# CYCADALES SPP. IN CHIAPAS, MEXICO (*CERATOZAMIA MIRANDAE*).

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## I. Background information on the taxa

### 1. BIOLOGICAL DATA

### 1.1. Scientific and common names:

*Ceratozamia mirandae* Vovides, Pérez-Farrera &Iglesias Amenduai

### 1.2. DISTRIBUTION

*Ceratozamia mirandae* is endemic to the Sepultura Biosphere Reserve along the west of Sierra Madre of Chiapas (figure 1). It grows in Oak forest and evergreen cloud forest between altitudinal ranges from 900 to 1,200 meters above sea level.

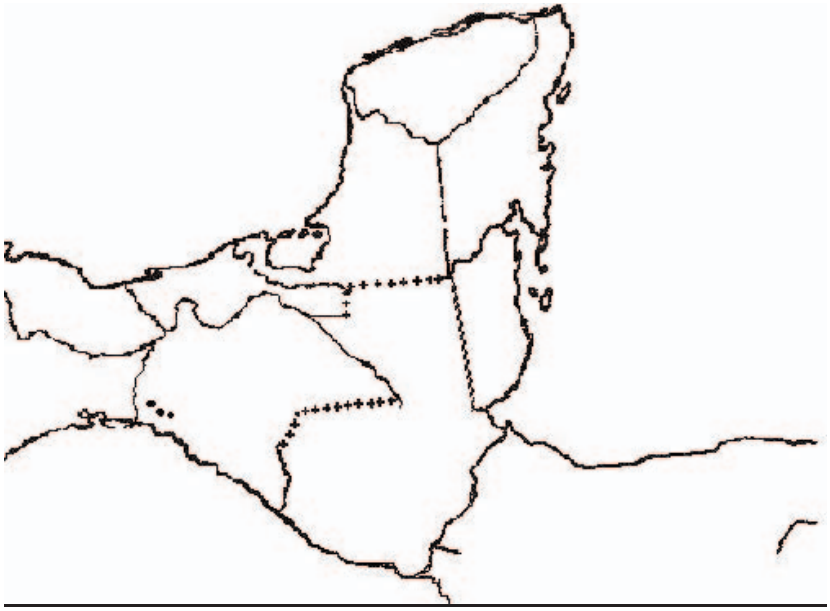

Figure 1. Distribution of *Ceratozamia mirandae*

## 1.3. Biological characteristics

Perennial dioecious long-lived tree.

**1.3.1.** *General biological and life history characteristics of the species*

*Ceratozamia mirandae* is a medium to large sized under-story cycad in pine-oak forests with trunks up to one meter long which are erect or prostrate topped with an ascending to spreading crown of up to 23 pinnate leaves approximately 1.5 m long and 70 cm wide (Vovides et al. 2001) (figure 2). It is dioeceous (consisting of male and female plants). An individual of this species between 80–90 cm tall can to reach up tp 490 years (Pérez-Farrera et al. 2006) (table 1). The species is entomophilous which accords with that reported by De La Cruz (1999) and only langurid beetles have been observed (figure 3). The female cone cycle is approximately one year from initiation, pollination to dehiscence. The size based population structure of this species corresponds to a type I curve according to Bongers et al. (1998) or "J" or Deevey type III curve, where there are more seedlings and juveniles than adults. Seed production and recruitment is relatively high with over 80% germination of seeds and the female cones produce from 74 to 170 seeds. The spatial distribution is non-random and aggregated with a preference to shallow rocky soils. Most seedlings, juveniles and seeds were located at the bases of steep slopes of over 40º, where we assume to be related to dispersal by gravity. In some relatively flat areas inside the study transect, seedlings and seeds were found located around the mother plant and under tree canopy providing shade. This suggests poor dispersion and/or seedling survival associated with tree and mother plant shade, which is a principal factor to the first phases of establishment and development (Pérez-Farrera et al. 2000; Perez-Farrera and Vovides 2004). Mortality is high during the seedling stages of the life history due to the prolonged droughts and fires in its habitats as well as seed predation by the Pecari *Tayassu tajacu* may also play an important role in the first phase of the colonization of other sites of oak forest. The sex ratio is approximately 9:1 male/female respectively but this can be deceiving since male plants cone more frequently than females, hence a greater presence of coning males at any given time.

