

Demography, distribution and threat assessment of *Cycas circinalis* L. in Sathyamangalam Tiger Reserve, Tamil Nadu, India

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ABSTRACT

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Cycads, one of the ancient plant groups, are under threat now in south Indian forests. *Cycas* is a monotypic genus and *Cycas circinalis* L. is found widely scattered. In particular, it is well thriving in Sathyamangalam Tiger Reserve. In India, population assessment of *Cycas* spp. is new. There is no previous record on demography and distribution pattern of any *Cycas* species. Sathyamangalam Tiger Reserve is the largest protected area in Tamil Nadu, about 1,455 km². All ranges were scrutinized for *Cycas* population and were found having them in considerable numbers in Talavadi and Tukkanayakkanpalaiyam. A total of 2,370 individuals were recorded during the survey period (April to June 2010). Several natural and man-made factors influenced *Cycas* populations. The study discussed a number of conservation techniques to improve the *Cycas* populations in Sathyamangalam Tiger Reserve.

Keywords: Demography, Gymnosperm, *Cycas circinalis* L., Conservation, Sathyamangalam Tiger Reserve, Tamil Nadu, India.

INTRODUCTION

Cycads are the primitive gymnosperms living since Jurassic Period, hence are known as living fossils. These plants have number of interesting botanical features such as early origin, naked seeds, dioecious sexuality, palm like structure, cone like sexual organs, nitrogen-fixing cyanobacterial and algal symbiosis in its coralloid roots, etc. Due to manmade disasters and habitat destruction, now

these plants are in threatened category throughout the world. According to the IUCN cycads status survey and conservation action plan, 297 cycads occur in the world (Donaldson 2003) and all are classified as globally threatened category. Cycad taxa belong to two families and 10 genera found worldwide. Lindstrom and Hill (2002) identified eight species found in India. Singh and Radha (2006) described a new *Cycas* species from the

Kerala Coast, Western Ghats. Singh et al. (2015) described a new species from Odisha.

Very few studies were conducted in India on cycads that too on other than population estimation, such as pest scale attack (Muniappan & Viraktamath 2006), mutualistic relationships (Saneesh & Anita 2007) and fungal association in coralloid roots of cycads (Muthukumar & Uadayan 2002). Raja Mamannan and Natarajan (2010) reported effect of *Cycas* seed extracts on Tilapia fish. Senadheera et al. (2021) referred toxicity of cycad seeds. Osborne (1994) referred cycad's population, i.e. 7,500 individuals in wild and 148 in public collections in India. These primitive gymnosperms are in high priority conservation concern, globally. But in India, even population assessment of the plant group was not initiated. Hence, a novel approach was started to assess population of *Cycas circinalis* L. in Sathyamangalam Tiger Reserve, Tamil Nadu. The study comprises of distribution, age, sex ratio and mortality and conservation strategies of *C. circinalis*.

STUDY AREA

The Sathyamangalam Tiger Reserve has mosaic of habitats, from dry scrub to wet evergreen forest and is located in the Erode district of Tamil Nadu. It lies between 11°29' and 11°48' north latitudes and 76°50' and 77°27' east longitudes, covering an area of 1,455 km². Sathyamangalam Tiger Reserve is the largest forest division in Tamil Nadu. It shares its border with Chamrajnagar and Kollegal Forest Division of Karnataka state in the northern side, Gobichettipalayam and Sathyamangalam towns in the southern side, Erode Forest Division in the eastern side and Bandipur and Niligiri Forest Division in the west.

Elevation of this division varies from 280 to 1,698 m above mean sea level. The annual rainfall also varies from 600 to 850 mm. Sathyamangalam Tiger Reserve comprises of several vegetation categories and forest types for instance Southern

tropical thorn forests, Southern tropical dry deciduous forests, Southern tropical semi-evergreen forests, Southern sub-tropical evergreen forests, Dry savannah forests and Southern tropical moist deciduous riparian forests. Though it is rich in floral wealth, there is no record of complete documentation of flora in the study area except for a few stray collections made by Fischer (1906), Blatter (1908) and Subramanian and Kalyani (1977). Their collections were deposited at the Madras Herbarium, Southern Circle of the Botanical Survey of India, Coimbatore. Salim Ali Centre for Ornithology and Natural History in Coimbatore conducted a few studies in recent past (Balasubramanian et al. 2009, Amirthalingam 2009).

