

## **Manuscript for: The Cycad Newsletter**

### **Title:**

A rescue, propagation, and reintroduction program for one of the most endangered lineage of cycads, *Chigua* in Northwestern Colombia

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*Chigua* was first collected as an unicate by Francis Pennell in 1918. It was not until 1986 that a population conforming to Pennell's collection was relocated by the Colombian botanist Rodrigo Bernal. In 1990 Dennis Stevenson described two species of the new genus *Chigua* based on collections made by him, Knut Norstog, and the Colombian botanist Padre Sergio Restrepo in the only known locality for the two species in northwestern Colombia. By the time the next collections were made at the end of the 1990s (by Colombian botanists Alvaro Idárraga, Carlos A. Gutiérrez, Antonio Duque, and Cristina López-Gallego), the known population used for species descriptions had mostly disappeared because of habitat destruction and only a few scattered individuals were observed near the type locality.

The two species of *Chigua* resemble some acaulous *Zamia* species, e.g. *Zamia melanorrhachis* D. Stev., in their overall morphology: a small subterraneous rhizome, few armed leaves with elliptic and papery toothed leaflets, and small cones with peltate unornamented sporophylls, and ovoid reddish seeds; but the presence of a central conspicuous vein distinguishes *Chigua* species from the rest of the *Zamia* lineage. The two species of *Chigua* can be separated by the shape of the mid-leaf leaflets, with *C. bernalii* having linear to lanceolate leaflets and *C. restrepoi* having lanceolate leaflets. The more linear leaflet shape has rarely been observed on individuals in the wild, and a large variation in leaf size and leaflet shape is observed among individuals growing closely in space in their natural habitat. The two botanists involved in a rescuing project, who have likely seen the highest number of *Chigua* plants in the wild, have observed great morphological variation in leaflet size and shape between male and female, and between shade and more exposed individuals within the same locality. Therefore, it is possible that on closer inspection on the natural variation of leaflet shape in natural populations the distinction between the two species should be reevaluated. But regardless of the species definitions, and regardless of whether or not *Chigua* is nested within *Zamia*, the *Chigua* clade of two species is highly threatened with extinction.

The two *Chigua* species are endemic and occur in the same locality in the Sinú river valley in northwestern Colombia. Apparently these species have very restricted distribution ranges, and searches for additional localities for the species have been unfruitful so far. This region is dominated by a transitional forest that contains species from both lowland rainforest and dry forests at low elevation, i.e. less than 200 masl. This region belongs to the biodiversity hotspot 'Tumbes-Chocó-Magdalena' in NW Colombia (according to the Center for Applied Biodiversity Science, Conservation International), that encompasses some of the most diverse and interesting tropical forests of the world. *Chigua* plants have been observed in the understory of forest patches, but also growing in more open canopy in regenerating forests. Unfortunately, the known localities for *Chigua* are not within protected areas, and the possibility of declaring conservation areas in the region has not been explored until now.

The region where *Chigua* species are distributed has been drastically affected by habitat destruction for several decades, mostly because of deforestation for livestock and crop production but also for logging and mining. Furthermore, the very locality from where the only populations for *Chigua* are known was transformed into a huge hydroelectric project ("Urrá I") at the end of the 1990s. About 7400 ha of habitat, containing the type locality of the *Chigua* species, were flooded as part of the development of the hydroelectric project. A few seeds from plants collected by botanists and from rescued plants were sent to botanical gardens during the 1990s, and, therefore, some live specimens of both *Chigua* species exist in *ex situ* collections. In the wild, it is highly probable that most of the localities representing the natural habitat for *Chigua* species has been lost permanently, and that these two species are in the verge of extinction. Because of this situation, the IUCN Cycad action plan proposed that the species of *Chigua* in Colombia required a rescuing program as an urgent alternative for its conservation.

