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RECOVERY PLAN FOR *BENTINCKIA CONDAPANNA* BERRY – AN ENDEMIC AND THREATENED TREE SPECIES (PALM) OF TROPICAL SEMI- EVERGREEN FORESTS IN SOUTHERN WESTERN GHATS, INDIA

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ABSTRACT

Bentinckia condapanna Berry is one of the endemic and threatened tree species (palm) of the Southern Western Ghats in Peninsular India. *B. condapanna* and *B. nicobarica* (Kurz) Becc. are the two species of this family enlisted as threatened species of genus *Bentinckia* by Botanical Survey of India during 1988. *B. condapanna* has narrow endemic zone of distribution in the hills of South Travancore and Tirunelveli Hills of Tamil Nadu and Kerala. The habitats of the species in Tamil Nadu particularly in Kalakad Mundanthurai Tiger Reserve were analysed using GPS, GIS and stratified random sampling techniques. Satellite remote sensing data with the aid of GIS were used for site-specific mapping of the threatened species, the status of niches with regard to its growth and degradation. The threat status of the species was reassessed. Growth habit, botanical description, silvicultural characters, ethnobotanic and other utility of the species are provided. The places of endemism, precise point-location data, the phyto-geographic parameters of the area and its phytosociological layout are illustrated. Immediate need to protect and propagate this endangered species is emphasized and its methods of artificial reproduction elaborated. Finally, Threatened Species Recovery Plan (TSRP) has been suggested to protect and promote the species using *in-situ* and *ex-situ* conservation methods.

Key words : Species recovery plan, Endemism, Artificial regeneration, *Bentinckia condapanna*

Introduction

The conservation and management of threatened plants needs to be prioritised and dealt with site specific geographic information of their natural habitats. Precise point-location data on phyto-geographic parameters in association with spatial distribution of threatened plant species in their phytosociological layout will lead to the exact locality information of the concerned taxa, their population status, factors limiting their distributions, and also the factors responsible for their present threat status. The protection, conservation and management of threatened plants need support of various kinds with systematic short term and long term planning. The present article deals with all these variables for the threatened species *Bentinckia condapanna* Berry.

Bentinckia condapanna Berry locally known as 'Coddappanna', 'Kanthl', 'Kanthakamugu' by Kani tribe; 'Varu Kamavu' Malayalam; and 'Varei–Kamugu' in Tamil is endemically distributed in KMTR and its surroundings in Southern Western Ghats, Tamil Nadu and Kerala. Lushington (1915) described it as 'Lord Bentinck's palm-The Hill Areca Nut Palm of Travancore'.

Bentinckia condapanna, a member of Arecaceae (Palmaceae) family is one of the very interesting and important orders (Monocotyledonous) of the tropical region of the Plant Kingdom. There are about a hundred indigenous species of palm in British India and Ceylon as described by Blatter (1926). The species has narrow endemic zone of distribution in the hills of South Travancore and Tirunelveli Hills and faces imminent danger of degradation. The overall objective of Species Recovery Plan is to protect existing populations of *Bentinckia condapanna* including establishing new sites by improving population stocks through *in-situ* conservation methods and facilitating self-perpetuation in addition to exploring similar bioclimatic zones for its *ex-situ* conservation.

Material and Methods

Kalakad Mundanthurai Tiger Reserve (KMTR) - the 17th tiger reserve in India and its surroundings forms a part of Agasthyamalai Hills, a biodiversity hotspot of global significance for its species richness and endemicity (Nayar, 1996) was selected as the study area. The reserve is located at the southern most part of the Western Ghats in the districts of Tirunelveli and Kanyakumari in Tamilnadu, India. The terrain is undulating with elevation ranging from 60 to 1868m. The reserve lies between latitudes 8^{0}21'27" to 8^{0}53'02" North and between longitudes 77^{0}10'10" to 77^{0}34'28" East covering the total area of 895.39 km^2 with tropical and montane subtropical climatic regimes.

A combination of satellite remote sensing, GPS

Threatened species recovery plan (TSRO) has been suggested to protect and propagate *Bentinckia condapanna* using *in-sutu* and *ex-situ* conservation methods.

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and integrative tools like GIS, together called as Geoinformatics, has been used for the present study. Applications of geoinformatics supplemented with floristic data collected from sample quadrats of 20 x 20 m^2 laid out in the forest along with stakeholders analysis of endemic and threatened plants in KMTR were carried out to make this study more holistic. For confirmation of species, the vegetative parts were compared with the herbarium available in Southern Regional Office, Botanical Survey of India (BSI), Coimbatore, Tamil Nadu.

