Ambient Science, 2019: Vol. 06(2); 38-42
DOI:10.21276/ambi.2019.06.2.aa01

ambient
SCIENCE
Vol. 06(2):38-42
Year 2019

Published by: National Cave Research and Protection Organization, India

AMBIENT APPRAISAL

Ethnoecology of Different Plant Species in use by Tribal Communities of the Lateritic Region of West Bengal, India

Bindia Gupta*, Tapan Kumar Mishra*

Department of Environmental Science, University of Calcutta, 35, Ballygunge Circular Road, Kolkata 700019, West Bengal, India.

Study Area: Jhargram district, West Bengal, India
Coordinates: 22.4550° N; 86.9974° E

Key words: Local Ecological Knowledge (LEK), ethnoecology, Non-Timber Forest Produce (NTFP), Species Use Value Index, Joint Forest Management (JFM)

Abstract

Though tropical dry forests are less rich in species than tropical rainforests, they continue to be utilized on a large-scale for various purposes and hence the most endangered tropical ecosystems. In this context, the study of interactions between forest fringe people and 40 highly extracted plant species in the dry deciduous forests of Jhargram in Bengal yielded noteworthy results. The overstory species were more exploited by the locals than the understory species in provisions of "food" ($U= 81.5$, $W= 487.5$, $Z= -3.09$, exact $p= 0.009$), "other uses" ($U= 98$, $W= 504$, $Z= -2.72$, exact $p= 0.039$) and "total uses" ($U= 99$, $W= 505$, $Z= -2.11$, exact $p= 0.042$). Women were found to be more knowledgeable than men. There was a moderately strong and highly significant positive correlation between use values and relative frequencies of plant species found in the study area. We recommend more active participation of women in forest management activities, least human interference during natural regeneration to maintain species richness and controlled the exploitation of forest resources in order to ensure their sustainability.

Introduction:

The ethnoecological approach focuses on the understanding of relationships of local human populations with their natural environment by merging both social and ecological data (Prado & Murrieta, 2015). In the present study, we collected information on the knowledge and practices of forest fringe people of the lateritic region of Jhargram district, West Bengal and their interactions with the forest ecosystems.

Jhargram district, located to the west of Paschim Medinipur, West Bengal, India has a diversified topography crisscrossed by rivers Subarnarekha, Kangsabati, and Dulung. The lateritic soil of the studied area with a gentle slope towards the east supports tropical dry deciduous forests. Generally, the climate is very hot and dry except for the monsoon. Winters are cold and short in duration. The mean highest and lowest temperatures recorded in summer are 38°C and 24°C respectively, while in winter the corresponding temperatures are 29°C and 13°C respectively (Misra, 1996). Mean annual precipitation of Jhargram is about 1400 mm. The ethnic communities of Jhargram representing 30-35% of the population include agro-based tribes of Santal, Munda, Bhumij, Kora and hunting tribes of Lodha and Savar (De, 2014).

Our study areas were under Joint Forest Management (JFM) that originated in West Midnapore in the 1970s where the state forest department and local forest fringe communities work together to protect and manage nearby forests. The benefits for them include direct right to use and control over the sale of Non-Timber Forest Produce, income share from timber as well as supporting, regulating and cultural forest ecosystem services. The most important ecological feature that influences vegetation composition of the protected forests of this region is 10 years coppice rotation. Due to its high coppicing property, *Shorea robusta* (Sal) is the dominant tree species with few associates in this region. Based on interactions and discussions with the local people, we had chosen forty locally popular and highly extracted plant species for our ethnoecological study that are enlisted in Table-3. We tested the following three hypotheses:

1. There were significant statistical differences in the distribution of use category scores (construction, food, medicine, other uses and total uses) between the overstory and understory plant species.
2. There was a significant difference in gender-based

**Corresponding Author*: *bindidebi@gmail.com*

Ambient Science, 2019: Vol. 06(2); 38-42
DOI:10.21276/ambi.2019.06.2.aa01

traditional ecological knowledge associated with the chosen species.

