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Research Article

AN ASSESSMENT OF ORCHID DIVERSITY OF HORSLEY HILLS, ANDHRA PRADESH

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ABSTRACT
Orchids due to their flowering floriferousness, ample array in flower color, size, and shape, astonishing relationships with their surroundings attract every organism. In this research article, exploration of species diversity of wild orchids of Horsley Hills *viz., Habenaria spp.,Vanda spp.*, *Bulbophyllum kaitiense* and *Diplocentrum recurvum* have been documented during the period of 2012- 2014 in different seasons at various specific geographic locations and altitude. IUCN status, phytosociology, ecological influence and species diversity studies of the enumerated wild orchids has been reported to understand the high priority of conservation.

Keywords: *Horsley Hills, Orchids, IUCN status, Diversity*

INTRODUCTION
Orchids are mycorrhizal herbs, belonging to the family Orchidaceae Jussieu, *nom. cons*. (APG III). This orchid family is one of the two largest families of angiosperms. Many species of terrestrial orchids have become rare, threatened or endangered and therefore are today under the protection of international or national laws or are included in directives and Red Data Books (Swarts and Dixon, 2009).
Orchids are constraint species becoming rarity and their evolutionary adaption evolved into astonishing relationships with their surroundings. These species are not only important for their aesthetic value but also because they work as ecological indicators and also been shown to be excellent indicators of overall biodiversity in a particular area. Orchids are very much habitat specific. Species are distributed in different habitats and are mostly narrow niched (Reddy *et al.*, 2006).
Diversity is a product of evolution. World is made up by the existence of two entirely different entities (living and non-living) to share the resources. Diversity is an factor, without it, the functionality, significance and the productivity of the ecosystem will be lost so that the equilibrium, which will result in the early extinction of species so that the human race. Evolution and extinction of species represents the present state of population structure.
Population structure is dependent on the population dynamics. Population dynamics is dependent of species diversity i.e., species richness, species evenness. Species diversity is a results of species interactions (phyto-sociology) and ecological factors (Stirling and Wilsey, 2001). "To conserve the species diversity and to maintain the equilibrium of the eco-systems, the ecological and diversity studies have a key role and are essential to be explored" Importance Value Index provides an overall importance of a species in a community.
It is the sum of Relative Density, Relative Basal area and Relative Frequency for each species involved. Previous workers (Miria *et al.,* 2012; Reddy *et al.,* 2006; Reddy, 2005a & 2005b) have documented Orchids of Eastern Ghats and its ethnobotanical usage. Previous workers, Gamble (1928), Mahendranath *et al.,* (2015) and Mitta *et al.,* (2015) reported few orchids present at horsley hills. But this is the first document evaluating the diversity of orchids at Horsley Hills.
Orchids impress us with their ability to exploit diverse and challenging habitats, even in temperate climates. Their evolutionary adaption evolved into astonishing relationships with their surroundings. Yet, the fate of many wild temperate orchids is at imminent risk with the rapidly increasing anthropogenic and ecological disturbance impacts. The orchids enumerated in this paper are collection from Scrub intermixed patches of dry deciduous forests of Horsley Hills of Andhra Pradesh. The wild orchids documented for this research are highly diverse, habitat specific and actively evolving plants, known for

their beautiful flowers. Before they may disappear, we are just starting to understand the extent of this group of plants and their complex biological adaptations at Horsley Hills of Andhra Pradesh.

MATERIALS AND METHODS

Study Site

Horsley Hills (4,332 feet above MSL) forms the broken hill ranges of the southern portion of the eastern ghats and is the only Hill Station in Chittoor district of Andhra Pradesh, India. This is also known as "Andhra Ooty". The locals call it as Yenugumallammakonda. These rolling hills are withscrubby vegetation with mixed dry deciduous forest type vegetation. Horsley Hills has salubrious climate and the temperature ranges from 50^{o}c in winter to about 32^{o}c in hot summer.

