Cycads and all but three species were assigned a threat status. Of the 341 species assessed, 27 were definitely considered to represent a genuine change in status over the 11 years (i.e. excluding taxonomic changes and new information). The results provide the first Red List Index for cycads and indeed the first RLI for any plant group. The RLI, which provides a cumulative indicator of threat status, declined from 0.58 in 2003 to 0.56 in 2014 (8.2% change). This is considerably below other groups that have been assessed (e.g amphibians = 0.75, mammals = 0.85) and highlights the particular risk to cycad populations. The data is presented to show the differences in threat status and RLI for different regions and further analysis is provided of high risk aspects of cycad biology that may contribute to their risk status.

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\* Speaker

## Session 8: Conservation / Information Management

### (61) Introducing the online edition of The World List of Cycads

Michael Calonje\*, Dennis W. Stevenson & Leonie Stanberg

**Abstract:** The World List of Cycads (WL), published under the auspices of the IUCN's Cycad Specialist Group (CSG), is a working list of known cycad taxon names including information about taxonomic status, nomenclatural types, geographic distribution, conservation status, and publication details. The WL has been published eleven times since its inception, and this year marks its 30th anniversary. During the last meeting of the CSG (Cycad IX, December 2011, Shenzhen, China) it was agreed that a frequently updated, searchable online version of the WL would be an invaluable resource for cycad researchers and conservationists alike. Consequently, the online edition of the WL was launched in June of 2013 and is currently hosted at <http://cycadlist.org>. The website allows for immediate updates reflecting changes in cycad nomenclature and taxonomy and provides advanced search capabilities within a user-friendly interface as well as additional information not found on the printed version such as taxonomic and nomenclatural notes, additional associated literature, taxonomically useful photographs, and links to other useful websites. The extensive dataset for the WL is now managed using BRAHMS botanical database and exported for use on the printed and online versions of the WL. The website's development, data management and interface are discussed.

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\* Speaker

## Session 9: Ecology / Root Symbionts

### (62) Cycad coralloid roots as a novel source of biosynthetic gene clusters of specialized metabolites

Francisco Barona-Gómez\*, Pablo Cruz-Morales, Karina G. Gutiérrez, Pablo Suárez-Moo, José Antonio Corona, Angélica Cibrián-Jaramillo

**Abstract:** We hypothesize that bacteria associated to cycad coralloid roots harbor an array of specialized metabolites with possible adaptive functions for the cycad and of biotechnological interest to humans. Using a hybrid field-lab system we have isolated bacterial strains previously unknown to inhabit coralloid roots of *Dioon*. Shotgun metagenomics of ‘nearly natural’ co-cultures, as well as genomes of selected bacterial strains, were mined with state-of-the-art bioinformatics pipelines for biosynthetic pathways of known and novel natural products. We searched for metabolites that may serve specialized roles within this cycad-bacterial association. The identified biosynthetic gene clusters may occur in genomes from more than one bacterial lineage, implying that genetic and metabolic capacity rather than specific taxa could be driving local adaptation via the root. A particular case study involving *Pseudomonas* endophytes isolated from cycads growing in contrasting environments will be presented.

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\* Speaker

**(63) Ecological genomics of cycads and their root symbionts: insights into a million-yr old association**

Angelica Cibrian-Jaramillo\*, Pablo Cruz, Pablo Suarez Moo, Jose Antonio Corona, Francisco Pérez, Karina Gutierrez, Francisco Barona-Gómez