Figure 2. *Ceratozamia mirandae* in the Sepultura Biosphere Reserve

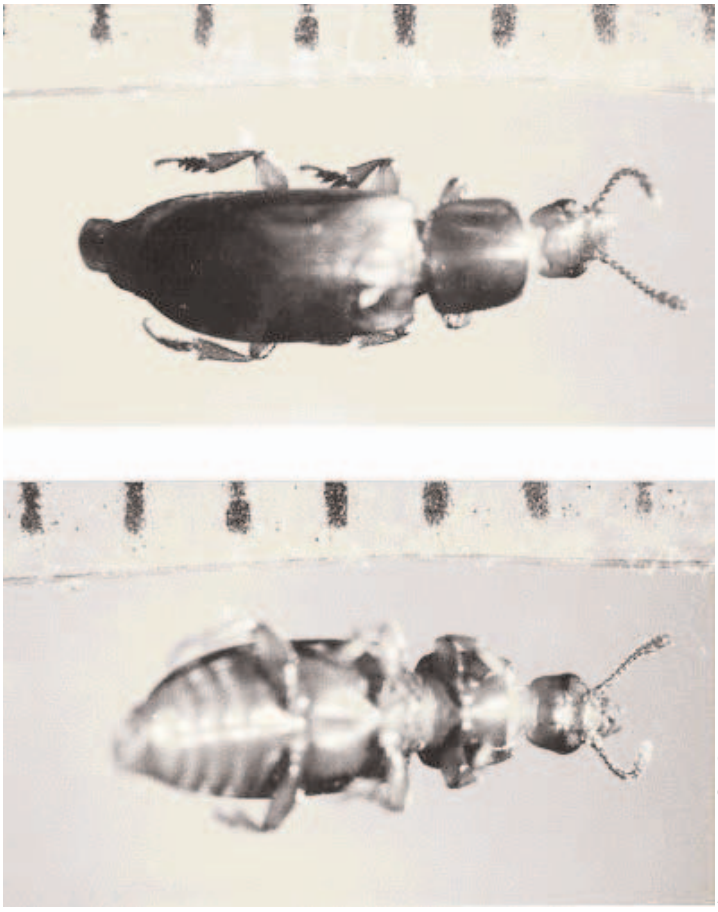

Figure 3. Pollinators of genus *Pharaxonotha* collected on microsporophyll of male cone of *Ceratozamia mirandae*

The finite growth rate Ï (lambda) in *Ceratozamia mirandae* analyzed in a populations in the buffer zone population in the Sepultura Biospere Reserve showed a tendency for decrease whilst in the nucleus zone this estimate remained stable. The highest elasticity values were in the transition of the first three classes of the "La Sombra" population (buffer zone) (figure 4), in "Tres Picos" (nucleus zone) this corresponded to adult plants between 20 and 30 cm tall (figure 5). Given the above, it is proposed that in the nucleus zone, reproductive adults should be of highest conservation priority, whereas in the buffer zone seedling reintroduction should be carried out regularly until the population increases (Pérez-Farrera *et al*. 2006).