3. There was a linear relationship between the two variables, Use Value (UV) and relative frequency of occurrence of plant species as an indicator of the sustainability of plant resources in the wild.

Materials and methods:

Site Selection: as edaphic factors fundamentally describe vegetation composition, site selection for vegetation sampling was based on the principal soil sub-groups by following soil classification (Soil Survey Staff, 1992) of the study area. Since forest areas were managed by Forest Protection Committee (FPC) members, five FPCs were randomly selected from the soil sub-group zones. They were Malabati- N 22°35'51.0" E 87°53'03.2", Ghritakham- N 22°21'41.3" E 87°00'59.2", Dakshinshole-Kendua- N 22°26'22.1" E 86°55'42", Tutuha- N 22°18'45.5" E 87°02'26.0" and Tiyakathi- N 22°25'47.5" E 87°02'03.2".

Ecological analysis: the ecological sampling of vegetation was done using "quadrat method" (Clements, 1904, 1905, 1907; Pound & Clements, 1898, 1900) during April 2017 to December 2018 along with the recording of their GPS locations. Five quadrats of 10m x 10m for trees (minimum size and number were determined from the species-area curve) were laid randomly along a 1 hectare (500m x 20m) belt transect at each site. 5m x 5m quadrat for shrubs and lianas and 1m x 1m quadrat for herbs were nested inside each 10m x 10m quadrat. Trees, shrubs, lianas, and herbs were identified up to the species level using keys to the genera and species (Prain, 1903). Relative frequency of chosen plant species was calculated using data from the late monsoon season.

Data collection for ethnobotanical study and statistical analysis: interviews using semi-structured questionnaires were taken in the study area by selecting a population sample of 102 people (62 males, 40 females) after taking their consent by stratified random sampling involving FPC members, NTFP collectors, traditional healers, and foresters. Out of 102 people interviewed, knowledge of 25 key informants (aged between 45 to 85 years) that included traditional healers and NTFP collectors were considered for calculation of Species Use Value Index (Phillips & Gentry, 1993) of the selected 40 plant species. The basic use categories included "food", "construction", "medicine" and "others" (Hoffman & Gallaher, 2007). Furthermore, following Ticktin & Johns (2002) and Ghimire *et al*. (2004), the traditional knowledge of each individual was quantified by classifying and coding response categories as: i. no knowledge (0) when no uses of plants were documented or all the uses told were incorrect, ii. basic knowledge (1) when correct uses were documented of the plant species and iii. high knowledge (2) when more elaborate information about plant uses was shared. The uses were being verified by traditional healers and also published clinical research. As we intended to compare the distribution of use categories between the two forest strata and Local Ecological Knowledge (LEK) based on the number of plants uses reported between the two genders, non-parametric Mann-Whitney U test was performed with the data. In case of comparing the number of uses between overstory and understory species, the maximum number of users reported in each category was considered. Furthermore, in order to find out the degree of association between the two variables, use value and relative frequency of occurrence of plant species, Pearson's correlation was performed. The software used was SPSS Version 20.

Results & Discussion:

The results of Mann-Whitney U test evaluating our first hypothesis were summarized in Table-1. The over-story species were more exploited by the locals than the understory species in provisions of food ($U= 81.5$, $W= 487.5$, $Z= -3.09$, exact $p= 0.009$), other uses ($U= 98$, $W= 504$, $Z= -2.72$, exact $p= 0.039$) and total uses ($U= 99$, $W= 505$, $Z= -2.11$, exact $p= 0.042$). Other uses included leaf plates, resins, bark tannins, dry branches as firewood, twigs for worship, leaf as a wrapper for local cigar and insecticide, seed oil as an illuminant, oil cake as fertilizer, etc. Some of the overstory species were timber yielding and hence were more used in construction (mean rank= 23.04). Though the understory plant species (mean rank= 22.46) including shrubs, lianas, and herbs were more used for medicinal purposes than the overstory species (mean rank= 15.92) but the difference in use scores between the two groups was not statistically significant.