**Abstract:** Cycads are the oldest lineage of extant seed plants with specialized root structures that house nitrogen-fixing bacterial symbionts. We hypothesize that cycads have survived changing habitats by re-sampling root symbiont bacterial diversity, and by acquiring their metabolites or their enzymatic machinery to produce adaptive secondary compounds uniquely known to cycads. We established a hybrid field-lab system based on sampling coraloid roots of the endangered Mexican *Dioon* to characterize the taxonomic and functional composition of its bacterial communities. We developed a series of microbiological co-cultures from contrasting environments of *D. merolae*, aimed at increasing our ability to characterize taxonomic, phylogenetic and genomic composition of cycad bacterial endophytes, and their potential role in plant adaptation to local environments. Genomes, metagenomes and 16S rRNA- iTAGs suggest a wide range of bacterial groups in addition to Nostocales, structured in complex bacterial communities. We found evidence of bacterial production of natural products unique to this association. We discuss the relationship of the root communities and the cycad genotype and the landscape genetics of the host throughout its range. Phylogenomic and ecological analyses of this data provided an unprecedented ecological and functional understanding of the evolutionary process in the cycad-bacteria relationship.

**Resumen:** Las cícadas son el linaje más antiguo de plantas con semillas con estructuras de raíz especializadas que albergan bacterias simbiontes fijadoras de nitrógeno. Es factible que las cícadas hayan sobrevivido a cambios en el ambiente re-muestreando la diversidad bacteriana, quizá adquiriendo productos naturales o la maquinaria enzimática para producir compuestos secundarios con valor adaptativo para la planta. Hemos establecido un sistema de campo-laboratorio para muestrear raíces coraloides de *Dioon*, y caracterizar la composición de sus comunidades bacterianas. Desarrollamos una serie de co-cultivos de raíz obtenidas de diversos ambientes de *D. merolae* con el fin de aumentar nuestra capacidad para caracterizar la composición taxonómica, filogenética y genómica de endófitos bacterianos de cícadas, y su posible papel en la adaptación de la planta a los entornos locales. Genomas, metagenomas y 16S rRNA sugieren diversos grupos además de Nostocales, estructurados en comunidades complejas. Encontramos evidencia de producción bacteriana de productos naturales únicos a esta asociación. Se discute la relación de las comunidades de raíz y el genotipo de la planta, y la genética del paisaje del hospedero. Los análisis filogenómicos y ecológicos proporcionan información sobre la taxonomía bacteriana y su capacidad metabólica y funcional, y contribuyen al entendimiento de la relación cícadas-bacterias.

\* Speaker

## Session 10: Cycad 2018 Presentation

### (64) South Africa - Hosting Cycad 2018

Wynand van Eeden\* & Piet Vorster

**Abstract:** Cycad 2018 is to be held in South Africa. The hosting country boasts two genera (*Encephalartos* and *Stangeria*) and about 40 species of cycad and is one of the centres of diversity for cycads. The richness of South Africa's cycad population lends itself to many different topics for research. Given the variety of cycad species, each with its own ecological preferences, it comes as no surprise that the habitats of different cycad species is also quite varied and widely distributed. Furthermore, given the endangered and protected status of many South African species, it is becoming increasingly difficult for individuals to visit some of the habitats. A post conference tour is planned and almost 20 species may be seen in habitat. Species seen will range from *E. aplanatus*, growing in small groups, to the spectacular forest of *E. transvenosus* at Modjadji. Thus, attendance of Cycad 2018 may afford delegates the unique opportunity to visit some of these habitats.

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**(P1) Population biology research to support the conservation action plan for *Zamia encephalartoides* in Colombia**

Cristina López-Gallego, Michael Calonje & Alvaro Idárraga

**Abstract:** *Zamia encephalartoides* inhabits the highly-endangered tropical dry forest of the Chicamocha canyon in Colombia. For several years, we have been conducting research to explore population distribution and abundance and to perform an evaluation of population viability to complete a detailed evaluation of the conservation status and suggest an action plan. We identified five main localities with populations for the species, most of which have never been recognized on the Red List assessments. Two of these localities have populations of ca. 1000 individuals, and the total number of individuals for the species approaches 2500, a number much higher than reported before. We estimated the extent of occurrence for the species = 360 km<sup>2</sup>, larger than previously known, and we provided the first estimation of the area of occupancy for the species = 76.5 km<sup>2</sup>. We have also performed demographic census to monitor population dynamics of the two largest populations that appear to be stable or growing in time. We suggested two main localities with the largest known populations as important sites for conservation. We have identified seed sources and collected seeds to enrich an ex-situ conservation program at a local botanical garden that will use these seeds for potential reintroduction programs for the species. With all the information available, and after interacting with some of the land owners and officers from the local environmental authorities, we elaborated a “Conservation action plan” for the species that has been used as an important foundation for the national conservation action plan for zamias of Colombia.