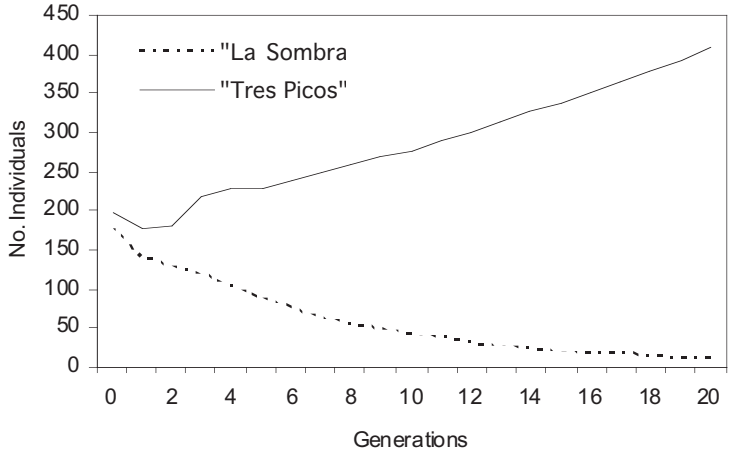


Figure 4. Population projection of two the populations of *Ceratozamia mirandae* in the *Sepultura Biosphere Reserve*

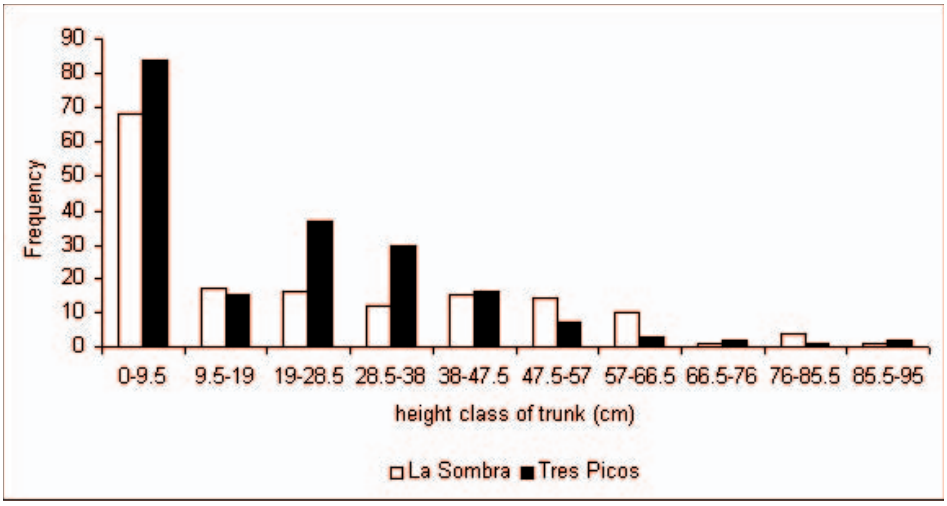


Figure 5. Height class population structure of the two populations of *Ceratozamia mirandae* in the *Sepultura Biosphere Reserve*

The genetic diversity and heterozygosity mean between populations were relatively low (h =0.18; H = 0.29) while the gene flow and percentage of polymorphic loci mean between population pairs was found to be relatively high (*Nm* = 3.68; %P = 67.2). The gene flow between population pairs was significantly correlated with altitude differences (Mantel r = 0.57 p = 0.10, n = 10) (Pérez-Farrera, 2005).

| Height Class (cm) | Mean total bases | Increment | Mean leaves /year | Residence | Age (year) |
|---|---|---|---|---|---|
| 0–10 | 42.6 | | 1.44 | 30 | 30 |
| 10–20 | 123.07 | 80.5 | 1 | 80.5 | 110.5 |
| 20–30 | 565.68 | 442.61 | 2.5 | 117 | 227.5 |
| 30–40 | 985.71 | 420.03 | 3.67 | 114 | 341.5 |
| 40–50 | 1408.2 | 422.46 | 7 | 60.4 | 401.9 |
| 50–60 | 1721.2 | 313.05 | 7.8 | 40.1 | 442 |
| 60–70 | 1985 | 263.77 | 12 | 22 | 464 |
| 70–80 | 1996.1 | 11.15 | 16 | 0.7 | 464.7 |
| 80–90 | 2523.5 | 538.48 | 21.6 | 24.9 | 489.6 |

