Status of the rare palm *Bentinckia condapanna* Berry in two habitats of Goodrical Reserve Forests; Western Ghats of India.

Abhilash ES[1] and Brijesh Sathian[2]

[1]Assistant Professor, P.G. Department of Botany, Sree Narayana College, Nattika, India

[2]Assistant Professor MCOMS, Pokkara, Nepal

Original Article

Corresponding Author
Dr. Abhilash ES
Assistant Professor, P.G. Department of Botany
Sree Narayana College
Nattika, Thrissur, India
Email: abhies@gmail.com

Abstract

Bentinckia condapanna shows more IVI values and there by dominance and ecological stress in both the sites, that is, in sparsely distributed habitats as well as in dominated habitats (Site-II). Major associations /co dominance to *Bentinckia condapanna* in site -I were the evergreen species like *Macaranga peltata*, *Elaeocarpus tuberculatus*, *Lannea coromandelica*, *Schefflera venulosa* etc. and for site-II was the secondary species *Chionanthus ramiflorus.* Higher IVI values for *Bentinckia condapanna* in both the sites proves the capacity of this species to establish in mono-dominant and co- dominant communities.

Key Words: Biodiversity, IVI, t test, z test, Density, Frequency.

Introduction

Tropical Rainforests are the largest treasures of biodiversity. Tropical forests cover only seven percent of the earth's surface but contain up to 60-70 percent of all living species (Myers *et al*, 2000) and among the 34 hot spots in the world two are in India viz. Eastern Himalayas and the Western Ghats, which are a treasure house of plant and animal life.

India is rich in its palm diversity and about 21 genera and 100 species of palms occur in three major geographical regions viz: Peninsular India, North Eastern India and Andaman and Nicobar Islands. Peninsular India is represented with 11 genera and about 32 species. Most of the genera contain one species with an exception of *Calamus,* the only rattan genus in South India. In Kerala there are eight indigenous genera, *Arenga, Bentinckia, Borassus, Calamus, Caryota, Corypha, Phoenix* and *Pinanga.* All genera except *Calamus* and *Phoenix* are represented with one species (Renuka, 1999).

In Kerala many palms are considered as endangered (Nayar and Sastry, 1990 and IUCN, 2000). Loss of habitats and over exploitation are major threats to the survival of many species of palms. Palm population in the forest areas are decreasing; *Arenga wightii*, *Bentinckia condapanna and Pinanga dicksonii* are much restricted in distribution and destruction of evergreen forests is affecting their population (Renuka, 1999). Among the above three species *Bentinckia condapanna* is peculiar with its habitat (steep cliffs of hills) and there by restricted in distribution.

Bentinckia condapanna Berry is one of the rare, endangered and endemic palms occurring in the forests of Western Ghats of India. It is a solitary, slender stemmed, and pleonanthic palm. Stem reaches up to 10 m height and about 15 cm in diameter. It occurs at an altitude of 1,000 - 1,400 m in the steep cliffs of hills. It is seen either in homogenous brakes or intermingled with high altitude evergreen forests. In Kerala it is distributed in Agastyamala, Kulathupuzha, Peerumedu, Pachakkanaum, Uppupara, Moozhiar and Peppara (Renuka, 1999; Varghese, 1997).

Study area:

Goodrical Reserved Forest lies in between 9^0 10' and 9^0 30' latitudes and 76^0 55' and $77^0$17' longitude in Kerala, in hill chains of Western Ghats of India. This being a rainforest region, humid climate exists without much seasonal variation. The temperature varies from 15^0C to 31^0C with May being the hottest month and December or January the coolest. The area receives both the south-west and north-east monsoon with maximum rainfall in July and minimum in January. This area had experienced selection felling up to 1986 for the extraction of timbers for both railway sleepers and packing case industries (Raghavan Nair, 1991). Two study sites were identified with Urani; site-I habitat (1403 m above sea level), where *Bentinckia condapanna* is growing intermingled with other tropical evergreen species and in

Moozhiar site-II habitat (1215 m above sea level) where it is seen as a homogenous patch. In both the cases the terrain is steep and rugged in nature, there by very difficult to conduct ecological studies.

According to Chandrasekharan (1962) and Championn & Seth (1968) the vegetation of study site-I falls under West Coast Tropical Forest and that of study site-II is of *Bentinckia condapanna* Brake.

Material and Methods

Stratified random sampling method was adopted for the present study. Five 0.1ha quadrats were established in the two study sites, viz. *Bentenkia* sparsely distributed area (Study site-I) and *Bentenckia* dominant area (Study site-II). In every quadrat the tree species having >30.1 cm GBH (girth at breast height) have been measured in the full quadrat based on *Chandrasekhara* (1998).