In this article, *Habenaria roxburghii* Nicolson (SVUTY – 0/HH- 2895)., *Habenaria rariflora* A. Rich. (SVUTY – 0/HH- 1775)., *Habenaria longicornu* Lindl. (SVUTY – 0/HH- 1097)., *Diplocentrum recurvum* Lindl. (SVUTY – 0/HH- 1026), *Vanda tessellata* (Roxb.) Hook.exG.Don (SVUTY – 0/HH- 0886), *Bulbophyllumkaitiense* Rchb.f. (SVUTY – 0/HH- 0659) and *Vanda spathulata* (L.) Spreng. (SVUTY – 0/HH- 1194) have been documented which are present in different geographical positions at Horsley hills. Identification of orchid taxa was done according to Local Floras, NCBI taxonomy and Plant list search engines.

Status of the orchid taxa has been documented according to IUCN 2013 *ver* 13. GPS documented with Garmin GPS and the Way points were analyzed with Google Earth. Nomenclature and authentication was done according to the plant List and International Plant Name Index (IPNI). APG III classification was followed. Diversity studies were made with Microsoft Excel ver.2007.

Data Collection

Regular field surveys were undertaken in and around the Horsley Hills between 2013 and 2014. Orchid taxa either with flowers or fruits were collected and photographed (Figures 1-8), identified and confirmed with available regional floras (Gamble 1915-1936 and Chetty, 2013), revisions (Rajendran and Daniel, 2002; Dutta and Deb, 2004; Ansari, 2008) and monographs (Sivarajan and Pradeep, 1996; Singh, 2000; 2001). Abbreviations of authors' names of plant names strictly follow Brummitt and Powell (1992). The standard herbarium technique given by Fosberg and Sachet (1965) was followed for preparation of herbarium specimens. Voucher specimens have been deposited at Herbarium (SVUTY) Department of Botany, Sri Venkateswara University, Tirupati for reference. The current nomenclature of all taxa was further determined by referring to authentic databases such as IPNI, Tropicos and The Plant list and NCBI Taxonomy.

Orchid diversity have been calculated according to the method followed by Prasad *et al.*, (2007). The data were quantitatively analyzed for density, frequency and abundance following Curtis and McIntosh (1950). The relative values of density, frequency and abundance were determined as per Philips (1959). These values were summed up to get Importance Value Index (IVI).

Frequency denotes the homogeneity of distribution of various species in the ecosystem. It was calculated as follows and expressed in percentage. The species which is well distributed and have a chance of being recorded in any part of the ecosystem, will have frequency 100 %. While a species which is restricted to certain areas will be encountered in low frequency value.

$$\text{Frequency} = \frac{\text{No. of quadrates in which a species occurred}}{\text{Total number of quadrates studied}}$$

Abundance of a species is determined as the number of individuals per quadrat.

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{No. of quadrates in which the species occurred}}$$

Density is defined as the number of individuals of a species in a unit area and is an expression of the numerical strength of a species in a community. From the sampling data the density was calculated as follows-

$$\frac{\text{Total number of individuals}}{\text{Total number of quadrates studied}}$$

Relative density (RD) is the study of numerical strength of a species in relation to total number of all species and is calculated as

$$\text{Relative Density} = \frac{\text{Number of individuals of species}}{\text{Number of individuals of all species}}$$

RESULTS AND DISCUSSION

There are 6 species of orchids belonging to 5 genera has been located at the study and restricted to only a 10 locations (Figure 1-6). So, all the locations have been covered to study their diversity and composition by plotting 10 quadrates. The recorded Orchids of Horsley Hills with Synonyms, GPS readings of specific collected site and IUCN Status has been documented in Table 1. Q1 and Q7 consist of only a single species and remained as quadrate with least number of species among all the quadrates and the Q8 had all 5 types of species and remained as the quadrate with the highest number of species in it. The location at where Q8 plotted can be considered as orchid species rice region and the orchid growth supporting region of the Horsley Hills. Among all the 6 species present, *Habenaria rariflora* (59) was highest in number and *Bulbophyllum kaitiense* (3) was found to be least in number (Table 2).