Table 1. Age estimation of C. mirandae based on mean annual leaf production per size class and the mean total number of leaf bases present on trunks per height class. Leaf production data obtained from 181 individuals in the transect over a period of 3 years at "Ejido La Sombra de la Selva", Sepultura Biosphere Reserve, Chiapas, Mexico

**1.3.2.** *Habitat types*

The vegetation type of this cycad's habitat is mainly oak/pine forest as described by Rzedowski (1978), with an open forest canopy (72–89% cover) on a 40% slope at an elevation of 950 m, dominated by *Quercus elliptica* Neé and *Pinus oocarpa* Schiede, together with less common species such as *Rapanea myricoides* (Schltdl.) Lundell and *Ternstroemia tepezapote* Cham & Schltdl. The shrub layer is dominated by Miconia glaberrima (Schltdl.) Naudin, *Calliandra hirsuta* (GDon) Benth., Canavalia hirsuta Standl. The soil type of this habitat is an acid grey-brown humic cambisol (Cmu) consisting of a loamy-sandy clay texture with abundant surface humus (Vovides *et al*. 2001).

Botanical explorations in other parts of the Sierra Madre de Chiapas have resulted in the discovery of other populations of Ceratozamia mirandae in other vegetation types such as semi-deciduous tropical rain-forest, deciduous tropical forest and cloud-forest as described by Rzedowski (1978). These habitats are all within a range of altitude between 910 to 1,300 meters (Vovides et al. 2001).

**1.3.3.** *Role of the species in its ecosystem*

It can be considered to occupy the herbaceous to mid strata levels of the oak forests. It sometimes can to be abundant. However every year, forest fires affect the populations; adult plants survive and are benefited by a temporary release of minerals into the ecosystem, but the seedlings do not survive. Also like all cycads, *C. mirandae* fixes atmospheric nitrogen through coralloid roots in association with cyanobacteria. The cycad is also the host for the butterfly (*Eumaeus debora*) during the larval stages when it feeds on leaves and sometimes sporophyll tissue of the female cone. The beetle pollinators, though still not yet identified, are thought to be specific.

## 1.4. Population:

**1.4.1.** *Global Population size*

We have observed that this species is distributed on both the Pacific and inland slopes of the Sierra Madre de Chiapas in five municipalities. However, the pine-oak forests that are the cycads principal habitat are rapidly being transformed by slash-and-burn agriculture techniques by subsistence farmers. This activity, though of a lesser extent within the Biosphere reserve, is rendering the cycad an endangered species. During the exceptional drought of 1998, forest fires have affected the cycad populations, including the locality studied within the La Sepultura Biosphere Reserve and biodiversity generally throughout the state of Chiapas. We estimate between 1000 to 2000 plants. We recommend an IUCN Red List category of Vulnerable (VU C, 2a), largely due to difficult-to-control destructive annual forest fires that occur in this Reserve (Vovides *et al*. 2001)

**1.4.2. Current global population trends:**

___increasing __X_decreasing in one population (by fires)
__X_ stable in two ____unknown in most

## 1.5. Conservation status

**1.5.1.** *Global conservation status (according to IUCN Red List):*

___Critically endangered ___Near Threatened
___Endangered ___Least concern
_X_Vulnerable ___Data deficient

**1.5.2.** *National conservation status for the case study country***.**

Amenazada (A) = threatened in the NOM (Norma Oficial Mexicana). We propose En Peligro de Extinción (P) = Endangered.

**1.5.3.** *Main threats within the case study country*

___No Threats
_X_Habitat Loss/Degradation (human induced)
___Invasive alien species (directly affecting the species)
X__Harvesting [hunting/gathering]
___Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)
___Pollution (affecting habitat and/or species)
X__Other. Fires and illegal collecting
___Unknown

## 2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

### 2.1. Management measures

A program of conservation and propagation began through establishment of three nurseries *in situ* with three communities in the buffer zone in the Sepultura Biosphere Reserve in collaboration with personnel of this reserve, Universidad de Ciencias y Artes de Chiapas (UNICACH) and campesinos.