Thematic maps on forest cover and other phytogeographic parameters were generated from satellite imagery, IRS – P/6 LISS III FCC hard and soft copies of 18th February 2005 of path, 101 and row 67 and 68 were used for interpretation of endemic species *Bentinckia condapanna*. "Digital image Processing methods" was adopted for the classification of species using Clutter (an image on radar screen that hinders observation) technique. Three different processes were under taken with the help of ERDAS 9.1 and Arc GIS 9.3 software. The seeds for sample recognition of spectral signature of the species were collected in the various sites within KMTR as the first processes to ensure real distribution. Geo co-ordinates were registered by GPS during field verification with the assistance of Survey of India maps (1969, 1978). Finally reclassified data was calculated by their own serial extent based on the resultant clutter classes, with the help of Arc GIS software. Visual and supervised digital classification techniques were adopted to delineate the habitats in micro level and the status of each habitat. Frequent field visits were made during 2001 to 2011. Nine specific habitats of *B. condapanna* were identified in the study area.

The matrix of phytosociological layout and geographic parameters of provenance area where this species grow such as, forest type and floristic association, geological formations, landform with slope pattern and altitudinal zone, hydro-geomorphologic set up, climatic conditions, soil types, all in common Geo reference were studied in GIS domain (Sarkar, 2010). Soil samples were collected mainly from places of endemism identified from the sample quadrats.

Detailed study on nursery techniques from seed origin were made at Tamil Nadu Forestry Training College, Vaigai Dam. The natural regenerations, floral compositions, phonological and silvicultural characters of the species were studied.

Data on existing conservation and management practices, the information about various acts, rules and policies in managing the flora particularly the threatened plants of the study area were gathered from the various stakeholders of endemic and threatened plants by Questionnaire and Interview methods (Sarkar, 2010) .

Result and Discussions

Characters of the plant

It is an erect palm with solitary stem, 10-22 m height and 15-90 cm diameter at breast height. Its flowering period is from April to June and fruiting period during June to October. It has distinct morphological and silvicultural characters along with ethno botanic properties and other potential utility.

Morphological *characters:* Stem distinctly annulated. Leaves 1.0-1.5 m long, pinnate, leaflets 40-80 x 2-4 cm, linear - lanecolate, acuminate. Inflorescence monoecious, intrafoliar; outer and inner spathes papery, caduceus. Flowers bisexual, pinkish red to dull white, Fruits ovoid, 1.2 - 1.4 x 7 - 8 mm, reddish brown pericarp fleshy. *Seed* ovoid, 6 mm long; endocarp brittle; endosperm homogeneous (Fig.1).

Silvicultural characters: *Bentinckia condapanna* is a strong light demander, mist hardy, fire and drought tender. It is a good colonizer and grows gregariously (Fig.1) with very restricted distribution in steep to precipitous slope in high altitude areas. It is very sensitive species in its regeneration process and prefers to grow in open places. The species occur well in shallow, porous soil with good drainage in first or second order stream where continuous soil moisture regime is ensured from frequent precipitation. It is not readily browsed by cattle.

Ethno botanic characters and other potential value: The species has medicinal value. Its parts are used in Siddha under Indian system of medicine (Ved, 2000). The terminal buds and juvenile leaves are edible. The local Kani tribe people use to eat the same. It has nutty flavour. It is a palm of great botanical interest. The slender stem and feather like leaves of the species are very graceful can be suitably cultivated as oranmental palm in botanic gardens and parks. It is a palm of great botanical interest.

Natural distribution zone

The species is endemic to the hills of South Travancore and Tirunelveli Hills, i.e. to tail end of the southern western ghats, Agasthiyamalai area, in the districts of Tirunelveli and Kannyakumari in Tamil Nadu and Thiruvanthapuram, Iddukki and periyar areas of Kerala of the peninsular India. Its scattered distribution is also reported from Srivilliputhur in Virudhnagar district and palney hills in dindugal district of Tamil Nadu. It has very restricted distribution in steep to precipitous slope in an elevation zone from 760 to 1830 m. The general distribution pattern has been illustrated by Pascal (1988). The distribution pattern has also been depicted in endemic Atlas by Ramesh and pascal (1997).

(a) (b)

Fig.1: *Bentinckia condapanna* Berry – (a) A matured tree in wild; (b) the gregarious growth of pure crop at Naraikadu.