METHODOLOGY

The present study was designed as per the suggestions of IUCN/ SSC Cycad Specialist Group for long term monitoring programme for population estimation of the cycads (Cristina 2007). Demography of the individuals such as seedling, juvenile, non-reproductive adult, reproductive adults, sex and age (Sutherland 2001) were documented to all available individuals in the study area. The entire area of Sathyamangalam Tiger Reserve was surveyed rapidly to find the locations, where the *Cycas* plants are present. Based on the initial results, careful survey was conducted to record all available individuals of the particular locality. A small piece of tin sheet was used to tag on the leaflets of the individuals with colour codes. Orange colour sticker was used for seedlings, Red colour sticker was used for juveniles, Blue colour sticker was used for non-reproductive adult, double Green colour stickers were used for reproductive male and blue and Green stickers were used for reproductive female. Exact location (latitude, longitude and altitude) of all available individuals was recorded by the help of GPS instrument and geographical distributional maps were made.

RESULTS

The entire Sathyamangalam Tiger Reserve was surveyed and 17 locations were found with *Cycas* populations. All 17 areas were scanned thoroughly for further demographical data. A total of the 2,370 individuals recorded during the survey, 1027 numbers were documented from Siddakuttai area and its surrounding places, i.e. Kanjimaduvu, Uruthalkuttai, Jeerahalli, Jeerahallikuttai, Iyannamokkai, Kadakuttai, Makkalmallapakoil, Sudukadumokkai and Ganesapuram. In Talavadi range, Jeerahalli area is prime location for *Cycas* populations. Of the 17 *Cycas* populations, 11 are present around Jeerahalli forest beat. Three

populations, i.e. Kongallikoil, Alakavundankuttai and Belathur are nearby forest beats.

Three populations are present in Tukkanayakkanpalaiyam range, i.e. Alakarai, Makkampalayam and Jodukaraikuttai. Each individual of the 17 populations was tagged with colour codes. The data was further classified and analyzed. The results reveal some mixed reactions. The population size varies from three to 1,101 individuals depending upon the location (Table 1). Siddakuttai area near Jeerahalli village of Talavadi range have more numbers of individuals, i.e. (n = 1,101). Near Siddakuttai, Uruthalkuttai and Kanjimaduvu have more than 200 individuals,

