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## Fairylake Botanical Garden, Shenzhen & Chinese Academy of Sciences

Fairylake Botanical Garden, Shenzhen & Chinese Academy of Sciences, is situated in the eastern suburb of Shenzhen City and covers an area of 546 hectares. The garden was established in 1983 and was open to the public at 1988. The garden is renowned for its abundant and colorful plants, gorgeous landscape and beautiful gardens, and is becoming one of the important scenic spots in Shenzhen and receive more than 2 million visitors each year. In 2008, Fairylake Botanical Garden became a new member of the Chinese Academy of Sciences and a joint institution of Shenzhen Government and the Chinese Academy of Sciences. In 2010, the garden becomes more powerful with the combination of Shenzhen Institute of Landscape Architecture.

Fairylake Botanical Garden is an important centre for conservation and research of plant diversity in southern China. There are twelve botanical laboratories covering morphology and anatomy, molecular phylogeny, tissue culture, plant protection, plant physiology and et al.

The herbarium collects about 100,000 specimens which mainly from Guangxi, Guangdong and other neighboring regions. The library holds about 16000 books and journals. There are seven greenhouses covering a total 40000 m<sup>2</sup> with automatic temperature, moist and lighting control system.

The 19<sup>th</sup> International Botanical Congress will be held in Shenzhen in 2017, which is supported by Shenzhen Government and the Botanical Society of China. Fairylake Botanical Garden will involve a lot in preparing and organizing the congress.



### 深圳市中国科学院仙湖植物园

深圳市中国科学院仙湖植物园（以下简称仙湖植物园）位于深圳市罗湖区，东倚梧桐山、西邻深圳水库，面积546公顷。仙湖植物园1983年开始筹建，1988年正式对外开放，是一座集植物引种与驯化、生物多样性保护、园林与林业研究、植物科学知识普及和旅游观光休闲为一体的多功能植物园，年接待游客超过200万人次。2008年，仙湖植物园正式加入中国科学院体系，成为深圳市政府和中国科学院合作共建单位。2010年，深圳市园林科学研究所并入仙湖植物园，研究力量进一步加强。

仙湖植物园是深圳市植物科学和园林与林业研究的重要基地。拥有12个常规植物学研究实验室，建有收集近10万份植物标本的标本馆，一个收藏植物专业图书近16000册的图书馆，拥有占地面积约40000 m<sup>2</sup>的科普实验园（有可控温度、湿度和光照条件的温室大棚7座）。

第19届国际植物学大会将于2017年在深圳举办，由深圳市政府和中国植物学会共同承办，仙湖植物园会是本届国际植物学大会的主要筹办机构。

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# Contents 目录

## Oral Presentations 大会及分组报告

(1) Overview of taxonomy, resource status and conservation strategy of <i>Cycas</i> L. in China. 中国苏铁属的分类、资源现状及保护战略综述	1
(2) Cycad architecture. 苏铁类植物的构架	2
(3) Comparative studies of tracheary element structure of some gymnosperms with angiosperms. 一些裸子植物和被子植物管状分子结构的比较研究	3
(4) Investigation of fossil cycad leaves from the early Cenozoic of North America. 北美新生代早期苏铁植物叶化石的研究	4
(5) Structure of ovulate organ in <i>Cycas</i> and its implication for interpreting the female parts of seed plants. 苏铁属雌性器官的结构及其种子植物雌性器官理解的启示	5
(6) Study on anatomical structure of the stem of <i>Cycas siamensis</i> . 暹罗苏铁茎的解剖学研究	6
(7) An introduction to the IUCN Species Information System database as the platform for cycad Red List assessments. 作为苏铁类植物红色名录评估平台的IUCN物种信息系统数据库简介	7
(8) Effect of disturbances on the population dynamics of Mexican cycads. 干扰因素对墨西哥地区苏铁类植物种群动态的影响	8
(9) Demographic comparison between two sites of <i>Ceratozamia mexicana</i> Brongn. with different perturbation histories. 不同干扰条件下的 <i>Ceratozamia mexicana</i> Brongn两个地点的生长量统计比较	9
(10) From the Jurassic to your table top: Ethnobotany, trade, life history and population dynamics of the endemic <i>Cycas</i> species in the forests of Southern India. 从侏罗纪到你的餐桌：印度南部森林中特有濒危苏铁种类的民族植物学、贸易、生活史以及种群动态变化	10
(11) A role for cycads in the adoption of maize agriculture: Discussion of the evidence. 苏铁类植物在玉米农业化过程中所扮演的角色：基于证据的讨论	11
(12) Genetic population structure of <i>Cycas micholitzii</i> complex inferred from chloroplast and nuclear DNA. 基于核糖体与叶绿体基因片段的叉叶苏铁复合种群遗传结构研究	12
(13) Cycas conservation centres: An indigenous effort to conserve <i>Cycas circinalis</i> in the Nilgiri Biosphere Reserve, Western Ghats, India. 苏铁保护中心：为保护印度西高止山脉尼尔吉里生物圈保护区内的拳叶苏铁而做的本土努力	13
(14) Using genetic variation of <i>Cycas taitungensis</i> to evaluate the <i>ex situ</i> conservation strategies. 运用台东苏铁族群遗传变异评估境外保育策略	14
(15) Observations on serious threats to <i>Cycas beddomei</i> Thiselton-Dyer endemic and critically endangered species in its natural habitat Tirupati-Cudapa Hills of Andhra Pradesh, India. 特有和极度濒危种 <i>Cycas beddomei</i> 在其自然栖息地印度安得拉邦蒂鲁伯蒂市古德伯山的受威胁状况观察	15
(16) Integrated Conservation of Ancient Plants (ICAP). 古老植物的综合保护 (ICAP)	16
(17) Cycads: Then and now. 苏铁类植物：过去和现在	17
(18) A taxonomic revision of <i>Cycas</i> L. in China. 中国苏铁属分类学修订	18
(19) DNA barcoding of Africa's endemic cycads: <i>Encephalartos</i> Lehm. and <i>Stangeria</i> (Kunze) Baillon. 非洲特有苏铁的DNA条形码研究：非洲铁属和蕨铁属	19
(20) Genetic diversity among the Indian <i>Cycas</i> species based on RAPD markers. 基于RAPD标记的印度苏铁属遗传多样性分析	20
(21) A phylogeny of <i>Zamia</i> based on four single-copy nuclear genes. 基于四个单拷贝核基因的泽米铁属谱系发育	21

(22) A molecular phylogeny of <i>Encephalartos</i> Lehm. 非洲铁属的分子系统发育 .....	22
(23) Quantifying the trade in cycads ( <i>Encephalartos</i> species) in the traditional medicine markets of Johannesburg and Durban, South Africa. 非洲铁属植物在南非约翰内斯堡和德班传统药材市场的贸易量化分析 .....	23
(24) Thermogenesis of cycad cones in several <i>Cycas</i> species and implications for pollination. 几种苏铁球花产热现象及其与传粉的关系 .....	24
(25) The physiology of cycads: leaf structure, hydraulics, nutrition, and photosynthesis. 苏铁生理学: 叶片结构、水分运输、养分和光合作用 .....	25
(26) An overview of the role of cone volatiles in the pollination ecology of <i>Encephalartos</i> . 非洲铁属球花挥发性物质在传粉中的作用 .....	26
(27) Examination of diel metabolic, thermogenic and volatile activity of <i>Macrozamia macleayi</i> and <i>lucida</i> cones: methodology and correlations. <i>Macrozamia macleayi</i> 和 <i>M. lucida</i> 球花昼夜代谢强度、温度变化和挥发性气体排放的研究 .....	27
(28) Weevils in the cones of Asian <i>Cycas</i> : their phylogeny based on analysis of the 16S rRNA mitochondrial gene. 亚洲苏铁属球花中的甲虫的谱系发育—基于16S rRNA线粒体基因序列 .....	28
(29) Sleep alterations in a cycad model of Parkinsonism. 帕金森氏症苏铁模型中的睡眠变化 .....	29
(30) Comparative analysis of biochemical and molecular markers efficiency to sex identification in <i>Ceratozamia mexicana</i> Brongn. 生物化学和分子标记比较分析鉴定 <i>Ceratozamia mexicana</i> Brongn. 的性别 .....	30
(31) Resources investigation on <i>Cycas guizhouensis</i> from Guizhou Cycas Nature Reserve. 贵州苏铁自然保护区贵州苏铁资源调查 .....	31
(32) Survey, population study and conservation status of <i>Cycas pectinata</i> in Assam, India. 印度阿萨姆邦篦齿苏铁的居群研究及保护现状 .....	32
(33) A structured analysis of factors affecting low seed germination in <i>Encephalartos latifrons</i> Lehm. 宽羽非洲铁种子低萌发率影响因子的结构分析 .....	33
(34) <i>Microcycas calocoma</i> : Legacy plant collections, conservation horticulture and economics. <i>Microcycas calocoma</i> : 植物的收藏、园艺保护和经济价值传承 .....	34
(35) Phylogeography and conservation genetics of the Caribbean <i>Zamia</i> clade: an integrated systematic approach with SSRs and single copy nuclear genes. 泽米属加勒比海支的植物地理和保护遗传学分析一种通过SSR分子标记和单拷贝基因的综合分析方法 .....	35
(36) Uncovering the cycad taxa ( <i>Encephalartos</i> species) traded for traditional medicine in Johannesburg and Durban, South Africa. 南非约翰内斯堡和德班传统药材市场上交易的非洲铁属植物种类调查 .....	36
(37) Structural evolution of cycads: Do traits in extant cycads inform ancestral conditions? 苏铁植物的结构演化: 现存苏铁类植物的特征是否能告知祖先的状况? .....	37
(38) Understanding life-history of <i>Zamia</i> species using data from field studies and botanical-collections. 使用野外研究及植物园收藏数据了解泽米铁属的生活史 .....	38
(39) Recent studies on Philippine cycads. 菲律宾苏铁植物研究现状 .....	39
(40) Phenology of <i>Zamia</i> L. - phylogenetic and biogeographical insights. 泽米铁属物候学系统发育关系和生物地理学初探 .....	40
(41) Conservation Status of <i>Cycas sancti-lasallei</i> from the Philippines. <i>Cycas sancti-lasallei</i> 在菲律宾的保护现状 .....	41
(42) Scouting Philippines for <i>Cycas</i> . 菲律宾苏铁属植物初探 .....	42
(43) Genetics-based conservation action plan for <i>Zamia lucayana</i> , the only cycad species endemic to the Bahamian archipelago (Caribbean Island Biodiversity Hotspot). 加勒比海岛生物多样性热点地区--巴哈马群岛唯一苏铁类植物特有种 <i>Zamia lucayana</i> 的遗传学保护行动方案 .....	43
(44) Evaluating inorganic and organic container media for growth of <i>Zamia</i> species. 有机和无机容器培养介质对泽米铁属种类的生长评估 .....	44



(45) The results of a translocation and re-establishment program undertaken almost 30 years ago. 三十年前苏铁移栽和重建项目的结果 ..... 45

(46) Botanic gardens cycad collections: 4<sup>th</sup> GBGC Symposium Report. 植物园苏铁植物收集: 来自第四届国际植物园大会的报告 ..... 46

(47) An overview of cycad conservation based on the 2010 Global Cycad Assessment and its implications for the IUCN/SSC Cycad Action Plan. 基于2010年全球苏铁类植物评估的苏铁保育综述及其对苏铁行动计划的影响 ..... 47

(48) Provenance investigation and genetic diversity study on *Cycas szechuanensis*. 四川苏铁的产地调查及遗传多样性分析 ..... 48

(49) Comparative patterns of genetic variation among populations of the *Zamia pumila* L. complex across three islands of the Greater Antilles. *Zamia pumila* L. 复合体在大安的列斯群岛中三个岛屿上分布居群的遗传变异式样比较 ..... 49

(50) Divergence and introgression of allopatric distributed *Cycas* section *Asiorientales*. 异域分布的苏铁属亚洲苏铁组的分歧与基因渐渗 ..... 50

(51) Study of dioecism in *Zamia furfuracea* L. f. *Zamia furfuracea* L. f. 雌雄异株现象的研究 ..... 51

(52) Maternal inheritance of plastids and mitochondria in *Cycas* L. (Cycadaceae). 苏铁属 (苏铁科) 质体与线粒体的母性遗传 ..... 52

(53) Identification of molecular markers associated with sexual expression in *Ceratozamia mexicana* Brongn. (Zamiaceae). *Ceratozamia mexicana* Brongn. (泽米铁科) 与性别表达相关的分子标记的鉴定 ..... 53

(54) Complete chloroplast genome of *Zamia furfuracea* and *Stangeria eriopus* and their evolutionary implications. 鳞秕泽米铁和托叶铁叶绿体全基因组及进化上的意义 ..... 54

Posters 壁报

(P1) Review of the genus *Cycas* (Cycadaceae) in China. 中国苏铁属 (苏铁科) 综述 ..... 55

(P2) A new genus of fossil cycads, *Yixianocladus* gen. nov., from the Early Cretaceous Yixian Formation, Western Liaoning, China and its evolutionary significance. 辽宁义县早白垩世义县组苏铁类一新属--*Yixianocladus* gen. nov. 及其演化意义 ..... 56

(P3) The ex-situ conservation and landscaping of cycads in Qingxiushan scenic spot of Nanning, Guangxi, China. 中国广西南宁青秀山风景区苏铁植物迁地保育与园林景观应用 ..... 57

(P4) Fire contributes to the natural succession of *Cycas panzhihuaensis* L. Zhou et S. Y. Yang. 火烧促进攀枝花苏铁自然演替 ..... 58

(P5) Cycad horticulture at MBC: best practices, new developments and new efficiencies. 蒙哥马利植物园苏铁园艺学: 最佳实践、新发展和新功效 ..... 59

(P6) *Cycas debaoensis* conservation project in China. 中国德保苏铁的保育项目 ..... 60

(P7) *Cycas nongnoochiae* population status. *Cycas nongnoochiae* 的种群状况 ..... 61

(P8) *Encephalartos laevifolius* current status of all the localities how it happened? *Encephalartos laevifolius* 的存活现状及其缘由 ..... 62

(P9) Non-detriment findings for *Cycas chamaoensis* K.D.Hill. *Cycas chamaoensis* K.D.Hill. 的无危害调查报告 ..... 63

(P10) Illegal trade of *Cycas* cones: Major threats to *Cycas* populations in North East India. 苏铁球果非法贸易: 印度东北部苏铁种群面临的主要威胁 ..... 64

(P11) Preliminary study on the harm caused by *Liloceris* sp. feeding on *Cycas guizhouensis*. 贵州苏铁负泥虫危害初报 ..... 65

(P12) A putatively new genus of Pharaconothinae (Coleoptera: Erotylidae) collected from *Cycas* in Asia. 亚洲苏铁属中拟叩甲亚科一新属 (鞘翅目: 大蕈甲科) ..... 66

(P13) Risk analysis on cycad diseases in the Global World. 全球苏铁类植物病害发生风险分析及应对措施 ..... 67

## Contents 目录

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(P14) Coffee grounds: Assessing a potential control for cycad <i>Aulacaspis</i> scale, <i>Aulacaspis yasumatsui</i> . 咖啡渣: 评估苏铁白轮盾介壳虫的潜在控制 .....	68
(P15) Transcriptome characterization for male and female plants of <i>Cycas elongata</i> (Leandri) D.Y.Wang. 越南篦齿苏铁雌、雄株转录组研究 .....	69
(P16) The microsporogenesis of <i>Cycas</i> and its systematic implications. 苏铁属小孢子发生及其系统学意义 .....	70
(P17) Anatomical description of the cytoplasmic connections between the central cell and transfer cells in <i>Ceratozamia mexicana</i> Brongn., and <i>Zamia furfuracea</i> L.f. (Cycadales). <i>Ceratozamia mexicana</i> Brongn.和 <i>Zamia furfuracea</i> L.f. (苏铁目)的中央细胞和传递细胞之间胞间连丝的解剖学描述 .....	71
(P18) Development cycle of the ovule and seed of <i>Zamia furfuracea</i> L. f. (CYCADALES). 鳞秕泽米铁(苏铁目)胚珠和种子的发育周期研究 .....	72
(P19) Research on reproduction in <i>Cycas revoluta</i> . 苏铁若干繁殖问题的研究 .....	73
(P20) Cycad sex ratios at Montgomery Botanical Center. 蒙哥马利植物中心苏铁的雌雄性别比例 .....	74
(P21) Season and Frequency of <i>Cycas micronesica</i> reproductive events. <i>Cycas micronesica</i> 生殖活动的季节和频率 .....	75
(P22) Heat production in male cones of Chinese <i>Cycas</i> . 中国产苏铁属雄球花的产热机制研究 .....	76

## Appendix 附录

National Cycad Germplasm Conservation Center 国家苏铁种质资源保护中心. ....	77
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## December 2

### Plenary Talk 1

#### (1) Overview of taxonomy, resource status and conservation strategy of *Cycas* L. in China

Nan Li and Dan Qian

*National Cycad Germplasm Conservation Center, FairyLake Botanical Garden, Shenzhen and Chinese Academy of Sciences, 160 Xianhu Rd., Liantang, Shenzhen 518004, China.*

Twenty three species in the genus *Cycas* L. from China are recognized on the basis of long term field survey and cultivation. Analysis of resource status in China for the last three decades indicates that illegal excavation and trade and habitat loss are the major endangered factors. Illegal excavation and trade happened mainly in the 1990s and almost resulted in the complete loss of wild resource such as the beautiful and unique *C. hongheensis*, *C. debaoensis*, *C. multipinnata* and *C. bifida*. Entering into 21<sup>th</sup> century habitat loss has become the one of the most important endangered factors because of the rapid development of economy and accelerated urbanization. The resource loss of 1/7 total species was directly caused by highway construction and deforestation. On the other hand, the Chinese government issued a series of policies and regulations and carried out a number of key programs for wildlife protection and natural reserves construction, which play a significant role in preserving the *Cycas* species in China. Government policy and support have a key impact on the protection of wildlife resources.

A comprehensive assessment and categorization have been conducted for the 23 species of *Cycas* according to their existing individual numbers in field, land properties of distribution and threatened status. It is note worthy that *C. hongheensis*, *C. multipinnata* and *C. taiwaniana* are currently the three most endangered species at critical level (CR). They have less than 100 individuals in total and must be protected from extinction urgently via effective measures. Problems and solutions are also discussed for future conservation of *Cycas* in China.

#### 中国苏铁属的分类、资源现状及保护战略综述

本文作者在多年栽培和野外观察的基础上，将中国苏铁属植物归为23种；对中国近30年来苏铁资源的主要致濒因素和后果进行了分析，指出非法盗挖和贸易，以及生境改变是导致中国苏铁资源濒危的最主要因素。前者主要影响于上世纪九十年代，其后果是使得一些姿态优美、株型奇特的种类，如红河苏铁、德保苏铁，多歧苏铁，叉叶苏铁等的野生资源几乎损失殆尽。进入二十一世纪以来，由于经济的快速发展和城市化进程加快，因原生境改变而造成的苏铁资源骤减上升为主要致濒因素。有研究数据表明，在中国分布的23种苏铁植物中，约有1 / 7的种类的资源大量流失是因城市化、修高速路或毁林开荒直接引起的。另一方面，2000年以后，中国野生苏铁资源总量骤减的趋势有所缓解，这和政府出台的一系列相关政策法规，以及些重大保护工程的实施密切相关。研究数据表明，国家的政策和支持对生物多样性的保护事业至关重要。

此外，作者根据每个物种现存的野外资源总量、分布地属性及受威胁状况等，对23种苏铁的资源现状和濒危等级进行了综合评定和划分。指出包括灰干苏铁，多歧苏铁和闽粤苏铁在内的3个苏铁物种是目前我国苏铁种类中濒危程度最为严重的，被定为极危等级（CR），其野外资源总量不足100株，必须尽快采取有效措施，以防灭绝。

最后，作者对中国苏铁保护中存在的主要问题和解决对策，提出了自己的思考。

## Session 1: Taxonomy & Phylogeny 1 / Information Management

### (2) Cycad architecture

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Branching in extant cycads occurs in two ways, by isotomous (equal) branching of the apical meristem and by the formation of adventitious buds. The production of adventitious buds (bulbils) is from callus tissue produced by a phellogen that also gives rise to an abscission layer in the leaf bases and by adventitious buds produced by the vascular and cork cambia, and from apical dichotomies, which are isotomous. The easiest way to observe the result of apical dichotomies is to examine both transverse and longitudinal sections of mature trunks stained with phloroglucinol. In this manner, in examining an acropetal series, one sees a single vascular cylinder become two equal vascular cylinders (one for each shank of the isotomy). Each successive isotomy occurs at right angles to the previous one, again with a single vascular cylinder dividing into two equal vascular cylinders. The places limits on cycad growth patterns and makes them more like non-seed vascular plants that lack the precise relationship of leaves and buds as in the axillary bud of seed plants. Thus, the process of “reiteration” is lacking; i.e., the partial or total repetition of a tree’s architecture, as when subject to some disturbance within a biological environment.

### 苏铁类植物的构架

现存苏铁类植物的分枝方式分为两种类型, 由顶端分生组织形成的等叉分枝和由不定芽产生的分支。不定芽可由愈伤组织产生, 该愈伤组织由木栓形成层(该木栓形成层还在叶基部形成离层)以及维管束和木栓形成层共同产生的不定芽所形成; 不定芽亦可由顶端等二叉分枝产生。观察顶端等二叉分枝最简单的方法是应用染色法。用间苯三酚染色后, 观察成熟茎干的横向和纵向部分, 可看到单一的维管束转变成2个相当的维管束(每个等叉分枝的柄)。每个相应的等叉分枝发生在前一个分枝的垂直方位, 呈直角, 再与另一个分为两个相等维管束的单一维管束相对。苏铁类植物生长分枝模式中位点的有限性使得苏铁更近似于非种子维管植物, 缺乏类似于种子植物中腋生芽的叶与芽的确切关系。苏铁类缺失“重复生长”现象, 但树木在遇到干扰时, 则往往会呈现部分或者完全的重复生长。



### (3) Comparative studies of tracheary element structure of some gymnosperms with angiosperms

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Tissues of the pinna and rachis of *Cycas diannaensis* and pinna, rachis, and root of *C. taiwaniana*, stem of *Metasequoia glyptostroboides* (Taxodiaceae), stem of *Chamaecyparis obtusa* (Sieb. et Zucc.) Endl. cv. *Tetragona* (Cupressaceae), and leaves and stems of *Michelia alba* and *M. figo* and stem of *Amygdalus persica* (angiosperms) were compared using scanning electron microscopy. In all species of these gymnosperms, their many tracheary elements have perforation in end wall and lateral wall. These structures are same as vessel of angiosperms, therefore these tracheary elements are vessel elements. Many types of vessels were found in the two cycads, pitted vessels in *M. glyptostroboides*, spiral and pitted vessels in *Chamaecyparis obtusa* cv. *Tetragona*. The development and structural characteristics of vessels of cycads, the two other gymnosperms, and the angiosperms were identical. Some characters such as extent of incline of perforation plate in the end wall, showed that vessel characters of some angiosperms are more primitive than the cycads or *Metasequoia glyptostroboides* and *Chamaecyparis obtusa* cv. *Tetragona*. Many of the vessel elements of the angiosperms were band shape, without end walls, and had only two lateral walls and other two margins, the end is acute or with an arc margin, the end of some vessel elements are acute with no perforations, many perforations located only in lateral wall. Such the results are rarely reported in past time. In all species, perforations were seen only in tracheae, and the walls of parenchyma cells only had a thin primary wall and without perforation. Cognized to vessel of cycads, Taxodiaceae and Cupressaceae, help us to understand the mechanism by which these most primitive or more primitive extant gymnosperms adapted to harsh environments and to understand these species' evolutionary extent, and has significance to the studies of plant anatomy, plant systematics and plant evolution.