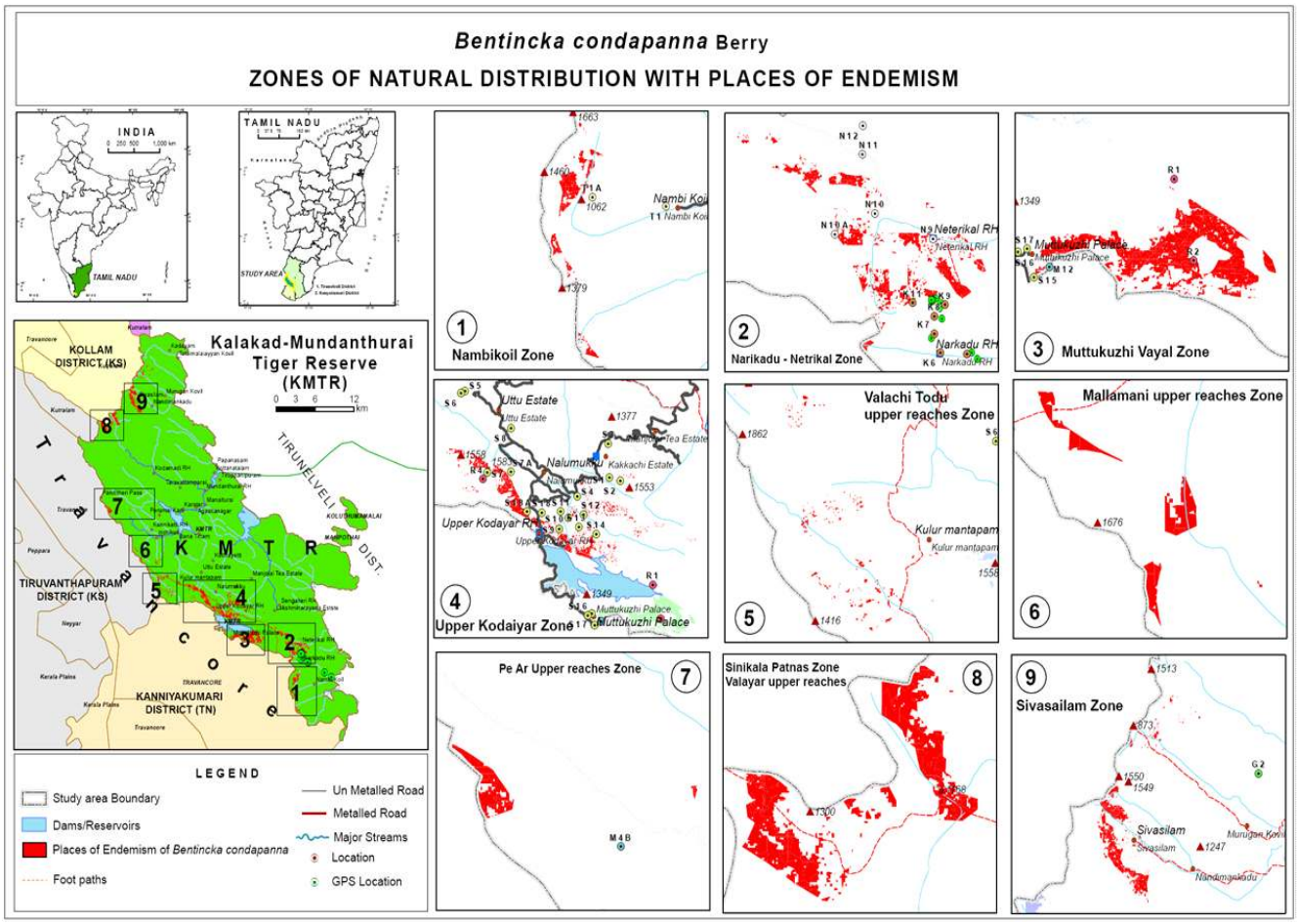

Fig.2: Natural distribution zones of Bentinckia condapanna Berry in KMTR

Table 1: Summary of abiotic factors for - *Bentinckia condapanna* Berry

Geology	:	Garnet-Biotite gneiss
Elevation and landform	:	760-1800 m; Part of Upper Plateau and Steep Hilly terrain
Slope	:	Very Steep to Precipitous slope (>15° to 89°)
Rainfall	:	200-500 cm
Temperature	:	15°- 24°C
Wet Season Length	:	10 months
Drainage density	:	High
Geomorphology	:	Upper Plateau, Structural Hill , Curvilinear ridge, Mountain Cliff , Streamlet bed
Soil series/Type	:	Puncholai series (Typic Haplustepts); Pallamkadu, *(Udic Argiustolls);* Kadamparai,(*Humic Dystrustepts);* Sethumadhagu *(Aquic Ustifluvents);* Karumutti (*Lithic Dystrustepts);* Ergangalli,(*Typic Haplustepts)* with very shallow soil depth (31 to 69 cms)
Soil pH	:	Mildly acidic to neutral to mildly alkaline varies from 4.8 to 8.23