F and the RF of species was more for *Vanda tessellate* and lesser for the *Bulbophyllum kaitiense*. *Habenaria rariflora* found to be abundant among all the species. Least abundant species was *Habenaria longicornu* (A=20.00; RA=0.52).

Species density and relative density is higher for *Habenaria rariflora* (A=1060; RA=28.00) and least in the case of *Habenaria longicornu* (A=20.00; RA=0.52) when compared to the other species. As the Species dominance can be studied using Important Value Index, which is a sum of RF, RA and RD indicated that the *Habenaria rariflora* (86.37) is a dominant species among the others following *Vanda tessellata, Diplocentrum recurvum, Habenaria longicornu and Bulbophyllum kaitiense* (Table 3).

Table 1: Orchids of Horsley Hills representing IUCN Status

S.No	Orchid taxa and GPS readings	Synonyms	IUCN Red List Category & Criteria:
1.	*Habenariaro xburghii* Nicolson A: 834 MSL N 16 24 49.5 E 061 19 47.3	*Gymnadenia plantaginea* (Roxb.) Lindl. ex Wall. *Orchis plantaginea* Roxb.	This taxon has not yet been assessed for the IUCN Red List, but is in the Catalogue of Life
2.	*Habenaria rariflora* A.Rich. A: 1120 MSL N 13 48 43.5 E 079 12 54.3	----------	This taxon has not yet been assessed for the IUCN Red List, but is in the Catalogue of Life
3.	*Habenaria longicornu* Lindl. A: 1216 MSL N 15 48 43.5 E 082 13 44.1	*Blephariglottis longicornu* (Lindl.) Raf. *Habenaria decipiens* Wight	Not Evaluated (NE) The IUCN Red List of Threatened Species.
4.	*Diplocentrum recurvum*Lindl. A: 1258 MSL N 13 48 43.5 E 079 12 54.3	*Diplocentrum longifolium* Wight	This taxon has not yet been assessed for the IUCN Red List, and also is not in the Catalogue of Life.
5.	*Vanda tessellata* (Roxb.) Hook. ex G.Don A: 789 MSL N 13 28 43.5 E 066 10 64.1	*Aeridestes sellata* (Roxb.) Wight ex Wall. *Cymbidium tessellatum* (Roxb.) Sw. *Epidendrum tessellatum* Roxb. *Vanda roxburghii* R.Br.	Least Concern ver 3.1
6.	*Bulbophyllum kaitiense* Rchb. f. A: 924 MSL N 13 48 43.5 E 079 12 54.3	*Cirrhopeta lumnilgherrense* Wight; *Phyllorkis kaitiensis* (Rchb.f.) Kuntze	This taxon has not yet been assessed for the IUCN Red List, and also is not in the Catalogue of Life.