#### 一些裸子植物和被子植物管状分子结构的比较研究

对滇南苏铁 (*Cycas diannaensis*) 的羽片、叶轴, 台湾苏铁 (*C. taiwaniana*) 的羽片、叶轴和根, 水杉的茎 (*Metasequoia glyptostroboides*)、孔雀柏 (*Chamaecyparis obtusa* cv. *Tetragona*) 的茎, 白兰 (*Michelia alba*)、含笑 (*M. figo*) 的叶和茎, 桃 (*Amygdalus persica*) 的茎用扫描电镜进行了比较研究, 发现这些裸子植物的管状分子的端壁和侧壁中均具有穿孔; 这些导管分子在结构的组成上与被子植物相同。在2个苏铁植物中存在多种导管类型, 在水杉中发现孔纹导管, 在孔雀柏中发现螺纹导管和孔纹导管。对苏铁植物与其它两个裸子植物以及被子植物的导管结构特征进行了分析, 认为大致是处在相同的进化水平。但是, 部分指标, 如端壁穿孔板的倾斜程度, 显示这几种被子植物的导管比上述裸子植物更为原始。这些被子植物较多的导管分子呈现带状, 尤其在端部, 没有端壁, 仅有两个侧壁及两个边, 端部是尖的, 且在上述部位没有穿孔, 多数穿孔分布于侧壁。这些研究结果在过去鲜有报道。在所有的上述植物种类中, 穿孔仅仅分布在管状分子上, 而在薄壁组织细胞中是没有任何穿孔的, 仅有薄的完整的初生壁。认识苏铁植物的导管、杉科、柏科的导管结构, 有助于我们认识这些原始植物对逆境适应的机制以及其进化程度, 对于植物解剖学、植物系统学及植物进化具有很重要的意义。

#### (4) Investigation of fossil cycad leaves from the early Cenozoic of North America

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The post-Mesozoic fossil record of cycads in North America is mainly confined to the Paleocene and Eocene, but includes occurrences over a wide geographic range. The record consists mainly of foliage, but the preservation of cuticle with epidermal characters compliments macromorphology in many instances providing additional important features for comparative study with extant cycads. Reexamination of cycad foliage from the Eocene floras of Hamilton Bay, Alaska and La Porte, California, indicates that species formerly assigned to extant genera *Ceratozamia*, *Dioon* and *Zamia* do not actually represent these modern cycad genera; they belong to *Dioonopsis*, an extinct genus first recognized in the Paleogene of Japan. The epidermal features of the simply pinnate leaves distinguish these fossils from extant genera and coincide well with the extinct genus *Dioonopsis*. Confirmation of *Dioonopsis* in the Eocene of western North America and Japan, combined with its apparent absence in the European Tertiary, indicates that it probably spread via the Beringial phytogeographic pathway. The presence of *Dioonopsis* in southern Alaska during the Eocene, along with current understanding that these fossiliferous strata were nearly in their modern latitudinal position by the Eocene, leads to the conclusion that these cycads were able to occupy high latitude environments. The Alaskan and Californian leaf remains, additional foliage records from the Eocene Clarno Formation, Oregon, and from the Eocene of Panama, Central America together with earlier leaf records (*Eostangeria* Wyoming, Oregon) indicate a relatively diversified spectrum of cycads during the early Palaeogene. (Study was supported by a Fulbright award and grant-OTKA-K73199).

#### 北美新生代早期苏铁植物叶化石的研究

北美的中生代后期苏铁化石记录主要局限于古新世和始新世, 但却分布在较宽的地质范围内。这些化石记录主要是叶部化石, 但这些保留下来的叶化石的表皮及角质层所提供的大量特征为我们开展与现存苏铁进行比较研究是非常重要的。我们基于对产自汉密尔顿湾、阿拉斯加、拉波特和加利福尼亚始新世植物群中苏铁植物叶化石的重新研究, 发现过去归入现存的角状泽米属*Ceratozamia*、双子铁属*Dioon*和泽米铁属*Zamia*的一些种, 实际上并不是这些现存属的代表, 它们应该被归入一个已经灭绝了的、最初发现于日本老第三纪的拟双子苏铁属*Dioonopsis*。这些单羽叶化石的表皮特征不同于现存属, 而与灭绝属----拟双子苏铁属的叶表皮特征相吻合。拟双子苏铁属在北美西部和日本始新世的存在以及在欧洲第三纪的明显缺乏, 表明它可能是通过白令陆桥散布的。拟双子苏铁属在始新世存在于阿拉斯加南部, 这些化石产地当时的纬度位置与现在大致相当。因此, 我们得出结论, 苏铁植物曾经可以分布于高纬度地区。阿拉斯加和加利福尼亚的叶化石、俄勒冈始新世克拉诺组Clarno和中美洲巴拿马始新世的叶化石以及更早的产自怀俄明和俄勒冈的叶化石记录(如*Eostangeria*), 表明苏铁类植物在早古新世时就已经呈现出了相对多样化的形态(该研究由Fulbright奖学金赞助)。

## (5) Structure of ovulate organ in *Cycas* and its implication for interpreting the female parts of seed plants

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Female organs of plants play a central role in phylogeny of seed plants. Among living seed plants, interpretation of the female organs directly influences our understanding of the plant systematics. For example, the megaspore-bearing parts in Gnetales and Coniferales are now taken as shoot-like structures, unlike previously as megasporophylls. Moreover, recently advanced Unifying Theory thinks that the carpels of angiosperms are composed of ovule-bearing shoots (placentae) and foliar structures enclosing them. This brings up one question: Are there any common features behind all these various types of seeds? Is there any real megasporophyll? Among all the ovule-bearing structures of *Cycas* may be the only parts of living plants that greatly resemble the idealized ovule-bearing leaf (megasporophyll). Therefore, the nature of ovule-bearing parts of *Cycas* becomes the focus of our study. Here we observe the anatomic features, particularly the venation, xylem and phloem deployment in the vascular bundle, of the ovule-bearing parts in *Cycas*. Through comparison with those in typical leaves or shoots, we analyze the nature of ovule-bearing part of cycads and try to find a universal interpretation for female structures among all seed plants.

### 苏铁属雌性器官的结构及其种子植物雌性器官理解的启示

在种子植物的谱系中，雌性器官的特征起到了关键的作用。对于现生种子植物雌性器官的解读直接影响着我们对于植物系统学的理解。例如，不同于过去认为的大孢子叶，人们现在认为尼藤类和松柏类的大孢子器官是轴性的。而且最近提出的一统理论认为，被子植物的心皮是由长胚珠的枝和包裹其的叶性器官共同组成的。这就提出了一个问题：世界上各种不同的种子背后有没有共性呢？到底有没有所谓的大孢子叶？在所有的现生植物中，苏铁属的雌性器官与人们理想中的大孢子叶最为接近。因此苏铁的大孢子器官变成了我们的研究重点。这里我们观察了苏铁雌性器官中的解剖结构，尤其是其中的脉序、维管束中木质部与韧皮部的排列关系。通过与典型的叶和枝进行对比，我们试图分析苏铁雌性器官的性质并寻找种子植物雌性器官背后的共性。



## (6) Study on anatomical structure of the stem of *Cycas siamensis*

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Anatomy of stems of *Cycas siamensis* was studied. The results show that: The stem of *C.siamensis* has abundant cortex and pith. Periderm and exodermis have plentiful tannin cells, crystalidioblasts and sclereids. Being able to see three kinds of different trend vascular bundles horizontal, vertical and slantwise in the identical section of cortex. The cortex has amphicribral bundles and collateral bundles and the main type is amphicribral bundles. Usually, 1~3 layers parenchyma around of cortex vascular bundles has crystalidioblasts. All vascular bundles compose of xylem, cambium and phloem. The phloem of amphicribral bundles and stele vascular bundles has sieve elements, fibers, parenchyma cells and crystalidioblasts. The area of xylem is greater than the phloem's in all vascular bundles. The secondary structure of stele composes of secondary vascular tissue with some concentric rings. Every ring contains secondary xylem, vascular cambium and secondary phloem, there are secondary parenchyma cells between the two rings, No tannin cells and crystalidioblasts in piths. These results further revealed that structural characteristics of *Cycas* plants stems are very different to other spermatophytes. The present study also analyzed the advantages and mechanism that structural character of stems of *C.siamensis* adapt to environment.

### 暹罗苏铁茎的解剖学研究

通过对暹罗苏铁的解剖学研究,发现茎具有发达的皮层和髓,周皮及皮层外侧具有大量的单宁细胞、晶细胞及部分石细胞。在皮层的同一切面上能看到横、纵、斜3种不同走向的皮层维管束,为周韧和外韧两种类型,以周韧型为主。通常有晶细胞分布在皮层维管束周的1-3层薄壁组织中。所有的维管束都由木质部、形成层和韧皮部组成,但皮层周韧维管束及中柱维管束的韧皮部中都具筛分子、纤维、薄壁细胞和晶细胞;所有维管束的木质部面积都大于韧皮部;中柱的次生结构由多个具有同心环的次生维管组织构成,幼嫩时的环数为一个,随着茎的不断成熟,环数逐渐增加。每个同心环均含有次生木质部、维管形成层、次生韧皮部的结构,环与环之间有次生的薄壁细胞相间隔。髓部不具异细胞。这进一步反映了苏铁科植物与其它种子植物茎在次生结构方面的差异性。本文还探讨了暹罗苏铁茎的特征与该植物对环境的适应能力之间的关系。

## **(7) An introduction to the IUCN Species Information System database as the platform for cycad Red List assessments**

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The IUCN/ SSC Red List is the globally recognized standard for assessing the threatened status of different organisms. The assessments require specific information that is then assessed in terms of different criteria to determine the threatened status. Until recently, individual specialist groups had to gather and collate their own information to support these assessments. However, the IUCN/SSC now has an online database that enables contributors from all over the world to contribute data, check assessments, and provide narratives for species that have been assessed. This Species Information System is a powerful tool that can aid ongoing cycad assessments and the cycad data has been loaded and is available via the SIS. The purpose of this presentation is to provide an introduction to the SIS database and a hands-on demonstration of its capabilities.

### **作为苏铁类植物红色名录评估平台的IUCN物种信息系统数据库简介**

IUCN/SSC红色名录是全球公认的评估生物濒危等级的标准。评估需要特定的信息，然后根据不同标准来判定濒危等级。直到最近，各个专家组仍然不得不收集他们各自的信息来支持这些评估。然而，现在IUCN/SSC拥有了一个网上数据库，可供全世界的编著者上传数据、检验评估、以及对已经评估的物种进行叙述。这个物种信息系统是一个可以对苏铁植物评估工作的进展起到帮助的强大工具，而且苏铁植物的数据已经上传，可以通过SIS获得。本报告旨在介绍SIS数据库，并手动示范它的功能。

## Session 2: Ecology I

### (8) Effect of disturbances on the population dynamics of Mexican cycads

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The cycads are dioecious, persistent and ancient plants. The populations are small distributed throughout the tropical and subtropical regions of the world. Australia and Mexico are countries with greater diversity of species. Currently, all Mexican species are protected due to illegal extraction, traffic and decrease their natural habitat by agricultural activities. The effect of these activities on populational dynamic can be inferred by the use of the demographic models based on projection matrices. However, by the longevity of the cycads, is difficult to determine its long-term population dynamics. Fortunately, today there has been several population studies have allowed us to determine the overall effects of disturbance on these long-lived species, which will facilitate decision making for conservation and management. In general, the disturbance decreases the reproductive potential of populations and increases the importance of staying on adults for survival of all the Mexican cycads.

#### 干扰因素对墨西哥地区苏铁类植物种群动态的影响

苏铁类植物为雌雄异株的多年生古老类群。居群小, 分布于热带和亚热带地区, 澳大利亚和墨西哥是苏铁类植物的多样性分布中心。目前, 由于非法采挖, 贩卖和农业活动所引起的天然栖息地减少等原因, 墨西哥所有苏铁种类均被列为保护对象。利用基于投影矩阵的人口统计学模型可以推断出这些干扰活动对苏铁类植物种群动态的影响。而通过苏铁类植物的寿命是很难推断其长期的种群动态的。幸运的是, 目前我们通过几项种群研究已可以确定外界干扰对这些长命物种的总体影响, 这将有利于制定保育和管理的决策。总之, 对于所有幸存的墨西哥苏铁类植物来说, 这些干扰降低了种群的繁殖潜力, 也能增加保存成年植株的重要性。



### (9) Demographic comparison between two sites of *Ceratozamia mexicana* Brongn. with different perturbation histories

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Cycads are long-lived dioic plants that are considered as vulnerable, threatened or in danger of extinction. The fragmentation of their habitats and extraction for illegal commercialization are the major factors influencing the reduction in their populations. *Ceratozamia mexicana* is a cycad endemic to Veracruz, classified as threatened. The objective of this research was to compare the dynamics of the two sites with different management histories (with and without recent disturbances), this work being carried out in two reproductive periods. Starting from matrix projections, the rate of population growth was calculated for each site. Both sites showed a tendency to remain stable through time, with a  $\lambda$  of  $1.047 \pm 0.06$  for the undisturbed site and of  $0.996 \pm 0.064$  for the disturbed site. The relative contributions of the elasticity components were: L = 0.792, G = 0.179, F = 0.029 for the preserved site and L = 0.909, G = 0.082 and F = 0.009 for the disturbed site. In conclusion, preserving and protecting the adults guarantees the continuity of the sites.

#### 不同干扰条件下的*Ceratozamia mexicana* Brongn.两个地点的生长量统计比较

苏铁是长命的雌雄异株植物，被认为是易危、受危或濒危物种。生境破碎化和非法商业贸易是导致苏铁类植物种群量减少的主要原因。*Ceratozamia mexicana*是韦拉克鲁斯特有种，保护级别为受威胁物种。本研究的目的在于比较不同管理措施下（近期有无干扰）两个地点的*C. mexicana*生长动力学特征。我们的研究工作在两个生殖时间段进行，即从母体开始进行测量，对两个地点的种群增长率分别进行计算。研究显示，两个地点都保持稳定生长的趋势。未受干扰地的代入数据 $\lambda$ 为 $1.047 \pm 0.06$ ，干扰地为 $0.996 \pm 0.064$ 。弹性部分的相关贡献是：未受干扰地分别为L = 0.792, G = 0.179, F = 0.029，受干扰地分别为L = 0.909, G = 0.082, F = 0.009。由此得出结论，对成年苏铁植株进行保留和保护可以确保这些生境的种群连续性。

## (10) From the Jurassic to your table top: Ethnobotany, trade, life history and population dynamics of the endemic *Cycas* species in the forests of Southern India

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*Cycas circinalis* L. and *C. indica* Lindstrom & Hill are non-timber forest products extensively harvested from the forests of south India. They are harvested for pith, leaves, seeds and male cones by indigenous people as well as commercial harvesters. Although indigenous people have a long association with *Cycas* spp, harvest for sale in the national market has been uncontrolled over the past several years. My research explores the effects of commercial trade and local use on the ecology of these two species in the states of Karnataka, Kerala and Tamil Nadu. I conducted interviews in villages and markets to look at the use dynamics and economics of the trade. Further, I gathered ecological data from plots in unharvested and harvested areas. My preliminary results illustrate that harvest has a significant effect on the population structure. Trade dynamics has been constantly changing for leaf harvest which has a strong association with cultural factors and quality of the leaves harvested. Pith sales have been very variable over the years owing to dwindling population in harvest sites and uncertainty in the authenticity of the plant product. A more detailed understanding of trade patterns and of the factors affecting population dynamics in different harvest and habitat types over the long-term is critical to implement protection of these species.

### 从侏罗纪到你的餐桌：印度南部森林中特有濒危苏铁种类的民族植物学、贸易、生活史以及种群动态变化

虽然为非用材树种，但是印度南部的拳叶苏铁(*Cycas circinalis* L.)和 *C. indica* Lindstrom & Hill还是被大量采伐。当地居民和商业采伐者分别采售苏铁的髓、叶、种子和雄球花。虽然当地居民对苏铁类植物的了解有很长的历史，但是苏铁类植物的贸易失控仅在近几年才出现。本人研究了卡纳塔克邦、喀拉拉邦和泰米尔纳德邦州的商业贸易和当地利用对这两种苏铁的生态影响效应。一方面，在当地居民和贸易市场进行走访，分析当地的利用特征和售卖的经济效益；另一方面，分别在苏铁生境破坏和未破坏的地方设点收集相关生态数据。初步结果表明，人工采挖对苏铁居群结构变化有显著影响。苏铁叶子的贸易变化同社会文化以及采收的叶片质量密切相关。近年来，由于野生资源的不断减少以及物种真伪的不确定性导致髓销量不稳定。实施保护这些物种的关键还在于更详细地了解贸易方式、以及对不同习性苏铁和不同售卖器官对居群结构影响的长期观察。

## (11) A role for cycads in the adoption of maize agriculture: Discussion of the evidence

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The origins and cultural history of the world's premier food crop are uncertain and contentious. Beyond the many botanical debates on the domestication of corn from teosinte is the question of why ancient Mesoamerican peoples would have been interested in cultivating *Zea* in the first place, given the profusion of other available foods. In this context, the current paper weighs the significance of evidence for meaningful connections between races of *Zea mays* and *Ceratozamia*, *Dioon*, and *Zamia* cycads over the course of the last 6,000 years in Mexico and Honduras. Direct evidence of cycad harvesting and maize cultivation occurring together is found in the archaeological and ethnohistorical record during the entire period, in the agricultural practices of contemporary societies such as the Teenek, Xi'ui, and Nahuatl, and in mythology and folklore. The conclusion that can be drawn, though tenuous, point to cycads as symbolic progenitors of maize wherever cycads played a prominent role in diets prior to the introduction of maize. The inevitable question, probably unanswerable, is whether cycads could have served as the very inspiration for the domestication of maize from wild teosinte.

### 苏铁类植物在玉米农业化过程中所扮演的角色：基于证据的讨论

对世界主要粮食作物的起源地和文化历史的争议一直未决且仍在持续。除了关于由墨西哥类蜀黍驯化成玉米的生物学争论，另外一个问题是为什么古代的中美洲人会在众多的作物资源中对栽培玉米感兴趣。本文对墨西哥和洪都拉斯地区在过去6000年内对玉蜀黍同角果铁属，双子铁属以及泽米铁属植物的历史进行了追溯，揭示了玉米同这些苏铁类植物之间的重要关联，并重申了这些证据的重要意义。苏铁类植物和玉米同时种植的直接证据来自考古学和人种史学资料，据记载在远古的Teenek、Xi'ui和Nahuatl社会的农业活动和神话传说中，均记载苏铁类植物和玉米同时种植。虽然证据尚不充分，但是我们认为苏铁类是玉米的标志性先驱，即在玉米还未栽培前，苏铁类植物就在日常饮食中扮演着重要角色。一个不可避免或者无法回答的问题是，苏铁类植物是否在野生墨西哥类蜀黍驯化成玉米的过程中起到了激发灵感的作用。



## Session 3: Conservation I

### (12) Genetic population structure of *Cycas micholitzii* complex inferred from chloroplast and nuclear DNA

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*Cycas micholitzii* complex is composed of 5 species: *C. micholitzii* Dyer, *C. bifida* (Dyer) K. D. Hill, *C. longipetiolula* D. Y. Wang, *C. debaoensis* Y. C. Zhong et C. J. Chen, *C. multipinnata* C. J. Chen et S. Y. Yang, and distributed from southwest China to central Vietnam and eastern Laos. Based on sequence data from two maternally inherited cpDNA and one biparentally nuclear DNA fragments, our study revealed the population genetic structure of *C. micholitzii* complex and explored the potential causes. The evolutionary and demographic histories were investigated. We analysed chloroplast sequence variation of the *atpB-rbcL* and *psbA-trnH* intergenic spacers in 27 populations sampled of *C. micholitzii* complex, AMOVA analysis showed that the component of among-species/region component (59.21%). However, phylogenetic analysis showed that the haplotypes of *C. micholitzii* complex couldn't grouped into four clusters closely corresponding to the narrowly defined *C. micholitzii*, *C. multipinnata*, *C. debaoensis* and *C. longipetiolula*. We concluded that the conflict may result from several factors: firstly incomplete lineage sorting of *C. micholitzii*; secondly hybridization/introgression of sympatrically cycads, which would be supported by evidence base on nrDNA ITS sequences; thirdly intramolecular recombination in cpDNA of cycads; eventually the neotectonic movement in the distribution range of this species.

### 基于核糖体与叶绿体基因片段的叉叶苏铁复合种群遗传结构研究

叉叶苏铁复合体(*Cycas micholitzii* complex)包括5种, 叉叶苏铁 (*C. bifida* (Dyer) K. D. Hill)、越南叉叶苏铁 (*C. micholitzii* Dyer)、长柄叉叶苏铁 (*C. longipetiolula* D. Y. Wang)、德保苏铁(*C. debaoensis* Y. C. Zhong et C. J. Chen)和多歧苏铁 (*C. multipinnata* C. J. Chen et S. Y. Yang), 主要分布于我国西南部以及越南北部、中南部及老挝东南部。本研究基于两个母系遗传的叶绿体基因(cpDNA)片段和一个双亲遗传的核糖体基因(nrDNA)片段对其谱系地理和遗传结构进行研究, 并依据这些结果探讨居群动态历史和复合群内各种间的演化关系。对叉叶苏铁复合群27个居群cpDNA进行序列分析, 结果表明种间分化占总遗传变异的59.21%, 但是复合群内四个种的单倍型并不能各自形成单系。这种谱系地理结构与演化关系可能与以下几个因素有关: 1. 叉叶苏铁cpDNA中存在的不完全的谱系分选; 2. 同地域分布的苏铁植物之间的杂交和基因渐渗; 3. 苏铁属植物cpDNA中的分子内重组现象; 4. 板块移动对苏铁分布与分化的影响。

### (13) *Cycas* conservation centres: An indigenous effort to conserve *Cycas circinalis* in the Nilgiri Biosphere Reserve, Western Ghats, India

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Use of biodiversity is very high in the tropics. For India it is estimated that 100 million people are forest dependant. Many times rare endangered and threatened species are part of this use and *Cycas circinalis* L. is one such species. The participation of people in biodiversity conservation remains a challenge and there are no win-win situations. Keystone Foundation is a grass roots NGO that works in the Nilgiri Biosphere Reserve (NBR), India. As a part of the work on conservation and livelihoods, we undertook a study on harvest impacts, life history, ecological status and distribution of *C. circinalis* L. in the NBR. The research involved local indigenous communities. Study results were shared with the people, threats were discussed and a way forward for the conservation of the species was planned. As a step forward four ‘*Cycas* Conservation Centers’ were established in remote forest villages of the region. These centers serves as hubs where the following activities are conducted - conservation education for children and adults, monitoring of sale and harvest of *Cycas* produce, raising nurseries and improving germination rates of *Cycas* seeds. Regular meeting of harvesters at the centers and discussion of the threats to cycads has greatly reduced the indiscriminate harvest of cycad plant parts. Monitoring of *C. circinalis* populations and phenology has been also conducted. The “*Cycas* Conservation Centers” over a period of four years have evolved to become “Village Conservation centers” that are leading the way to show case and implement conservation on the ground.

#### 苏铁保护中心：为保护印度西高止山脉尼尔吉里生物圈保护区内的拳叶苏铁而做的本土努力

热带地区生物多样性的利用率很高。据估计印度地区有一亿人口依赖于森林生活。许多濒危植物都是被利用的对象，其中就包括拳叶苏铁*Cycas circinalis*。寻求当地人参与到生物多样性的保护中仍然面临很大的挑战，而且很难实现双赢。Keystone基金是印度西高止山脉保护区工作的基础。作为保护工作和谋生的一部分，我们研究了保护区内拳叶苏铁的收割，生长历史、生态环境以及分布情况。研究工作涉及当地土著部落，研究结果与他们共享，同时也讨论了潜在的威胁，以及为如何保护拳叶苏铁制定了方案。作为保护苏铁的一步，在遥远的森林部落中建立了“苏铁保护中心”。该中心是开展了以下工作：小孩和成年人的保护教育；监测苏铁产品的采割和买卖；兴建苗圃和提高苏铁种子的发芽率；在中心定期组织苏铁采收人员开会并一起讨论关于苏铁受威胁情况的话题极大地降低了任意的采割行为对苏铁造成的危害；监测种群动态和物候情况。经过四年的发展，苏铁保育中心已经成为“村民保育中心”，成为当地开展保育的典范。

## (14) Using genetic variation of *Cycas taitungensis* to evaluate the *ex situ* conservation strategies

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The perennial cycad, *Cycas taitungensis* Shen, Hill, Tsou & Chen is an endemic species with two remaining populations in Taiwan. In 1997, this species was categorized at the vulnerable level in the IUCN Red List of Threatened Species. In 2009, the IUCN was increased this endemic species to endangered level caused by *Aulacaspis yasumatsui*, an invasive species that infests cycad plants in the past decade in Taiwan (IUCN Red List of Threatened Species, Version 2011.1: <http://www.iucnredlist.org/>). Past genetic studies show low levels of differentiation between two populations. However, populations have been in extreme decline and we need to enhance the conservation administration of the threatened taxa. The Forestry Bureau in Taiwan has considered *C. taitungensis* for *ex situ* conservation management such as “seed storage” or “transplanting” to keep this endemic species survival if the wild population becomes extinct. Based on this propose, we use molecular markers, including ISSR and SSR, to evaluate population genetic variation, identify distinct genetic units, and select individuals for seed storage. Totally, 356 individuals for three subpopulations from Taitung Hongyeh Village Cycas Nature Reserve, one population from Coastal Mountain Range Taitung Cycas Forest Reserves, and one population from seed orchard are selected to evaluate. In total, the analyses showed 29.20% and 9.45% variation among populations and 70.80% and 90.55% variation among individuals within the populations by data of ISSR and SSR, respectively. Based on the AMOVA results, the mean  $\Phi_{ST}$  was 0.292 and 0.095 and the result was significant ( $p < 0.010$ ). The PCoA result showed those individuals from seed orchard were transplanted from the subpopulation of Taitung Hongyeh Village Cycas Nature Reserve. The assignment test by MCMC simulation was performed by the STRUCTURE program. Both the admixture and non-admixture models were tested in 10 replicates for different clustering (K) and choose the best clustering. The grouping was consistent with distinct genetic units for *in situ* or *ex situ* conservation managements.