**2.1.1.** *Management history*

During period 1995 to 1996 three group of campesinos were invited to collaborate in a pilot project of the Instituto de Historia Natural for the conservation and propagation of *Ceratozamia mirandae* through establishment of nurseries *in situ* with financial support of CONABIO (National Commission for the Knowledge and Use of Biodiversity). Later, the project was taken up by the school of biology at Universidad de Ciencias y Artes de Chiapas 1997 during 1998 to 2000 with financial support from Fondo Mexicano para la Conservación de la Naturaleza, MAB-Tropical Ecosystem Directorate and U.S. Fish and Wildlife Service No. 99 G350, Fauna and Flora International and GTZ-Germany PN93.2208.2-06.201. A nursery was established in Ejido Nueva Independencia, another in Ejido Tres Picos and a further one in ejido La Sombra de la Selva. They received official permits in 1998 from SEMARNAT in order to operate as a non-forest products nursery that became the forerunners to the concept of UMAS for plants (Unidades de Manejo y Aprovechamiento de la vida Silvestre) or wildlife management units (INE-SEMARNAP. 2000). During 1997 to 1998 demographic studies were under development along with taxonomic studies (Vovides et al. 2001; Pérez-Farrera *et al*. 2006). The farmers were being trained on basic horticultural and nursery management with continuous assessment. The original idea is to harvest seed from mother

plant, sow and cultivate the plants in order to provide and additional alternative income for the farmers and at the same time the farmers are obliged to protect the habitat from poachers and loggers (Vovides & Iglesias, 1994; Vovides *et al*., 2002). Often, accidental fires or agriculture activities burn the oak forests where *Ceratozamia mirandae* grows. The farmers became concerned about this practice, and after the project began the fires deceased.

**2.1.2.** *Purpose of the management plan in place*

The main objective of this project is to diminish the pressure for field collecting and illegal traffic through the establishment of *in situ* nurseries. This way, economic incentives are created through the propagation and sale of plants leading to habitat conservation, by this system of harvesting seeds from habitat mother plants. Seedlings are sold and a percentage will be re-introduced back into habitat for conservation of the population. The monitoring process can to continue through the collaboration between the farmers and reserve personnel.

**2.1.3.** *General elements of the management plan*

The farmers are organized through small group (5 to 8 persons). Each farmer collect seeds in their "Predio" or land but they all collect together. Originally when the project began each farmer established his nursery in his "patio". A condition set by SEMARNAT is that 5 to 10% of the seedlings produced must be re-introduced back into habitat and to establish one ejidal nursery. The SEMARNAT authority requires a management plan where the nursery area is specified, availability of water and other infrastructure. As part special permission they must inventory the approximate number of seeds to be harvested per year, number of plants to be cultivated and an inventory of plants under cultivation, sold, deaths etc. Annual reports are required for permit renewal.

**2.1.4.** *Restoration or alleviation measures*

In 1999 and 2000 the farmers reintroduced 10% of the total production from 1997 to 1998. The seedlings reintroduced were three years old. These were reintroduced back into the oak-forest habitat. A reintroduction experiment has been established, and the monitoring of plants is in process.

## 2.2. Monitoring system

**2.2.1.** *Methods used to monitor harvest*

Normally each female cone is bagged with a mesh bag and tied at the peduncle. When the female cone is dehiscent, the seeds are collected

and after storage in a bag with sand and seeds are monitored for embryo maturity (within 9 months) in order to observe if the seeds have matured and are ready for sowing. The monitoring of female cones is made by a farmers group from the same town who keep guard to prevent anyone from collecting seed, seedlings, or adult plants. They also monitor fires in the forest by agriculture activities and they only collect mature seed and never immature cone. The campesinos have received training about identification, collection, and processing of seed, and propagation of seed. When the farmers detect anything unusual, they made a report to SEMARNAT (Secretaría del Medio Ambiente y Recursos Naturales). To collect seed the farmers have organized themselves into groups according to their "Parcelas o Terrenos".