**(P2) Restoration programs for three critically-endangered species (*Zamia restrepoi*, *Z. disodon* and *Z. wallisii*) in the Northern Andes of Colombia**

Cristina López-Gallego

**Abstract:** Colombia has 21 recognized species of *Zamia*, with at least 6 species critically endangered in the Andes. The Andean region is highly degraded by human activities, and cycads persist only in fragmented and disturbed forests. We gathered information on population status for three of the most endangered *Zamia* in the Andes and proposed a restoration plan for each species. *Zamia wallisii* persists in relatively large forest-fragments in four locations, with a total population size estimated in ca. 250 individuals. *Zamia disodon* has three known populations in small forest-fragments (<100 ha) with less than 250 adults. *Zamia restrepoi* is extinct from the type locality, and it is known currently from two very small forest-fragments (<10 ha) containing less than 50 individuals and some rescued plants cultivated. We are working with environmental authorities, park-rangers, and local land owners to obtain seeds and seedlings to produce juveniles and reintroduce them in protected areas. We have built several greenhouses for local land owners that are propagating these species and have translocated at least 50 plants of each species into safer places. These restoration efforts are being now monitored and plan to continue in the long-term to improve population status of the focus species.

**(P3) Herbivory patterns for two *Zamia* species for different habitats and herbivores**

Dani Zabaleta & Cristina López-Gallego

**Abstract:** Few studies estimate herbivore levels for cycads in their natural habitats, but herbivory could have important ecological effects on populations. Here, we explore the magnitude of herbivory in populations of *Zamia manicata* and *Z. encephalartoides* for different types of herbivores. We estimated herbivory levels as the proportion of leaf area affected in hundreds of individuals from interior-forest to edge habitats in the case of *Z. manicata* and from open and closed-canopy habitats for *Z. encephalartoides*. For *Z. manicata* we found that leaf damage by insect-miners was greater at forest-interior than at the edge for both seedlings and adults, while damage by *Eumaeus* larvae was greater at intermediate and edge habitats for seedlings and adults. Gills or pathogen attacks are rarely present in individuals, but they tended to be more frequent in forest interior and in adults. Herbivory levels in *Z. encephalartoides* are in general lower than for *Z. manicata*. For *Z. encephalartoides* herbivory by *Eumaeus* was greater in closed-canopy forest than in open habitats, while herbivory by miners was greater in open habitats. This study suggests that herbivory can vary across populations from different habitats, and the effects of the herbivory on population biology remain to be explored.

**(P4) Population dynamics of the rainforest cycad *Zamia manicata* across edge and interior habitats in forest fragments**

Cristina López-Gallego

**Abstract:** Habitat fragmentation is a major threat for many cycads, but no studies are available about population dynamics of cycads in fragmented landscapes. Here, I describe the demography of a *Zamia* in different habitats within fragmented-forests in the Darien region (Colombia). I sampled demes across interior to edge habitats in forests fragments differing in the level of anthropogenic degradation; and estimated population density, size-distribution, and the population growth rate (using IPMs) for each habitat. Overall, populations appear to be near stable population size in the forest fragments, but demes vary in their population dynamics across habitats within the forests. Edge habitats had higher canopy openness and higher levels of herbivory than interior habitats. Plant density was higher, and there was a higher proportion of seedlings compared to adults in demes from edge habitats. Furthermore, a gradient of higher adult growth, fecundity, and seedling survival in demes from edge to interior resulted in edge-habitats demes having the largest population growth rate. Further exploration of the long-term dynamics of these populations requires extensive demographic census; nevertheless, this study suggests that demographic parameters can vary across habitats within forest fragments, which might be important for the long-term persistence of these cycads in anthropogenic landscapes.