The assessment of the second hypothesis (Fig.-1) revealed that women (mean rank=72.49) were found to be more knowledgeable than men (mean rank=37.96) and the difference was statistically highly significant ($U=400.5$, $W=2353.5$, $Z= -5.76$, $p<0.00001$). Moreover, concerning the use values of individual species shared by the key informants or specialists (Table 2), a significant difference also existed in mean ranks between the genders in case of 75% of the species. As women are more frequent visitors than men, their participation in grazing activities, firewood, and other NTFP collection is more than that of men.

Lastly, while testing our third hypothesis, it was evident from the regression graph (Fig.-2) that there was a moderately strong and highly significant positive correlation (Pearson's $r = 0.729$, $p <0.000001$) between use values and relative frequencies of plant species found in the study area. With the increase or decrease in the relative subsistence importance of a species, there was an increase or decrease in relative frequency of the species or in other words, with the increase in the essential uses of a plant, there was a greater chance of that species to be conserved by the local people in the study area. Most of the herbs, shrubs, and lianas had lower use values and lower frequencies and hence formed a more or less distinct cluster near the origin of the graph. In selective cases like *Shorea robusta*, *Madhuca longifolia*, *Combretum decandrum*, *Zizyphus nummularia* and *Rivea hypoctrateriformis*, use values and relative frequencies were comparatively higher than the others and hence they were away from the cluster. Thus the sustainable availability of a plant species was fairly determined by its subsistence importance in the lives of the local communities.

Table 1. Summary of Mann-Whitney U test comparing the distribution of use category scores: overstory and understory species in Jhargram

Use Categories	Forest strata	N	Mean Rank	Sum of Ranks
Construction	Overstory	12	23.04	276.5
	Understory	28	19.41	543.5
Food	Overstory	12	27.71	332.5
	Understory	28	17.41	487.5
Medicine	Overstory	12	15.92	191
	Understory	28	22.46	629
Others	Overstory	12	26.33	316
	Understory	28	18	504
Total uses	Overstory	12	26.25	315
	Understory	28	18.04	505

Test Statistics

Use Categories	Mann-Whitney U	Wilcoxon W	Z	Exact Sig*
Construction	137.5	543.5	-1.57	0.373
Food	81.5	487.5	-3.09	0.009
Medicine	113	191	-1.68	0.108
Others	98	504	-2.72	0.039
Total uses (all categories)	99	505	-2.11	0.042

Table-2: Comparison of traditional knowledge based on species use values shared by the two genders (M-Male; F-Female) among key informants (N=25) by for 40 plant species in Jhargram