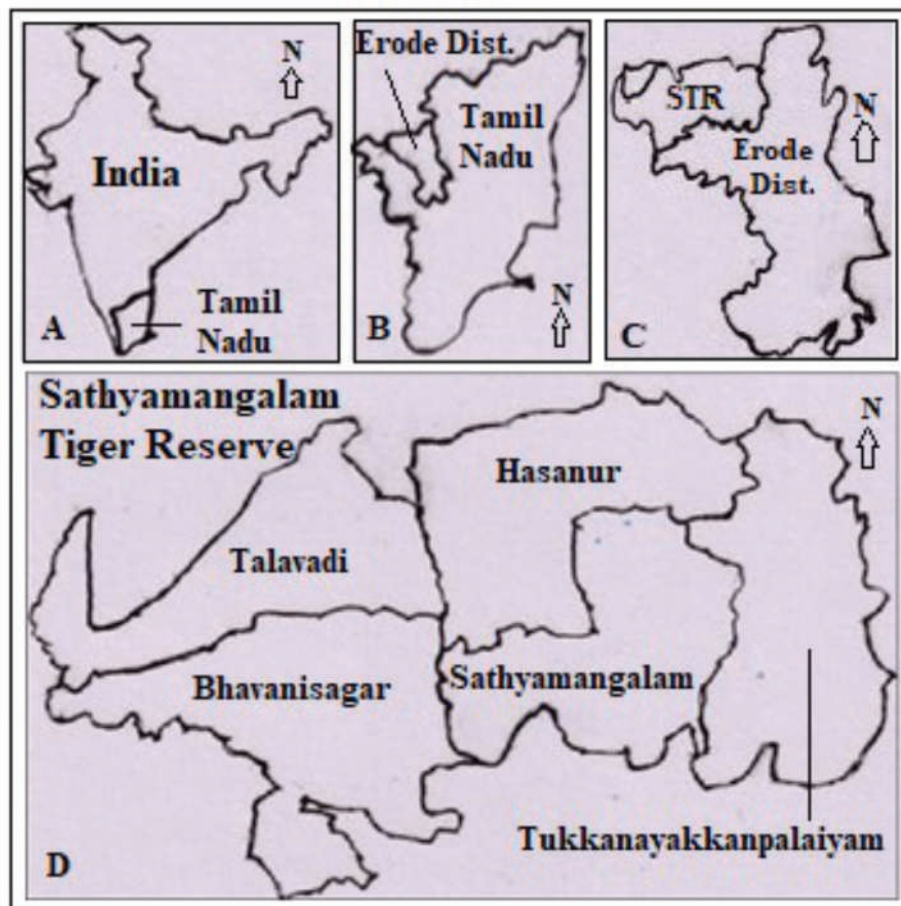


Figure 1. A. Outline map of India showing location of Tamil Nadu. B. Outline map of Tamil Nadu showing location of Erode District. C. Outline map of Erode District showing location of Sathyamangalam Tiger Reserve; STR = Sathyamangalam Tiger Reserve. D. Outline map of Sathyamangalam Tiger Reserve showing localities of *Cycas* data collection.

Table 1. Populations of *Cycas circinalis* L. recorded during the study (n = 2370).

S No.	Location	Seedling	Juvenile	Non-Reproductive Adult	Male	Female	Total
1	Siddakuttai	343	508	148	88	14	1101
2	Uruthalkuttai	77	81	26	17	2	203
3	Kanjimaduvu	64	96	35	34	5	234
4	Jeerahalli	22	42	13	17	3	97
5	Kadakuttai	21	15	20	21	1	78
6	Jeerahallikuttai	4	15	10	9	2	40
7	Varadakuttai	6	6	6	14	2	34
8	Iyannamokkai	34	24	14	18	3	93
9	Makkalmallapakoil	32	27	17	22	4	102
10	Kongallikoil	1	11	9	13	5	39
11	Alakavundankuttai	3	2	4	4	0	13
12	Belathur	0	0	1	1	1	3
13	Sudukadumokkai	5	43	21	36	4	109
14	Ganesapuram	7	14	9	5	2	37
15	Alakarai	32	26	11	0	0	69
16	Makkampalayam	48	33	10	8	4	103
17	Jodukaraikuttai	2	1	2	10	0	15
Total		701	944	356	317	52	2370

i.e. (n = 203) and (n = 234) respectively. Three sites have above 100 individuals, i.e. Makkalmallapakoil (n = 102), Makkampalayam (n = 103) and Sudukadumokkai (n = 109).

Four sites have above 50 individuals but below 100 in numbers, i.e. Jeerahalli (n = 97), Iyannamokkai (n = 93), Kadakuttai (n = 78) and Alakarai (n = 69). Six sites have above ten individuals but below 50 in numbers, i.e. Jeerahallikuttai (n = 40), Varadakuttai (n = 34), Kongallikoil (n = 39), Ganesapuram (n = 37) and Jodukaraikuttai (n = 15). Belathur is the only place having three individuals.

A total of 2,128 individuals were found in Siddakuttai and its surrounding areas. In other sites near Siddakuttai area, the *Cycas* population is not notably well, for instance Kongallikoil (n = 39), Alakavundankuttai (n = 13) and Belathur (n = 3). In Tukkanayakkanpalaiyam range *Cycas* population found only in three places for example

Alakarai (n = 69), Makkampalayam (n = 103) and Jodukaraikuttai (n = 15). Of the 17 sites identified with *Cycas* populations, and highest number of seedlings were found at five sites and second highest numbers were found at seven sites. Juveniles were found in highest numbers at seven sites and second highest numbers at six sites. Non-reproductive adults were found in highest numbers only at two sites and in second highest numbers at five sites. Male trees were found in highest numbers at six sites and in second highest numbers at only one site.

DISCUSSION

Cycad species are restricted at limited locations in Tamil Nadu, even though climate and altitude favours its distribution. In spite of several reasons speculated, the very important reason is man-made destruction. A number of threats are analyzed here for *Cycas* conservation in the



Figure 2. A. Seedling. B. Juvenile. C. Non-reproductive adult. D. Adult male. E. Adult female. F. *Cycas* leaves decoration in tribal wedding. G. *Cycas* leaves decoration in cities.

study area. At present, only one study is available on *Cycas* conservation and leaf harvest in *Cycas* (Gunasekaran et al. 2010).