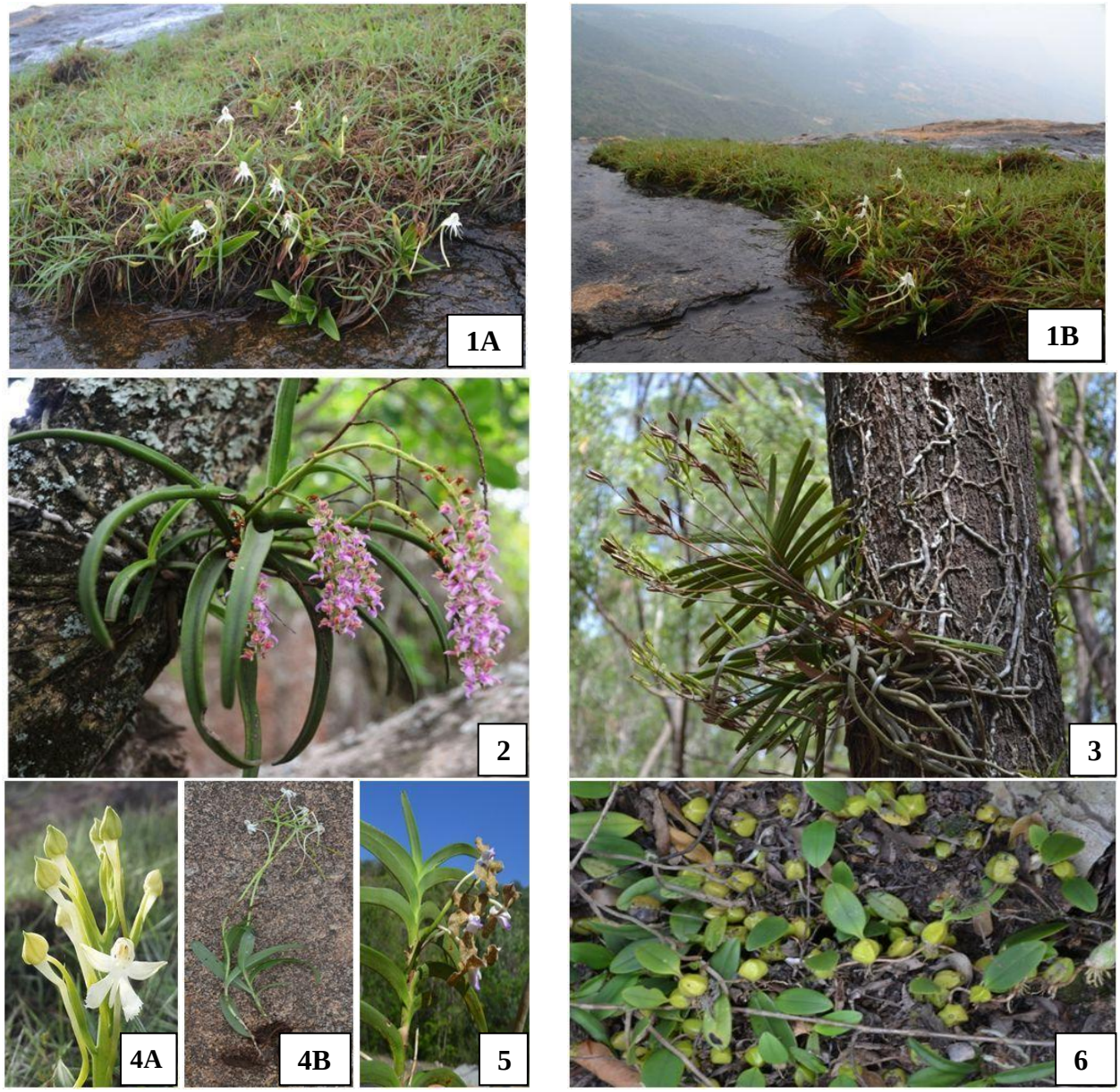


Figure 1 – 6: Orchids of horsley hills. Figure 1: A, B. *Habenaria rariflora* & its habitat; Figure 2: *Diplocentrum recurvum*; Figure 3: *Vanda spathulata*; Figure 4A & 4B: *Habenaria longicornu*; Figure 5: *Vanda tessellata*; Figure 6: *Bulbophyllum kaitiense*

Table 2: Orchid composition, quantitative analysis and distribution of orchid taxa

	Number of the quadrate										Total number
Name of the Sps	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**of sps**
Bulbophyllum kaitiense	4	23	11	0	0	0	0	0	0	0	38
Vanda tessellata	2	7	1	0	0	0	0	0	2	3	15
Habeneria roxburghii	3	2	0	2	0	0	0	0	0	0	7
Habenaria rariflora	0	0	0	0	19	21	13	0	0	0	53
Habenaria longicornu	0	0	0	0	0	0	3	2	2	1	8
Diplocentrum recurvum	0	0	0	0	0	0	0	0	3	16	19
Total	9	32	12	2	19	21	16	2	7	20	140