Species Use Values	Gender	N	Mean R	Sum R
Shorea robusta	M	15	8.9	133.5
	F	10	19.15	191.5
Madhuca longifolia	M	15	9.87	148
	F	10	17.7	177
Diospyros melanoxylon	M	15	10.07	151
	F	10	17.4	174
Terminalia bellerica	M	15	9.7	145.5
	F	10	17.95	179.5
Semecarpus anacardium	M	15	10.57	158.5
	F	10	16.65	166.5
Cleistanthus collinus	M	15	11.9	178.5
	F	10	14.65	146.5
Bombax ceiba	M	15	11.37	170.5
	F	10	15.45	154.5
Syzygium cumini	M	15	10.9	163.5
	F	10	16.15	161.5
Terminalia tomentosa	M	15	8.67	130
	F	10	19.5	195
Lannea coromondalica	M	15	8.27	124
	F	10	20.1	201
Adina cordifolia	M	15	9.23	138.5
	F	10	18.65	186.5
Buchanania lanzan	M	15	10.13	152
	F	10	17.3	173
Clerodendrum indicum	M	15	9.07	136
	F	10	18.9	189
Zizyphus oenoplia	M	15	10.13	152
	F	10	17.3	173
Zizyphus nummularia	M	15	11.27	169
	F	10	15.6	156
Hemisdesmus indicus	M	15	9.73	146
	F	10	17.9	179
Smilax ovalifolia	M	15	11	165
	F	10	16	160
Combretum decandrum	M	15	9	135
	F	10	19	190
Dioscorea alata	M	15	10.3	154.5
	F	10	17.05	170.5
Ichnocarpus frutescens	M	15	9.27	139
	F	10	18.6	186
Rivea hypoctrateriformis	M	15	9.23	138.5
	F	10	18.65	186.5
Jatropha gossypifolia	M	15	9.6	144
	F	10	18.1	181
Butea superba	M	15	12.17	182.5
	F	10	14.25	142.5
Cissus adnata	M	15	10.27	154
	F	10	17.1	171
Acacia pennata	M	15	9.1	136.5
	F	10	18.85	188.5
Dioscorea bulbifera	M	15	11.03	165.5
	F	10	15.95	159.5
Asparagus racemosus	M	15	8.87	133
	F	10	19.2	192
Asparagus adscendens	M	15	8.97	155.5
	F	10	19.05	190.5
Curculigo orchioides	M	15	10.33	155
	F	10	17	170
Mimosa pudica	M	15	10.8	162
	F	10	16.3	163
Aristolochia indica	M	15	9.47	142
	F	10	18.3	183
Leea macrophylla	M	15	12.3	184.5
	F	10	14.05	140.5
Andrographis paniculata	M	15	8.3	124.5
	F	10	20.05	200.5
Cynodon dactylon	M	15	9.97	149.5
	F	10	17.55	175.5
Atylosia scarabaeoides	M	15	8.43	126.5
	F	10	19.85	198.5
Sida cordifolia	M	15	10.77	161.5
	F	10	16.35	163.5
Desmodium motorium	M	15	9.7	145.5
	F	10	17.95	179.5
Rungia pectinata	M	15	9	136.5
	F	10	18.85	188.5
Elephantopus scaber	M	15	8.8	132
	F	10	19.3	193
Ampelocissus latifolia	M	15	9.6	144
	F	10	18.1	181

Test Statistics Species Use Values	Mann-Whitney	Wilcoxon W	Z	Exact Sig.
Shorea robusta	13.5	133.5	-3.49	0.002
Madhuca longifolia	28	148	-2.78	0.008
Diospyros melanoxylon	31	151	-2.62	0.026
Terminalia bellerica	25.5	145.5	-2.84	0.004

Ambient Science, 2019: Vol. 06(2); 38-42
DOI:10.21276/ambi.2019.06.2.aa01

Semecarpus anacardium	38.5	158.5	-2.08	0.041
Cleistanthus collinus	58.5	178.5	-1.62	0.367
Bombax ceiba	50.5	170.5	-1.53	0.177
Syzygium cumini	43.5	163.5	-1.98	0.08
Terminalia tomentosa	10	130	-4.16	0.00008
Lannea coromondalica	4	124	-4.04	0.000007
Adina cordifolia	18.5	138.5	-3.61	0.001
Buchanania lanzan	32	152	-2.49	0.016
Clerodendrum indicum	16	136	-3.66	0.001
Zizyphus oenoplia	32	152	-2.82	0.016
Zizyphus nummularia	49	169	-1.76	0.16
Hemisdesmus indicus	26	146	-2.96	0.005
Smilax ovalifolia	45	165	-2.23	0.103
Combretum decandrum	15	135	-3.43	0.0004
Dioscorea alata	34.5	154.5	-2.59	0.023
Ichnocarpus frutescens	19	139	-3.34	0.001
Rivea hypoctrateriformis	18.5	138.5	-3.68	0.001
Jatropha gossypifolia	24	144	-3.2	0.004
Butea superba	62.5	182.5	-0.81	0.495
Cissus adnata	34	154	-2.57	0.023
Acacia pennata	16.5	136.5	-3.61	0.001
Dioscorea bulbifera	45.5	165.5	-2.08	0.103
Asparagus racemosus	13	133	-3.92	0.0002
Asparagus adscendens	14.5	134.5	-3.77	0.0003
Curculigo orchioides	35	155	-2.98	0.026
Mimosa pudica	42	162	-2.45	0.071
Aristolochia indica	22	142	-3.26	0.002
Leea macrophylla	64.5	184.5	-0.71	0.567
Andrographis paniculata	4.5	124.5	-4.15	0.000007
Cynodon dactylon	29.5	149.5	-2.71	0.01
Atylosia scarabaeoides	6.5	126.5	-4.31	0.000018
Sida cordifolia	41.5	161.5	-2.14	0.062
Desmodium motorium	25.5	145.5	-3.08	0.004
Rungia pectinata	16.5	136.5	-3.57	0.001
Elephantopus scaber	12	132	-3.79	0.00016
Ampelocissus latifolia	35.5	155.5	-2.48	0.026

