Conservation of the endemic overexploited cycad, *Cycas circinalis* L., in the Nilgiri Biosphere Reserve, South India

Anita Varghese, MS
Keystone Foundation
P.B. 35 Groves Hill Road
Kotagiri, Niligiris District
Tamil Nadu 643217
INDIA

Tamara Ticktin, PhD
Botany Department
University of Hawai at Manoa
3190 Maile Way
Honolulu, Hawaii 96822
USA

A. Abstract

Cycas circinalis L., *endemic to South India, is heavily harvested for its pith, male cones, leaves and fruits for both local and commercial use. A pilot study carried out in the Nilgiri Biosphere Reserve (NBR), Western Ghats, confirmed the high threats to which* C. circinalis *populations are subject. This proposal seeks to obtain the information necessary to design a strategy for effective conservation through research on life history, harvest impacts, extent of trade and propagation potential. One output is a conservation plan which will be implemented by Keystone Foundation, a non-governmental organization that has more than ten years of experience working on options to improve conservation and livelihoods in the NBR.*

B. Project Description

B1. Introduction

This aim of this research project is to obtain the data needed to help conserve *Cycas circinalis* L. populations in South India. *C. circinalis* is a cycad endemic to South India. The pith, male cone, young leaves, mature leaves and fruits are all harvested, used locally, or sold regionally for a diversity of purposes. *C. circinalis*' endemic status combined with the fact that it is listed as 'Data Deficient' on the IUCN Red List (Hill 2003), but listed as 'Critically Endangered' by the Foundation for the Revitalization of Local Health Traditions (FRLHT) in the states of Karnataka and Tamil Nadu and 'Vulnerable' in Kerala (Ravikumar and Ved 2000), make it of special conservation concern and high priority for study. In addition, although many species of cycad populations are harvested, few studies have documented the demographic impacts of harvest (Raimondo and Donaldson 2003).

In 2006, Anita Varghese (MSc) of Keystone Foundation (www.keystone-foundation.org) in collaboration with Tamara Ticktin (PhD) of University of Hawai'i/ People and Plants International (www.botany.hawaii.edu/faculty/ticktin), carried out a pilot study to assess the conservation status of *C. circinalis* in the Nilgiri Biosphere Reserve (NBR), South India. Keystone is a non-governmental organization that has been working in the NBR to improve conservation and livelihoods for twelve years and has successfully worked on conservation of other traded species. Ticktin has over 10 years of experience assessing the ecological impacts of harvesting wild plant species and designing conservation plans for them. Varghese's observations on the destruction of *C. circinalis* populations in the forests of the Nilgiris led to the idea for this pilot study. The results, described briefly below, demonstrated the urgency of designing and implementing conservation plans for this heavily harvested and declining species and therefore the need to obtain the information necessary to do so effectively.

B2. Species & study site

C. circinalis is endemic to the Western Ghats and hilly regions of the southern peninsula of India, in the states of Kerala, Karnataka, Tamil Nadu, and the south of Maharashtra (Jones 2002). It is arborescent, growing up to 8 m tall, with leaves that are about 1.5-2.5 m long. It is usually found in fairly dense, seasonally dry scrubby woodlands in hilly areas. Male cones are orange, 60-90 cm long x 20-25 cm

wide. Seeds are ovoid to subglobose, up to 4 cm long, with red-yellow sarcotesta. To our knowledge, there are no published studies on any aspect of the life-history or ecology of this species.

The Nilgiri Biosphere Reserve (NBR) is part of the Western Ghats mountain chain, a biodiversity hotspot (Meyers et al. 2002). It was the first Biosphere established India, declared by UNESCO in 1986. It lies between 10^0 45'N to 12^0 N and 76^0 E to 77^0 15' E with a total area of 5520 sq. kms spread across the three south Indian states of Karnataka, Kerala and Tamil Nadu. Altitude varies from 250m to 2650m. The NBR is also home to a large number of different indigenous communities, their total population numbering about 200,000.

B3. Results of pilot study

Our pilot study provided identification of the threats to which *C. circinalis* is subject and assessed the structure of populations subject to different types of harvest in 15, 20x 20 m plots located across nine regions of the NBR. We found that *C. circinalis* fruits and young leaves are harvested by indigenous communities in the NBR for food, and in Kerala the seeds are heavily harvested and sold locally as medicine. The stems (pith) and male cones are extracted by outside harvesters (i.e. not from local communities) and traded as medicines in regional and national markets. In Tamil Nadu the mature leaves are very heavily harvested by outside harvesters for the floriculture industry. Leaf-harvested populations showed low levels of recruitment and high adult mortality. In these populations, 92% of all individuals > 20 cm high were harvested for their leaves, and 91.3 ± 15 % of all leaves per tree were harvested. Stem-harvested populations showed clear signs of overexploitation, being devoid of all individuals > 50 cm high. We estimated that these cycads could take up 15-20 years to begin to reproduce and that they become of harvestable size for their pith once they are about 50 years old.