**2.2.2.** *Confidence in the use of monitoring*

The female and male cone are monitored before pollination. When pollination occurs the females are constantly monitored. Upon cone dehiscence the seeds are collected. The female cone cycle is one year since female cone emerging until that it is dehiscent. The seeds are then stored for a further 9-12 months pending embryo maturity (Pérez-Farrera & Vovides, 1997).

### 2.3. Legal framework and law enforcement

As a cycad, *Ceratozamia mirandae* is covered by the Norma Oficial Mexicana (national) NOM-059-2001 and CITES (international) legislation. SEMARNAT give special permission to transport, collect, propagate and trade cycads in Mexico by all established UMAS (environment management units). All plants and seedlings propagated from mother plants must have an official label with the nursery and permit number displayed. Breaching of these laws is considered a federal crime with heavy fines and/or imprisonment.

## 3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

### 3.1. **Type of use** (origin) **and destinations** (purposes)

In famine time the seeds of *Ceratozamia mirandae* were consumed by farmers in the Frailesca region, but now it is no longer a famine food. The farmer uses the species as an ornamental plant. Sometimes the leaves of *C. mirandae* are cut to adorn some religious event or festivity in some towns in the Frailesca region.

### 3.2. Harvest:

#### 3.2.1. Harvesting regime

The seeds are collected once a year. However they only have collected seeds during period 1998 to 2000. The collection of seeds is manual. The collecting program was interrupted because permits had expired. However in 2008 SEMARNAT renewed the special permission in order to continue with the collecting program and the same institution awarded financial support for the continuation of the project. They have selected collection areas and conservation areas where seed may be collected. Often the collection is made from August to October and frequently one or two time per month

#### 3.2.2. Harvest management/ control

The UMAS permit covers harvesting of seed, there are no set quotas nor seasons stipulated.

### 3.3. Legal and illegal trade levels

The nurseries have produced about 15,000 seedlings. They have made a sale to *Cycadmania* in the USA. Also they have made some sales at national events such as national flower exhibitions in Mexico City with sales of about $ 30,000 pesos during 2001. However, sales are not constant. During the period 1998 to 2000 they collected about 5,000 seeds per year. No exports have occurred recently, nor do we have details on illegal trade.

## II. Non-detriment finding procedure (NDFs)

**1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS?**

__yes _X_no

**2. CRITERIA, PARAMETERS AND/OR INDICATORS USED**

Anecdotal and empirical, based on experience at the ejidales nurseries.

**3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED**

A demographic study was made during period 1997 to 2000. It included population structure, mortality, recruitment, phenology, spatial distribution of two populations in the Sepultura Biosphere Reserve. This information was used as basis for management. However no

information has yet been generated for the reintroduction program. About 1500 seedlings have been reintroduced to their habitat (oak forest). The seedlings were planted 1 to 2 meters distance between seedlings.

## 4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Percentage of germination, number of seedlings obtained, number of seedling established in the first, second and third year, number of seedling sales, organization of the nursery

## 5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

If the information provided is what is sought then no difficulty was experienced in the elaboration of the case study.

The main problems have been the organization of the campesinos groups, coordination between them, communication difficulties because the ejidos do not have efficient communication infrastructure such as telephones and roads. Contacting the farmers for meetings has been very complicated. Also, difficulty was experienced in obtaining sufficient long-term funding.

## 6. RECOMMENDATIONS

It is very important to include a sociologists or anthropologists to solve organizational and communication problems between the farmers. Also long-term funding to this type of lengthy projects is important. Marketing specialist for sales and export are needed as well as a closer collaboration with Reserve personnel and other national authorities such as SEMARNAT and PROFEPA.

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