Threats for *Cycas* conservation: Several factors influenced the population reduction in *Cycas* species in the study area. These issues can be classified into two major categories, for example natural and man-made. Though natural factors forced on *Cycas* population, that can be easily overcome by this species. Since several millions of years *Cycas* alone triumph over natural calamity and time. But at present, anthropogenic pressure is the major threat to these primitive plants.

Collection of leaves: In Tamil Nadu the leaves harvest is a major threat to these prehistoric plants. *Cycas* leaves are regularly collected in many parts of the state for ornamentation of marriage halls and conference halls, etc. Collection of *Cycas* leaves is a common phenomenon to decorate gateways of wedding halls invariably from tribal people to elite societies (Figures 7 and 8).

Cycas is a dioecious plant both male and female reproductive parts (cones) produced by separate plants. It is an important primitive character in plant evolution. Though a good number of seedling and juvenile plants were recorded during the survey, lesser number of plants were found in the adult stage. The demographic data clearly indicate a huge variation among the adult plants found in the study area. Population of adult female is very less when compared to adult male plants. It is warning signal for *Cycas* conservation, because single sex reduction within a location leads adverse effects in population. A total of 317 adult male plants occur in the study area whereas only 52 adult female plants were recorded, i.e. only 16.40% female adult plants found for 100 adult male plants. Biotic, abiotic and anthropogenic pressure causes this ill-effect. Of the 17 sites surveyed, the adult female numbers in 16 sites are in single digit or absent and it shows the intensity of the problem. Variations in sex ratio of adult plants within a population would

create imbalance in reproductive composition in dioecious plants. Based on field observations three possible reasons are discussed here for the reduction of adult female trees in the study area.

Seed collection: The leaf collection for ornamentation is the major threat for *Cycas* population in other areas in India. But there are no such activities found during the study in the study site and also found old and dry leaves in withered condition around the trees. But, *Cycas* seed collection among tribal groups is a common practice for food resource. At the time of megasporophyll maturity the plants emit an awful odour around the forests and it attracts forest dwelling communities to collect the seeds. Since, 28 tribal settlements situated in and around 1450 km² forest area. These people collect and dried the seeds, after that the seeds are grind well and washed by water several times to remove harmful alkaloids before cook. Seed collection was the major threat for the *Cycas* populations in the area.

Sago collection: During the survey several stakeholders, for instance local tribes and villagers, were interviewed about *Cycas* population and its decline. In Alakarai and Makkampalayam areas these people said that large numbers of *Cycas* trees were cut down for collecting sago for edible and commercial purpose during last decade. This practice might be the possible reason for restricting the distribution of *Cycas* population in very limited locations in the study area. This practice not only reduced the female trees but also entire population of the species.

Biotic factors: Even though the *Cycas* cones possess an unpleasant odour, some wild herbivores animals are interested in it. Mature seeds are fallen from the trees and animals such as wild Boar, Sambar deer consumes the seeds. Even these animals feed on the seeds when female plants are at reachable heights. Certain numbers of fallen seeds are destroyed by ants and termites and it is

common sight noticed during the survey around adult female trees.

Abiotic factors: Natural forces also destruct a number of seeds during its process. If other biotic factors are not negotiating with the fallen seeds the majority of the seeds are withered by rain and sunlight.

RECOMMENDATIONS FOR CONSERVATION

1. Raising separate *C. circinalis* nurseries through Tamil Nadu Afforestation Programmes or National Afforestation Programmes would provide enough seedlings for planting in the forest area.
2. Reintroduction of *C. circinalis* species through seedling, especially female trees, in the same area as in-situ conservation would help to retain healthy sex ratio.
3. Planting of *C. circinalis* sapling in a degraded forest area near its original habitat would act as an alternative habitat for ex-situ conservation.
4. Introduction into the safe abodes for instance Forest Guest houses, Government Circuit houses, Inspection bungalows, etc. also would act as ex-situ conservation.
5. Creation of special botanical gardens for example cycads parks or separate areas in upcoming or in existing botanical gardens would also serve as ex-situ conservation.
6. Introduction of *C. circinalis* as ornamental plant instead of *C. revoluta* in Government and private buildings would create a chance to survive these prehistoric plants.
7. Enough publicity materials, for examples handouts, brochures, posters and bill boards on importance of *C. circinalis*, should produce to create awareness among stakeholders as well as planters.

CONCLUSION

Though it was a first *Cycas* demographic survey in India, a detailed study was conducted on populations and threats. Management implications were given for state forest department as conservation recommendations.

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