### 运用台东苏铁族群遗传变异评估境外保育策略

台东苏铁(*Cycas taitungensis*)现仅局限分布于台东海岸山脉与红叶村的珍稀濒危物种。1997年开始名列IUCN红色名录之受威胁等级, 2009年因受到入侵生物白轮盾介壳虫危害导致族群下降, 提升为濒危等级。遗传研究显示二族群遗传分化低, 然而, 因族群下降, 需要针对此濒危物种加强保育管理。台湾保育管理单位已审慎评估异地保育策略如“种子保存”或是“移植”之可行性。基于此目的, 利用灵敏度高的ISSR和SSR分子标记评估族群遗传变异、界分遗传单位和选取代表个体作为“种子保存”。由台东红叶村采集三亚族群、海岸山脉采集一族群和境外苏铁苗圃样本共356单株进行评估, 分子变方分析显示ISSR和SSR结果分别有29.20%和9.45%变异存在于族群间。主坐标分析结果显示境外苏铁苗圃样本来源为台东红叶村之I亚族群。利用STRUCTURE程序之MCMC仿真分群方式, 使用混合和非混合模型方式进行每一分群重复10次分析, 以获得最佳分群数, 此最佳分群结果可视为不同遗传单位之界分, 来做为就地或异地保育管理策略使用。

## (15) Observations on serious threats to *Cycas beddomei* Thiseleton-Dyer endemic and critically endangered species in its natural habitat Tirupati-Cudapa Hills of Andhra Pradesh, India

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The present paper deals with serious threats to *Cycas beddomei* Thiseleton-Dyer, the only species of *Cycas* included in Appendix I of CITES endemic to Tirupati-Cudapa (Sheshachalam) Hills in Andhra Pradesh of India. I have been visiting the localities of *C. beddomei* for the last twenty-two years. The threats to this species fall in two categories, viz. anthropogenic and natural. The anthropogenic threats are in form of habitat destruction because of developmental activities in the religious centre of profound importance, like construction of dams and laying of huge drinking water pipelines, creation of metallic roads for connectivity, establishment of aero-turbine towers for augmented power generation and establishment of educational centre amid natural habitat of this important species. At the same time cutting adult plants for medicinal purpose is further reducing the population. The natural threats are in form of hemipteran scale *Saissetia coffeae* and lepidopteran butterfly *Chilades pandava* in its natural habitat. The persistent occurrence of *Saissetia coffeae* and massive infestation by *Chilades pandava* may prove fatal in the future. The occurrence of these devastating pests was found more in shady places having plantation of tall species which provide favorable niche. Though Government of India has established Sheshachalam Biosphere Reserve encompassing about 8000 km<sup>2</sup> in year 2010 which may mitigate the anthropogenic threats to some extent, the scattered population of this species is open to vagaries of serious natural threats. Remedial steps are urgently needed before the malady of *C. micronesica* of Guam is repeated in case of *C. beddomei* in India.

### 特有和极度濒危种——*Cycas beddomei*在其自然栖息地印度安得拉邦蒂鲁帕蒂市古德伯山的受威胁状况观察

本文对*Cycas beddomei*的严重受威胁状况进行了介绍。*Cycas beddomei*是苏铁属唯一被列入CITES（濒危野生动植物国际贸易公约）附录1的物种，印度安得拉邦蒂鲁帕蒂市-古德伯山特有种。笔者在过去的二十二年里对*C. beddomei*的栖息地进行了访查，将其受威胁原因归纳为两个方面，即人为因素和自然因素。人为因素威胁主要为栖息地破坏，如宗教活动，建设大坝和铺设巨大的饮用水管道，创建连通的金属管路，为了扩充发电量建立航空涡轮机高塔以及在这一物种的自然栖息地建立教育中心。同时，以药用目的砍伐成年苏铁植株使得*C. beddomei*种群的数量进一步减少。自然威胁表现为半翅类昆虫（hemipteran）咖啡硬介壳虫（*Saissetia coffeae*）和鳞翅目蝶曲纹紫灰蝶（*Chilades pandava*）在其自然栖息地的大量繁殖。曲纹紫灰蝶的持久发生和大量咖啡硬介壳虫（*Saissetia coffeae*）的持续不断虫蛀现象有可能导致了该物种种子不育。这种毁灭性害虫通常发生在以盈利为目的种植的高大植物荫蔽附近。虽然印度政府已经在2010年建立面积共约8000平方公里的Sheshachalam生物保护区，可以在一定程度上减轻人为因素的威胁，但*C. beddomei*零散的种群分布始终将面对严重的自然威胁。因此，迫切需要采取一些补救措施以防*C. beddomei*重演关岛的*C. Micronesica*悲剧。



## (16) Integrated Conservation of Ancient Plants (ICAP)

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Cycads are remnants of the most ancient group of higher plants, with origins dating to the late Carboniferous period (300 MYA). Many of the c. 300 species / subspecies exist as small, isolated populations in transformed habitats. Horticultural interest has stimulated cycad research but also increased (often illegal) wild-sampling for landscaping and collections. A combination of unsustainable harvesting, ecological changes and complex life cycles has contributed to c. 23% of cycad species being critically endangered or endangered and 15% listed as vulnerable (IUCN Red List, 2010). The IUCN Cycad Specialist Group (CSG) 'Status Survey and Conservation Action Plan - 2004' has called for urgent conservation action through: (1) integration of *in situ* and *ex situ* approaches; (2) generation of scientific understanding; (3) enhanced host country conservation capacity; (4) knowledge transfer to the public and greater establishment of community nurseries.

With the support of many members of the CSG, the State Forestry Administration in China, the Scientific Authority in RSA, the CITES authority in Thailand, UNEP-WCMC, BGCI, etc, we are developing a global project that aims to resolve outstanding challenges in the production, conservation and use of cycad seeds. Approaches include research on seed production *in situ* and *ex situ*, seed handling *ex situ* for conservation and nursery use and optimised handling of pollen. Our main focus initially will be on the characterisation of seed storage biology of c. 20 species, germination enhancement methods and embryo cryopreservation. The work will support many Aichi Biodiversity Targets, including 'safeguarding species' and 'building scientific capacity.'

### 古老植物的综合保护 (ICAP)

苏铁类是最古老的高等植物的孑遗, 其起源可追溯至石炭纪晚期(3亿年前)。现存的约300种的苏铁大多数种群小且间断, 分布在改变后的栖息地。园艺方面的应用促进了苏铁的研究, 但也增加了园林和标本收集方面对野外个体的采样(通常是非法的)。在不可持续性的采挖、生态的变化和复杂的生活史这些因素的共同影响下, 23%的苏铁处于极度濒危或濒危状态, 15%处于低危状态(IUCN红色名录, 2010)。自然保护联盟苏铁专家组(CSG)的“现状调查及保护行动计划-2004年”紧急呼吁通过以下方式开展保育活动: (1)整合就地保育和迁地保育; (2)拓展科学认识; (3)增强原产国的保育能力; (4)向公众传播知识和建立大型社区苗圃。

在自然保护联盟苏铁专家组众多成员、中国国家林业局、RSA的科学机构, 泰国濒危物种进出口(CITES)管理局、环境规划署养护监测中心(UNEP-WCMC)、植物园国际保护组织(BGCI)等机构的支持下, 我们正在开发一个全球性的项目, 旨在应对苏铁种子的生产、保存和使用方面的严峻挑战。所采用的方法包括就地和迁地种子生产的研究、用于迁地保育和苗圃种植的种子处理以及花粉的优化处理。本研究初期的重点是研究约20个种的种子保存生物学, 包括提高发芽率的方法和胚胎冷冻保存。这项工作将支持许多爱知生物多样性目标(Aichi Biodiversity Targets), 包括“维护物种”和“科学能力建设”。

## December 3

### Plenary Talk 2

#### (17) Cycads: Then and now

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Because much of the overall diversity of Cycadales are represented by fossils, integrating fossil taxa into explicit phylogenetic hypotheses is important for understanding cycad evolution. Therefore, character and minimum age mapping were performed on a phylogeny of extant and fossil taxa. Anatomical features are well preserved in many fossil cycads and many of these structural elements are also found in extant cycads. Thus, we can determine both the occurrence and timing of anatomical features and morphological transformations in the history of cycads from the Permian to the Present. These results suggest that major extant lineages of Cycadales had diverged by the Permian to Triassic and that certain synapomorphies for Cycadales had evolved by the Permian. Evidence of insect feeding on *Antarcticycas* suggests that associations between cycads and insects are ancient and date minimally from the Middle Triassic.

#### 苏铁类植物：过去和现在

由于苏铁目的整体多样性基本上可以化石上表现出来，因此将苏铁化石分类群整合到清晰的系统发育假说中对于认识苏铁类植物进化就显得尤为重要。本研究利用特征和最小年龄图谱展示了现存和化石的苏铁分类群的系统发育关系。很多解剖特征都很好地保存在苏铁化石中，而其中的很多特征也同样出现在现存苏铁类植物中。我们从而可以据此判断出从二叠纪至今的一些苏铁类植物解剖学特征及形态特征改变是何时出现的。研究结果显示苏铁目现存类群的分化大约发生于二叠纪到三叠纪，而苏铁目的同源形状在二叠纪就已经分化形成。以 *Antarcticycas* 为食的昆虫证据表明苏铁和昆虫之间的联系自古就有，且最迟可追溯到中三叠纪。

## Session 4: Taxonomy II / Economic Botany I

### (18) A taxonomic revision of *Cycas* L. in China

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Since 1991, detailed field and herbarium work on cycads have been dramatically carried out in China, and some molecular biological studies of Chinese cycads have been done by the authors and others at home and abroad. About 35 new taxa have been described from China, and more publications on Chinese cycads have appeared. It is necessary for us to make a taxonomic revision on the genus *Cycas* within China. The authors treat taxonomic species of cycads in comprehensive characters with their geography, and following three principles, i.e. 1) to be provided with at least a pair of morphologically distinct relative-character; 2) the existence of a population(s) entity in the wild, not individual specimen only; 3) the existence of its own distributional area in geography. These three essential factors are closely related and mutually dependent, and an inevitable outcome for any species coming into being in time and space. Among the 50 valid named species, 23 species of *Cycas* in China are recognized in the paper. They are *Cycas balansae*, *C. bifida*, *C. changjiangensis*, *C. debaoensis*, *C. diannanensis*, *C. dolichophylla*, *C. fairylakea*, *C. ferruginea*, *C. guizhouensis*, *C. hainanensis*, *C. hongheensis*, *C. multifrondis*, *C. multipinnata*, *C. panzhihuaensis*, *C. pectinata*, *C. revoluta*, *C. segmentifida*, *C. sexseminifera*, *C. simplicipinna*, *C. szechuanensis*, *C. taitungensis*, *C. taiwaniana* and *C. tanqingii*. They come to four sections of five sections in the world, among them, the Section *Panzhihuaenses* is D.Y. Wang's conception, not K.D. Hill's limit. Distribution of all species is mapped, and a key to the species is provided. Color photos are provided for most species. Conservation status is discussed.

### 中国苏铁属分类学修订

自1991年以来, 本文作者及其它海外学者, 对中国的苏铁深入开展了大规模的野外考察、标本室研究及对某些类群进行了分子生物学等研究, 共报道了大约32个新种和其它的一些类群。本文作者认为, 现在有必要对中国苏铁属进行一次分类学修订。作者采用综合性状分析方法, 遵循我们的苏铁分种三条原则, 即: 1) 在形态上有一对以上相关的区别特征; 2) 在野外存在野生居群实体(这有时要在检查标本之后很久才得到证实); 3) 在地理分布上有自己的分布区。这三者缺一不可, 相互联系, 是物种长期形成的时空条件必然结果。在中国文献有效记载的50种中, 本文承认23种, 即宽叶苏铁(*Cycas balansae*)、叉叶苏铁(*C. bifida*)、葫芦苏铁(*C. changjiangensis*)、德保苏铁(*C. debaoensis*)、滇南苏铁(*C. diannanensis*)、长叶苏铁(*C. dolichophylla*)、仙湖苏铁(*C. fairylakea*)、锈毛苏铁(*C. ferruginea*)、贵州苏铁(*C. guizhouensis*)、海南苏铁(*C. hainanensis*)、灰干苏铁(*C. hongheensis*)、多羽叉叶苏铁(*C. multifrondis*)、多岐苏铁(*C. multipinnata*)、攀枝花苏铁(*C. panzhihuaensis*)、篦齿苏铁(*C. pectinata*)、苏铁(*C. revoluta*)、叉孢苏铁(*C. segmentifida*)、石山苏铁(*C. sexseminifera*)、单羽苏铁(*C. simplicipinna*)、四川苏铁(*C. szechuanensis*)、台东苏铁(*C. taitungensis*)、闽粤苏铁(*C. taiwaniana*)及绿春苏铁(*C. tanqingii*)。还有些种有待进一步研究。中国的苏铁种分别隶属于全世界五个组中的四个。其中攀枝花苏铁组不是K.D. Hill所定义的组, 而是王定跃概念的组。所记载的种都附有分布图及分种检索表。大部份种附有彩照, 对保护现状也有讨论。

## (19) DNA barcoding of Africa's endemic cycads: *Encephalartos* Lehm. and *Stangeria* (Kunze) Baillon

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Africa's cycads (66 species and 2 subspecies in two endemic genera: *Encephalartos* and *Stangeria*) are extremely endangered with four species Extinct in the wild and 80% threatened (CR, EN, or VU) with all included in CITES appendix 1. Although South Africa has some of the world's strictest cycad legislation, cycads are still under threat from illegal collection for horticulture and medicine especially where plants seized in an unidentifiable condition. Currently developed legislation demands accurate identification for permit issuing. *Ex situ* conservation of genetic and locality based diversity is paramount. Furthermore, taxonomically many species of unknown origin are difficult to identify especially when diagnostic characters are absent. Species delimitation and numbers are uncertain with field observations often contradicting current understanding. DNA barcoding can assist in all the above-mentioned scenarios and as such all proposed DNA barcoding regions (*matK* + *rbcLa* + *psbA-trnH*, nrITS) along with several additional regions were tested for all species encompassing ~350 samples. Results will focus on amplification success and discriminatory power of the different markers.

### 非洲特有苏铁的DNA条形码研究：非洲铁属和蕨铁属

非洲有两个苏铁特有属非洲铁属 (*cephalartos*) 和蕨铁属 (*Stangeria*)，包括66个种和2个亚种，均处于极濒危状态，4个种已在野外灭绝，80%的种类受到威胁 (CR, EN, 或VU)，全都收录于CITES附录I。虽然南非拥有一些世界上最为严格的保护苏铁的法律，当地苏铁仍然受到非法采集 (用于园艺和药材贸易) 的威胁。当前，准确识别苏铁植物是制定完善的保护法规的前提。迁地保护和就地保护对非洲苏铁至关重要。另外，应用分类学特征难以鉴定那些未知来源的种类，尤其是缺乏诊断特征时。当野外观测结果与目前的了解发生冲突时，种的划分是难以确定的。DNA条形码有助于解决上述难题。本研究测定了南非及临近地区350份苏铁样品的多个DNA条形码片段 (*matK+rbcLa+psbA-trnH*, nrITS)，进行了数据分析，讨论了各个条形码片段扩增成功率以及它们各自的辨识能力。



## (20) Genetic diversity among the Indian *Cycas* species based on RAPD markers

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Random amplified polymorphic DNA (RAPD) markers were used to discriminate and construct the genetic relationship between ten species of Indian *Cycas*. In the present study, twenty oligonucleotide decamer primers were screened and six primers were selected to analyze the polymorphism in *Cycas* species. Among the six primers, five primers generated polymorphic bands. A total number of fifty three amplified products of 100-1200 bp were generated. To analyze the genetic relationship among species, the genetic similarity (GS) values between pairs of samples were determined according to Jaccard's coefficient and the data was subjected to generate dendrogram using UPGMA method of the software NTSYS pc. The RAPDs analysis clearly differentiated the Indian cycads in to two clusters with five clades. Similarity index between the species ranged from 0.11 to 0.62 with 98.1% polymorphism. The dendrogram of RAPD was in conformity with morpho-anatomical characters and geographical distribution.

### 基于RAPD标记的印度苏铁属遗传多样性分析

用随机扩增多态性DNA标记 (RAPD, random amplified polymorphic DNA) 对印度分布的苏铁属10个种间的遗传多样性进行了分析。本研究从20个随机多态核苷酸序列(长度为10个碱基对)筛选引物, 以分析苏铁属物种的基因多态性, 共筛选出6个引物, 其中5个引物在最终的实验中呈现多态性。在100-1200 bp之间产生了53种条带。随后分析了苏铁属种间的遗传关系, 依据Jaccard系数得出样品间的遗传相似度, 然后由NTSYS软件通过UPGMA法构建系统树。结果表明, 印度的苏铁属植物明显分为两大组, 每组均有五个小分支。种间相似系数为0.11-0.62, 多态性达98.1%。由RAPD构建的系统树状图与形态解剖和地理分布状况一致。

## (21) A phylogeny of *Zamia* based on four single-copy nuclear genes

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*Zamia*, a cycad genus restricted to the neotropics, is comprised of approximately 70 species and is widely considered 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 80% of the currently accepted species in the genus. Phylogenetic relationships were examined using maximum likelihood and maximum-parsimony methods based on the sequences of the single-copy nuclear genes: Cy-AGAM (*Cycas Agamous*), a C MADS-box gene thought to control reproductive organ identity; PEX4, a gene encoding for a peroxisomal ubiquitin conjugating enzyme; PMP22, a gene encoding for a peroxisomal membrane 22 kDa family protein; and ATG2, a gene encoding for a metalloproteinase M24 family protein. PCR protocols for these genes have been developed at the labs at the USDA and FTBG. Major clades and novel phylogenetic relationships are discussed within the context of biogeography and comparative macromorphology.

### 基于四个单拷贝核基因的泽米铁属谱系发育

泽米铁属 (*Zamia*) 仅分布于新世界热带地区, 大约有70种, 是苏铁目中形态特征和生态类型变化最丰富的属。本研究选取泽米铁属中已被大家公认的大部分种 (涵盖整个属80%以上的种类), 测定4个单拷贝核基因的分子序列, 并使用似然法和最大简约法分析了它们之间的谱系发育关系。4个基因分别是: Cy-AGAM (*Cycas Agamous*), 其是与调控花发育相关的C MADS box转录因子; PEX4, 编码过氧化物酶泛素结合酶的相关基因; PMP22为一个过氧化物酶体膜22 kDa的蛋白家族成员的编码基因; ATG2为metalloproteinase M24家族蛋白编码基因。在美国农业部USDA和FTBG的实验室已成功获得这些基因的PCR检测方案。该文还应用生物地理学和宏观形态学比较的方法讨论了基于上述基因片段建立的泽米属的主要支系和新建立的亲缘关系。

## (22) A molecular phylogeny of *Encephalartos* Lehm.

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*Encephalartos* is an African endemic cycad genus of 65 species and 2 subspecies and is the most endangered group of cycads with 80% considered threatened (CR, EN, or VU) by the IUCN and all classed as CITES appendix 1. Currently relationships within the genus, including species delimitation, are uncertain and in need of taxonomic investigation. Most studies to date have used a combination of more traditional lines of evidence such as morphology, anatomy and geography. Also no all-inclusive phylogenetic framework currently exists for *Encephalartos*. In the current study, DNA sequence from three plastid regions (*rbcLa*, *psbAtrnH* and *matK*) along with the nuclear region ITS were used to produce a phylogeny using multiple accessions per species where possible. Results show an increase in resolution at both species and higher level and the delimitation of several new groupings. Each species grouping is characterised by shared derived morphological, ecological, and geographic characters. This study provides the first steps towards a much-needed monograph of the entire genus.

### 非洲铁属的分子系统发育

非洲铁属(*Encephalartos* Lehm.)是非洲特有的苏铁植物, 包括65个种和2个亚种。该属是苏铁植物中最濒危的类群, 80%的种被国际自然保护联盟认为受到威胁(CR、EN或VU), 全部被收录入《濒危绝种野生动植物国际贸易公约》附录I中。当前该属物种间的关系以及种的界限并不清晰, 且缺乏系统的调查研究。前人主要从形态学、解剖学以及地理学数据研究苏铁植物, 未曾揭示非洲铁属的系统发育关系。本研究通过测定叶绿体基因片段(*rbcLa*, *psbAtrnH*和*matK*)和细胞核ITS基因片段的序列, 构建了非洲铁属的分子系统发育树。该发育树能够较好地分辨属内的物种, 以及它们所属的组群, 且发现了数个新的组群。每个类群均具有相似的形态学、生态学以及地理学特征。此研究为该属专著编写奠定了基础。

## (23) Quantifying the trade in cycads (*Encephalartos* species) in the traditional medicine markets of Johannesburg and Durban, South Africa.

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Cycads have been used for traditional purposes for centuries. In South Africa, *Encephalartos* species are traded for traditional medicine (TM) in local TM markets. South African cycads are facing an extinction crisis, primarily due to collecting for the horticultural trade. The trade in *Encephalartos* for TM also impacts several species, and is largely understudied. In this study, the trade in *Encephalartos* for TM was quantified in South Africa's two largest TM markets, Faraday in Johannesburg and Warwick in Durban. Harvesting *Encephalartos* for TM involves the removal of bark strips and/or whole stem sections. *Encephalartos* species were sold at 26% and 13% of the stalls at Faraday and Warwick respectively, with an estimated 9.0 metric tonnes traded at Warwick in 2009. Stem samples purchased in the markets were assigned to stem diameter size classes using a size class chart, and regression analysis was used to validate the allocations. Mostly sub-adult and adult cycads are harvested, and it appears that bark strips are removed from larger arborescent plants, whereas smaller individuals and subterranean-stemmed species are harvested by removing the entire plant. There is generally a strong positive relationship between stem diameter and leaf base length as well as stem diameter and pith radius. The former can be used as a predictor of stem diameter size class for market samples that prove difficult to assign to diameter classes. Overall, this is the first study to quantify the trade in *Encephalartos* for TM in South Africa with reference to the size classes of the plants traded.

### 非洲铁属植物在南非约翰内斯堡和德班传统药材市场的贸易量化分析

人们使用苏铁植物的传统已经有几个世纪的历史了。在南非，非洲铁属(*Encephalartos*)植物作为传统药材在当地传统药材市场上交易。由于对苏铁植物的大量采集以用于园艺贸易，苏铁植物正濒临灭绝。另外，非洲铁属植物的传统药材贸易也是其面临灭绝的重要原因，这影响了非洲铁属几个种的生存状况。本文对南非最大的两个传统药材市场约翰内斯堡的法拉第市场和德班的沃里克市场进行非洲铁属植物的传统药材贸易进行了评估。获取非洲铁属植物的药用部分要剥下树皮和整个茎干部分。在法拉第市场和沃里克市场的摊位上，非洲铁属植物的销量分别占26%和13%，其在2009年沃里克市场的成交量大概在9.0公吨。我们在市场上购得茎干样本，并依照尺寸等级表对其直径进行等级分配，并且用回归分析法验证分配。大部分未成熟和成熟的苏铁植物都在采伐之列，较大的树状植株被剥去树皮，而较小的植株和地下茎种类就被整株拔起。通常茎的直径和叶基的长度以及髓的半径都有很强的正比关系。前者可以用来对难以确定茎直径等级的市场样本进行预测分类。综上所述，这是首次根据市场交易的植株的尺寸等级来评估南非传统药材市场的非洲铁属植物贸易的研究。



## Session 5: Ecology II / Toxicology

### (24) Thermogenesis of cycad cones in several *Cycas* species and implications for pollination

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Thermogenesis occurs in reproductive structures of plant species in several basal clade angiosperm families and has been reported in almost all cycad species that have been examined. We measured the thermogenesis-related temperature elevation magnitude and diel timing in several species of *Cycas* growing at Montgomery Botanical Center (MBC) and compared those results with thermogenic profiles of previously reported cycad species. We also compared thermogenic properties of several species within the *C. rumphiae* complex, i.e., those species with an expanded layer within the seed that helps the seed float in water thus allowing oceanic dispersal. The *C. rumphiae* complex species examined thus far include *C. micronesica*, *C. thouarsii*, *C. rumphii*, *C. edentata* and *C. bougainvilleana*. In addition, we compared the thermogenesis profile of male cones of *C. micronesica* grown at MBC that are well managed with fertilizer and water to that of *C. micronesica* cones growing in their native habitat on the island of Guam to determine whether garden management affects thermogenesis. We will report on these findings and then review some of the proposed roles of thermogenesis in plants with a focus on potential functions related to the pollination phase of cycads.