Fortunately, the company in charge of the dam construction ("Empresa Urrá S.A.") did fund a plant rescuing program during the building of the dam and after the beginning of the flooding. During this program individuals from sites that were sure to be affected by habitat destruction (mostly flooding by the Urrá dam) were translocated into suitable places by a two Colombian botanists (Marco Correa and Norberto López-Alvarez). During 1997-1998, Marco Correa was able to rescue about a dozen plants from the forests in the vicinity of the dam and these collections were translocated into a conservation center in a site nearby. Later, Norberto López-Alvarez was able to continue with the rescuing program and between 1999 and 2006 he was able to locate and rescue another dozen of plant in the same region. As a result of this rescue program, a *Chigua* collection exists today near the *Chigua* natural habitat.

The rescued *Chigua* plants are now being cared for at the conservation center CCDEBAS ("Centro de conservación de biodiversidad y desarrollo sostenible del Alto Sinú") administered by the Colombian conservation NGO, "Fundación Biozoo" (<http://www.biozoo.org.co/>), using funds from the company administering the dam ("Empresa Urrá S.A.") and a regional governmental conservation institution ("Corporación autónoma regional de los Valles del Sinú y del San Jorge"). In this conservation center, there are about thirty *Chigua* plants growing in open areas and the understory of a regenerating forest patch. These plants are reproducing naturally or without artificial pollination, and thus presumably the local pollinator populations are not extinct. The local *Eumaeus* butterfly populations appear to be healthy, and attacks on the *Chigua* collection have been reported as well. The *Eumaeus* larvae have been manually removed from plants and their life cycle is being monitored at the conservation center. As the result of natural reproduction and the planting of produced seeds, there are about 25 seedlings that have survived from the germination trials carried out by the Biozoo team in the CCDEBAS conservation center.

Thanks to the rescue program and the recent work by the botanists associated with the NGO Fundacion Biozoo, some information about the possibility of the existence of extant wild populations of *Chigua* is now available. The NGO has carried out social programs with the local human communities, and has established that the locals use the rhizome of the *Chigua* plants (or 'coquito' as is locally known) as one of the plants within a snake-bite antidote and also for skin-related injuries. There is a local traditional healer ('curandero') that keeps some cultivated *Chigua* plants in his garden for his own use. In addition, the local mestizo women harvest part of the rhizome of a plant (and claim that the plant can survive the harvesting), and dry it to produce a powder that is used on skin sores and to prevent fungal skin infections. Given the current sporadic use of *Chigua* by the local people, it is assumed that some plants may be still in existence in the wild, and plans for locating new wild populations of *Chigua* are underway.

In addition to the efforts for locating and protecting potential new wild populations of *Chigua*, the local conservation center (CCDEBAS) is interested in managing the genebank for *Chigua* that resulted from the rescue program, and on propagating the plant for conservation purposes. Within this framework, we are very interested in proposing a propagation and reintroduction program for *Chigua* in the region where it is and/or was distributed naturally. We are planning to explore the region in search for new localities for *Chigua* and localities known to have had populations in the past. In these places, we plan to evaluate the demographic status of plants (i.e. the probabilities of survival and recruitment of individuals) and/or the environmental conditions where individuals can thrive. With this information, we plan to choose a few suitable places for reintroduction of populations, hopefully in localities that could be in some figure of protection for conservation. In addition, we plan to genetically characterize the available plants at the CCDEBAS collection to estimate the genetic relatedness among potential parents and delineate an artificial propagation program seeking to maximize the genetic variation in the seedlings produced for reintroduction. With seedlings available from controlled and natural crosses from within the *Chigua* collection, we plan to establish three reintroduced populations with large but differing levels of genetic relatedness among seedlings in order to try to ensure 'healthy' populations and to evaluate the effect of genetic composition on the viability of populations in the long-term.

To our knowledge there are no reintroduction programs for cycads such as the one proposed here, and we hope that this proposal will find adequate support from institutions and people interested in cycad conservation. We think this program could generate interesting and relevant information for cycad conservation, and will represent a worthwhile effort to preserve one of the most interesting lineages and certainly one of the most endangered species of Neotropical cycads.

Female plant from the CCDEBAS center greenhouse.



Female plant and germinated seedlings at the CCDEBAS center.



*Chigua* collection used by a local healer.