Importance value index (I.V.I) (*Curtis and McIntosh*, 1950), density, abundance, frequency, basal area etc. have been worked out. To study the species richness, of trees *Margalef* (R1) (1958) was used. Abundance of the species is represented by evenness indices. Pielou's evenness measure is the most commonly used method (Pileou, 1975). Species diversity is one of the most important characteristics of a community and this was determined as per *Shannon and Wiener* (H') (1963). The differences in the value of Shannon-Wiener index obtained for different communities was tested for significance using Student's *t* test (Magurran, 1988). Fisher's (α) (Fisher *et al*., 1943) is yet another measure of diversity and using the standard deviation, significant differences in diversity between habitats were judged by Z-test.

Species dominance values were measured by *Simpson's* index (1949). The ratio of abundance to frequency (AB/F) was worked out to interpret the distribution pattern of the species indicate as regular (<. 025), random (0.025 to 0.05), and contagious (>0.05) (*Curtis and Cottom* 1956).

Results and Discussion:

In the study site-I, 112 individuals of trees/half hectare area, belonging to 16 species were encountered. In order to express dominance and ecological stress of any species, Importance value index (IVI) has been widely used. Most dominant species and major associations here are *Macaranga peltata* (IVI = 40.61) followed by *Elaeocarpus tuberculatus* (IVI = 32.62), *Lannea coromandelica* (IVI = 23.37). Here *Bentinckia condapanna* (21.18) also forms a co-dominant species which is well established in nature. Basal area refers to the ground actually occupied by the stems and is one of the chief characters of dominance; higher the basal area, higher the dominance. Here *Macaranga peltata* shows more basal area (5.92 m^2/0.5 ha) followed by *Elaeocarpus tuberculatus* (3.68m^2/0.5 ha), *Lannea coromandelica* (2.11 m^2/0.5 ha) and for *Bentinckia condapanna* it is 0.002 m^2 /0.5 ha (Table-1).

Table. 1.Quantitative analysis of Site- I

Species	D	F	AB	BA	AB/F	IVI
Bentinckia condapanna	300	100	3.00	0.002	0.030	21.18
Bhesa indica	160	100	1.60	1.027	0.016	19.76
Chionanthus ramiflorus	80	80	1.00	0.076	0.013	9.35
Cullenia exarillata	100	100	1.00	1.016	0.010	17.01
Diospyros bourdillonii	300	100	3.00	0.142	0.030	20.88
Dipterocarpus indicus	80	80	1.00	0.103	0.013	9.50
Elaeocarpus serratus	100	100	1.00	1.203	0.010	18.10
Elaeocarpus tuberculatus	100	100	1.00	3.677	0.010	32.42
Lannea coromandelica	100	100	1.00	2.113	0.010	23.37
Litsea wightiana	180	100	1.80	0.083	0.018	15.18
Macaranga peltata	100	100	1.00	5.092	0.010	40.61
Michelia nilgirica	100	100	1.00	0.087	0.010	11.63
Microtropis stocksii	100	100	1.00	0.087	0.010	11.63
Schefflera venulosa	260	100	2.60	1.690	0.026	28.06
Syzygium calophyllifolia	140	100	1.40	0.223	0.014	14.21
Syzygium laetum	40	40	1.00	0.459	0.025	7.11
Total	**2240**	**1500**	**23.40**	**17.272**	**0.25**	**300.00**

D-Density, **F**-Frequency, **BA**-Basal area, **AB**-Abundance, **IVI**-Importance Value Index.

In the case of study site-II, 74 individuals of trees/0.5 ha area, belonging to 2 species were recorded. Here a clear-cut dominance was shown by *Bentinckia condapanna* (IVI = 232.91). Basal area, density, frequency etc. were also more compared to the next species. Basal area was found to be 0.165 m^2/0.5 ha and 0.151 m^2/0.5 ha for *Bentinckia condapanna* and *Chionanthus ramiflorus* respectively (Table-2).