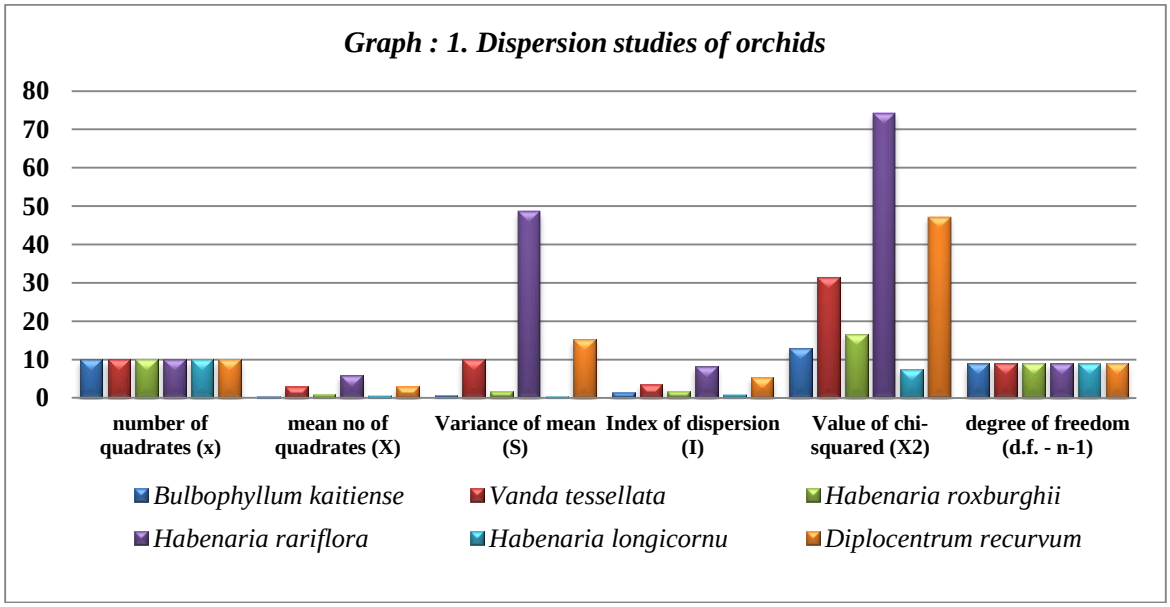
Table 3: Vegetation analysis of Orchids:

Name of the sps	F	RF	A	RA	D	RD	IVI
Bulbophyllum kaitiense	20	7.41	1900	50.19	380	28.57	86.17
Vanda tessellata	60	22.22	250	6.60	150	11.27	40.10
Habeneriaroxburghii	40	14.81	175	4.62	70	5.26	24.70
Habenaria rariflora	50	18.52	1060	28.00	530	39.84	86.37
Habenaria longicornu	50	18.52	20	0.52	10	0.75	19.79
Diplocentrum recurvum	50	18.52	380	10.03	190	14.28	42.84

F= Frequency; RF= Relative Frequency; A=Abundance; RA= Relative Abundance; D=Density; RD=Relative Density; IVI= Important Value Index

Table 4: Dispersion studies of Orchids

Name of the Sps	Number of quadrates (x)	Mean no of quadrates (X)	Variance of mean (S)	Index of dispersion (I)	Value of Chi-Square (X2)	Degree of freedom (d.f. - n-1)
Bulbophyllum kaitiense	10	0.5	0.722	1.444	13	9
Vanda tessellata	10	2.9	10.1	3.483	31.345	9
Habeneria roxburghii	10	0.9	1.656	1.84	16.556	9
Habenaria rariflora	10	5.9	48.544	8.228	74.051	9
Habenaria longicornu	10	0.6	0.489	0.815	7	9
Diplocentrum recurvum	10	2.9	15.211	5.245	47.207	9



Based on the dispersion studies, it was found that the *Habenaria rariflora*is highly distributes species among all the quadrates when compared to the other species present, by having Index of dispersion (I) value as 8.228 and least dispersed species was *Habenaria longicornu* (0.815). Chi square value was also more for the *Habenaria rariflora* (74.051) and least for *Habenaria longicornu* (7) (Table 4)(Graph 1).