#### 几种苏铁球花产热现象及其与传粉的关系

生殖器官产热, 是植物生殖发育过程中的一个特殊现象。被子植物中仅有数个基部科的植物存在该现象, 但几乎所有的苏铁类植物均具有此现象。本文以蒙哥马利植物研究中心苏铁属的数个物种为材料, 测定了它们生殖过程中球花的产热现象, 比较了该结果与前人报道的异同。同时比较了 *Cycas rumphiae* 复合体中数种苏铁球花产热的特性, 包括 *C. micronesica*、*C. thouarsii*、*C. rumphii*、*C. edeniaia* 和 *C. bougainvilleana* 四种苏铁。另外, 还比较了原产地和蒙哥马利研究中心栽培条件下 *C. micronesica* 球花产热现象的差异, 以期揭示人工栽培是否影响球花产热现象。本文将汇报这些发现, 介绍植物生殖产热的作用, 并探讨生殖产热在苏铁授粉过程中可能起到的作用。

## (25) The physiology of cycads: leaf structure, hydraulics, nutrition, and photosynthesis

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Cycads are the most ancient living seed plant lineage, and named living fossils because of the morphological similarity between fossil and extant species. However, there is little information on the physiology of cycads. We studied leaf structure, hydraulics, nutrition and photosynthesis in 11 species from two cycad families (family Cycadaceae and Zamiaceae) in a common garden. The studied cycad species varied greatly in leaf mass per area (LMA), major nutrient concentrations, maximum photosynthetic rate and hydraulic conductance. Assuming that variations in these leaf traits are of adaptive nature, it may help to explain the dominance of cycads across numerous habitats since the Mesozoic. No differences were found between the two families in all the leaf functional traits measured, but species of wet and dry habitats showed different water use strategies. Across species, light-saturated photosynthetic rate was correlated with LMA and leaf concentrations of N, Fe, S, and Zn, but not with leaf hydraulic conductance. The relationships among leaf functional traits of cycads generally agreed with those of angiosperms. However, cycads tended to have relatively low photosynthetic nitrogen use efficiency.

### 苏铁生理学：叶片结构、水分运输、养分和光合作用

苏铁是现存种子植物家族中最古老的一员，由于其形态与化石和现存物种类似而被称为活化石。但是，人们对苏铁的生理学还知之甚少。我们对来自于植物园栽培的两科（苏铁科和泽米科）11种苏铁植物的叶片结构、水分运输、养分和光合作用进行了研究。测定的11种苏铁在叶片比叶重、最大光合速率、主要养分含量和叶片传导水分能力上都表现出很大差异。假定这些结构和功能上的多样性代表了苏铁类植物对不同生境的适应，那么这些结果可以有助于解释苏铁自中生代开始成为优势类群的原因。该两个科的苏铁在所测定功能特征上没有差异，但是分别来自潮湿和干旱生境的物种在水分利用策略上存在差异。不同的物种之间，叶片最大光合能力和比叶重、叶片养分含量（N、Fe、S、Zn）相关，但是和叶片传导水分能力不相关。总体而言，苏铁类植物叶片功能性状之间的关系同被子植物大致相同，但是苏铁类植物的光合作用氮素利用率较低。

## (26) An overview of the role of cone volatiles in the pollination ecology of *Encephalartos*

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Ever since the role of insects in cycad pollination was first proposed by Pearson (1906) there have been questions about the role that cone volatiles play in mediating the interaction between cycads and their insect pollinators. A series of studies over the past five years have greatly increased knowledge on the volatiles occurring in *Encephalartos* and their potential role in influencing pollinator behaviour. This paper examines the advances made in these studies and how they affect our interpretation of cycad pollination ecology. The analyses show that several compounds in *E. villosus* attract pollinators and provide the first evidence of pollinators attracted to traps baited with particular volatile compounds. The review also shows how the composition of cone odour can vary across the distribution of a species with no apparent change in pollinators. The paper examines convergence in cone odours between species occurring in the same area and puts these results into context with other studies of cycad pollination.

### 非洲铁属球花挥发性物质在传粉中的作用

自皮尔逊(1906年)首次报道昆虫参与苏铁授粉以来,关于球花挥发性物质协调苏铁类植物和昆虫授粉者之间的相互作用的问题,一直倍受大家的关注。最近五年,研究者开展了一系列的工作,提高了人们对非洲铁属球花产生的挥发性物质在影响昆虫传粉行为方面所起潜在作用的了解。本文对这些研究进展进行了综合概括,归纳了球花挥发性物质释放在对苏铁传粉生态中可能起到的作用。相关研究表明,非洲铁雄球花可释放数种能吸引昆虫的化学物质,并已用实例证明这些挥发性物质确实能够吸引昆虫。研究还发现不同分布地区的同一种苏铁,其球花所产生的挥发性物质会有所变化,但同样会吸引传粉者来访。本文还对比了同一地区不同苏铁之间球花挥发性物质成份的共性和差异,并借鉴前人报道的有关结果,进行了综合的比较和分析。

## (27) Examination of diel metabolic, thermogenic and volatile activity of *Macrozamia macleayi* and *lucida* cones: methodology and correlations

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During the pollination phase of *Macrozamia macleayi* and *M. lucida*, both pollinated solely by the thrips *Cycadothrips chadwicki*, cones have a diel thermogenic episode over 10-14 days. Metabolism increases, cone temperature increases, and volatile emissions increase dramatically over a several hour period and then subside. We have developed methods to measure all of these traits simultaneously and we report here our methodology and the results of these measurements. We also examine and propose how and why these traits are correlated and demonstrate how these traits change as cones mature during their pollination phase. Finally we discuss how some of these traits affect thrips behavior.

### *Macrozamia macleayi* 和 *M. lucida* 球花昼夜代谢强度、温度变化和挥发性气体排放的研究

*Macrozamia macleayi* 和 *M. lucida* 在传粉时期，仅发现一种传粉昆虫——蓟马 (*Cycadothrips chadwicki*)，在传粉过程中在10-14天时间内球果有昼夜温度变化。在几个小时内，球花代谢增强，锥温度升高，气体挥发排放量剧增，后消退。本文作者已设计出同时测量这些特性变化的方法，在这里介绍我们的方法论和这些测量的结果。我们也对这些性状之间的相关关系进行了探讨和解释，并阐明这些性状在授粉阶段球花成熟过程中的变化。最后，我们也讨论了这些特征如何影响传粉蓟马的行为。



## (28) Weevils in the cones of Asian *Cycas*: their phylogeny based on analysis of the 16S rRNA mitochondrial gene

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Two types of beetles are commonly found on cones of *Cycas* in Asia and are believed to be involved in pollination: 1) beetles in the family Erotylidae and 2) weevils in the *Tychiodes* genus complex (family Curculionidae). The mitochondrial gene 16S rRNA was sequenced in a sample of these beetles. Preliminary results indicate that the weevils consist of 7 lineages, each possibly deserving to be recognized as a distinct genus. The basal lineage of the weevils appears to be confined to the Philippines, suggesting that this may be their center of origin.

## 亚洲苏铁属球花中的甲虫的谱系发育—基于16S rRNA线粒体基因序列

在亚洲地区, 通常在苏铁的球花中发现两种类型的甲虫, 并被认为参与了苏铁的传粉活动, 一类隶属于大蕈甲科的甲虫, 另一类属于象甲科悦象属复合群的象鼻虫。本实验测定了这两类甲虫线粒体基因组16S rRNA基因片段并进行了分子谱系发育分析。初步分析表明, 这些甲虫可以划分为7个支系, 每一个支系均可以作为一个独立的属。基部的支系来自菲律宾, 暗示可能是这些甲虫的起源中心。

## (29) Sleep alterations in a cycad model of Parkinsonism

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Epidemiological studies elucidated a link between the Guamanian variant of Amyotrophic Lateral Sclerosis/Parkinsonism Dementia Complex (ALS/PDC) and consumption of flour from the washed seeds of the plant *Cycas micronesica* (cycad). When cycad flour is fed to outbred Sprague-Dawley rats, they develop Parkinsonism including motor behavioral deficits and biochemical abnormalities in neurons and glia including  $\alpha$ -synuclein accumulation in the substantia nigra pars compacta (SNc). Behavioral deficits are progressive, 36 weeks after cycad exposure; cycad-fed rats display a significant loss of dopaminergic neurons in the SNc and the presence of  $\alpha$ -synuclein aggregates, a classical histological hallmark of Parkinson's disease (PD) (Shen *et al.*, 2010). Changes in sleeping habits, particularly hypersomnolence, are an early symptom in PD. Here we present a further analysis of non-motor symptoms in sleep/wake patterns in cycad-fed rats. Cycad-fed rats exhibited an increase in length and/or number of bouts of rapid eye movement sleep (REM, 38.9%) and Non-REM sleep (NREM, 24.9%) at the expense of wakefulness during their active period when compared to control rats. This hypersomnolent behavior suggests an inability to maintain arousal. In addition, cycad-fed rats had significantly fewer orexin cells in their hypothalamus. Orexin neurons are involved in maintaining wakefulness and a similar loss of orexin neurons has been found in Parkinson's disease. This change in arousal occurred before the cycad-induced motor symptoms occurred. Similar findings of hypersomnolence occurred in the Chamorro with ALS/PDC. Our results reveal a novel rodent model of Parkinsonism that includes a non-motor symptom of loss of arousal and orexin neurons.

### 帕金森氏症苏铁模型中的睡眠变化

流行病学研究表明，肌萎缩性侧索硬化/帕金森氏痴呆综合征（ALS/PDC）的关岛变异和苏铁属植物 *Cycas micronesica* 洗涤过的种子制成的粉末所引起的肺病有联系。用苏铁植物粉末饲养远亲后代小白鼠，它们会出现一系列帕金森氏症状，包括自主行动障碍、神经元生物化学畸形以及包括神经胶质  $\alpha$ -突触蛋白在内的神经胶质在黑质致密部分积累（SNc）。小鼠的行动障碍是在苏铁植物饲养36周后逐渐出现的；用苏铁植物喂养的小鼠呈现出显著的SNc神经元细胞的缺失以及  $\alpha$ -突触蛋白的积累，这些都是帕金森氏症（PD）的典型组织学特征（Shen *et al.*, 2010）。在睡眠习惯方面变得特别嗜睡，也是帕金森氏症的早期症状。我们展示了关于睡眠/清醒状态的苏铁植物饲养小鼠的行动障碍症状的进一步分析。与对照组相比，苏铁植物喂养的小鼠不能在活跃期保持清醒，出现快速眼动睡眠（REM, 38.9%）和非快速眼动睡眠（NREM, 24.9%）的时间增加和/或发作次数增多。这种行为说明它们不能维持清醒状态。此外，苏铁植物喂养的小鼠下丘脑中食欲素细胞显著减少。食欲素神经元能维持清醒状态，而在帕金森氏症中就可以发现类似食欲素神经元的缺失。清醒状态的变化发生在苏铁植物抑制行为的症状发生之前。相似的嗜睡症状在患有ALS/PDC的查莫洛人中也有发现。本研究结果揭示了帕金森氏症表现出的包括嗜睡和食欲素神经元的减少的非自主性症状的啮齿类动物的异常模型。

## Session 6: Conservation II / Horticulture

### (30) Comparative analysis of biochemical and molecular markers efficiency to sex identification in *Ceratozamia mexicana* Brongn.

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*Ceratozamia mexicana* Brong. (Zamiaceae) is an endemic threatened cycad which is located in the center of the Veracruz state. They are dioecious plants by what the sex of these plants only can be recognized when the same ones reach its reproductive maturity that can be around of 15-20 years. Little is known about the sex determination in cycads. Based on the utility of molecular markers for this purpose in various plant species it was assessed the potential usefulness of various biochemical markers (total protein and esterase activity, polyphenoloxidase, amylase and acid phosphatase) and molecular (RAPD, ISSR) for sex discrimination in this species. The results showed that the molecular markers has a greater sex discriminatory than the biochemical markers. RAPD markers showed high levels of polymorphism, assay efficiency index (Ai) and marker index (MI), greater than the ISSR markers. These results may be useful to establish efficient strategies to early sex identification for conservation and sustainable management of this species.

### 生物化学和分子标记比较分析鉴定*Ceratozamia mexicana* Brong.的性别

*Ceratozamia mexicana* Brong.是一种受威胁的角状泽米属植物, 仅分布于墨西哥维拉克鲁斯州中心区。苏铁类植物是雌雄异株, 但只有当植株成熟(从播种伸张出幼苗到大概15到20年后才算成熟)后能通过外观特征分辨出植物的雌雄, 很少能通过植物内部机体辨别出雌雄。在苏铁类中, 至今仍未找到一个有效的方法能在植物生长初期分辨其性别。我们用分子标记和生化标记比较雌雄株差异以鉴定性别。生化方法指标主要是总蛋白和酯酶的活性、多酚氧化酶、淀粉酶和酸性磷酸酶等, 分子方法主要采用RAPD, ISSR等。实验结果表明分子标记法比生物化学法涵盖更多有效鉴定信息。分子标记方法中, 通过计算有效指标(Ai, assay efficiency index)和记号指标(MI, marker index)都说明RAPD标记比ISSR标记多态性更高。这些结果能够建立有效的方法在早期对苏铁的性别进行鉴定, 从而对物种的保护和可持续管理有重大意义。

### **(31) Resources investigation on *Cycas guizhouensis* from Guizhou Cycas Nature Reserve**

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Based on existing investigations, the current research aims to investigate the resources of the *Cycas guizhouensis* from Guizhou Cycas Nature Reserve, using transect survey and fixed-spot observation. With 11 populations and 6,700 individuals of *Cycas guizhouensis*, Guizhou Cycas Nature Reserve holds the most abundant wild populations and acts as a distributed center of the species. The result shows Guizhou Cycas Nature Reserve is of significant conservation value.

#### **贵州苏铁自然保护区贵州苏铁资源调查**

在历次调查的基础上，采用样方和定点调查相结合的方法，对贵州苏铁自然保护区内贵州苏铁（*Cycas guizhouensis*）资源现状进行调查分析。结果显示，保护区目前拥有贵州苏铁11个居群共6700株，是贵州省野生贵州苏铁保存最多、分布相对集中的地区。该保护区具有重要的保护价值。

### **(32) Survey, population study and conservation status of *Cycas pectinata* in Assam, India**

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*Cycas pectinata* was discovered in 1826 by Hamilton from Kamrup district in Assam, India. The species is one of the least studied Indian species of *Cycas*. The paper elucidates the current population status of *Cycas pectinata* in Assam based on the field surveys done during 2007-2011. Based on the field surveys and documentation of sex ratio, viability of the populations, the conservation status of *Cycas pectinata* in the state has been assessed and community based conservation plan is suggested.

#### **印度阿萨姆邦篔齿苏铁的居群研究及保护现状**

汉密尔顿先生于1826年在印度阿萨姆邦的坎如普区发现了篔齿苏铁 (*Cycas pectinata*)。在印度分布的苏铁属植物中, 篔齿苏铁是研究得最少的物种之一。因此, 本文依据2007-2011年的阿萨姆邦野外调查描述了目前篔齿苏铁的居群状况。根据野外考察以及性别比例和遗传多样性记录, 本文评估了篔齿苏铁在阿萨姆的保护地位并提出了基于群落的保护方案。



### (33) A structured analysis of factors affecting low seed germination in *Encephalartos latifrons* Lehm.

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Germination of seeds from hand pollinated cones of *Encephalartos latifrons* cultivated at Kirstenbosch National Botanical Garden is typically <10%. Such low germination impacts on conservation programmes for this Critically Endangered cycad and warrants further investigation. In this study, we investigated pollen viability, pollen resorption into the micropyle, growth in the nucellus and fertilization, and compared results between wet and dry pollination methods. We further analysed pollination in relation to periods of droplet formation on the micropyle and studied the effects of seed storage, seed scarification and treatment with gibberellic acid (GA3) on germination. In addition to *E. latifrons*, the same analyses were carried out on *E. altensteinii*, a more common species with comparatively high levels of seed germination (over 75 %). The results show that pollen viability, resorption and growth in the nucellus are comparable between *E. latifrons* and *E. altensteinii* and don't appear to influence seed germination. No differences were observed between wet and dry methods of pollination. Significant effects were observed only between seeds subject to different treatments prior to germination (storage, scarification, GA3). The highest rate of germination as well the best overall response (25%) was recorded in seeds that were scarified and treated with GA3. Although all treatments with GA3 improved germination, the best results were obtained from soaking seeds for 96 hours. The results are discussed in relation to their impact on propagation programmes.

#### 宽羽非洲铁种子低萌发率影响因子的结构分析

康斯坦博西国家植物园栽培的宽羽非洲铁 (*Encephalartos altensteinii*) 通过人工授粉后获得的种子其萌发率一般低于10%，这将严重影响这个备受争议的濒危苏铁物种的保护及其以后的研究工作。本文研究了其花粉活力、花粉穿过珠孔、在珠心生长并完成受精的过程，并比较了干法和湿法授粉结果的差异，进一步研究了与传粉相关的珠孔液滴形成时期、种子贮存、种子松土以及采用赤霉素处理对于种子萌发的影响。除了宽羽非洲铁，我们还采用了同样的方法对另外一种相对更为常见、发芽率较高（大于75%）的宽羽非洲铁进行了研究。研究结果表明2个种的花粉活力、吸收和在珠心生长是相似的且都不影响种子萌发，干法和湿法授粉之间也不存在差异。而种子贮存、种子松土以及采用赤霉素处理等方式对于种子的萌发则影响极大，最高萌发率（整体达到25%）出现在同时采用松土和赤霉素处理的种子中。尽管所有采用赤霉素处理的种子其萌发率都提高了，但最佳结果出现在种子浸泡96个小时的处理。本文就实验结果对繁殖方案的影响进行了讨论。

### **(34) *Microcycas calocoma*: Legacy plant collections, conservation horticulture and economics**

Judy Kay, Arantza A. Strader, Vickie Murphy, Lan Nghiem-Phu, Michael Calonje and M. Patrick Griffith\*

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Horticulture is essential to plant conservation programs, and botanic gardens are uniquely suited for conservation horticulture work. This talk presents a case study of a successful cycad propagation program, using *Microcycas calocoma* as an example. This cycad species is much sought after in the nursery trade, and over-collection of wild plants is considered to be one factor that threatens natural populations. Thus, propagation and distribution of *Microcycas* can offer a strategic contribution to in situ conservation. Provenance history of *Microcycas* living collections is reviewed, and techniques for propagation and establishment are detailed. An innovative botanic garden/industry partnership to provide seed for cultivation is discussed. Finally, we consider market forces with regard to rare plant availability and conservation, using *Microcycas* as an example. Average price per seed has fallen by nearly two thirds since offered on public auction. This inversely correlates with seed supply, which has steadily increased over 15 years, helping to meet the high market demand. We project the cost of nursery-propagated *Microcycas* will fall further to a point where collection from the wild has no further economic incentive.

#### ***Microcycas calocoma*: 植物的收藏、园艺保护和经济价值传承**

园艺栽培是植物保育的重要方法, 而植物园是唯一适合园艺栽培的场所。本文介绍了一个成功的苏铁繁殖案例研究, 选取*Microcycas calocoma*作为试验物种。这种苏铁是苗圃贸易上比较推崇的物种, 同时对野生个体的过度采伐被认为是威胁该物种野外居群数量的一个因素。因此, 小苏铁属 (*Microcycas*) 的繁殖和推广可以为就地保护提供一个工作思路。在考证了收集的小苏铁属植物的种源历史, 并制订了详细的繁殖技术体系, 建立了一种创新的植物园/行业合作伙伴关系, 以提供种子进行繁育。最后, 我们以小苏铁属为例, 评价了市场因素对珍稀植物利用和保护的影响。由于提出公开拍卖, 小苏铁每颗种子的平均价格已经下降了近2/3。这与种子的供应在过去的超过15年内连续稳步上升恰好相反, 有助于满足更高的市场需求。我们预计小苏铁属园艺培育的成本将会进一步降低, 使得野外采集种子无任何经济利益可赚。

## December 4

### Plenary Talk 3

#### (35) Phylogeography and conservation genetics of the Caribbean *Zamia* clade: an integrated systematic approach with SSRs and single copy nuclear genes

Alan W. Meerow<sup>1\*</sup>, Javier Francisco-Ortega<sup>2,3</sup>, Dayana Salas-Leiva<sup>2</sup>, Patrick Griffith<sup>4</sup>, Michael Calonje<sup>4</sup>, Dennis W. Stevenson<sup>5</sup> and Kyoko Nakamura<sup>1</sup>

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The *Zamia pumila* complex (Zamiaceae) is a monophyletic, diploid ( $2n = 16$ ) and distinctive assemblage of cycad populations restricted to the West Indies and Florida that has been treated as comprising one to nine species. We are simultaneously investigating patterns of microsatellite DNA (SSR) and single copy nuclear gene sequence variation in the complex and applying these data to various evolutionary and biogeographic questions. The overall goal is to document patterns of genetic variation and phylogeographic relationships across populations of the *Z. pumila* complex throughout its range, infer its history in the region, and attempt to understand processes of speciation within the group. Populations from Florida, Puerto Rico, Dominican Republic, Jamaica and the Bahamas have already been sampled. Collections on Cuba are scheduled for 2012. Phylogeographic analysis will be conducted, and a phylogenetic approach for evaluating conservation priority in the group will be evaluated. Overall, we hypothesize that patterns of genetic variation and phylogeographic relationships within Caribbean *Zamia* will reflect Quaternary environmental history of the region. Primer pairs for 30 SSR loci have been designed that are successfully capturing polymorphism in *Zamia*. Twelve single copy nuclear genes have been isolated and successfully sequenced from a test panel of Caribbean *Zamia* species. Six of these are so far informative. The simultaneous analyses of two different DNA data sets across organisms that inhabit the gray zone between population and species will offer an unprecedented opportunity to test the convergence of genetics and evolutionary history in a recognized biodiversity hotspot.

#### 泽米属加勒比海支的植物地理和保护遗传学分析一种通过SSR分子标记和单拷贝基因的综合分析方法

泽米铁科的 *Zamia pumila* 复合体是单系的二倍体 ( $2n=16$ )，且仅分布于西印度群岛和佛罗里达州，包括可能1到9个种。我们通过使用微卫星DNA (SSR分子标记) 及单拷贝核基因序列变异来分析复合体以解决进化和亲缘地理上的一些问题。本研究旨在掌握该复合体居群间的遗传变异模式和亲缘地理关系，从而了解该复合体在分布区域内的历史和物种分化进程。取样地点包括佛罗里达、波多黎各、多米尼加共和国、牙买加、巴哈马群岛等地的居群。古巴的样品将于2012年进行取样。本研究将进行亲缘地理分析，并通过系统发育学的研究方法确定优先保护单元。最终，本研究推测通过分析加勒比海地区泽米属的遗传变异模式和系统发育关系可以推断该地区第四纪的环境演化。在泽米属中，已获取30对具有多态性的SSR引物。12个单拷贝基因已经成功分离并测序，其中有6个涵盖大量信息。通过对灰色区域中该复合体居群间和种间不同个体的两种不同DNA信息的同步分析，可为探究已知生物多样性热点区域的遗传趋同以及进化历史提供前所未有的机遇。

## Session 7: Taxonomy & Phylogeny III / Economic Botany / Information Management

### (36) Uncovering the cycad taxa (*Encephalartos* species) traded for traditional medicine in Johannesburg and Durban, South Africa

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The bark and stems of *Encephalartos* species are used for traditional medicine (TM) across South Africa. The absence of characteristic plant parts such as leaves and cones in the chopped up *Encephalartos* material in TM markets presents a major challenge to the identification of the species traded. In this study, South Africa's two largest TM markets were surveyed to ascertain the species of *Encephalartos* in trade. Stem fragment samples were purchased from vendors, identified to probable species and their stem diameter size class distributions determined. Species identification was undertaken by comparing trader citations of harvesting areas with the distributions of *Encephalartos* species in the province of KwaZulu-Natal. The species most commonly recorded were *E. natalensis*, *E. villosus* and *E. ghellinckii*; small quantities of what are likely to be *E. ferox* and *E. senticosus* were also observed. Following this study, the total number of South Africa's 37 *Encephalartos* species recorded as being used for TM is 25. Stem diameter size class distributions showed that most stem fragments came from sub-adult and adult cycads. Large arborescent species appear to be harvested by removing bark strips from adult individuals, while smaller arborescent and subterranean species are harvested by removing the entire plant. *Encephalartos natalensis* and *E. ghellinckii* show strong, positive linear regression relationships of leaf base length and pith radius with stem diameter. Overall, this is the first known study that attempts to identify the *Encephalartos* species traded in South African TM markets in conjunction with the size classes of the specimens in trade.