B4. Project objectives

Our pilot study confirmed the great need to promote the conservation of *C. circinalis* populations. The proposed project aims to obtain the information necessary to do so by identifying the current status of populations throughout the Western Ghats, obtaining some of the information necessary for designing strategies for sustainable harvest under cultivation (including data on *C. circinalis* life-history, demography, impacts of harvest, and germination) and designing materials for environmental education. Our objectives and methods are listed below:

Objective 1: Identify monthly leafing& fruiting phenology and harvest rates

Each month we will monitor subsets of individuals in populations subject to different rates of exploitation in order to 1) obtain information on life-history, 2) better assess the impacts of harvest, and 3) identify potential strategies for sustainable harvest of cultivated populations. We hope to subsample ~ 10 individuals in each of at least three populations, including harvested and non-harvested populations (note that there are currently no cultivated populations). Monthly monitoring will provide the needed information on how often and when leaf flushing occurs, and when leaf harvest occurs in relation to flushing, as this timing clearly affects the impacts of harvest. It will also allow us to determine the number of leaves produced per year. By comparing rates of leaf production, leaf size, rates, and patterns of coning and seed production, and male:female ratios between harvested and non-harvested populations, we will elucidate the impacts of harvest on these variables.

Objective 2: Assess demographic rates and population growth/decline of C. circinalis populations subject to different types of exploitation.

As part of our pilot study, in March of 2006 we established 15 permanent 20x20 m plots in harvested and non-harvested populations and tagged and measured all *C. circinalis* individuals in them. We are now remonitoring these populations and would like to remonitor in March 2008 to obtain rates of survival, growth and germination. We can use this data to assess population structure and also create simple matrix models to estimate population growth/decline. We will use life table response experiments

to identify management practices that may most effectively lead to increased population growth and simulate different rates of harvest to identify what levels will be sustainable for harvest from cultivated populations (Caswell 2000).

Objective 3: Assess the conservation status of C. circinalis over a larger area

Our pilot study covered parts of Tamil Nadu and Kerala but there are large areas of the NBR and elsewhere in the Western Ghats that we did not survey. It is essential that we obtain an idea of the status of populations over *C. circinalis*' range in Western Ghats in order to identify those populations or regions with highest priority for conservation and restoration. We will carry out surveys to identify existing populations and then establish 20x20 m plots in which to record the number, size and status of all *C. circinalis* individuals. We will use log-linear analyses to compare population structure across sites and multivariate analyses to identify possible relationships between population structure and other variables (canopy cover, fire, grazing etc).

Objective 4: Promote and test the potential for germination and outplanting of seedlings

Keystone Foundation has initiated *C. circinalis* seedling nurseries in several indigenous communities in the NBR as a conservation strategy. This was achieved by collecting seeds from wild plants in neighboring forest areas. We plan to extend this effort to other communities and to outplant in home gardens as a strategy for conservation through the sustainable harvest of leaves and seeds from cultivated populations. The production of leaves and seeds from cultivated populations for sale and local use should therefore lead to decreases in pressure on wild populations. We will continue germination trials and monitor growth and survival of outplanted seedlings.

Objective 5: Use the above information to design a strategy for better conservation

The ultimate goal of our project is to foster conservation of *C. circinalis* through better protection of wild populations and promotion of cultivation for sustainable leaf and seed harvest. That is, we can help conserve populations by working with communities to begin cultivation (objective 3), to obtain information for sustainable harvest of cultivated populations (objectives 1&2) and to simultaneously increase awareness of the importance and plight of this species so as to help stop harvest of wild populations. To this end, we will produce educational materials both for local communities and for the larger public (such as posters, pamphlet, press release etc) to increase awareness of cycad conservation. We hope to collaborate with Mysore Amateur Naturalists in this effort and have been in contact with them.

C. How project fits TCS

Our proposed research clearly fits the mission of the TCS, specifically the first four mission objectives: 1) it seeks to promote conservation of existing cycad populations; 2) it includes educating the public – in this case the Indian public - on the threats to this species and need for conservation; 3) it involves research; and 4) if approved, it would involve TCS' cooperation with an international organization (Keystone) for the benefit of cycad conservation.

D. Timeline

Project timeframe is one year; objective numbers correspond to those listed above (p.3).

Objective	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	X	X	X	X	X	X	X	X	X	X	X	X
2							X					
3			X	X								
4	X	X									X	
5	X	X			X			X	X			X

E. Budget

Our proposed research involves field monitoring, data analyses and production of education materials. While this work will be carried out by Anita Varghese and Tamara Ticktin, the field monitoring necessitates research assistants. We plan to hire members of local communities, both as a strategy to promote awareness of *C. circinalis* conservation and in recognition of their long-term knowledge of this species and the forests it grows in.

Activity [1]	**Cost**
1. Travel [2]	
a. Monthly travel to study sites in the NBR for field monitoring (~$50/month)	$500
2. Local assistants for fieldwork [3] (~$300/month * 12 months)	$1200
3. Educational Products (booklet, posters, pamphlet)	$600
TOTAL REQUESTED FROM TCS	**$2300**

[1] 2006 Pilot study was funded by IDRC. No other funds are currently being sought for this work.
[2] Cost of two roundtrip airfares for Tamara Ticktin to India & living expenses will be covered by the University of Hawaii and are therefore *not* included in this budget.
[3] All field equipment and materials required will be provided by Keystone Foundation as well as some costs associated with transportation and educational products.

References Cited

1. Caswell, H. 2000. Matrix population models. Sinauer Associates, Sunderland, Massachusetts.
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APPENDIX. *Cycas Circinalis* L. in the Nilgiri Biosphere Reserve forests:
a) unharvested, with ripening seeds, b) pith harvest; male cone beside stump, c) harvest of leaves, d) seedlings growing in community nursery established by local community members and Keystone Foundation.