Table 5: Beta diversity studies of orchids of Horsley Hills

S. No.	Name	Value
1	Total species	6
2	Mean sps	2.8
3	Whittaker's index	2.143
4	Mean Sorenson's index	0.383
5	Slope log S v/s distance	-0.808

As the Beta diversity is variation in species composition among different sites within a geographical area of interest we have calculated different variables to study the beta diversity of orchids. The beta diversity index, Whittaker's index value was as 2.143 and its relative dissimilarity index, Mean Sorenson's index values was 0.383 (Table 5).

Table 6: Diversity indices of the Orchids

S. No.	Name of the Index	Value
1	Total no of sps (S)	6.00
2	Total no of individuals (N)	137.00
3	Natural log of sps (ln S)	1.79
4	Natural log of individuals (ln N)	4.92
5	Margalef's index (M)	1.02
6	Simpson's index (1/D)	3.54
7	Shannon-Wiener's index (H')	0.00
8	Pielous index (J)	0.81

By using the Diversity indices, species richness and the diversity of orchids has been computed. Marglef's index value indicated richness of species (1.02). Greater the value of the Simson's index indicates greater diversity of species, so based the Simson's index value (3.54) of the present study indicates that the diversity of the orchids is fair in the study area. Shannon-Wienner's index value was "0" which represented only one type in the dataset, as here we have worked on a single type of plant community i.e., Orchids (Equal abundances type). Pielous index value less than 1 indicated the presence of species evenness (0.81) in the study area (Table 6).

Species Dispersion Studies of Orchids of Horsley Hills:

Our investigation revealed that there is a great decrease in the population of orchids at Horsley Hills due to many factors such as less habitat management, illegal removal of endangered or rare wild orchids from their native location. Orchids present at Horsley Hills face an uncertain future through overexploitation, habitat loss and impacts of climate change (Mitta *et al.,* 2015).

With their intricate abiotic and biotic dependencies, these orchids typify the plight of global plant resources and, thus, provide ideal model species for ecological tracking and focussing conservation.

Some orchid populations respond to variation in annual rainfall, with reduced flowering after drought in the same or previous year and was well explained by other researchers (Wells, 1981; Inghe & Tamm, 1988; Wells & Cox, 1991). Typically, terrestrial orchids such as *Bulbophyllum kaitiense, Habenaria roxburghii, H. rariflora, H. longicornu* remain dormant for one or many years and may emerge from dormancy in either a vegetative or flowering state, although only a limited proportion of the plants emerge above ground annually.

Our analysis of diversity studies denote that there is a big threat to this orchid taxa due to the over grazing of sweet smell flavoured flowers, exploitation of humans and expansion of non-local species and their allelopathic effect by their potential biochemicals which payed an impact on the increase in population.

The orchid taxa investigated viz., *Habenaria roxburghii, H. rariflora, H. longicornu, Bulbophyllum kaitiense* has not yet been assessed for the IUCN Red List, but is in the Catalogue of Life. These orchids has suffered decline in subpopulations due to habitat loss and failing in multiply and there is a need for its

diversity Conservation. Managing a landscape for its natural resources while attempting to ensure an ecologically sustainable future is a truly complex and challenging task (Lindenmayer and Cunningham, 2013). Extension programmes by tourism should create an awareness among the tourists and native people regarding the protection of natural ecosystems, biodiversity and nature.

Species richness and composition shown in table 2-4 proved Horsley hill species-rich site are related may have far-reaching conservation implications. At the one extreme, species composition of a species-poor site may be completely different from that of the most. In this case, conservation of the species-poor site should be encouraged as it contains species that are not to be found elsewhere. At the other extreme, species composition of the species-poor sites may be a subset of the species-rich sites (i.e. nestedness or nested subsets). Focus on the most species-rich site may be sufficient to effectively conserve a maximum of species. Species richness is a measure of the number of species found in a sample. mathematical relationships hold true whether one is dealing with species in an ecological community. This ecological community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. Mitta *et al.,* (2015) documented the by Status, conservation strategy and Action Plans of orchids of Horsley hills.