### 南非约翰内斯堡和德班传统药材市场上交易的非洲铁属植物种类调查

在南非, 非洲铁属植物的树皮和茎常被用作传统药材。在传统药材市场上交易的非洲铁属药材被切成块, 已经没有了叶和球果等植物的特征部分, 这是鉴定市场上的主要困难。在本文中, 我们调查了南非最大的两个传统药材市场来鉴定用于交易的非洲铁属植物的种类。根据从商贩处购得的茎的碎片样本可以鉴定出可能的种类, 然后根据茎的直径尺寸对其进行等级分类。种类鉴定是通过商贩对于其产地的描述进行的, 再对比分布于夸祖鲁-纳塔尔省地区的非洲铁属种类即可以进行鉴定。已经记录的种类大多是 *E. natalensis*, *E. villosus* 和 *E. ghellinckii*, 而采集到的少部分样本可能是 *E. ferox* 和 *E. senticosus*。在南非的37种非洲铁属植物中, 有25种被用于传统药材。直径大小等级分类显示出, 大部分的茎的碎片来自近成熟和成熟的植物。较大的树状苏铁的成熟植株在收获时被剥下树皮, 而小的树状植株和地下茎种类植株则被整株拔起。 *Encephalartos natalensis* 和 *E. ghellinckii* 的叶基长度和髓的半径与茎直径的比例有很明显的线性回归关系。总之, 本文是已知的第一篇鉴定南非药材市场上用作药材交易的非洲铁属植物的种类, 以及对交易的苏铁药材样本的大小等级进行划分。

### (37) Structural evolution of cycads: Do traits in extant cycads inform ancestral conditions?

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Cycads are often used as models for early evolution of plant structure. One long-held hypothesis is that cycads inform early seed plant biology. Recent phylogenetic work can help inform such hypotheses. An emerging finding offers a new context: while major groups diverged in the Mesozoic or before, modern cycad species are of very recent origin. So, given the modernity of extant cycad diversity, are extant structural characters useful for interpreting early cycad evolution? If modern anatomy is very divergent, and divergent from early cycads, polarity of these traits can inform structural evolution. Testing phylogenetic dependence or independence of modern cycad structure can help clarify the use of cycads as living models of ancient plant biology. We examine three basic questions: (1) What is the range of anatomical variation in extant cycads? (2) How useful is anatomy in cycad systematics? (3) What phylogenetic signals can be understood from anatomical characters? Structural characters studied emphasize leaves, based largely on fresh material collected from the living collections at Montgomery Botanical Center (MBC), and Jardin Botanico Francisco Clavijero (JBC), and also on characters from fossil cycads. Current results are presented as a synoptic key to genera, which gives some indication of present diversity. Further work will surely refine this information.

#### 苏铁植物的结构演化：现存苏铁类植物的特征是否能告知祖先的状况？

苏铁植物经常被视为植物结构早期进化的模型。一个长期存在的假说就是苏铁植物映射了早期种子植物的生物学特征。目前的系统发育工作支持这个假说。然而，最新的研究工作提供了另外一种新的观点，虽然苏铁的大部分类群在中生代或是更早的时候即发生分歧，但现代苏铁物种却是新近起源的。因此，现存苏铁植物的多样性是最近才产生的，能否用于解释早期苏铁植物形状特征的演化？是一个值得思考的问题。如果现存苏铁植物的解剖学性状高度变异，并且与早期的苏铁植物不同，那么这些特征的分歧则能够反映苏铁植物结构形状的演化。依赖或独立于现今苏铁植物结构的系统发育构建，均能帮助澄清现代苏铁植物可否作为远古植物生物学的活的模型的问题。这里，本文主要探讨三个基本问题：（1）现存苏铁植物解剖学性状变化的幅度，（2）解剖学在苏铁植物系统分类学中的应用，（3）解剖学性状特点能够揭示系统发育的哪些特征。所采用的解剖学性状主要来源于叶片，这些叶片取材于蒙哥马利植物园和 Jardin Botanico Francisco Clavijero (JBC) 种植的活植株，以及苏铁植物化石的特征。研究结果以分属检索表的形式列出，描述了苏铁解剖学性状多样性的部分特征。今后将继续完善相关信息。



### (38) Understanding life-history of *Zamia* species using data from field studies and botanical-collections

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*Zamia* species can exhibit a wide range of ecological diversity, ranging from small species with subterranean stems to large species with tall stems, and from xerophytic plants in open habitats to species in the understory of tropical rainforests. Diversity in life-history strategies in plants can result from high investment in reproduction or in survival, and from trade-offs between reproduction-growth-survival, among others. Field studies with several *Zamia* species evidence a wide variation in life-history traits like frequency of reproduction, fecundity allocation, and early-stages survival. For example, populations of *Z. obliqua* in the dark understory of the Choco rainforests reproduce sparsely and several years can pass between coning events in a locality, while populations of *Z. encephalartoides* in open dry areas of the Chicamocha canyon in Colombia produce massive cones and many seeds every year; and germination rates and survival of seedlings can differ drastically between these two species growing in contrasting habitats. In the other hand, monitoring data on growth and reproduction in botanical collections can be useful to document life-history trade-offs. For example, individuals of *Z. elegantissima* growing at MBC show decreased leaf production after coning, which could represent a cost of reproduction. Long-term data from studies in natural populations and collections can be used to explore variation in life-history traits in cycad populations and to evaluate the impact of this variation on population dynamics and viability, therefore providing important information for conservation programs.

#### 使用野外研究及植物园收藏数据了解泽米铁属的生活史

泽米铁属 (*Zamia*) 植物具有丰富的生态多样性, 植株形态可从具有地下茎的小型种类演变到具有高大茎的大型种类, 分布范围则涵盖生境开阔的旱生地区至热带雨林下层。生活史多样性产生的主要原因是繁殖或是生存方面的高消耗, 繁殖-生长-生存方面的权衡取舍, 以及其它生存状况。野外调查数种泽米铁植物性状的结果表明: 不同生境下, 它们呈现不同的生活史, 具体表现为生殖频率、繁殖分配以及幼苗存活率不同。例如, 生活在Choco雨林荫暗林下层的*Z. obliqua*居群很少开花结果, 且要间隔数年时间才会开花一次; 但生长于哥伦比亚Chicamocha峡谷开阔、干旱地区的*Z. encephalartoides*居群, 每年大量开花结实。同时值得注意的是, 不同生境中, 上述两种苏铁植物的种子发芽率和幼苗存活率亦明显不同。另一方面, 可利用监测人工栽培苏铁的生长和繁殖性状获得的数据, 推测其生活史变化的基础。例如, 栽培条件下的*Z. Elegantissima*开花之后, 叶片生长量降低, 暗示生殖生长消耗了大量营养。长期监测苏铁天然居群和栽培居群性状, 并进行比较, 可以用来探讨苏铁植物居群生活史特征的变化, 并推测这些变化对种群动态和生存能力的影响, 从而为苏铁保护工作提供重要信息。

### (39) Recent studies on Philippine cycads

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Recent field explorations reveal that the Philippines is one of the centers of diversity for Cycads in Southeast Asia. In the last ten years new species have been described in the country which brings the total number of species to eleven (11). One of the problems in cycad taxonomy is that some species are described based on single collections only, i.e. the male or female plant only or from single populations. Thus, there is a need for more information about the range in variation in morphology of both the male and female plants, biology, habitat requirements, and distribution. Field works undertaken by the authors in the past ten years in various parts of the country revealed several suspected new species. These are presently being described for eventual publication.

#### 菲律宾苏铁植物研究现状

野外调查显示菲律宾是东南亚苏铁植物多样性中心之一。最近十年，多个苏铁新种在该国被发现，使得菲律宾国内的苏铁种类达到11种。苏铁属植物分类常存在的一些问题，例如，对一些种的描述过于简单，常常仅基于雄株或雌株，或是单种群。上述问题的解决，依赖于开展更多的调查工作，以获得雌雄株双方在形态学性状上的变化特征、生物学特征、栖息地要求和分布特点等方面的信息。最近10年，作者对菲律宾国内多个地方的苏铁居群开展了野外调查工作，发现了数个疑似新种。这些新种目前正被描述，将会正式发表。

#### (40) Phenology of *Zamia* L. - phylogenetic and biogeographical insights

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Pre-zygotic, geographical isolation mechanisms have been cited as important factors in *Zamia* speciation. As an expansion of a previous study, we gathered data of coning events across 168 species and infraspecific taxa across all extant genera. Cone stages including early and late, micro- and megasporangium production were recorded from herbarium specimens from thirty-four herbaria. Events were recorded based on dates on the label. From this dataset, 21 species of *Zamia* were selected based on quality of available data. An additional 10,588 living-specimen phenological events databased at Montgomery Botanical Center were added for 14 of the 21 species. In total, phenology data for nineteen species not yet recorded were added to the existing dataset for twelve species, giving (total 43% of species in the genus). Comparisons of the phenology data against a phylogeny of the studied *Zamia* species and other representatives of Cycadales based on combined sequence data for *matK*, *trnK*, *NEEDLY*, *nrITS*, and *rpoB* gene regions and morphology to determine if phenology reflects phylogeny. Radar graphs and circular statistics were used to summaries phenological data. The phylogeny of *Zamia* shows limited resolution in some areas, particularly in a basal, but provides insights into the phenological patterns observed. The results of the study will be discussed as will the scope for applying similar techniques across the wider Cycadales dataset.

#### 泽米铁属物候学系统发育关系和生物地理学初探

合子前隔离这种地理隔离机制被认为在泽米铁属 (*Zamia*) 的物种分化中发挥着重要的作用。做为先前研究的拓展, 本研究收集了168种和所有现生属种上阶元的球果形成事件数据。本研究记录来自34个植物标本馆的球果标本信息, 球果阶段包括大孢子叶和小孢子叶形成的早期和晚期。本研究同时根据标签上的日期来记录事件。根据已有数据的质量, 泽米铁属中21个数据较完整的种被选用。其中14个种还补充了来自蒙哥马利植物园10588种活植物的物候数据。有19个尚未记录的物种被添加到已有12个种的数据集中, 总共占该属种类的43%种类。通过*matK*, *trnK*, *NEEDLY*, *nrITS*和*rpoB*基因区段的联合数据分析和形态学, 本研究对已研究的泽米铁属种类和其他苏铁目代表属的物候学数据和系统发育关系进行比较, 从而来判定物候学是否会影响系统发育关系。雷达图和循环统计法被用来总结物候学数据。泽米铁属的系统发育关系在某些部分的分辨率有限, 尤其是基部的系统发育关系。但是可帮助深入了解已观察到的物候模式。本研究的结果将被继续探讨并被应用到更宽泛的苏铁目植物数据中。

## Session 8: Conservation III / Horticulture

### (41) Conservation Status of *Cycas sancti-lasallei* from the Philippines

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*Cycas sancti-lasallei* is a proposed new species from Mindanao, Southern Philippines. It is distinct from other *Cycas* species in having long leaves, undulating pinnules, and megasporophyll lamina with a semi-orbicular to orbicular base and triangular top with few but well-defined spines. Other species found in the island are *C. lacrimans*, *C. vespertilio*, and *C. edentata*.

The species is assessed as CRITICALLY ENDANGERED based on crucial factors such as low population density, low number of mature individuals, very limited extent of occurrence, and poor quality of habitat with low to high vulnerability to landslides and soil erosion. Current reforestation and ecotourism efforts implemented by the government in partnership with private corporations play a very important role in the conservation of the species.

### *Cycas sancti-lasallei*在菲律宾的保护现状

*Cycas sancti-lasallei*为菲律宾南部棉兰老岛发现的一新种。该种与其他苏铁种类的区别表现在：叶较长、羽片波状、大孢子叶基部为半圆形至圆形、端部三角形且具少量明显的刺。该岛上其他种类的苏铁为*C. lacrimans*, *C. vespertilio*和*C. edentata*。该种主要由于其低种群密度、成熟个体数量少、现存数量有限以及塌方和土壤侵蚀所导致的生境恶化而被划分为极危种。目前该物种的保育工作主要依靠政府以及私人合作的重新造林以及生态旅游等方式。

## (42) Scouting Philippines for *Cycas*

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We have traveled within the Philippines in recent years in attempts to characterize variation among *Cycas* populations. Our travels have identified many habitats that were previously unreported. Numerous populations exhibit characters that do not conform to described taxa. The only populations lacking overt threats are those located on medium-sized island devoid of roads. The remaining populations are facing serious threats, all of which are anthropogenic. Population size decreased in every locality, we visited at least two times, usually due to land use conversion, logging, or poaching. We will discuss local terminology, local uses, our methods for finding populations within suspected locations, and known range for each of the distinct taxa.

### 菲律宾苏铁属植物初探

近年来, 笔者在菲律宾进行多次考察以描绘苏铁种群变化。通过这些考察, 很多以前未被报道的生境被发现, 许多种群呈现出不符合已知分类群的特点。唯一未受到明显威胁的种群处于没有道路的中型岛屿上, 这些保留下来的种群正面临来自人类的严峻威胁。本文所调查的每个点的种群大小均至少缩小两倍, 通常是由于土地使用变更、伐木或偷猎。本文主要探讨苏铁的本地术语、用途、在疑似地点寻找种群的方法, 以及迄今所知的每个独立分类单位的分布范围。



### (43) Genetics-based conservation action plan for *Zamia lucayana*, the only cycad species endemic to the Bahamian archipelago (Caribbean Island Biodiversity Hotspot)

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We developed a conservation project focusing on *Zamia lucayana*, a species endemic to Long island (The Bahamas). The project was based on extensive field studies aiming to understand the threats faced by this species and its geographic distribution. Sixteen microsatellite DNA markers were used to determine the number of management units and the genetic structure of the three known populations of this species. Seeds were collected for *ex situ* conservation in botanic gardens. All populations are moderately heterozygous with no significant departure from Hardy-Weinberg Equilibrium.  $F_{st}$  was highly significant, but indicates very little differentiation among the three population of *Z. lucayana*. Similarly Jost's estimate of differentiation is very low. Over 90% of the genetic variation is within populations. Number of migrants between each population is high enough ( $> 3.0$ ) to indicate gene flow among the populations. The genetic data support the three populations of *Z. lucayana* as a single management unit. Field studies strongly suggest that the conservation status of this species should be changed from Endangered to Critically Endangered because the species is limited to approximately only 980 adult individuals covering a small area of 1 km<sup>2</sup>. We recommend the land where *Z. lucayana* grows be purchased by the Bahamian Government or the Bahamas National Trust to establish a nature reserve. Until this action is implemented the team recommends to establish regulations for sand mining on the area where the species occurs and to develop housing and urban plans that are compatible with the distribution area of the species.

### 加勒比海岛生物多样性热点地区--巴哈马群岛唯一苏铁类植物特有种*Zamia lucayana*的遗传学保护行动方案

围绕巴哈马群岛中Long Island上的特有种*Zamia lucayana*，本研究提出了相关的保护方案。本项目基于大量生存因子和地理分布相关的野外调查。本文应用16对微卫星引物来确定三个已知*Z. lucayana*居群的遗传结构和系统进化单元。所用种子均采自迁地保护的植物园。所有居群虽然都有部分杂合性但都遵从哈迪-温伯格定律。 $F_{st}$ （固定指数）极其显著，这说明三个*Z. lucayana*居群间的变异不大。约斯特相似性系数D也说明变异很小。超过90%的遗传变异是存在于居群内。每个居群至少有三个漂流者，这足以说明居群间存在基因流。遗传学数据证明*Z. lucayana*的三个居群都是一个进化单元。野外调查发现大约980个成年植株仅分布于1平方千米狭小的地区，这也充分说明*Z. Lucayana*的濒危等级应该由濒危改为极危。本研究建议巴哈马政府或者巴哈马国家信托基金购买分布有该种的土地将其建成国家自然保护区。在该保护区投入建设前，本研究组建议在该类群分布的地区规范其采沙活动，并且在制订住房和城市规划时予以考虑。

#### (44) Evaluating inorganic and organic container media for growth of *Zamia* species

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*Ex situ* conservation is an essential tool in rare cycad conservation and horticulture is the foundation of *ex situ* conservation. Appropriate container media conditions, especially excellent aeration, are crucial to successful cultivation of most cycads. Typical cycad media include substantial portions of organic materials that will decompose over time, reducing aeration. At Montgomery Botanical Center, novel inorganic media have improved survival and growth of several very rare and horticulturally challenging *Zamia* species, suggesting the need for a rigorous evaluation of different inorganic container media. In an initial experiment, two inorganic media, calcined clay (Turface MVP) and coarse silica sand, and one medium with organic and inorganic components were evaluated for growth of three rare *Zamia* species: *Z. fairchildiana*, *Z. cunaria*, and *Z. aff. portoricensis* over a period of 14 months. Medium type affected leaves per seedling and leaf length. There were also significant interactions between media and species for stem diameter and leaf variables, likely reflecting ecological differences among the species. All three substrates performed adequately for growth of *Zamia*. Initial findings of a follow-up experiment will also be reported. The effects of silica sand, perlite, Turface, pumice, calcined shale, calcined diatomaceous earth, Profile (a finer grade of calcined clay), a ½ sand:½ Profile mix, and a peat/perlite mix on growth of *Z. pumila* seedlings are being evaluated. Media physical properties, leaf growth parameters and nutrient status will be reported. At the end of the experiment, whole plant, stem and root relative growth rates will also be compared among substrates.

#### 有机和无机容器培养介质对泽米铁属种类的生长评估

迁地保护是保护稀有苏铁植物的重要手段, 园艺栽培是进行迁地保护的基础。适宜的容器基质条件, 尤其是良好的透气性, 是大部分苏铁培育成功的决定性因素。典型的苏铁培养介质包括有机物质, 这些有机物质会随着时间的推移而逐渐分解从而降低培养介质的透气性。在蒙哥马利植物园中心, 通过新创的无机培养介质提高了泽米属 (*Zamia*) 几种珍稀和园艺栽培上难度很大的物种的存活率和生长率, 表明有必要对不同的无机培养介质进行严格评估。在试验初期, 分别利用两种无机介质, 即煅烧粘土 (Turface MVP) 和粗石英砂以及一种含有有机和无机成分的介质对三种罕见的泽米属物种: *Z. fairchildiana* (鳞秕泽米铁), *Z. cunaria* 和 *Z. aff. portoricensis* 进行超过14个月的生长评估。不同的介质类型对幼苗的叶片数量和叶片长度有影响。不同的介质类型也对泽米属不同物种的茎干直径和叶片变化有显著相关性, 可能反映了不同物种之间的生态差异。所有三种基质可以充分满足泽米属植物的生长。后续实验的初步结果也将报道。中石英砂, 珍珠岩, 浮石, 煅烧页岩, 蒙脱石, 煅烧硅藻土, 属性成分 (一种较好的煅烧粘土), 一半沙与一半属性成分的混合物, 一种泥炭或珍珠岩与属性成分混合物等介质对矮泽米 (*Z. pumila*) 幼苗生长影响的评估正在进行中。将陆续报道介质的物理特性, 叶片生长参数和营养状况。在实验结束时, 还将会对不同培养介质的栽培的整株植物、茎和根的相对生长率进行比较。

### **(45) The results of a translocation and re-establishment program undertaken almost 30 years ago**

S.W.K. Trollip

*South Africa.*

We will look at 6 priority species of *Encephalartos* namely, *E. humilis*, *E. inopinus*, *E. cupidus*, *E. dyerianus*, *E. middelburgensis* and *E. laevifolius*. These six species were deemed as facing possible extinction that various conservation management strategies were carried out /enacted by the Nature Conservation Authorities. Photographic as well as historical data are evaluated and the long term results given.

#### **三十年前苏铁移栽和重建项目的结果**

我们对6个非洲铁属中应优先保护的物种，即*Encephalartos humilis*, *E. inopinus*, *E. cupidus*, *E. dyerianus*, *E. middelburgensis* 和 *E. laevifolius*进行调研。这些物种曾被认为面临灭绝，自然保护机构对它们采用了数种保护措施。我们对照片和历史数据进行了分析，并给出了长期的结果。

## (46) Botanic gardens cycad collections: 4<sup>th</sup> GBGC Symposium Report

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As part of the 4<sup>th</sup> Global Botanic Garden Congress in Dublin (2010) six gardens (FairyLake BG, JBC, Lowveld BG, MBC, NYBG, and Orto Botanico) convened a *Cycad Collections in Botanic Gardens* symposium highlighting their main research topics, cultivation, collections and challenges. This talk summarizes the consensus produced from that symposium. Many public gardens hold cycads as display plants in landscaping exhibits or glasshouses. Given specific circumstances of long generation times, limited number of taxa, small population sizes, and in situ conservation threats, these botanic gardens cycads are an increasingly important resource. Collections focus and structure are diverse: Some gardens hold extensive cycad collections for purposes of *ex situ* conservation and research, others hold comprehensive regional collections for general horticulture, taxonomy and systematic research, yet others hold cycad DNA collections and data, and others hold historic collections of both old and new world cycads where cycad research is ongoing since the 19<sup>th</sup> century. Cognoscente of BGCI's successful Plant Search database system connecting researchers looking for material, it was suggested a consortium be formed to share valuable information on the maintenance of collections, cultivation, research, educational programmes as well as security problems peculiar to cycads. Close contact between gardens will encourage exchange of material, information and collaborative advances. We highlight here how research outcomes at these gardens, benefit from integrating expertise, resources and assets internationally. We also present a draft of the consortium mission. The invitation is open to other botanic gardens that hold cycad collections for research.

### 植物园苏铁植物收集：来自第四届国际植物园大会的报告

作为在都柏林召开的第四届国际植物园大会（2010）的一部分，六所植物园（仙湖植物园, JBC, Lowveld BG, 蒙哥马利植物园, 纽约植物园和奥托植物园）联合召集了题为“植物园苏铁收集”的专题会，主要展示它们的研究课题、栽培情况、物种收集和挑战。本报告就是对于该专题会所达成共识的概述。许多植物园将苏铁在景观美化和温室中作为观赏植物来栽培。苏铁植物的繁殖周期长、种类有限、数量少，并且处于就地保护危机中。在这种特殊情况下，这些植物园的苏铁植物成为越来越重要的资源。植物园对苏铁植物收集的焦点和构成是多样化的：一些植物园拥有广泛的苏铁植物资源，目的在于迁地保护和研究；另外一些植物园拥有综合的地区性的资源，为的是进行一般性的园艺学研究以及分类学、系统学的研究；还有一些植物园拥有苏铁植物的DNA资源和数据库；而一些植物园收集了从19世纪开始在苏铁植物研究发展过程中具有历史意义的全球古老和新生的苏铁植物。鉴于BGCI的植物研究数据系统成功地将寻找材料的研究者们联系起来，因此也有人提出了应当建立起一个联合会，以共享关于各植物园拥有的苏铁植物的维护、栽培、研究、教育项目和安保问题。植物园间的亲密合作必将促进材料和信息的交流以及合作进展。我们在这里突出了这些植物园是怎样受益于国际间专业知识、资源和资产的整合而得到研究成果的，我们也提出了一个联合会的使命草案。最后，欢迎其他拥有苏铁植物研究资源的植物园加入。

## December 5

### Plenary Talk 4

#### (47) An overview of cycad conservation based on the 2010 Global Cycad Assessment and its implications for the IUCN/SSC Cycad Action Plan

John Donaldson

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The 2010 Global Cycad Assessment provided an updated assessment of the current threat status of all cycads. At the time of the assessment, cycads turned out to be the most threatened group of organisms to have been comprehensively assessed, with >62% of all cycad taxa falling into one of the IUCN threat categories. A comparison with the 2003 assessment shows that cycads are generally worse off than they were only 7 years ago. Using the Red List Index as a comparative measure, there has been an overall decline in the RLI for all cycads. Analysis by region shows that Africa has consistently been the region with the greatest threats but the decline in RLI over the past 7 years has been greatest in Central and South America, Asia and Australia. The analysis shows that cycads are particularly vulnerable to extinction, with ~10% occurring at single sites and a large number with very small populations. The generally worsening situation for cycads means that it is necessary to revisit the 2003 IUCN/SSC Cycad Action Plan to identify actions that have led to positive results and to review those that have had little or no impact. These analyses examine problems at a scale that takes into consideration regional differences in threats. For example, the ongoing decline in southern African cycads is driven primarily by illegal and poorly regulated trade resulting in dramatic declines in almost all the taxa being monitored. Actions in this region need to focus on more effective management of trade. The intention is to set the scene for revision of the Action Plan.

#### 基于2010年全球苏铁类植物评估的苏铁保育综述及其对IUCN/SSC苏铁行动计划的影响

2010年的全球苏铁类植物评估为当前所有苏铁类濒危现状提供了最新数据。在评估开展的同时，苏铁类也成为所有被评估的生物类群中受威胁程度最高的类群，超过62%的苏铁类群被划入IUCN的不同濒危等级。与2003年评估结果比较，苏铁类植物的生存状况总体上比7年前更为恶化。采用红色名录濒危等级评定（RLI）做为比较衡量标准，苏铁类植物的评价指标总体下降。区域分析表明，非洲一直是最受威胁最严重的区域。但是在过去7年中，RLI指数在美洲中部和南部、亚洲以及澳大利亚下降幅度最高。分析表明，苏铁类植物极易灭绝，有大约10%的种类仅具有一个分布点，且很多都是极小种群。苏铁生存状态整体的恶化意味着我们有必要重新审视2003 IUCN/SSC苏铁行动计划，以确定具有积极效应的行动计划和审查那些效果不明显或根本无效的行动计划。这些问题的分析检查在一定程度上考虑了受威胁的区域差异问题。例如，非洲南部苏铁持续下降主要由于非法贸易大量存在且政府监管不力，导致几乎所有被监控保护的苏铁类群急剧下降。因此，在该区域需要采取的行动是更为有效的贸易管理。此举目的是为了行动计划的修订做准备。



## December 6

### Session 9: Genetics I.

#### (48) Provenance investigation and genetic diversity study on *Cycas szechuanensis*

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*Cycas szechuanensis* C.Y. Cheng, W.C. Cheng & L.K. Fu is named after the place Szechuan (Sichuan Province) where the type plant being cultivated. It might be one of the cycad species being cultivated most widely and with a history of more than hundreds years in China. Chinese National Cycad Germplasm Conservation Center organized a team to investigate this species completely during May and July in 2011. We found there are many individuals which have hundreds of cultivated years in the provinces of Sichuan, Guangxi, Guangdong, Fujian and so on. Fortunately, most of them grow well with female cones. We did not find male individuals or large wild populations. Because of transplanting and ramet propagation, the planting pattern has some change comparing with 1990s. The cultivated areas is far from each other, and the transportation is rather inconvenient long ago, and also there is no historical record of large-scale transplanting. So the question is where is the original distribution center? Does the male one extinct so long that all the individuals around come from the same clone? Is there some other interesting story that we ignored? So we use SSR molecular markers to test the genetic diversity, and try to find the answer. The experiment is undergoing and 5 primers have selected.