Table 2: *Bentinckia condapanna* Berry- Area occupied under various geomorphologic features

Geomorphologic features:	Extent in Ha	%
Structural origin		
Upper plateau,	518.43	47.67
Structural hill,	146.03	13.42
Curvilinear ridge	89.73	8.25
Mountain cliff	76.78	7.06
Upland	21.11	1.94
Hill Top Plain	19.55	1.79
Hog back Ridge	18.88	1.74
Debris slope	18.42	1.31
Middle plateau	2.75	
Plateau fringe.	2.52	
Lower plateau	2.12	
Total	916.32	84.27
Denudational Origin		
Swampy land	49.94	4.59
Pediment slope	5.57	
Valley Fill	3.47	
Total	58.98	5.42
Fluvial Origin		
Streamlet Bed	80.22	7.38
Rift Valley ,Valley	31.73	2.92
Total	111.95	10.29

Table 3: *Bentinckia condapanna* Berry- extent of area occupied under various slope categories

Slope in degrees	Extent in Ha
Moderate Slope (8-14)	268.87
Steep Slope (15-24)	353.53
Very Steep Slope (25-45)	429.66
Precipitous Slope (46-89)	35.29

Geographical range in KMTR

Nine natural distribution zones of *Bentinckia condapanna* Berry could be delineated using the satellite image of KMTR and detailed floristic study by sample quadrats (Fig. 2).

1) Nambi Koil zone (Nambiyar upper reaches),
2) Naraikadu - Neterikal zone (Naraikadu Ar, Manimuthu Ar upper reaches),
3) Muthukuzhi vayal zone,
4) Upper Kodayar Zone,
5) Valachi Todu upper reaches,
6) Mallamani upper reaches,
7) Pe Ar upper reaches,
8) Sinikala patnas (Valayar upper reaches),
9) Sivasailam and sorroundings (Karunaiar upper reaches).

These nine zones occupy 1087.35 ha covering 4 reserved forests (RFs) and one reserved land (RL) namely Virapuli RF (362.62 ha), Papanasam RF (315.56 ha), Kalakkad RF (303.09 ha), Kalamalai RF (16.44 ha) and Sigampatty RL (89.63ha). The species could also be located in adjacent Peppara wildlife sanctuary in Kerala (Verghese and krisnamurthy, 2006) and on Sulakoil mettu in Kadayanallur range of Tirunelveli Forest Division (Sarkar, 1999).

Phyto geographic conditions of the area of provenance

The occurrence of species could be located in the semi-evergreen to evergreen forest types in KMTR, where the milieu of phytogeographic factors has played a key role in its endemism, growth and also for its present 'threat status'. The study of the phytogeographic parameters helps in protecting the existing populations and its further propagation efforts. The summary of abiotic factors is provided in Table 1.

Geology : The species occurrence could be observed mainly in Garnet-Biotite Gneiss formation.

Topographic Matrix

The area occupied by major geomorphologic features that support the species growth are presented in Table 2.

The major area of distribution of the species could be observed mainly between 1000 to 1700 m occupying nearly 88 % area in part of Upper Plateau and Steep Hilly terrain. However, general distribution extends its limit between 760-1800 m. Similarly the species mainly could be seen in steep, very steep to precipitous slope (>15° to