**(P5) Study for the long term conservation of *Dioon edule* Lindl. (Zamiaceae) in San Luis Potosí**

Gabriel Rubio-Méndez, Alberto Prado-Farias, Laura Yáñez-Espinosa, Jacqueline C. Bede, José Arturo de Nova-Vazquez, Humberto Reyes-Hernández, Joel Flores-Rivas

**Abstract:** Knowledge of genetic diversity and its structure in wild populations of threatened species allows us to propose strategies for its conservation, being relevant in long-lived species as *Dioon edule*, a relevant element in the flora of the Sierra Madre Oriental (SMO). In this study we analyze five populations of *D. edule* in the SMO region in San Luis Potosí. We estimated and analyzed the levels of genetic variability (SSR), population structure (GenAlex and Structure) and habitat as a whole (Ascending Hierarchic Classification, CAJ). The populations show high levels of allelic fixation and the observed heterocigosity was below than expected. This patterns are attributed to the loss of habitat for agricultural activities, producing isolation of populations and impacting on its survival. We didn't find genetic structure defined between populations, but on having analyzed individually its stages of development, adult detected a light structure to himself in the categories and seedlings, probably for effect of damping of his longevity united to a neck of bottle generated during the glaciations of the Pleistocene. The CAJ analysis shows a major similarity in three populations where the nearness with the Reservation of the Biosphere of the Sierra Gorda allows his connectivity and the genetic flow.

**Resumen:** El conocimiento de la estructura y diversidad genética de poblaciones silvestres de especies amenazadas permite proponer estrategias para su conservación, siendo relevante en especies longevas como *Dioon edule*, elemento relevante en la flora de la Sierra Madre Oriental (SMO). En este trabajo estudiamos cinco poblaciones de *D. edule* en la región de SMO de San Luis Potosí. Se determinó y analizó su variabilidad genética (marcadores microsatélites), la estructura poblacional (GenAlex y Structure) y el hábitat en conjunto (Clasificación Ascendente Jerárquica, CAJ). Las poblaciones presentan índices altos de fijación alélica, además de una heterocigocidad observada por debajo de lo esperado. Lo que se atribuye a la perdida de hábitat por actividades agropecuarias, generando aislamiento en las poblaciones e impactando su supervivencia. No se encontró estructura genética definida entre las poblaciones, pero al analizar individualmente sus etapas de desarrollo, se detectó una ligera estructura en las categorías adulto y plántula, probablemente por efecto de amortiguamiento de su longevidad aunado a un cuello de botella generado durante las glaciaciones del Pleistoceno. El análisis CAJ muestra una mayor similitud en tres poblaciones donde la cercanía con la Reserva de la Biosfera de la Sierra Gorda permite su conectividad y favorece el flujo genético.

**(P6) Caracterización demográfica, rescate y reubicación de una población de *Zamia muricata* Willd. en un bosque seco tropical de Santander (Colombia)**

Raquel Sofía Gómez-Parra

**Abstract:** A *Zamia muricata* population integrated by 134 individuals and located in a tropical dry forest between 800 and 1000 m were registered in the Colombian Andes (Dpto. Santander). This area will be flooded by the construction of a dam. The population structure was described, the population density was determined and a hábitat characterization of the population and two near areas were realized. Biotic and abiotic parameters were comparated between the areas to determinate the sector with environmental conditions similar to the original habitat to carry out the relocation of the population. The population structure showed an “inverse J” shape, where the majority of the individuals are represented by the smaller sized clases, suggesting a high individual recruitment. The population density was 0,01 ind/m<sup>2</sup>. There was found similarity in the floristic structure and the abiotic parameters analyzed between the sites. Therefore, the 68% of the adult rescued individuals moved into the two evaluated zones and the remaining 32% to a botanical garden in order to ex-situ conservation. Five months after the rescue, 66% of survival success was observed, but the remaining 34% state is unknown, because there weren't leaves in the recount.