#### 四川苏铁的产地调查及遗传多样性分析

四川苏铁 (*Cycas szechuanensis* C.Y. Cheng, W.C. Cheng & L.K. Fu) 因模式标本采于四川峨眉山的栽培植株而得名, 是我国栽种苏铁历史最悠久的苏铁物种之一, 其百年以上的植株个体至今仍广泛栽培于四川, 广西, 广东, 福建等省份。2011年国家苏铁种质资源保护中心对分布于我国以上4省的四川苏铁进行了系统的摸底调查, 共发现分布或栽培居群14个。这些植株大多生长状况较好, 丛生, 在测量调查的115株中, 当年开花个体数有25株, 全部为雌株, 且有一个植株不同茎干上有多个球花的现象。说明四川苏铁开花现象并不像民间说的那样少。由于缺乏雄株, 几乎所有的雌花的胚珠均未发育而干枯。调查时还发现, 各地栽培格局较90年代有很大变化, 有移栽分株等现象。这些调查地区相距甚远, 且早前交通不便, 历史上也无大规模的移植记录, 为何各地所存的四川苏铁均为雌株? 所调查植株很多都是年龄在100年以上的个体, 这些现象是如何形成的? 是偶然形成, 还是他们是同一无性系起源? 此次调查中唯一有野生迹象的是福建三明的瑞云山, 我们在此山中发现了8个幼株。另在周边村民家中发现有约19个体, 这些个体大多年龄在50年以上, 其中4株今年有雌球花。另在四川峨眉山苗圃发现有较多的四川苏铁个体, 据悉是来自于四川洪雅地区。还有称广西东部如贺州地区也可能是原产地。这些个体间的遗传多样性怎样? 哪里可能是其原产地? 故此我们采用SSR分子标记检测各地栽培的四川苏铁的遗传多样性, 看其是否一系, 推测原分布中心, 解决相关疑问。我们以及筛选出5对引物, 相关实验还在进行中。

### (49) Comparative patterns of genetic variation among populations of the *Zamia pumila* L. complex across three islands of the Greater Antilles

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The *Zamia pumila* L. complex is a diploid ( $2n=16$ ) clade of populations restricted to the West Indies and Florida currently considered to encompass one polymorphic or nine distinct species. We are extensively genotyping populations of the group throughout its range with both microsatellite DNA (SSR) and single copy nuclear genes. Here, we analyze 16 SSR loci across three of the larger islands of the Greater Antilles: Hispaniola (Dominican Republic [DR]), Jamaica and Puerto Rico (PR). Of the three, PR has the greatest morphological diversity, with three species recognized by some accounts, two of which are reported from Jamaica and one from the DR. PR has the highest gene diversity. Some populations in Jamaica show indications of genetic erosion, with evidence of poaching and reduced population size. Mean pairwise  $F_{ST}$  and  $D_{EST}$  between populations is lowest in the DR, which we attribute to high levels of gene flow. In PR, while  $D_{EST}$  values among three populations each of *Z. portoricensis* and *Z. pumila* are 0.026 and 0.037, respectively, the mean among four populations of *Z. erosa* = 0.186, a 6-8 fold higher level of inter-population differentiation. Genetic distance resolves all of the Jamaican populations nested within *Z. erosa* from PR, with the DR populations as a sister cluster. This may indicate Pre-Colombian human inter-island movement of plants, since Jamaica and Puerto Rico have never had a land connection, and *Zamia* has limited long-distance dispersal capability. While DR and Jamaica have similar gene diversities, only a single private allele characterizes the DR populations vs. 32 and 34, respectively, for PR and Jamaica.

#### *Zamia pumila* L.复合体在大安的列斯群岛中三个岛屿上分布居群的遗传变异式样比较

*Zamia pumila* L.复合体是一个二倍体，分布于西印度群岛和佛罗里达州。该复合体目前被认为包括1个多型种或9个独立的种。应用微卫星标记和单拷贝核基因对分布于三个岛屿上的*Z. pumila* L.居群进行研究，共分析了16个微卫星位点。结果表明，波多黎各岛具有最丰富的形态多样性，可识别出3个种，其中的2个在牙买加亦有分布，而另1种则在伊斯帕尼奥拉岛（系多米尼加共和国）有分布。波多黎各岛上的苏铁复合体具有最高水平的基因多样性。伊斯帕尼奥拉岛上的*Z. pumila* L.具有最低水平的 $F_{ST}$ 值和 $D_{EST}$ 值，原因是存在频繁的基因流。在波多黎各岛屿，*Z. portoricensis*和*Z. pumila*三个群体之间的 $D_{EST}$ 分别为0.026和0.037，但*Z. erosa*四个群体间的 $D_{EST}$ 为0.186，是居群内歧度的68倍。遗传距离分析表明，牙买加居群均位于来源于波多黎各的*Z. Erosa*之内，而来源于伊斯帕尼奥拉岛岛屿的种群则是其姊妹类群。此表明先前存在人类活动并促进了岛屿间植物的交流。原因是牙买加和波多黎各从未发生过陆地连接，且泽米铁属植物进行长距离传播能力有限。虽然来源于伊斯帕尼奥拉岛岛屿和来源于牙买加岛屿的苏铁植物具有相似的基因多样性，伊斯帕尼奥拉岛群体仅具有一个特有基因等位点，而其它岛屿群体的特有位点分别为32和34。

## (50) Divergence and introgression of allopatric distributed *Cycas* section *Asiorientales*

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*Cycas* section *Asiorientales* composes of two East Asian species, *C. revoluta* and *C. taitungensis*, and one inland Asian species, *C. panzhihuaensis*. *Cycas revoluta* is distributed widely in the Ryukyu Archipelagos and the eastern mainland China, while *C. taitungensis* and *C. panzhihuaensis* are relatively restricted distributed and endemic to Taiwan and Yunnan, respectively. These three species are closely related in morphology and phylogeny but geographically distinct distributed. *Asiorientales* is located at the basal lineage of the *Cycas* phylogeny and thought to be originated roughly at 200~330 mya in the Mesozoic. The long-term evolutionary history and the disjunct distribution but highly genetic and morphological similarity raised two evolutionary hypotheses: (1) long-term evolved but recently diverged (i.e. sharing large amount of ancestral polymorphism) and (2) recent introgression between long-term divergent species. The nuclear multilocus sequences developed from the EST library and the AFLP genotyping are applied for resolving these two hypotheses by testing the isolation-with-migration model. Three species of the section *Stangerioides* (*C. hainanensis*, *C. guizhouensis*, and *C. fairylakea*) are used as outgroups for comparison. Divergent times are estimated and the introgression is evaluated by model test. The genome-wide determination of divergence pattern and speciation modes of *Cycas* section *Asiorientales* provide clear resolution for reconstructing the evolutionary history of these Laurasian species.

### 异域分布的苏铁属亚洲苏铁组的分歧与基因渐渗

亚洲苏铁组 *Asiorientales* 是由二东亚分布的物种琉球苏铁 *C. revoluta* 及台东苏铁 *C. taitungensis*, 及一亚洲内陆的物种-攀枝花苏铁 *C. panzhihuaensis* 所组成。琉球苏铁广泛分布于琉球群岛和中国大陆福建省, 台东苏铁和攀枝花苏铁分别局限分布在台湾东部与四川南部, 地理距离遥远, 此三种苏铁在形态与亲缘关系上皆相近。亚洲苏铁组在系统演化位于亲缘关系树的基部位置, 约起源于中生代两亿至三亿三千万年前。由于这些苏铁具有久远的演化历史且呈地理间断分布模式, 但遗传及形态上却有高度相似性, 因此本文提出两个演化假说并加以验证: (1) 演化历史久远但在最近才分歧 (即共用大量的共组多态性); (2) 早期分化但近期内有遗传渐渗发生。为检测这两个假说, 细胞核多基因座序列分析及 AFLP 基因型将用于隔离-迁移模型之检测; 海南苏铁、贵州苏铁及仙湖苏铁也将做为外群比较。分歧时间及基因渗入将以模型检测进行评估。以基因组层面的观点探讨苏铁属亚洲苏铁组的分歧模式及种化模型可更清晰地描述出这些劳亚古大陆起源的物种的演化历史。

## (51) Study of dioecism in *Zamia furfuracea* L. F.

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Cycads are an important group of plants for Mexico as it ranks second worldwide in a diversity of such species. Most, endemic and endangered, have been used as ornamental plants. These species are dioecious with longer sexual maturation times that not allow identify the sex in early stages. Little has been studied on the sexual determination within the group, so knowing how these mechanisms operate represents a contribution to knowledge of reproductive biology. It is accepted that external factors to DNA known as epigenetics plays an important role in plant sex determining. This study seeks to determine whether the expression of sex in the endemic species of Veracruz *Zamia furfuracea* L. f. operates through processes of DNA methylation and to correlate the methylation status of the plants with respect to the environment where they develop, by identifying possible morphological features associated with sex, edaphoclimatic characterization and determining the sex ratio of two natural populations. Trials will also be undertaken to assess the effect of hypomethylating drug 5-azacytidine on seeds and seedlings about the expression of morphological and reproductive characters, analyzed molecularly by methylation-sensitive markers (CRED-RA and MS-AFLP) the variation in the methylation profiles of male and female individuals and individuals treated with such compound. If this is confirmed in the future will be possible to reverse the sex and help reduce the pressure exerted on these valuable genetic resources.

### *Zamia furfuracea* L. F.雌雄异株现象的研究

苏铁类是墨西哥重要的一群植物，墨西哥的苏铁类植物多样性在全世界排名第二。大多数特有且濒危的苏铁类物种被用作观赏植物。这些种类雌雄异株且性成熟期较长，很难在生长初期区分性别。目前很少有研究涉及苏铁的雌雄性别决定机制。因此，掌握这些机制的内在机理有助于了解苏铁的繁殖生物学。事实上，目前DNA所决定的表观遗传学在植物性别决定机制中的重要作用已被广泛接受。本研究旨在通过识别外部可能与性别相关的形态特征，土壤气候特征以及识别2个自然居群的性别比例，来探究墨西哥维拉克鲁斯特特有的*Zamia furfuracea*的性别是否在DNA的甲基化过程中被表达，并且将植物甲基化状态与植物生长环境相关联。本研究尝试评估hypomethylating药物5-氮杂胞嘧啶核苷在种子和形成种子中对其形态和繁殖特征表达的影响，并利用甲基化敏感标记（CRED-RA和MS-AFLP）来分析雌性和雄性个体以及用此种化合物处理的个体中甲基化图谱。如果该结论得到证实，则有可能通过改变其性别来帮助减少有限遗传资源所带来的压力。

## Session 10: Genetics II.

### (52) Maternal inheritance of plastids and mitochondria in *Cycas* L. (Cycadaceae)

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*Cycas* is often considered a living fossil genus, thereby providing a unique model for revealing the evolution of spermatophytes. To date, the genetic inheritance of these archaic plants is not fully understood. The present study seeks to document the process of organelle inheritance in an interspecific cross of *Cycas* species. Extranuclear organelle DNA from chloroplasts and mitochondria was analyzed using both polymerase chain reaction-restriction fragment length polymorphism analysis and microscopy. Here, we show that the chloroplasts and mitochondria in the progeny of interspecific crosses between *Cycas taitungensis* and *C. ferruginea* were exclusively inherited from the female parent. Epifluorescence microscopic analyses of the pollen cells from *C. elongata* indicated that there was a significant degradation of organelle DNA in male reproductive cells following maturation; the DNA fluorescent signals were only seen after pollen mitosis two, but not detectable at mature stage. Lack of organelle DNA fluorescent signal in prothallial cells was confirmed by the absence of plastids and mitochondria in electronic microscopic images. In conclusion, these data suggest that the maternal plastid and mitochondrial inheritance in *Cycas*, native to the old world, are the same as seen in most seed plants.

### 苏铁属（苏铁科）质体与线粒体的母性遗传

苏铁属通常被视为活化石植物，从而成为研究种子植物进化的绝佳模式材料。迄今为止，这些古老植物的细胞器的遗传方式还未被完全了解。本研究旨在说明一个苏铁属种间杂交后代的细胞器的遗传过程。本文利用聚合酶链式反应-长度多态性技术和显微镜学方法研究了来自叶绿体和线粒体的核外细胞器DNA，发现台东苏铁*Cycas taitungensis*和绣毛苏铁*C. ferruginea*种间杂交后代的叶绿体和线粒体全部来自母本。荧光显微镜观察越南蓖齿苏铁*C. elongata*花粉母细胞发现其细胞器DNA在生殖细胞的发育过程中发生显著的降解；DNA荧光信号只在第二次有丝分裂以后可见，但成熟期没有发现有荧光信号。原叶细胞中没有细胞器DNA信号这一现象被电子显微照片中叶绿体和线粒体的缺失所证实。总之，研究表明原产于旧大陆的苏铁属其叶绿体和线粒体是母系遗传，这和在大多数种子植物中看到的情况是一致的。



### (53) Identification of molecular markers associated with sexual expression in *Ceratozamia mexicana* Brongn. (Zamiaceae)

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Cycads are dioicous plants without sexual differentiation in youthful stages, and therefore determination of sexual proportions in its populations is not possible. Many species are threatened or in danger of extinction at the moment due to anthropogenic pressures on their populations, due to its restricted distribution and its commercial importance. These factors have a direct impact on *Ceratozamia mexicana* Brongn., an endemic species of Veracruz, Mexico. To determine sex in this plant is useful to establish strategies of conservation and distribution in order to assure seed production. Nevertheless, no study of this type has been carried out in this species, and therefore we have used ISSR markers to evaluate the potentiality of the use of this marker to achieve early sex identification in *C. mexicana*. We have managed to isolate a marker associated to NEEDLY genes, implied in the process of sexual differentiation.

#### *Ceratozamia mexicana* Brongn. (泽米铁科) 与性别表达相关的分子标记的鉴定

苏铁类为雌雄异株但在未成年期看不出性别差异，因此无法确定其种群内的最初性别。目前，由于来自人类对种群的压力以及其自身分布的局限性和经济价值，很多苏铁处于濒危状态或面临绝种的危险。这些因素也直接影响着墨西哥维拉克鲁斯的特有种 *Ceratozamia mexicana* Brongn. 确定此类植物的性别有助于通过制订保育和配置策略从而保证其种子的发育。然而，目前还没有任何专业研究能完全解决这一难题。本研究使用简单重复序列间多态性 (Inter-Simple Sequence Repeat, ISSR) 来评估该标记用作 *C. mexicana* 的早期性别识别基因的可能性。本研究成功地分离到对于性别分化过程起作用的 NEEDLY 基因相关的标记。

## (54) Complete chloroplast genome of *Zamia furfuracea* and *Stangeria eriopus* and their evolutionary implications

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The entire chloroplast genome of *Zamia furfuracea* and *Stangeria eriopus* were sequenced and annotated. The chloroplast genomes sizes of *Z. furfuracea* and *S. eriopus* are 164413bp and 167895bp respectively. The gene order and transcription direction are the same as that of sequenced *Cycas taitungensis*. This two new chloroplast genomes are a circular molecule with the typical quadripartite structure: large single cope (LSC), two inverted repeats (IRs), small single cope (SSC), a pair of IRs (IRa and IRb) separated by LSC and SSC, respectively. It was inferred that *S. eriopus* lost *trnH*-GUG genes in IRb which caused shorter IR region. A total of 216 and 231 SSRs were obtained from *Z. furfuracea* and *S. eriopus* chloroplast genomes respectively. SSRs with A/T rich repeats represented the most abundant type. The result showed SSRs distributed mainly in intergenic region and were less frequent in coding region. The RNA editing involves C to U type conversion of *Z. furfuracea*, *S. eriopus* chloroplast genomes are 44 and 40 respectively. By calculating P distance of corresponding coding regions, introns and intergenic regions of *Z. Furfuracea*, *S. eriopus* and *C. taitungensis* plastome and combining with other requirements of DNA barcoding, 8 coding region candidates' loci and 11 IGS candidates were detected. These candidate loci might be useful in cycad DNA barcoding as well as in other plant groups.

### 鳞秕泽米铁和托叶铁叶绿体全基因组及进化上的意义

鳞秕泽米铁和托叶铁叶绿体全基因组已测序并完成注释。其基因组大小分别为164413bp和167895bp, 基因顺序和转录方向与已经测序的台东苏铁基本一致。两个叶绿体基因组均为环形, 由四部分结构: 大的单拷贝区(LSC区), 小的单拷贝区(SSC区), 两个反向重复序列IR区(IRa和IRb)将LSC区和SSC区隔开。托叶铁缺失IRb区的

## (P1) Review of the genus *Cycas* (Cycadaceae) in China

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The cycad flora of China has not been well understood in the past, as is evidenced by the history of species description. Since 1975, some 32 new species names have been published for cycads occurring naturally in China. Until Hill 2008 no recent publication had fully correctly applied the available names for the Chinese cycads (Chen & Stevenson 1999, Chen & Liu 2004, Xiao *et al.* 2004, Xiao & Gong 2006) and this publication was seen as necessary in order to clarify nomenclatural applications in China. This work was the outcome of ongoing studies, with the examination of herbarium collections held by A, B, BM, BO, E, HN, K, KNF, KUN, G, L, LAE, LE, NY, PE, P and U along with a total of three field trips undertaken during the period 1996-2000. As a result of this work, many names are now regarded as superfluous, falling into synonymies of other species. Of the 22 species recognised in Hill 2008, only four were described before 1975. A key to the species is provided, synonymies are listed and distribution of all taxa is mapped.

### 中国苏铁属（苏铁科）综述

根据历史上对苏铁物种的描述，人们在过去一直没有对中国苏铁植物有个比较全面的了解。自1975年以来，发表了约32个中国野生苏铁的新种名。在Hill（2008年）的论文以前，近期的文献一直没有完全正确地应用中国苏铁已有的种名（Chen & Stevenson 1999, Chen & Liu 2004, Xiao *et al.* 2004, Xiao & Gong 2006），因此Hill的论文被认为对澄清中国的苏铁命名是必要的。该论文是长期研究的结果，作者查看了标本馆（A, B, BM, BO, E, HN, K, KNF, KUN, G, L, LAE, LE, NY, PE, P和U）的标本，以及在1996-2000年期间进行了三次野外调查。研究表明，现存的许多种名已被认为是多余的，成为其他种的异名。在Hill（2008年）承认的22个种中，只有4个是1975年前描述的。本综述提供了检索表、异名和种的分布图。

**(P2) A new genus of fossil cycads, *Yixianocladus* gen. nov., from the Early Cretaceous Yixian Formation, Western Liaoning, China and its evolutionary significance**

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A new genus of fossil cycad, *Yixianocladus* gen. nov., is reported here. The specimen was collected from the southern hill of Jinjiagou village, Toudaohezi town, Yixian county, western Liaoning Province, China. The fossil plant-bearing bed belongs to the Zhuanchengzi bed of the Lower Cretaceous Yixian Formation. The new genus is established on the basis of recently finding foliage branches, the main shoot of which is preserved incompletely, about 7 cm long, 89 mm wide and the lateral shoot attaches on the main shoot at an angle of 45°, about 4 cm long and 6 mm wide. The lateral shoot at apex expands slightly into disk-shaped and four foliage leaves attach on the disk. The leaves belong to a formerly known genus “*Yixianophyllum*”-type. Thus, the new genus is a new name to a known genus “*Yixianophyllum*” and a new combined species, *Yixianocladus jinjiagouensis* (Zheng *et al.*) comb. nov., is described here.

**辽宁义县早白垩世义县组苏铁类一新属——*Yixianocladus* gen. Nov. 及其演化意义**

本文描述了一个化石苏铁类新属, *Yixianocladus* gen. nov.。标本采自中国辽宁西部义县头道河乡金家沟村南山。含植物化石的地层属于下白垩统义县组砖城子层。新属是根据最近发现的带叶小枝建立的。它由主枝和侧枝组成。主枝保存不全, 长约7 cm, 宽8-9 mm。侧枝大约以45°角着生在主枝上, 长约4 cm, 宽6 mm。侧枝的顶端微微膨胀成圆盘形, 具有4枚叶簇生在圆盘上。叶是属于从前已知的*Yixianophyllum*-型。因此, 新属是对已知*Yixianophyllum* 属的新修订, 并建立了一个新联合种*Yixianocladus jinjiagouensis* (Zheng *et al.*) comb. nov.。新属具有细长的茎、较短的分枝, 以及在侧枝顶端具有簇生单叶的习性表明: 细茎苏铁的原始性超过粗茎的; 但单个的全缘叶超过羽状分裂的复合叶的观点并不是没有得到化石证据支持的。

### **(P3) The *ex-situ* conservation and landscaping of cycads in Qingxiushan scenic spot of Nanning, Guangxi, China**

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Cycads should be protected actively due to value for research and ornamental landscapes, because they are rare and endangered species, and also as an ancient phytogroup. The *ex-situ* conservation to protect cycad plants is an effective method. It's an important subject of unfolding value of cycads, developing landscape and promoting popular science education and eco-tourism based on characteristics of cycad plants. Since the founding of Cycads Garden in 1998, we devoted to protect, study, breed, and develop cycad plants. Untill now, the Cycads Garden with an area of about 80 mu has collected 33 species of cycads belonging to 4 genera and 2 families. Cycads Garden has become a site for rest, and tourism, with distinctive characteristics of popular science education and eco-tourism by means of the good cultivated and protected cycads combined with developing landscape. This article describes the cycad *ex-situ* conservation in Qingxiushan spot, analyzes the thoughts and practices of the application of cycad plant landscaping and the significance and methods of cycad popular science education. On this basis, we investigate how to develop comprehensive application of cycad plants to aspects of conservation, landscapes, popular science and tourism.

#### **中国广西南宁青秀山风景区苏铁植物迁地保育与园林景观应用**

苏铁属珍稀濒危物种，是一个古老的植物类群，具有重要的科学研究和园林观赏价值，应积极保护。迁地保育是苏铁保护工作中一项重要而有效的方法，如何在做好苏铁保育的同时，根据苏铁植物特点，开展园林造景，促进生态旅游和科普教育，充分利用和展现苏铁植物的价值，是一项重要的课题。青秀山风景区苏铁园于1998年建成开放，多年来致力于苏铁植物的保护、研究、繁育及园林应用，现已收集了苏铁类植物2科4属33种，面积达5.3公顷。该园根据景区特点和自身条件，通过良好的栽培、保护手段和多形式的展示、造景手法，努力实现苏铁保护与园林造景的良好结合，苏铁植物得到良好保育，也使苏铁园成为特色鲜明的科普教育和旅游休憩场所。本文介绍青秀山风景区苏铁植物迁地保育的情况，分析青秀山苏铁植物园景观应用的思路和实践及苏铁植物科普教育的意义和方法。在此基础上，探讨深入开展苏铁植物保育和园林、科普、旅游综合应用的对策。



**(P4) Fire contributes to the natural succession of *Cycas panzhihuaensis* L. Zhou et S. Y. Yang**

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Controlled fire doesn't lead to the death of *Cycas panzhihuaensis* yet. New leaves emerge soon after the managed burn, the leaf number and growth potential are both increased after treatment. Young leaf number is higher than natural habit next year. The cone number doesn't change at the same year, but the cones tend to be smaller, and the number decreases next year. Natural vegetation restoration occurs two months later, and the species is stable during reestablishment process. On the other hand, controlled fire significantly affected soil characters, including water content, nitrate-nitrogen concentration, ammonium nitrogen concentration, and the carbon and nitrogen content of soil microbial biomass. These indicated that controlled fire can lead to the nutrient transference from cycad plants to soil, and in turn, the soil nutrient increase may benefit the growth of cycad and other plants as a consequence.