Conclusion

The study revealed that there is no uniform population of a single orchid species adapted to Horsley Hill environment and there has been more at risk in the population if environment and ecological habitat changes occur.

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REFERENCES

Curtis JT and McIntosh RP (1950). The Interrelations of Certain Analytic and Synthetic Phytosociological Characters. *Ecology* **31**(3) 434-455.

Gamble JS and Fischer CES (1928). *Flora of the Presidency of Madras* (Adlard& Son, Limited. London) **3** 1449-1477.

Inghe O and Tamm CO (1988). Survival and flowering of perennial herbs. V. patterns of flowering. *Oikos* **51** 203–219.

Lindenmayer DB and Cunningham SA (2013). Six principles for managing forests as ecologically sustainable ecosystems. *Landscape Ecology* **28** 1099–1110.

Madhava Chetty K, Sivaji K and Tulasi Rao K (2013). *Flowering plants of Chittoor district* (Student offset printers, Tirupati) 337-342.

Mahendranath M, Chetty KM and Prasad K (2015). A re-collection of *Diplocentrum recurvum* lindl (Orchidaceae) after a lapse of 100 years or more from Andhra Pradesh, India. *Journal of Threatened Taxa* **7**(10) 7712–7715.

Miria A, Khan AB and Rao BRP (2012). Orchids of Talakona Sacred Grove, Andhra Pradesh, India *American-Eurasian Journal of Agricultural & Environmental Sciences* **12**(4) 469-471.

Mitta MN, Prasad K, Rao MS and Chetty KM (2015). *Orchids of Horsley Hills: Status and Conservation*, edited by Viswanath B and Indravathi G (Paramount Publishing House, India) 173-177.

Phillips EA (1959). *Methods of Vegetation Study* (Henry Holt, New York, US).

Prasad PRC, Reddy CS and Dutt CBS (2007). Phytodiversity Assessment of Tropical Rainforest of North Andaman Islands, India. *Research Journal of Forestry* **1** 27-39.

Prasad PRC, Reddy CS and Dutt CBS (2007). Phytodiversity Assessment of Tropical Rainforest of North Andaman Islands, India. *Research Journal of Forestry* **1** 27-39.

Reddy CS, Pattanaik C, Murthy MSR and Reddy KN (2006a). Floristic census of orchids of Eastern Ghats, India. *Botanica* **56** 79-96.

Reddy CS, Pattanaik C, Murthy MSR and Reddy KN (2006b). Orchids of Eastern Ghats, India. *EPTRI-ENVIS Newsletter* **11**(4) 6-12.
Reddy KN, Reddy CS and Jadhav SN (2005b). Ethnobotany of certain orchids of Eastern Ghats of Andhra Pradesh. *Indian Forester* **135**(1) 90-94.
Reddy KN, Reddy CS and Raju VS (2005 a). Ethno-orchidology of Eastern Ghats of Andhra Pradesh. EPTRI State of Art Report, Hyderabad, 2005 and EPTRI-ENVIS News letter **11**(3)
Reveal JL and Chase MW (2011). APG III: Bibliographical Information and Synonymy of Magnoliidae. *Phytotaxa* **19** 71–134.
Shannon CE and Weiner W (1949). *The Mathematical Theory of Communication* (University Illinois press, Urbana, Illinois).
Simpson EH (1949). Measurement of diversity. *Nature* **163** 688.
Stirling G and Wilsey B (2001). Empirical Relationships between Species Richness, Evenness, and Proportional Diversity. *The American Naturalist* **158**(3) 286-299.
Swarts ND and Dixon KW (2009). Terrestrial orchid conservation in the age of extinction. *Annals of Botany* **104** 543–556.
Wells TCE and Cox R (1991). Demographic and biological studies of *Ophrys apifera*: some results from a 10 year study. In: *Population Ecology of Terrestrial Orchids*, edited by Wells TCE and Willems JH (SPB Academic Publishing, The Hague) 47–61.