Table-2. Quantitative analysis of Site- II

Species	D	F	AB	BA	AB/F	IVI
Benteckia condempana	1440	100	14.40	0.165	0.144	232.91
Chionanthus malaelengi	40	20	2.00	0.151	0.100	67.09
Total	1480	120	16.4	0.316	0.244	300.00

The vegetation characteristics like abundance, frequency and density are employed as three quantitative aspects describing the general nature of vegetation (Barucha and De Leeaw, 1957). Highest density in the site – I were recorded by the species *Bentinckia condapana* (300),*Diospyros paniculata* (300) and *Schefflera venulosa*(260)(Table-1). Site – II has clear-cut dominance of *Bentinckia condapanna* (100) and *Chionanthus ramiflorus* (280) (Table-2). The highest density of the species shows its ecological tolerance to the unfavorable conditions. Stand density of site – I was 112 individuals /0.5 ha and that of site – II was 72 individuals /0.5 ha. Individual density of *Bentinckia condapanna* in site-1 was 15 individuals /0.5 ha and in site-II it was 50 individuals /0.5 ha. Typically a community will generally consist of a small number of abundant species and much large number of a moderately common and rare species. A community in the

Published online by NepJOL-INASP
www.nepjol.info/index.php/APJEESD

early stages is having small number of species with an even distribution being succeeded eventually by a mature community of a large number of species with a much more even abundance distribution. (Richards, 1996). The high abundance value of *Bentinckia condapanna* (3.00) in site - I and (10.00) in site - II is due to highly suitable ecological niche for the species.

The presence of a species in high or low degree will indicate the importance of that species in association (Barucha and De Leeuw, 1957). The percentage frequency of the species indicates its distribution in the area. The absence of low frequency classes (B and C) suggests that characteristic species of an area are absent or few in number (Table-3).

Table 3. Frequency Classes of Evergreen forests.

S.NO	LOCALITY	FREQUENCYCLASS					NATURE
		A	B	C	D	E	
		(0-20)	(21-40)	(41-60)	(61-80)	(81-100)	
1	Site-I	0	1	0	2	13	HETERO-GENOUS
2	Site-II	2	0	0	1	1	HETERO-GENOUS

A constant species may have wide ecological tolerance and occur in several associations (Kershaw, 1974). The high percentage frequency of *Bentinckia condapanna* (100) in both the sites indicates its ecological tolerance to the adverse conditions (Exposure to wind and steep terrain). The distribution pattern of the two sites are as follows, in site - I, preponderance of regular distribution can be observed with rarity of random distribution; where as in site-II both the species shown contagious distribution. (Tabl-4). In site -1 *Bentinckia condapanna* show random distribution and site - II it shown contagious distribution.

Table 4.Distribution pattern

TYPE	CATEGORY	LOCALITY	DISTRIBUTION PATTERN		
			REGULAR	RANDOM	CONTAGIOUS
EVERGREEN	Trees	Site-I	12	4	0
EVERGREEN	Trees	Site-II	0	1	3

According to Odum (1971) contagious distribution is the most common pattern in nature, random distribution occurring in the uniform environments, and regular distribution in areas where severe competition between individuals exists.

Based on the girth class distribution site -I and II exhibited L shaped curve which indicates undisturbed nature of forest stand (Table-5) (Haleshi *et al.,* 1999).

Table 5. Girth Class Distribution of Trees

FOREST TYPE	LOCATION	D1-30-60	D2-61-90	D3-91-120	D4-121-150	D5-151-180	D6->180
EVERGREEN	Site-I	65	7	5	5	15	15
EVERGREEN	Site-II	55	17	0	0	0	0

Biodiversity indices are essential to compare the diversity pattern among different habitats.

As far as Species Richness is concerned, Margaleaf's Index (R1) was more in site-I (3.18) than in site- II (0.70) due to the less number of species in site-II. Shannon's Index (H') was also higher in site-I (2.63), when compared to site-II (0.889). The t-value for comparing H is 16.07 which are significant at 1 % level of significance (Table-6).

Table. 6. Biodiversity Indices

Localities	Shannon's species diversity (H')	Margelaf's species richness (R1)	Pielou's evenness (E3)	Simpson's index (CD)	Alpha Diversity (∝)
Site-I	2.63	3.18	0.95	0.0816	5.11
Site-II	0.889	0.70	0.64	0.5266	0.913
	16.07**				3.09***

** t-Value *** Z Value

This indicates the diversities of two localities are significantly different. Locality one is more diverse than two. Shannon's diversity is more affected by the addition of rare species with increase in sample size (Magurran, 1988). Simpson's index was found to be more for site-I (0.816) than site- II (0.5266) (Table-6). Heterogeneity of species is inversely proportional to Simpson's index (Magurran, 1988). The less value of Simpson's index in site II shows its higher heterogeneity of species. When compared among the forest types based on Pielou's evenness index, the species of site- I (0.95) was more evenly distributed than site-I (0.64) (Table-3). Alpha diversity was compared using Z test. Z value computed (3.09) is also significant at 1 % level of significance (Table-6). This indicates that Alpha diversity is also entirely different in two localities with site-I having higher Alpha diversity than II. Regeneration of *Bentinckia condapanna* is good in both the sites, where in site – I it competes with other evergreen species to establish compared to the site – II.