### 火烧促进攀枝花苏铁自然演替

人为控制燃烧强度的火烧, 不会造成攀枝花苏铁 (*Cycas panzhihuaensis*) 的死亡, 而且攀枝花苏铁在火烧后迅速发嫩叶, 单株叶片数量比实验前明显增多, 长势也较实验前明显增强; 火烧次年攀枝花苏铁嫩叶增长量也多于自然状态。火烧当年攀枝花苏铁开花数量没有变化, 但花明显变小, 火烧次年开花数量明显减少, 花形恢复正常。火烧2个月后自然植被开始恢复, 植被在恢复过程中能保持相对稳定。计划性的火烧除显著影响攀枝花苏铁植株根系周围土壤的含水量、土壤C、硝态氮、铵态氮、微生物量C、N含量, 还有利于植物体内的营养元素向土壤快速迁移。在短期的观测中发现计划性的火烧提高了攀枝花苏铁根围土壤中的C、有效氮及微生物量C、N含量, 这将有利于火烧后攀枝花苏铁及其他植被的生长。但是对土壤的pH值并无显著影响。

## (P5) Cycad horticulture at MBC: best practices, new developments and new efficiencies

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Montgomery Botanical Center (MBC) maintains a diverse living collection of cycads. As of 2011, 239 taxa are held, encompassing approximately 70% of currently known taxonomic diversity, with particular strength in New World species. Maintaining a globally diverse living collection in a single subtropical location presents challenges based on climate and substrate. In recent years, resource limitations add an additional challenge. This poster presents current practices which have allowed for continued addition of new diversity as well as creating new efficiencies. The following examples are detailed: (a) halting further development of raised beds and increasing direct planting in native substrates, including soil and rock; (b) converting existing raised beds back to at-grade plantings; (c) use of ceramic media at planting to improve drainage; (d) reducing use of organic mulches, including conversion of mulched beds to 'weed turf'; (e) biocontrol (*Heterorhabditis bacteriophora*) and transplanting to manage *Eubulus* sp. (zamia borer); and (f) field trials of used coffee grounds to suppress scale insects. From 2006-2011, cycad taxa at MBC have increased by 9% and individual plants have increased by 41%. During the same period, resources at MBC show a reduction (as in many botanic gardens). Thus, these metrics confirm the effectiveness and efficiency of recent practices.

### 蒙哥马利植物园苏铁园艺学：最佳实践、新发展和新功效

蒙哥马利植物园 (MBC) 收集了丰富的苏铁活植物。截至2011年，该植物园已经收集了苏铁239种，占全世界已知种的约70%，主要为新世界的种类。具有世界范围多样性的活植物专类园在亚热带地区维护存在气候等诸多挑战，近年来，有限的资源也成了重要的制约因素。本海报展示了近期的园艺实践，主要针对多样性和高效园艺的可持续发展，其中包括：(a) 限制凸起苗床的发展，增加在泥土和石头等本地栽培基质的直接种植；(b) 将现存的凸起苗床转化为适度种植；(c) 在种植中利用陶瓷介质以提高排水；(d) 减少有机护根物的使用，包括将护根苗床改为“杂草泥炭”；(e) 利用异小杆线虫(*Heterorhabditis bacteriophora*)来进行*Eubulus* sp.的生物防治；(f) 利用已种植的咖啡田来进行介壳虫的诱集以达到减少其危害的目的。自2006年至2011年，蒙哥马利植物园的苏铁种类增加了9%，植物个体数量增加了41%。同期，蒙哥马利植物园的投入资源是减少的（与其他植物园类似）。因此，这些数据证明目前的实践的有效性和高效性。

## (P6) *Cycas debaoensis* conservation project in China

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A conservation project for the endangered cycad, *Cycas debaoensis*, developed at the type locality in Fuping, Guangxi from 1999-2011. This project uses education, horticulture and ecological studies to help preserve the wild population of this plant. It is conducted under the guidance of the IUCN Cycad Specialist Group and contributors include The Cycad Society, The Palm and Cycad Societies of Australia, Guangxi Normal University and Fairylake Botanical Garden.

### 中国德保苏铁的保育项目

在1999-2011年间, 在德保苏铁的模式产地——广西扶平乡对德保苏铁开展了一项保护项目。本项目利用教育、园艺及生态研究等方法来开展对德保苏铁野生居群的保护。这是在IUCN苏铁专家小组倡导下, 由苏铁协会、澳大利亚苏铁和棕榈协会、广西师范大学和仙湖植物园共同完成。

## (P7) *Cycas nongnoochiae* population status

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*Cycas nongnoochiae* has an endemic population range restricted to a small cluster of hills in central Thailand east of Tak Fa. The plains from which the hills emerge are about 100 meters above sea level (masl), and the upper limits of the hills are about 400 masl. Areas of occupancy are restricted to the western facing slopes within an overall E-W range of about 11 km and a N-S range of about 7 km. We measured plant density, structure, and morphological variables within three transects. Site 1 was near the West limits of the range in a disturbed habitat showing signs of poaching, cattle grazing, and fire disturbances with ca. 520 plants per ha. Site 2 was at the South-east limits of the range within an undisturbed habitat under the protection of a temple grounds with ca. 730 plants per ha. Site 3 was near the middle of the endemic range in a disturbed habitat primarily under pressures of fire damage and had ca. 275 plants per ha. Demography was highly contrasting among the sites, with Sites 1 and 2 exhibiting substantial seedling and juvenile populations and Site 3 exhibiting few signs of recruitment. Our *in situ* data do not conform to all of the species descriptors, and will be used to clarify the natural variation in leaf and stem morphology. The greatest conservation threats to this species are habitat loss, fires, and poaching.

### *Cycas nongnoochiae* 的种群状况

在泰国中部的达府东面，存在着*Cycas nongnoochiae*的一个特有的种群，它在一小群丘陵之间，丘陵中出现的这个平原在海拔（年平均海拔面）100米以上，最高点为400米左右。东西方向约为11公里，南北方向约为7公里，种群范围局限在西侧的斜坡上。本研究测量了3个样带上的植物密度、结构和形态学变量。调查地点1位于本地区的西侧，该地区遭受偷猎、放牧、火耕等侵害，每公顷具有约520株。调查地点2位于本地区的东南侧，由于寺院的保护而未受人为因素干扰，每公顷具有约730株。调查地点3位于特有区系的中心，该地区曾遭受过火灾，每公顷只有约275株。三个调查地点在统计学上的区别非常明显。地点1和2具有大量的可持续种子萌发和幼苗种群，地点3的补充迹象不明显。本研究的原地保育数据不符合所有物种的描述用语，只是将被用语阐明叶和茎的自然变异。该物种保育的最大威胁来自于栖息地缺失、火灾和偷猎。

**(P8) *Encephalartos laevifolius* current status of all the localities how it happened?**

S.W.K. Trollip

South Africa ([lelaniet@gmail.com](mailto:lelaniet@gmail.com)).

This species is the most disjunct of all the South African species of *Encephalartos*. I will look at the seven different confirmed localities and discuss current status of these plants. I will look at discovery and subsequent loss of plants to poaching.

Kaapschehoop - Nelspruit

Mariepskop - Hoedspruit

Krokodilpoort - Kaapmuiden

Havelock - Swaziland

Tugela Ferry - Natal

Umtamvuna - Natal

Downs - Hoedspruit

These are all confirmed localities of *E. laevifolius*.

***Encephalartos laevifolius*的存活现状及其缘由**

*Encephalartos laevifolius* 是非洲铁属 中间断性分布最高的种。我将对该种确认的7个分布地点进行调研, 并讨论该物种存活的现状。我也将对盗采该物种导致的发现和种群减少进行分析。这7个地点是:

Kaapschehoop - Nelspruit

Mariepskop - Hoedspruit

Krokodilpoort - Kaapmuiden

Havelock - Swaziland

Tugela Ferry - Natal

Umtamvuna - Natal

Downs - Hoedspruit



## (P9) Non-detriment findings for *Cycas chamaoensis* K.D.Hill.

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*Cycas chamaoensis* K.D.Hill is one of the top three endangered cycads in Thailand. Due to the beautiful pagoda-like trunk shape, it is popular to collect from the wild and is in high demand and commands high prices for the cycad lovers. This species was found in protected area, endemic to Khao Chamao- Khao Wong, National Park in Chamao District, Rayong Province. In 1998 IUCN listed this species as “critical endangered”, and CITES listed as Appendix II. In accordance with CITES regulations, allowed to trade only when authorities in charge ensure that specimens will not be detrimental to the survival of this species. The study of non-detriment findings for *C. chamaoensis* was carried out in 2011 by using IUCN guideline. As a result 517 plants were found in 14 cliffs in difference altitude. Most of the plants occur in lying on the slope of granite stone in open area, 70 % of their populations, the trunks were damaged by human cutting. The local people have smuggled and harvested seeds from habitat. Many cultivated cycads nurseries of this species were found at buffer zone, surrounding the Khao Chamao- Khao Wong National park. To ensure that the trade is sustainable, conservation management, artificially propagated from seeds and re-introduction are suggested. Wild specimens' identification also is importance and is needed for relevance authorities to protect species from the illegal traded.

### *Cycas chamaoensis* K.D.Hill的无危害调查报告

*Cycas chamaoensis* K.D.Hill是泰国最濒危的3种苏铁之一。因为它有宝塔形的美丽树干，人们喜欢从野外采集它，在苏铁爱好者间具有很大的需求量且价格昂贵。*Cycas chamaoensis*是在泰国罗勇府乍猫山--旺山国家公园的保护区里发现的特有种。1998年IUCN（世界自然保护联盟）将其列为“严重濒危物种”，被CITES（濒危野生动植物种国际贸易公约）列在附录II中。根据CITES规定，只有主管当局保证该种的生存不受到威胁的情况下，才允许进行商业贸易。依据IUCN准则，我们在2011年进行了*C. chamaoensis*的无危害性调查研究。结果发现，在不同海拔的14个悬崖峭壁处发现了517株植物。大多数植物生长在开阔的花岗石斜坡上，其中70%的个体树干遭到人为刀割。当地居民直接从野外收获和走私种子。同时，在乍猫山--旺山国家公园周边的缓冲区发现了很多这种苏铁的栽培苗圃。为保证商业贸易的可持续性，建议进行保护管理，包括从种子萌发繁殖及回归等工作。此外，野生标本的鉴别也很重要，需要相关当局采用，以在非法贸易的情况下保护该苏铁。

## **(P10) Illegal trade of *Cycas* cones: Major threats to *Cycas* populations in North East India**

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Ever since the discovery of *Cycas pectinata*, the 4<sup>th</sup> species of the genus *Cycas* from Assam in 1826, no extensive works were carried out to study its taxonomy, status and ecology. Cycad populations are facing severe threats from shifting cultivation (*Jhum* in Assamese, *Pamlou* in Manipuri) which is a common practice in the region. Besides common practice of harvesting young leaves for decoration, food and ritual practices, *Cycas* cones are illegally collected from the reserve forests for medicines to cure several ailments and diseases. A study was carried to track the extent of this well co-ordinated mass illegal trade. With the help of local people and forest staffs, epicentre of the illegal trade in Northeast Indian states is identified. Action plan to check this illegal trade is suggested to revive the existing populations in the region.

### **苏铁球果非法贸易：印度东北部苏铁种群面临的主要威胁**

自从1826年在印度阿萨姆地区发现苏铁属的第四个种篦齿苏铁 (*Cycas pectinata*) 到现在, 一直未对它的分类学、状况和生态学进行深入的研究。苏铁种群正面临着来自轮换种植 (*Jhum* in Assamese, *Pamlou* in Manipuri)的严峻威胁, 轮换种植是该地区的惯例。除了收获嫩叶做为装饰、食物和仪式活动的惯例, 苏铁球果作为治疗一些疾病的药物在保护区森林里常被非法采集。目前已对这种大规模非法贸易的范围展开了调查。在当地群众和林业工作人员的帮助下, 已发现了存在于印度东北各邦的非法贸易中心。查办这个非法贸易的行动计划, 旨在使本地区的现存苏铁种群得以恢复。

## (P11) Preliminary study on the harm caused by *Liloceris* sp. Feeding on *Cycas guizhouensis*

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Within the boundaries of Wangmo County, the resource *Cycas* is seriously being jeopardized by *Liloceris* sp., whose larvae and imagoes live on the tender leaves and stalks of *Cycas guizhouensis*. In particular, the harm caused by the larvae is more serious. The tender leaves and stalks of the jeopardized *Cycas* are eaten up only to leave nothing but the outward skins, which has an effect on the normal growth, blossom and fruit-bearing of *Cycas* and even leads to feeble growth and gradual death when serious. *Liloceris* sp can propagate 4-8 generations annually, which spend winters in the form of pupae. Owing to the few natural enemies, quick spread and great harm, not only does it jeopardize the existence and development of the resource *Cycas* of Wangmo County, but also threatens other kinds of the *Cycas* genus. Therefore, it is suggested that *Liloceris* sp should be brought into the emergency prep schemes on the biological control of the pests in forestry, and in the pesty areas all kinds of effective measures be taken for the vigorous control.

### 贵州苏铁负泥虫危害初报

报道危害贵州苏铁(*Cycas guizhouensis*)的新害虫苏铁负泥虫(*Lilloceris* sp.)。苏铁负泥虫的成虫、幼虫以贵州苏铁的嫩叶、叶柄为食,尤其以幼虫危害较为严重,受害植株嫩叶、叶柄被吃仅剩外表皮,叶片干枯,影响苏铁的正常生长发育和开花结果,严重的树势衰弱,逐渐死亡。苏铁负泥虫在贵州望谟1年可繁殖4-6代,以蛹越冬。因天敌少,传播快,危害大,不仅危害贵州苏铁资源的生存和发展,而且威胁苏铁属其它种。

**(P12) A putatively new genus of Pharaxonothinae (Coleoptera: Erotylidae) collected from *Cycas* in Asia**

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Beetles belonging to the family Erotylidae are commonly found on the cones of Asian *Cycas* and are probable pollinators. These were studied using morphological characters and mitochondrial 16S rRNA gene sequences. The results indicate that they are related to erotylid beetles inhabiting New World cycads, but belong to a distinct lineage. We propose this lineage as a putatively new genus related to *Pharaxonotha* within Pharaxonothinae.

**亚洲苏铁属中拟叩甲亚科一新属（鞘翅目：大蕈甲科）**

大蕈甲科（Erotylidae）的甲虫常见于亚洲苏铁属的球果，而且是可能的传粉者。本研究使用形态特征和线粒体16S rRNA基因序列来研究该类昆虫。结果显示它们与新大陆苏铁植物上发现的大蕈虫科昆虫近似，但明显属于另外的一个谱系。我们推测该新属与拟叩甲亚科的拟叩甲属近缘。

### (P13) Risk analysis on cycad diseases in the Global World

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There are three families of Cycad, they are Cycadaceae, Stangeriaceae and Zamiaceae. Among them, only 23 species of Cycas in Cycadaceae are distributed in China,. In this paper, main cycads diseases and their damages were reviewed for the first time. Five *Cycas* diseases have been reported only in China and Japan so far. *Cycas* Bulb Rot Disease (*Fusarium solani* (Mart.) App. & Woll), *Cycas* Anthracnose (*Colletotrichum* sp.), *Cycad* spot disease (*Ascochyta cycadina* Scalia) and *Cycad* Sooty blotch (*Capnodium* sp.) were reported in China, and *Cycad* necrotic stunt virus (CNSV) was reported in Japan. *Cycad* Bulb Rot Disease and *Cycad* necrotic stunt virus lead to *Cycad* plant' death. *Cycad* Anthracnose, *Cycad* spot disease and *Cycad* Sooty blotch are *Cycad* leaf diseases which reduce *Cycad* growth and their ornamental value. As both hosts *Cycad* plants and plant pathogens of *Fusarium* sp., *Colletotrichum* sp., *Ascochyta* sp., *Capnodium* sp. are common in sub-tropical and tropical areas, there will be high risk of *Cycad* disease in the global scale. The risk prevention strategies for each disease are also discussed in this paper.

#### 全球苏铁类植物病害发生风险分析及应对措施

苏铁类植物全球有3科，即苏铁科、托叶铁科和泽米铁科。中国仅1科1属，即苏铁科苏铁属，共23种，产于台湾、华南和西南省区，均被列入国家一级重点保护野生植物名单。本文首先对国内外苏铁类植物病害发生和防治情况进行综述。到目前为止，中国报道了下列4种苏铁科植物病害及其防治技术，分别是苏铁镰刀菌球茎腐烂病 (*Fusarium solani* (Mart.) App. & Woll)，苏铁炭疽病 (*Colletotrichum* sp.)，苏铁斑点病 (*Ascochyta cycadina* Scalia) 和苏铁煤污病 (*Capnodium* sp.)。日本报道1种病害即苏铁坏死矮化病毒 (*Cycas* necrotic stunt virus (CNSV))。苏铁镰刀菌球茎腐烂病和苏铁坏死矮化病毒病导致苏铁死亡；苏铁炭疽病，苏铁斑点病和苏铁煤污病是叶部病害，影响植物生长，降低观赏价值，这些病害主要发生在人工栽培苏铁上。由于苏铁主要分布在南北半球的热带及亚热带地区，而镰刀菌是土壤习居菌，炭疽菌、斑点病和煤污病是常见植物病害，因此，随着苏铁类在景观方面应用的普遍化及其人工栽培面积的扩大，同类病害在其他国家发生的风险也很高。文中还提出了针对各种苏铁疾病的应对措施。



**(P14) Coffee grounds: Assessing a potential control for cycad *Aulacaspis* scale, *Aulacaspis yasumatsui*.**

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Cycad *Aulacaspis* Scale (CAS), *Aulacaspis yasumatsui* Takagi, is a serious pest insect in South Florida and worldwide. *A. yasumatsui* causes great damage and potential death to cycads, particularly *Cycas*. *A. yasumatsui* is taking a toll on cycad plantings and is also posing a problem for the foliage industry. The use of spent coffee grounds to prevent and control *A. yasumatsui* has received increase popularity in the last few years. As a recycled and free resource, spent coffee grounds are a potentially sustainable and green option for pest control. This study assesses whether the application of spent coffee grounds is a realistic control method against *A. yasumatsui*, and whether spent coffee grounds can successfully be used as an alternative to chemical pesticides. The study assessed five types of coffee treatments to control *A. yasumatsui* on *Cycas debaoensis* Y.C. Zhong and C.J. Chen. Reusing spent coffee grounds lowers pH and reduces the amount of waste that goes into landfills, but does it have a significant effect on the presence of *A. yasumatsui*? We seek to provide insight on whether or not spent coffee is a successful treatment for the control of *A. yasumatsui*.

**咖啡渣：评估苏铁白轮盾介壳虫的潜在控制**

苏铁白轮盾介壳虫是佛罗里达州和世界范围内影响非常严重的害虫，它引起苏铁类植物的严重损害和潜在死亡，对苏铁的种植产生了负面的影响，而且也给一些植物产业造成很大问题。在过去几年中，利用咖啡渣来预防和控制苏铁白轮盾介壳虫病越来越受到大众的欢迎，作为一项回收利用的、免费的资源，咖啡渣是害虫防治比较合适并且环保的选择。这项研究评估了咖啡渣的应用对于苏铁白轮盾介壳虫病的防治是否有效，以及咖啡渣是否能成功地应用于化学农药的研制。此研究用5种被处理的咖啡来控制德保苏铁的白轮盾介壳虫病，重复利用低pH的咖啡渣以减少了垃圾场里的咖啡废物。但对于苏铁白轮盾介壳虫病的存在，这种方法是否会产生有意义的影响呢？我们希望此研究能够为咖啡渣是否可以成功防治苏铁的白轮盾介壳虫病提供视角。

## (P15) Transcriptome characterization for male and female plants of *Cycas elongata* (Leandri) D.Y. Wang

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Cycads are dioecious plants. Transcriptome can reflect the gene difference of sexuality in dioeciously plants. The leaf of male, female, megaspore and microspore of *Cycas elongata* were selected for transcriptome analyses. The transcriptome data was achieved on the latest sequencing technology Solexa in the pair-end sequencing, 75bp was used as the sequencing fragments length. The results obtained following data: 1) 106,891 sequence reads (41,802 cluster, 65,089 Singletons) were generated from female leaf; 110,826 sequence reads (41,794 cluster, 69,032 Singletons) from male leaf; 110261 sequence reads (956 cluster, 109,305 Singletons) from megasporophyll; 87,762 sequence reads (515 cluster, 87,247 Singletons) from microsporophyll. 2) Difference analyses were done between female leaf and male leaf data, and between megasporophyll and microsporophyll data. Many genes expressed differently in each sample. The differential expression genes not only existed in reproductive organs (45% of expressed genes are differentially expressed between megasporophyll and microsporophyll), but also in the female leaf and male leaf samples (25% of expressed genes are differentially expressed between leaf samples). And some genes expressed only in female leaf (1,020 sequences), male plants leaves (1,337 sequences), megaspore leaves (17,449 sequences), and microspore leaves (3,081 sequences), respectively. 3) Sequence alignments with KEGG and COG database by BLASTX, some expressed genes got the function annotation and category by comparing with similar nucleic acid sequences and protein sequences. 4) Sequence function annotation was performed, genes related to DNA methylation, phytohormone, and volatile substance were found. We also aligned the sequences between male and female *C. elongata* by TBLASTX, then there are 37 pairs of female *C. elongata* specific sequences, 69 pairs of male *C. elongata* specific sequences, all the genes were annotated, and some gene's pathway were got.

### 越南篔齿苏铁雌、雄株转录组研究

苏铁是雌雄异株植物，引种回归时，需对雄株和雌株进行合理的配置。转录组能够反映雌雄异株植物在性别上的差异。本试验选用越南篔齿苏铁雌株叶片、雄株叶片、大孢子叶片和小孢子叶片为研究材料，应用新一代高通量Solexa双向测序法对四种材料进行测序。研究结果表明：1. 本试验共得到雌株叶片表达序列：106891（41802 cluster，65089 Singletons）条；雄株叶片表达序列：110826（41794 cluster，69032 Singletons）条；大孢子叶片表达序列：110261（956 cluster，109305 Singletons）条；小孢子叶片表达序列：87762（515 cluster，87247 Singletons）条。2. 将雄株叶片与雌株叶片设定为一组，大孢子叶与小孢子叶为另一组，用来对苏铁雌雄植株叶片，大小孢子叶的转录组进行表达基因的差异分析，找到了大量不同样本之间表达差异的基因。发现在苏铁雌雄植株中不仅雌雄生殖器官的表达基因存在差异（占大小孢子叶表达基因45%的属于表达差异的基因），而且雌雄植株的叶片中也有大量的表达基因具有显著差异（占叶片中表达基因25%的在雌雄植株的叶片之间为表达显著差异）；同时也存在单独在雌株叶片（1020条）、雄株叶片（1337条）、大孢子叶片（17449条），小孢子叶片（3081条）中表达的基因。3. 通过BLASTX与KEGG，COG数据库中具有的所有数据进行比对，通过与之相似的已有的核酸序列和蛋白质序列，将我们得到的所有数据进行功能注释，和功能分类。4. 应用表达基因功能的注释找到与DNA甲基化，激素，挥发气体相关的表达基因。应用TBLASTX对苏铁雌雄株间的表达序列进行比对，相似度E-value小于1e-10时，得到了雌株苏铁具有的特有序列37对表达序列，雄株苏铁特有序列69对表达序列。并对这些序列的功能进行注释，并得到了某些序列的相似基因的表达通路。

## (P16) The microsporogenesis of *Cycas* and its systematic implications

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The infrageneric classification and species delimitation within the genus *Cycas* is controversial among taxonomists depending on their broad or narrow species concept, as some species were defined based on comparatively minor morphological differences only. It was well known that the cytokinesis in pollen mother cell provided an important evidence for plant taxonomy, particularly at high taxonomic level. Here we present the first broad comparison of the cytokinesis of male meiosis in five species of *Cycas*. The comparative analysis on microsporogenesis in *Cycas* was conducted by using conventional microscopy, semi-thin sectioning, histochemistry, and fluorescence microscopy with a focus on the cytokinesis of meiosis in pollen mother cells. Our observations confirmed that the cytokinesis in male meiosis of five species in *Cycas* was simultaneous at the end of second meiosis, different from previous reports. The basic model of microsporogenesis and its systematic implications in *Cycas* were discussed based both on previous reports and our new results.