Table 4: *Bentinckia condapanna* Berry - results of soil samples*

Soil series	Area in Ha/(%)		Depth in cm	Soil Texture			pH	EC	NPK (mg/kg)		
				Sand %	Silt %	Clay %			N	P	K
Kadamparai, (*Humic Dystrustepts)*	414.51	(38.12)	26-50	54	20	26	5.25	0.02	0.51	5.00	0.18
Pallamkadu, *(Udic Argiustolls)*	285.16	(26.22)	29-59	66	16	18	5.25	0.10	0.47	3.50	0.81
Puncholai, (*Typic Haplustepts)*	161.37	(14.84)	23-68	24	20	56	8.16	0.19	0.89	4.00	0.30
Karumutti (*Lithic Dystrustepts)*	80.94	(7.44)	15-31	51	17	32	4.80	0.01	0.24	4.33	0.06
Ergangalli, (*Typic Haplustepts)*	56.08	(5.16)	20-41	51	12	37	5.27	0.02	0.33	6.75	0.05
Perumalmalai, (Rhodic Paleustalfs)	30.01	(2.76)	45-91	54	13	33	5.90	0.10	0.31	21.80	0.98
Tarkadu (*Lithic Haplustepts)*	27.10	(2.48)	23-35	54	21	25	5.33	0.02	0.24	2.00	0.07
Sethumadhagu *(Aquic Ustifluvents)*	14.36	(1.32)	22-62	79	8	13	6.24	0.03	0.34	4.20	0.20

*Soil samples analysed from Soil Testing Laboratory, T.N. Agricultural Department, Tirunelveli and Tiruchirapalli

89°). The area occupied by the species under various slope categories is in Table 3.

Climatic conditions

The natural distribution area of the species is located in the tropical monsoon rain forest climates (Am) as per climatic zones classified by Koppen (1954). The climate of the locality above 800 m remains cool and its temperature does not fall below 16.2 ^{0}C in the coldest month. April and May are the hottest months. Normal mean maximum temperature in these months remains 24^{0}C. The major portion of the Semi-evergreen forest - the home of the species is mainly located in Very Heavy rainfall zone (2000-5000 mm annually). The moisture regime of 10 months wet seasons prevail here.

Soil types and properties

The major occurrence of the species was observed in 8 types of Soil series namely Kadamparai, Pallamkadu Puncholai, Karumutti, Ergangalli, Perumalmalai, Sethu madhagu,Tarkadu. These soil series are generally with very shallow soil depths. The various soil characteristics of these soil series are presented in Table 4.

The characteristics of provenance area of the nine natural distribution zones of the species are presented below in Table 5.

Habitat and ecological situations

The resultant effect of various phytogeographic conditions and past treatment including biotic pressure have developed typical transitional forest types between southern tropical wet evergreen (rain) Forest (IA/C4), Tirunelveli semi-evergreen forest (2A/C3) as per Champion and Seth (1968) that supports the growth of the species.

Floristic structure, composition and species association

The species prefers to grow in open places forming it own colony of pure crop. The associated tree species in the surrounding area are *Antidesma menasu, Artocarpus heterophyllus*, *Elaeocarpus munronii*, *Glochidion zeylanicum*, *Gnidia glauca*, *Gordonia obtusa*, *Ochna obtusata*, *Ormosia travancorica*, *Rapanea wightiana, Symplocos cochinchinensis, Vaccinium neilgherrense*. The other shrub, herbs, stragglers, etc. are *Ochlandra travancorica, Osbeckia zeylanica*, *Embelia ribes, Hypericum mysurense*, *Ligustrum perrottetii*, *Phoenix loureirii*, *Vernonia ramaswamii*, *Schefflera venulosa.*

Conservation assessment and management plan (CAMP)

The Botanical Survey of India, Calcutta (Basu, 1988) has enlisted this plant under RARE category in their Red data book on Indian plants in Vol-II. The World Conservation Monitoring Centre (1996) also considered the species in RARE category. However, the recent field survey finds are: Extent of occurrence (km^2). < 150; Area of occupancy (km^2). < 15; Number of sub populations/locations: >9 locations in KMTR; *Habitat status:* Not stable in area as its habitats is being encroached gradually by *Ochlandra travancorica* and other species. The natural regeneration is affected by the *Ochlandra* invasion. It appears that the period of dry months has extended from 2 to 4 months; Generations studied: > 3 generations / 10 years; Data quality: Literature, herbarium and field study; Threat Status as Version 3.1: IUCN (2001) Endangered (EN)-A1c, B2a, bi, ii, iii, CI, E.

Species recovery plan and management proposed

Conservation efforts and method

The species with narrow endemic zone of distribution is in imminent danger of further degradation. The main threats to *Bentinckia condapanna* are not habitat disturbance by anthropogenic causes but invasion of its area of provenance by other floral species over the passage of time. The species is seen as pure patches in subtropical regions, especially in steep rocky slopes. A total of 1087.35 ha area is occupied by these patches in KMTR. It is observed that the *Bentinckia condapanna* brake in this Reserve is being replaced by *Ochlandra* reed brake and other species (Verghese,

2006). The establishment of reeds has been suppressing its regeneration. These threats are relevant to the threatened species occurring across the site.