Conclusion:

Bentinckia condapanna shows more IVI values and there by dominance and ecological stress in both the sites, that is, in sparsely distributed habitats as well as in dominated habitats (Site-II). Major associations /co dominance to *Bentinckia condapanna* in site –I were the evergreen species like *Macaranga peltata*, *Elaeocarpus tuberculatus*, *Lannea coromandelica*, *Schefflera venulosa* etc. and for site-II was the secondary species *Chionanthus ramiflorus.* Higher IVI values for *Bentinckia condapanna* in both the sites proves the capacity of this species to establish in mono-dominant and co- dominant communities.

Basal area in both the habitats for *Bentinckia condapanna* is 0.002 m^2 and 0.165 m^2 per half hectare area reveal marked difference in site-II but more or less uniform growth pattern

Published online by NepJOL-INASP
www.nepjol.info/index.php/APJEESD

in both habitats. The highest density and frequency values of the plants in both the sites show its ecological tolerance to unfavorable conditions. The high abundance value of *Bentinckia condapanna* in both the sites is due to the suitable ecological niche for the species. Even though diversity and richness was more in site-I, the higher heterogeneity of species was found in site-II. In general this study proves that *Bentinckia condapanna* is able to survive in both mono dominant and co-dominant communities due to its ecological tolerance.

Acknowledgments:
The authors are extremely thankful to Director, KFRI for the help rendered during the study, Dr.N.Sasidharan, Dr.Sujanapal; Scientists of KFRI for Taxonomic identification and Kerala Forest Department for financial assistance.

References:

Bharucha, F. R. and W. D. Deleeuw. 1975. A practical guide to plant sociology for foresters and agriculturists. Ecology. 3: 153-155

Champion, H.G. and S.K. Seth. 1968. A revised Survey of Forest Types of India. Manager of Publications, New Delhi, 404p.

Chandrasekhara, U.M. 1998. Evaluating Plant diversity in different forest types by laying out permanent sample plots. KFRI Research report No: 156.Kerala Forest Research Institute, Peechi, Kerala. 88p.

Chandrasekharan, C. 1962. Forest Types of Kerala State (1).Indian For.88: 660-674

Curtis, J.T. and G. Cottam. 1956. Plant Ecology Work Book. Laboratory field reference manual.

Curtis, J.T. and R.P. Macintosh. 1950. The Interrelations of certain analytic and synthetic phytosociological characters. Ecology. 31:434-455

Fisher, R.A., A.S. Corbet and C.B. Williams 1943. The relation between the number of species and the number of individuals in a random sample of animal population. Journal of Animal Ecology. 12, 42–58.

Haleshi,C., Y.N.Seetharam and Vijay (1999).Assessment of Plant Biodiversity of dry deciduous Forests of Sanduri, Karnataka. Ecol.Environ & Cons.5:1-16

IUCN [Hilton-Taylor, C. –compiler], 2000. IUCN Red List of Threatened species. IUCN, Gland, Switzerland and Cambridge, UK. 61p.

Kershaw, K.A. 1974. Quantitative and Dynamic Plant Ecology. Arnold, London, 183p.

Marglef, D.R, 1958. Information theory in Ecology. Yearbook of the society for general systems and research. 3: 36-71

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. Da Fonseca and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853–858.

Nayar, M.P. And A.R.K. Sastry. (eds) 1990.Red Data Book of Indian Plants ,Vol:3,Botanical Survey of India, Calcutta.

Pileou, E. C. 1975. Ecological Diversity. Wiley International, Newyork.165p

Raghavan Nair, 1991. *PODOCARPUS WALLICHIANA* (Presl). In Proceedings of Symposium on rare, endangered and endemic plants. Kerala Forest Department, Trivandrum, 70-71.

Richards, P.W. 1996. The Tropical Rain Forest. Cambridge University press.450p.

Renuka, C. 1999, Palms of Kerala, Palms of Kerala, Kerala Forest Research Institute, Peechi, Thrissur, India.72p.

Shannon, C.E and W. Weiner. 1963. The mathematical theory of communication. Urbana, Uni, Illinois press.117p.

Vargheese, A. O. 1997. Ecological studies of the forests of the Peppara Wildlife Sanctuary using remote sensing techniques. Doctoral thesis, Forest Research Institute, Dehradun – 279 p.

Article Information	
Article history	
Received	**21 October 2012**
Received in revised form	**13 November 2012**
Accepted	**2 December 2012**