### 苏铁属小孢子发生及其系统学意义

小孢子母细胞 (PMC) 减数分裂时的胞质分裂类型由于在特定的植物类群中具有稳定性而在植物分类学中被作为一项重要的胚胎学证据, 甚至用于探讨种子植物中大的类群的系统演化及分类学问题。目前, 苏铁类植物属水平上的分类已经没有太大争议, 但在属下等级的分类上仍然存在许多问题, 至少在苏铁属内还没有一个令人满意的分类系统。本研究利用常规石蜡切片技术、半薄切片技术、组织化学法及荧光显微技术等研究了德保苏铁等5种苏铁属植物PMC的减数分裂过程, 重点观察了PMC减数分裂时的胞质分裂类型。结果表明: 5种苏铁小孢子发生时母细胞的胞质分裂类型一致, 均为同时型, 这与先前关于苏铁属植物胞质分裂的报道不相一致。本文根据我们的观察研究, 并结合文献分析探讨了苏铁类植物小孢子发生的基本模式及系统学意义。

**(P17) Anatomical description of the cytoplasmic connections between the central cell and transfer cells in *Ceratozamia mexicana* Brongn., and *Zamia furfuracea* L.f. (Cycadales)**

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Both *Ceratozamia mexicana* and *Zamia furfuracea* occur in different environments and two years and one year pass from ovule initiation and appearance of the embryo respectively. Gametophyte development is similar in both species differing only in development speed. The gametophyte stores starch grains, proteins and fat after cell formation. Chamberlain sustained that the transference of nutrients from the jacket to the central cell occurs through cytoplasmic connections or haustoria from the central cell. In this study these connections are described anatomically for the two species. Standard microtechnique methods of embedding and sectioning were used and staining was done with periodic acid Schiff's reagent (PAS) for polysaccharides. Cell completion for *C. mexicana* gametophyte and consequent development of the central cell occurs nine months after ovule initiation, and five months in *Z. furfuracea*. The cytoplasm of the central cell is conspicuously vacuolated in both species, where *C. mexicana* presents a prominent nucleus of 75  $\mu\text{m}$  and *Z. furfuracea* a nucleus of 95  $\mu\text{m}$ . Cytoplasmic connections measure an average of 7  $\mu\text{m}$  and transverse the cell wall through pits measuring 7.5  $\mu\text{m}$  and 10.5  $\mu\text{m}$  in diameter respectively. The cytoplasmic connections that occur between the central cell and the transfer cells that make up the archegonial jacket, through pits in the cell wall of the central cell has been clarified by the PAS positive staining of the cell wall of the central cell.

***Ceratozamia mexicana* Brongn.和*Zamia furfuracea* L.f. (苏铁目) 的中央细胞和传递细胞之间胞间连丝的解剖学描述**

*Ceratozamia mexicana* 和 *Zamia furfuracea* 生长在不同的环境中，并且分别需要2年和1年的时间才能从胚珠萌发形成完整的胚芽。这两个种的配子体发育是相似的，唯一不同的仅仅是它们发育的速度。晶胞形成后，配子体就储存淀粉粒、蛋白质和脂肪。Chamberlain一直认为营养物质从胞外到中央细胞的转移是通过胞间连丝或者中央细胞的吸器来进行的。这项研究将在解剖学上对这两个种的这些胞间连丝进行描述。作者将材料包埋和切片，并用碘酸希夫试剂对多糖进行染色，然后用显微镜观察。*Ceratozamia mexicana*的配子体细胞在胚珠萌发的九个月后发育完成，中央细胞随之发育。而同样的过程，*Z. furfuracea*只需要5个月时间。这两个种中央细胞的细胞质中都有明显的液泡，*C. mexicana*的细胞核为75 $\mu\text{m}$ ，而*Z. furfuracea*的为95 $\mu\text{m}$ 。测量胞间连丝的平均值是7 $\mu\text{m}$ ，通过直径分别7.5 $\mu\text{m}$ 和10.5 $\mu\text{m}$ 的纹孔横穿细胞壁。中央细胞和传递细胞之间的胞间连丝形成颈卵器套，通过对中央细胞的细胞壁进行碘酸希夫试剂染色就可以使穿过中央细胞细胞壁的纹孔的胞间连丝变得清晰可见。

**(P18) Development cycle of the ovule and seed of *Zamia furfuracea* L. f. (CYCADALES)**

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Gymnosperms have reproductive cycles that take between one and three years to complete, these cycles being longer in temperate zones and shorter in tropical zones. In *Ceratozamia mexicana*, a cloud forest cycad, its reproductive cycle occurs in two years, whereas in *Zamia furfuracea*, a coastal sand dune species, the cycle takes one year. This study describes the reproductive chronology in *Z. furfuracea*. Ovules during the initial stages of development as well as mature seeds were collected from a natural population of *Z. furfuracea*. These were fixed and hand sections taken and histochemical tests were carried out for polysaccharides and starch with IKI and periodic acid Schiff's reagent (PAS), with red O for lipids and naphthol blue black (NBB) for proteins. Transmitted light microscopy was used for observations. Seed development for *Z. furfuracea* is completed in one year, from ovule initiation in June until the complete development of the embryo body. The gametophyte is coenocytic from June to the beginning of September. Cell formation takes three weeks in September and nutrient storage during the end of September. Hardening of the seed coat initiates beginning of November when the ovule presents mature archegonia and the first stages of suspensor development. Seeds are dispersed at first half of December, at which time archegonia maybe present and occasionally developing suspensors. Therefore, the disseminule could be or not be fertilized at the time of dispersal.

**鳞秕泽米铁（苏铁目）胚珠和种子的发育周期研究**

裸子植物的繁殖周期要一年到三年时间才能完成，这个周期在温带时间比较长，在热带时间比较短。*Ceratozamia mexicana*是一种生活在云雾林的苏铁，它的繁殖周期是两年。然而，*Zamia furfuracea*是一种生活在海岸沙丘的物种，它的繁殖周期是一年。本研究描述的是*Z. furfuracea*的繁殖年表。首先从*Z. furfuracea*的天然居群中收集植物发育初期的幼籽和成熟的种子，然后固定这些材料并徒手切片，再进行组织化学检测，即分别用IKI、过碘酸希夫试剂、Red O和蔡乙酸对多糖、淀粉、脂肪以及蛋白质进行染色，并用投射光学显微镜进行观察。*Zamia furfuracea*种子发育在一年内完成，即从六月份胚珠萌发到完全发育成胚芽。从六月到九月初的配子体是多核的，而九月份的晶胞生成要消耗3个星期的时间，在九月末储存营养物质。十一月份当胚珠出现成熟的颈卵器而胚柄处于发育的第一阶段的时候，种皮开始硬化。十二月上半月种子开始散落，并且在这时颈卵器出现并且有的正发育形成珠柄。因此，传播体有可能在散布的时候受精，也有可能不能受精。

### (P19) Research on reproduction in *Cycas revoluta*

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In this research, the result showed that the viviparous propagation of *Cycas revoluta* Thunb is seed viviparity. In the second year after the seeds matured, the new seedlings growth from the mother plant. The humid growth environment enabled the seed obtains water from dry megasporophyll petiole by osmosis. The seed viviparity is the advanced propagation for environmental adaptation. Sexual reproduction: the pollen viability has no obviously decreased after stored in sealed tube at  $-80^{\circ}\text{C}$  for 500 d. The result showed that pollen germinated after 24 h when growth in MS media (2 times the iron salt and  $\text{CaCl}_2$ ) contain  $10\text{g} \cdot \text{L}^{-1}$  Sucrose,  $0.1\text{g} \cdot \text{L}^{-1}$  boric acid and  $4\text{g} \cdot \text{L}^{-1}$  agar. 320-550 seeds were achieved from each plant through artificial pollination when megasporophyll petiole stains media. The seed can sowed immediately once ripen. The seed germination percentage could arrive at 70% after storage in normal temperature for 2 years and 35% for 3 years. Seed germination of the radicle after 15 d when immersed in concentrated sulfuric acid for 6 h or removed the hard mesosperm through mechanical methods and immersion in  $10\text{g} \cdot \text{L}^{-1}$  rooting powder for 5 h. Aseptic *Cycas revoluta* seedlings can be obtained when the seed cultured in MS media (2 times the iron salt and  $\text{CaCl}_2$ ) contain  $10\text{g} \cdot \text{L}^{-1}$  Sucrose and  $4\text{g} \cdot \text{L}^{-1}$  agar, pH 5.8 when removed hard mesosperm through mechanical methods.

### 苏铁若干繁殖问题的研究

本文分别报道了苏铁 (*Cycas revoluta*) 的三种繁殖方式及其具体实验条件。苏铁具有种子胎生现象, 种子成熟后的第二年在母株上生根发芽发育成幼苗。可能的成因是苏铁生长的环境较湿润, 经物理性质渗透作用从干枯的大孢子叶柄通过珠柄给种子提供水分。胎生繁殖是苏铁种子对生态环境的高级适应进化。苏铁花粉密封后在超低温冰箱 $-80^{\circ}\text{C}$ 的条件下, 储存500 d后, 经检验花粉的生命力与新鲜花粉无显著差异。对苏铁花粉进行花粉管萌发研究显示以MS (铁盐和 $1/2$ 的 $\text{CaCl}_2$ ) +  $10\text{g} \cdot \text{L}^{-1}$ 蔗糖 +  $0.1\text{g} \cdot \text{L}^{-1}$ 硼酸 +  $4\text{g} \cdot \text{L}^{-1}$ 琼脂, 花粉管萌发最快, 24 h可见萌发; 大孢子叶胚珠有沾液时人工授粉单株可得种子320-550颗, 种子没有休眠后熟期, 可随采随播; 种子常温保存2年、3年其发芽率分别为70%和35%。用浓硫酸侵蚀6 h或机械除去中种皮后的种子用 $10\text{g} \cdot \text{L}^{-1}$ 生根粉浸泡5 h, 15 d后可萌发出胚根。如果机械除去硬的中种皮用上述花粉管萌发配方减去硼酸, pH 5.8, 无菌接种培养10-15 d可得到无菌植株。



## (P20) Cycad sex ratios at Montgomery Botanical Center

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Cycads are dioecious plants, with ovulate (female) cones and pollen (male) cones borne on separate plants. Sex ratios estimated during field studies vary widely and are problematic because they typically only represent the conditions during the study, leading to biased estimates depending on the season and current phenology of the studied populations. In contrast, botanical gardens can provide insights into cycad sex ratios that would be difficult to match in the field without a very long-term commitment to monitoring. At Montgomery Botanical Center, individual plants are monitored during their entire lifespan, and their gender is recorded during first coning events. Using MBC's database, individual plant records were examined for 4873 cycads at MBC's living and historical ground collection, including members of all 10 genera. The collection as a whole is significantly male-biased. However, when considering only species for which  $\geq 90\%$  of individuals has coned, there is no detectable gender bias. The gender bias in the population as a whole is likely due to the lower energy expenditure for male cones, resulting in their production at a younger age. Many of the cycad plantings at MBC are less than 10 years old, so one would expect a male bias at the present time. However, this bias is likely to decrease as an increasing percentage of the collection reaches maturity.

### 蒙哥马利植物中心苏铁的雌雄性别比例

苏铁类是雌雄异株植物, 即具胚珠(雌性)的球花和花粉(雄性)的球花长在不同的植株上。野外考查期间估算苏铁的雌雄比例差异较大并存在问题, 因为它们通常只代表了该次调查当时的条件, 偏差取决于所调查居群所处的季节和当时的物候期。与此相反, 在植物园却能够洞悉在野外环境下很困难且需要长期观测才能发现的苏铁性别比例。在蒙哥马利植物中心, 每个个体的整个生活周期都会被监测, 并且在第一次开花就记录它们的性别。使用蒙哥马利植物中心的数据库, 对有记录的4873株苏铁的活植物和标本, 包括所有的10个属进行分析。总的来说, 这些记录明显偏向雄性。然而, 如果仅考虑已经形成球花的超过90%的个体, 这些性别偏差是无法察觉的。整体而言, 居群中性别偏离很有可能是由于雄球花的能量消耗较低, 导致它们在较年轻时期的出现。许多在蒙哥马利植物中心栽培的苏铁都少于10年, 所以有人认为目前将是雄性植株为主。然而, 这种偏差将很有可能因为植株迈向成熟而减少。

## (P21) Season and Frequency of *Cycas micronesica* reproductive events

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Leaf and reproductive flushing events within a high density *Cycas micronesica* population in western Guam were monitored from 2002 through early 2005. These were the final years prior to the invasions of *Aulacaspis yasumatsui* and *Chilades pandava*. Male cones emerged during every month of the year, but March and October were median months for two pulses of increase cone incidence. These led to major pollen shed events synchronized with female megastrobili abundance in May-June and December-January. The non-fixed pattern of reproductive season led to an overall mean of 9.5 months between successive male and 13.6 months between successive female reproductive events. We will correlate coning season with rainfall, photoperiod, and equinox-solstice patterns to determine if any environmental predictor(s) can be identified.

### *Cycas micronesica*生殖活动的季节和频率

本研究从2002年到2005年初对关岛西部一个高密度的*Cycas micronesica*居群内的叶和生殖活动进行监测。该年份为苏铁白轮盾介壳虫和曲纹紫灰蝶入侵之前的最后几年。那一年*C. micronesica*中的每个月都有雄球花出现，但是3月和10月是球花的发生率提高两次的中间月份。这样就导致了大部分的花粉的散布活动与5-6月和12-1月份雌性大孢子叶球的多度几乎同时。非固定模式的繁殖方式导致了雄球花的两次繁殖活动之间有一个平均9.5个月间隔以及雌球花有13.6个月的间隔。本研究将分析开花季节与降雨量、光周期以及昼夜平分点模式的关系来确认是否有相关的环境因子存在。

## (P22) Heat production in male cones of Chinese *Cycas*

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Temperatures were measured in male cones, during pollen shedding, for species of *Cycas* native to China and Vietnam. Species in *Cycas* sections *Panzhihuanses* and *Stangerioides* showed heat production with single daily temperature peaks in the range of 2-5°C above ambient. Species in *Cycas* sections *Asiorientales*, *Indosinenses* and *Cycas* displayed weak heat production without clear daily peaks and maximum temperatures usually below 1°C. Heat production patterns may be correlated with the types of beetles visiting *Cycas* cones. Those with stronger heat production tend to be pollinated strictly by beetles of the family Erotylidae, while those without strong heat production appear to be pollinated by beetles in the Nitidulidae or a mixture of Curculionidae and Erotylidae.

### 中国产苏铁属雄球花的产热机制研究

本文对中国和与越南本土苏铁种类传粉期间雄球花的温度进行了测量。苏铁属攀枝花苏铁组和叉叶类苏铁组的种类产生的热量具单一的峰值,且比周边环境日温值高2到5°C;苏铁属亚洲苏铁组、暹罗苏铁组和苏铁组的种类则表现出较低的产热量,通常不具明显的峰值,且其温度比周边环境日温值低1°C以内。苏铁产热模式可能与访问苏铁的甲壳虫种类有关。大蕈甲科的甲虫倾向于给那些具有较高的产热量的苏铁种类进行传粉,而那些产热量较低的个体基本上是由露尾甲科或象甲科和大蕈甲科的甲虫混合进行授粉的。

## National Cycad Germplasm Conservation Center

Shenzhen is located in the southern subtropical region with wild populations of *Cycas fairylakea* and therefore climate suitable for the conservation of cycads. In 2002 the National Cycad Germplasm Conservation Center (referred to as “the center” hereafter), was jointly founded in FairyLake Botanical Garden, by the China State Forestry Administration and Shenzhen Urban Management Bureau. After years of efforts the center has collected cycads of about 80% species in the world and all the species of *Cycas* from China, of which some species already flower and bear fruits normally.



### 1. Germplasm Collection and Conservative Cultivation

To date, the cycad center conserves cycads about of 240 species in 10 genera and 3 families. It covers an area of 3.3 ha. including nurseries, public education exhibition, bonsai display and *ex situ* conservation areas. With integrated functions of conservation, research, propagation and education, the center is becoming a worldwide cycad collection with unique conservation scale and display pattern.

### 2. Major Projects and Awards

Since the foundation of the cycad center, more than ten projects from government departments have been granted; a Guangdong Provincial Award for Science and Technology Progress, Shenzhen Award for Science and Technology Innovation Progress were awarded; A national technology patent and a new plant variety certificate were authorized and issued; A Guangdong provincial standards for “The Propagation & Cultivation Techniques, as well as Product Quality Grades of Common Commercial Cycads” was formulated and put into implement. In addition, the center fulfilled The Reintroduction Program of *Cycas debaoensis*, which is the first plant reintroduction project sponsored by national government in China, Furthermore more than 50 academic articles and 3 books have been published, and over 20 graduated students have been trained for their Master degree.

### 3. A Brief to the Reintroduction to Natural Habitat of *Cycas debaoensis* Project

*Cycas debaoensis* is an endangered cycad species distributed in western Guangxi and eastern Yunnan. With a unique, bamboo-like appearance, the species has suffered an abrupt damage after it was published. The total number of the wild 15 populations was less than 800 individuals. Supported by China State Forestry Administration, the center reintroduced 500 DNA-detected seedlings of *C. debaoensis* which were propagated in the center to their hometown, Huanglian Mountain Nature Reserve, Guangxi in April, 2008. The follow-up surveys for three years indicated that the *C. debaoensis* seedlings grow very well, where is very near to the type location of the species. In 2011 the shooting rate of the fronds reached 97% and 8 individuals flowered. This achievement has been received extensive affirmation. (by Nan Li)



### 国家苏铁种质资源保护中心

深圳地处南亚热带, 有天然分布的仙湖苏铁 *Cycas fairylakea* 野生种群, 气候条件十分适合苏铁类植物的生长。2002年经国家林业局与深圳市城市管理局合作共建了“国家苏铁种质资源保护中心”(以下简称“中心”)。经过多年的努力, 中心现已收集保育了中国分布的所有苏铁属植物, 以及约占全世界种类80%以上的苏铁类植物, 其中部分种类已正常开花结实。

#### 一、苏铁种质资源收集与保育栽培

中心成立至今, 已经收集和保存了苏铁类植物3科10属240余种、变种或品种, 保育面积达3.3公顷, 并建有专门进行苏铁类植物繁殖的专业苗圃、苏铁科普展室、苏铁盆景展区及活体保育区等, 基本形成了集苏铁保育、科研、繁殖生产及科普旅游于一体的中心, 其保育种类之多、规模之大、展示形式之丰富在世界范围内是罕见的。

#### 二、完成的主要科研项目及获奖情况

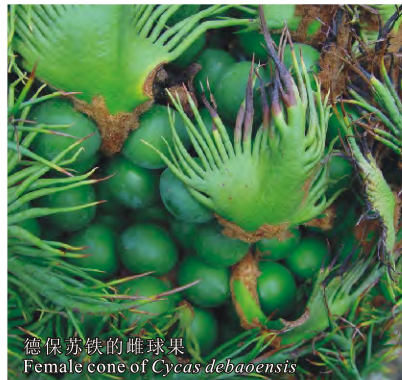
自中心建成以来, 已先后主持和参与的部、省、市级课题共十余项, 获广东省科技进步奖一项、深圳市科技创新奖一项、国家技术专利一项、新品种保护一项, 并完成了广东省地方标准“主要商品类苏铁植物繁育栽培技术与产品质量分级”的编制。承担并实施了中国首个由政府部门主导的“德保苏铁回归自然项目”, 先后发表学术论文50余篇, 出版编著3部, 培养研究生20余名。

#### 三、德保苏铁回归自然项目简介

德保苏铁 *Cycas debaoensis* 是一种主要分布在我国广西西部和云南东部的濒危苏铁植物, 因其羽叶多回分叉, 姿态奇特, 而备受关注。自发表后其野生种群数量因被盗挖而急剧下降。在目前被发现的15个野生居群中, 野生个体总数加到一起不足800株。2007年, 在国家林业局的主导和资助下, 苏铁中心承担并实施了我国首个珍稀濒危植物回归自然项目“德保苏铁回归自然项目”。2008年4月, 中心将自行繁育的500株经DNA检测的德保苏铁实生苗回归定植到它们的家乡——广西壮族自治区德保县黄连山自然保护区。经过3年的跟踪调查, 回归后的德保苏铁长势良好, 2011年发叶率达到97%, 8株开花。这一成果受到上级主管部门和社会各界的一致肯定。(李楠 供稿)



中心的美洲区  
American collections of cycad center



德保苏铁的雌球果  
Female cone of *Cycas debaoensis*



司氏非洲铁开花(雌球果)  
Female cone of *Encephalartos sclavoi*



攀枝花苏铁的种子  
Seeds of *Cycas panzhihuaensis*



锈毛苏铁  
New frond of *Cycas ferruginea*



苏铁光合生理指标测定  
Postgraduate student was doing experiment



## Journal of Fairylake Botanical Garden-Call for papers

Journal of Fairylake Botanical Garden (JFBG) is a peer-reviewed quarterly journal for papers on any aspect of botany, horticulture and related fields. All types of papers are considered, including monographs, reviews and revisions, catalogues / checklists / inventories, research briefs, conference proceedings, etc. Special issue with collected papers within the scope of the journal or taxonomic monographs and revisions are occasionally published. Free access is currently available. To find more about information, please visit <http://www.szbg.org/html/EN/PUBLICATIONS/MAGAZINES/FAIRYLAKE/>.

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### 《仙湖》征稿启事

《仙湖》为深圳市中国科学院仙湖植物园主办的以植物科学和园艺学为主的综合性学术期刊（季刊）。本刊办刊宗旨为促进植物学研究的创新和发展，加强植物学领域学术交流。本刊主要刊载植物学、植物分类学及其相关领域的国内外最新研究动态、中国及地方植物学学会、植物园的各种活动和消息；设有专论与综述、研究论文、研究简报、技术与方法、经验交流、译文（由本刊约稿）、书评、学术动态等栏目，并可根据实际需求再开辟新的栏目；对于植物分类学的高水平综述与专论，将给予尽快发表。期刊接受中、英文稿件；为促进国际交流，欢迎投递英文稿。来稿请发电子版至：[xhqk@yahoo.cn](mailto:xhqk@yahoo.cn)或[zhangli\\_siu@yahoo.com](mailto:zhangli_siu@yahoo.com)。更多信息欢迎访问：

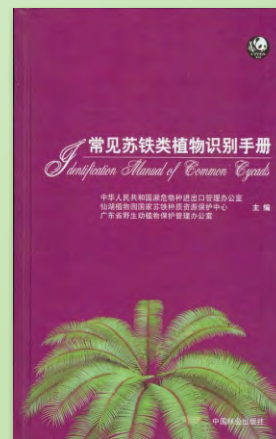
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## New Book: *Identification Manual of Common Cycads*

Edited by: The Endangered Species Import and Export Management Office of the People's Republic of China  
National Cycads Conservation Center of Fairylake Botanical Garden  
Wildlife Protection and Management Office of Guangdong Province  
Published: China Forestry Publishing House, 2011. ISBN978-5038-6107-9. Price RMB \$60.00.



Cycad is also called “iron tree” or “phoenix-tail canna” in China. As one of the most primitive seed plants living today, cycad has important value of science and ecology, as well as economy and be regarded as “living fossils”. Cycad plays rather important role in biodiversity conservation all over the world. They also play a very important role on studying in the origin and evolution of seed plants, as well as the change of ancient climate.

In order to fulfill the International Convention preferably and to strengthen law enforcement and management in export and import links and to facilitate the supervision, inspection and examination for custom, as well as to vindicate the authority of law enforcement, The endangered Species Import and Export Management Office of The People's Republic of China organized cycad experts, scholars and managers to compile and edit this Identification Manual for Common Cycads. This manual contains 76 species which covers 11 genera and 3 families of living cycads, including all cycad species distributed in China, common smuggling cycad species distributed in southeast Asia, common commercial or representative cycad species of each genus and family. In each species, both Latin name and Chinese name are given, the morphological characteristics, habitats, general distribution and protection grade in IUCN red list assessment system are described concisely, three more colorized photos consisting of holistic or typical pictures are presented in the book, with reproductive organs or identifiable characteristics. Therefore, identification could be quickly made by using of the manual. This manual is also applicable to law enforcement officer's training, popularization and education. The publisher hope that this manual will play an active role in the promotion of cycad protection, the management of cycad import and export, the conscientious implementation of international treaty, the strengthening of law enforcement and supervision. Meanwhile, it will also provide an important reference material for the management of cycad protection in China. (by Nan Li)

### 新书推介：《常见苏铁类植物识别手册》

主 编：中华人民共和国濒危物种进出口管理办公室  
仙湖植物园国家苏铁种质资源保护中心  
广东省野生动植物保护管理办公室

出 版：中国林业出版社(2011), ISBN978-5038-6107-9, 定价¥60.00元。

在中国苏铁俗称“铁树”，又名“凤尾蕉”。苏铁类是现存最古老的种子植物，珍贵的植物“活化石”，具有重要的科学、生态和经济价值。在全球生物多样性保护和研究种子植物的起源、演化中，以及古气候变迁等方面苏铁类植物也扮演着重要角色。为了认真履行国际公约，加强进出口环节的执法和管理，方便口岸海关和执法部门查验监督工作，中华人民共和国濒危物种进出口管理办公室组织有关专家共同编辑出版了《常见苏铁类植物识别手册》。

该书全册共包含了76个种，涵盖了苏铁类3科11属，列出了中国所有分布种、中国邻国分布的可能涉及走私的种类、常见贸易种和各科属的代表种。其中每种都配有简明的形态识别特征描述、分布区、生境特点、花期及保护级别等。为了便于识别鉴定，本书特别编写了苏铁类植物11个属的分属检索表，同时对每个介绍的苏铁物种均配有3幅以上的彩色插图，包括每个物种的整体图片、繁殖器官及具有典型鉴别特征的图片等。通过查阅，可以较快地对有关物种进行鉴别。本《手册》也可用于执法培训和宣传教育等方面。我们希望该手册对加强苏铁类植物进出口管理、切实履行国际公约、强化执法监督、促进我国苏铁植物保护事业发挥积极的作用，同时也为我国苏铁的保护管理工作提供一本重要的参考资料。（李楠 供稿）

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