Measures taken

There is no recorded information on natural regeneration of this species. The species is only enlisted as a threatened palm. No significant efforts have been made so far except a few plants planted in the Indian botanic garden, Howrah, West Bengal and Experimental garden, Botanical Survey of India, Yercaud, Tamil Nadu.

Growth dynamics

The field study unfolds the fact that the species grow as pioneer invading the bare areas in open land slips of steep to precipitous slope with first order of stream having Curvilinear ridge, Linear plateau, Mountain cliff as the geomorphologic features. The land slips are better sites because of the presence of original top soil mixed up in the rock pieces, and good drainage. These slightly improved conditions make it suitable for colonization by *Bentinckia condapanna* forming colony of their pure fresh groves as primary succession. The colony reaches its climax over the passage of time. The groves at Naraikadi-Neterikal zone, Agasthiamalai base, Muthachi peak are such examples. The new plant community of *Bentinckia condapanna*, further in course of time improves the soil and the climatic factors and thus makes the place suitable for some other exacting species which comes *in* gradually and replaces the previous plant community. As a result of changed conditions, the colonizers of *Bentinckia condapanna* are seldom found to regenerate *in-situ* and their place is taken by comparatively more exacting species.

The field inventory shows that the natural regeneration is very scanty in the places where the species is covered by the canopy of the other species of evergreen forests and also by the reeds. This appears to

Table 5: *Bentinckia condapanna* Berry- Matrix of phytogeographic parameter of the provenance area

Map no	Zone of Endemism (RF/RL)	Forest Types	Geomorphologic features	Slope in Degrees	Temp. in ^{0}C	Rain fall in cm	Elevation Zone in m (above MSL)	Soil Series	Soil pH	Soil depth in cm	Extent of Area in Ha (in %)
1.1	Nambi Koil Zone (*Kalakad RF)*	Reed Brakes, Semi Evergreen	Debris slope, Hogback ridge, Curvilinear ridge, Mountain cliff, Streamlet bed , Upper plateau	8-14,15-24,25-45	19 to 23	Rain fall in 200 to 500 cm	1000 to 1700	Puncholai, Tarkadu, Vandaeruvu	5.25 to 8.17	36-105	69.68 (6.41)
1.2	Naraikadu - Neterikal Zone(*Kalakad RF) &(Virapuli RF)*	Semi-evergreen, Reed Brakes	Curvilinear ridge, Streamlet bed ,Upland Upper plateau	8-14,15-24,25-45	18 to 23		1000 to 1750	Ergangalli, Kadamparai, Kallar valasai, Karumutti, Pallam kadu, Puncholai, Sethu madhagu, Vandaeruvu	4.8 to 8.23	31 - 105	45.30 (4.17)
1.3	Muthukuzhi vayal Zone *(Virapuli RF)*	Semi evergreen, Reed Brakes	Curvilinear ridge, River ,Upland, Upper plateau	8-14,15-24,25-45,26-89	17 to 23		1000 to 1700	Ergangalli, Kadamparai Pallam kadu, Puncholai Sethu madhagu, Thenkadu	5.25 to 8.17	36-68	128.65 (11.83)
1.4	Upper Kodayar Zone, (*Singampatty RL*),(*Kalakad RF), (Kalamalai RF) and (Virapuli RF)*	Reed Brakes, Semi evergreen	Debris slope, Hill Top, Curvilinear ridge, Middle plateau, Mountain cliff Plateau fringe, Rift valley, Upland, Upper plateau	8-14,15-24,25-45,26-89	16 to 23		1000 to 1750	Kadamparai, Karumutti, Pallam kadu, Perumal malai Puncholai	4.8 to 8.17	31 -91	273.79 (25.18)
1.5	Valachi Todu upper reaches *(Kalamalai RF)* , (*Singampatty RL)*	Reed Brakes, Semi evergreen	Debris slope, Escarpment Hog back ridge, Curvilinear ridge ,Mountain cliff, Upper plateau, valley	8-14,15-24,25-45,26-89	20 to 23			Kadamparai, Pallam kadu, Perumal malai,Puncholai, Sethu madaghu	5.16 to 8.17	32-91	1.42 (0.13)
1.6	Mallamani upper reaches, (*Singampatty RL)*	Semi evergreen, Reed Brakes	Curvilinear ridge Mountain cliff Streamlet bed , Upper plateau	8-14,15-24,25-45,26-89	19 to 23		1300 to 1700	Pallam kadu	5.25	59	16.50 (1.52)
1.7	Pe Ar upper reaches *(Papanasam RF) and* (*Singampatty RL)*	Semi evergreen, Reed Brakes	Structural hill	8-14,15-24,25-45,26-89	18 to 23		1100 to 1750	Kadamparai, Puncholai	5.3 to 8.17	36-68	27.41 (2.52)
1.8	Sinikala patnas (Valayar upper reaches - *(Papanasam RF)*	Reed Brakes, Semi Evergreen	Debris slope, Hill Top plain, Hog back ridge, Curvilinear ridge, Pediment slope, Rift Valley, Structural hill, Swampy land	8-14,15-24	17 to 23		1000 to 1650	Kadam parai, Pallam kadu, Tar kadu	5.2 to 5.35	36-59	133.00 (12.23)
1.9	Sivasailam and surroundings *(Papanasam RF)*	Semi Evergreen, Reed Brakes	Curvilinear ridge; Lower plateau; Mountain cliff; Rift valley; Structural hill	8-14,15-24,25-45	16 to 23		1000 to 1600	Ergangalli, Kadamparai Karumutti, Pallam kadu,Perumal malai Puncholai ,Sethu madhagu	4.8 to 8.17	31 -91	155.88 (14.34)