**Resumen:** Se registró una población de *Zamia muricata* en los Andes Colombianos (Dpto. Santander), compuesta por 134 individuos y localizada en un bosque seco tropical sobre los 800 y 1000 m. Este sector se inundará por la construcción de un embalse. Se describió la estructura poblacional, se determinó la densidad poblacional y se realizó la caracterización del hábitat de la población y de dos zonas cercanas. Se compararon parámetros bióticos y abióticos de las zonas evaluadas para determinar el sector con condiciones medioambientales similares al hábitat original para llevar a cabo la reubicación de la población. La estructura poblacional mostró una forma de J invertida, donde la mayoría de los individuos están representados por las clases de tamaño más pequeñas, sugiriendo un alto reclutamiento. La densidad poblacional fue de 0,01 ind/m<sup>2</sup>. Se encontró semejanza en la estructura florística y en los parámetros abióticos analizados entre los sitios. Por tanto, se trasladó el 68% de los individuos adultos a las dos zonas evaluadas y el 32% restante a un jardín botánico para su conservación ex-situ. Cinco meses después del rescate, se ha observado un 66% de éxito de supervivencia, y se desconoce el estado del 34% restante de individuos.

**(P7) Anatomy of neck cells during the growth stage of the central cell in archegonia of *Ceratozamia mexicana* Brongn. and *Zamia furfuracea* L.f. (Zamiaceae).**

María Ydelia Sánchez-Tinoco & Andrew P. Vovides

**Abstract:** The archegonium where the egg cell is formed in archegoniate plants represents an ancestral character in the Spermatophytes. Outstanding within the archegonial chamber are the neck cells that are formed during the growth stage of the central cell. It is believed that the neck cells present characteristics favoring fertilization. In this study we describe the neck cells during the growth stage of the central cell in both *Ceratozamia mexicana* and *Zamia furfuracea*. In both species there are two neck cells with conspicuous nuclei and nucleoli. Material, probably the result of secretory activity, is accumulated externally on the cell wall. An anticlinally elongated cell underlies each neck cell that differs in size to the rest of the cells of the archegonial jacket and to the superficial cells of the vegetative gametophyte. The anatomical characteristics of the neck cells during this stage correspond to cells with great secretory activity whose products may be guides for the pollen tubes, antherozoid liberation and later fusion of the nuclei that form the zygote.

**Resumen:** El arquegonio en donde se forma la ovocélula en plantas arquegoniadas, representa un carácter ancestral de las Spermatophyta. En su estructura sobresalen dentro de la cámara arquegonial y durante la etapa de crecimiento de la célula central, las células del cuello. Se presume que las células del cuello presentan características que favorecen la fertilización. Aquí se describen anatómicamente las células del cuello durante la etapa de crecimiento de la célula central tanto en *Ceratozamia mexicana* como en *Zamia furfuracea*. En ambas especies hay dos células del cuello con núcleos y nucléolos conspicuos. Su pared externamente presenta material acumulado que podría ser producto de actividad secretora. A cada célula del cuello subyace una célula alargada anticlinalmente que difiere en tamaño del resto de las células de la vaina arquegonial y de las células superficiales del gametofito vegetativo. Las características anatómicas de las células del cuello en esta etapa, corresponden a células con gran actividad secretora cuyos productos pueden ser guía para tubos polínicos, liberación de anterozoides y posterior fusión de los núcleos que formarán el cigoto.