Fig. 3: *Bentinckia condapanna* Berry– Floristic structure and composition at Narikadu

be the root cause of non availability of healthy regeneration of new recruits and accumulation of only large number of old trees (with very tall stem 10-15 m above) while down storey is covered by dense vegetation of other species.

Plant propagation practices

Artificial reproduction methods were attempted from seed origin and are illustrated in Fig.4 and Fig.5.

Fig. 4: *Bentinckia condapanna* Berry a. Flowers and fruits; b. Fruits in bunch (yet to ripe); c. Fruits in bunch (ripe). d Fruits and seeds

Seed collection and propagation

Dark scarlet shinning ovoid fruits with fleshy pericarp were collected from Naraikadu in the month of November, 2006. 916 mature fruits made a kilogram. Again mature fruits were collected by the end of June from Vellachipadu (below Agasthiamalai), 940 mature fruits (nuts) made a kilogram. In each nut solitary seed was available; they were covered with fleshy and fibrous pericarp. Before putting in mother bed nuts (with fibrous pericarp) were soaked in water for 2 hours. The germinative capacity was as high as 77% nuts germinated after more than 6 months and the survival plant per cent recorded as 70. Growth rate of seedlings found to be slow at the initial stages.

Fig. 5: *Bentinckia condapanna* Berry seedling: a) and b) Stages of Germination. c) Seedlings transplanted in poly bags (16 x32 cms bags) - 10 months old

Habitat protection

The species is very sensitive in its regeneration process and it prefers to grow in open places. The habitats are being encroached gradually by *Ochlandra travancorica* and *Ochlandra scriptoria.* It appears that because of gradual rise in temperature along with gradual scarcity of rainfall in the habitat, the period of dry months has extended from 2 to 4 months. *Bentinckia condapanna* and *Ochlandra travancorica* occur side by side along with other species associated as mentioned earlier. With the change in climatic condition over the period (> 3 generations/10 years) Ochlandra species which comparatively thrive better in drier condition than *Bentinckia condapanna* are colonizing vigorously in its habitat by suppressing the younger regeneration of this species. To protect the natural regeneration of this beautiful palm species from the invasion of Ochlandra species, boundary clearing in the habitat as well as canopy opening of other species will be of immense use.

Measures proposed

Appropriate conservation measures are to be taken up immediately to ensure its survival in the wild by protecting the existing known population of the species and its rare habitat.

The habitat area possesses only the general protection provisions available under the Indian Wildlife (Protection) Act (IWPA); 1972, 2006 as it comes under protected area (KMTR- 17th Tiger Reserve of India). The species does not get specific protection support under any acts, legislation or policy except above general protection. It is not in any Schedule of IWPA (1972, 2006) nor included in CITES list.

Following species specific conservation measures are proposed for immediate action:

(a) A specific and comprehensive plant schedule including this species may be brought under Wildlife Protection (amendment) Act / Biological Diversity Act (Sarkar, 2012) as proposed.

(b) The sole surviving population of the species studied in KMTR and in its surroundings should be accorded full protection by declaring the specific locality and its vicinity as a "Plant sanctuary" (Sarkar *et al*., 2005). Intensive species inventory needs to be conducted in its distribution range.

(c) High resolution satellite data and geoinformatics to prepare species specific *zonation maps* for intensive care and management. Similarly, an Atlas showing the spatial distribution of each endemic and threatened plant as per IUCN Guidelines (2001) needs to be prepared to make species specific future management plan.

(d) Efforts should be taken to raise forest nurseries at convenient place in or around its habitat by collecting mature seeds during September - October. After growing healthy seedlings, they can be planted in its natural habitat to increase the stock density of the species as *in-situ* conservation.

(e) For *ex-situ* conservation, healthy seedlings of the species can also be planted in other parts of Western Ghats having similar phyto-geographic and ecological conditions. Artificial reproduction must be made for restocking the area in addition to cultivate it as ornamental palm in botanic gardens and parks etc. as an *ex- situ* measures.

(f) Application of tissue culture techniques can be attempted for propagation and reintroduction of the species.

Conclusion

The present study attempted to focus on species-specific information along with phytogeographic parameters and ecological situations where this plant grows. Species recovery plan, with plant propagation practices and conservation measures are provided for further stock improvement of the species. However, all the above scientific and technical information can only be effectively implemented when protection, conservation and management of such natural resource is supported by the required regulations, institutional mechanism and strong legislation for all the imperilled plant resources of the country (Sarkar, 2005). Presently more than 7 to 10 per cent plants and Gillett. (Kerry and Gillett, 1997) suffer from various degrees of threats in the country, but we are yet to frame specific policy / guidelines in this sector of plant protection except six plants. Hence, it is suggested that all Threatened plants be covered under separate Plant Schedules including *Bentinckia condapanna* Berry at the earliest to protect them from further degradation.

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बेन्टीनकिया कोन्डापाना बेरी की कमी पूरा करने की योजना - भारत के दक्षिण पश्चिमी घाटों के उष्णकटिबंधीय सम सदाबहार वनों में पाई जाने वाली देशज और संकटापन्न वृक्ष प्रजाति ½पाम½

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सारांश

प्राय: द्वीपीय भारत के दक्षिण पश्चिमी घाटों में *बेन्टीनकिया कोन्डापाना* बेरी देशज और संकटापन्न प्रजाति ½पाम½ है। वर्ष 1988 के दौरान भारतीय वनस्पति सर्वेक्षण विभाग द्वारा *बेन्टीनकिया* वंश की दो प्रजातियां यथा : *बी. कोन्डापान्ना* और *बी. नाइकोबरिका* ½कुर्ज½ बेक्क को संकटापन्न प्रजाति के रूप में सूचीबद्ध किया गया। तमिलनाडु और केरल की दक्षिणी टेवंकोर और तिरूनेल्वली पहाड़ियों में बी कोंडापान्ना का शंकरा और देशज क्षेत्र है। जी पी एस, जी आई एस तथा वर्गीकृत त्वरित नमूना तकनीकों के जारिये तमिलनाडु सरकार, कालाकड मुंडाथुरैई वाघ रिजर्व में इस प्रजाति के वासस्थलों का विशलेषण किया गया। संकटापन्न प्रजातियों के स्थल विशेषक मानचित्रीकरण के लिए उसकी वृद्धि और निम्नीकरण को जानने हेतु सुदूर संवेदन डाटा का उपयोग जी आई एस की सहायता से किया गया। प्रजाति के संकटग्रस्त होने की स्थिति का पुन: आकलन किया गया। प्रजाति के वृद्धि स्वभाव, वानस्पतिक विवरण, सांवर्धनिक अभिलक्षण, मानव वनस्पति विज्ञान तथा अन्य उपयोजनों के बारे में बताया गया है। देशज उत्पति स्थलों, संक्षिप्त अवस्थिति डाटा, क्षेत्र पादप भौगोलिक प्राचल तथा पादप सामाजिक संरचनातंत्र के उद्धारण दिये गये हैं। इस संकटापन्न प्रजाति के प्रभाव एवं रक्षण के लिए त्वरित उपाय करने पर जोर दिया गया है और इसकी कृत्रिम पुनरूत्पति करने की आवश्यकता है। अन्तत: स्वस्थानिक तथा परास्थानिक संरक्षण पद्धतियों का प्रयोग करते हुये 'संकटापन्न प्रजाति पुनरूत्पति योजना' के तहत इस प्रजाति को रक्षित और प्रसारित करने पर जोर दिया गया है।

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