**(P8) Landscape genetics of *Dioon***

Francisco Pérez, Dánae Cabrera-Toledo, Jorge González-Astorga, Andrew Vovides, Angélica Cibrian-Jaramillo

**Abstract:** Species of the genus *Dioon* have a wide distribution range from México to Honduras encompassing strikingly contrasting habitats, from humid forests to dry shrublands. Previous population-level work with allozymes in *Dioon* suggests various contrasting ecological and demographic scenarios of *Dioon*'s history in its local habitats. Our work is focused on describing the fine-scale and landscape genetics of *Dioon* in most of its distribution throughout Mexico, measured by transcriptome-derived SSRs. We place emphasis in two species with contrasting distribution, *D. merolae* and *D. caputoi*, and include samples from live collections to evaluate their genetic relationship with wild populations. Our main goal is to investigate population-level processes that would inform several demographic models at the landscape level and help clarify the phylogeographic history of this genus in Mexico, as well as contribute to its conservation.

**Resumen:** Especies del género *Dioon* tienen una amplia distribución desde México hasta Honduras en hábitats asombrosamente contrastantes, desde bosques húmedos hasta matorral xerófilo. Estudios previos a nivel de poblaciones con aloenzimas en *Dioon* sugieren diversos escenarios ecológicos y demográficos en la historia de *Dioon* y sus hábitats locales. Nuestro trabajo se enfoca en describir la escala fina y genética del paisaje de *Dioon* a lo largo de su distribución en México, medidas por microsatélites derivados de transcriptomas. Ponemos énfasis particular en dos especies de distribución contrastante, *D. merolae* y *D. caputoi*, e incluimos muestras de colecciones vivas para evaluar su relación genética con poblaciones silvestres. Nuestro objetivo principal es el de investigar los procesos a nivel de poblaciones que puedan informar modelos demográficos a nivel de paisaje, y ayudar a clarificar la historia filogeográfica de este género en México, además de contribuir a su conservación.

**(P9) Preliminary phytochemical analysis of the leaves and seed stalks *Dioon mejiae* / Análisis fitoquímico preliminar de las hojas tallos y semillas de *Dioon mejiae***

Ana Carolina Arévalo, Onán Reyes\*, Ligia Medina, Laura Flores, Jessica Días & Ludovic Bouilly

**Abstract:** *Dioon mejiae* or teosinte is an endemic species of Honduras distributed in the departments of Olancho, Yoro and Colon, considered a living fossil survivor burning, logging, drought and many millennia in age of the earth, has ornamental valuations and widely used in the national and international landscape, although it has been part of the diet since pre-Columbian times ensuring food sovereignty and security by providing a starch, flour or sago which is a carbohydrate extracted from the seed, our study focused on analyzing three parts plant leaf, stem and seed alkaloids and flavonoids in identifying all parties mentioned, we highlight the antioxidant and anti-inflammatory activity of flavonoids, coumarins are used in skin conditions, alkaloids pose on the nervous system. as the percentage of gluten obtained indicate that the starch is of good quality, given that this is the first phytochemical study of the species it is recommended to continue the analysis of structural characterization and determination of the pharmacological activity of the compounds present in the species.

**Resumen:** *Dioon mejiae* o teosinte es una especie endémica de Honduras distribuida en los departamentos de Olancho, Yoro y Colon, considerada un fósil viviente sobreviviente a quemas, talas, sequias y muchos milenios en edades de la tierra, tiene valoraciones ornamentales y muy utilizada en el paisajismo nacional e internacional, aunque ha formado parte de la dieta alimenticia desde la época precolombina garantizando la soberanía y seguridad alimentaria proporcionando un almidón, harina o sagú que es un glúcido extraído de la semilla, nuestro estudio se enfocó en analizar tres partes de la planta la hoja, el tallo y la semilla identificando alcaloides y flavonoides en todas las partes mencionadas, podemos destacar la actividad antioxidante y antiinflamatoria de los flavonoides, las cumarinas se usan en afecciones de la piel, los alcaloides posen actividad sobre el sistema nervioso. En cuanto los porcentajes de gluten obtenidos indican que el almidón es de buena calidad, en vista que este es el primer estudio fotoquímico de la especie se recomienda seguir con los análisis de caracterización estructural y determinación de la actividad farmacológica de los compuestos presentes en la especie.

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