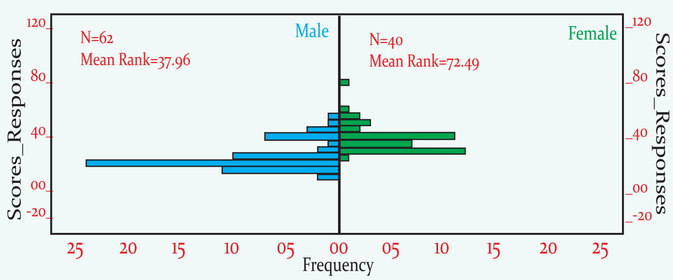

Figure-1: Bars representing the results of statistical analysis of LEK in terms of mean ranks between the two genders in Jhargram.

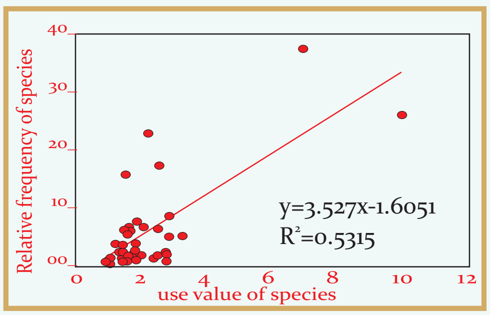

Figure-2: Relationship between Use Value and Relative Frequency of occurrence of plant species in Jhargram .

Table 3. A brief description of 40 plant species used by the tribals in the study area

Scientific name	(Common name)	Type	Family	UV-I	Part Used
Shorea robusta Roxb.ex Gaertn.f	(Sal)	Tree	Dipterocarpaceae	6.88	Whole plant
Madhuca longifolia J.F. Macbr.	(Mahua)	Tree	Sapotaceae	9.92	Whole plant
Diospyros melanoxylon Roxb.	(Kend)	Tree	Ebenaceae	2.78	Leaves, fruits, seeds
Terminalia bellirica (Gaertn.) Roxb.	(Bohera)	Tree	Combretaceae	2.48	Fruits, seeds, gum
Semecarpus anacardium Linn.	(Bhela)	Tree	Anacardiaecae	2.72	Fruits, seeds, dry branch
Cleisthanthus collinus(Roxb.) Benth & Hook. f.	(Parashi)	Tree	Euphorbiaceae	0.94	Leaves, bark
Bombax ceiba L.	(Shimul)	Tree	Malvaceae	2.32	Roots, pods, resin
Syzygium cumini (L.) Skeels.	(Jam)	Tree	Myrtaceae	1.72	Fruits, seeds, bark, roots
Terminalia tomentosa Linn.	(Asan)	Tree	Combretaceae	1.48	Timber, bark
Lannea coromondalica (Houtt.) Merr.	(Doka)	Tree	Anacardiaecae	2.68	Bark, stem, leaves
Adina cordifolia (Roxb.) Brandis.	(Chakalta)	Tree	Rubiaceae	1.36	Bark
Buchanania lanzan Spreng.	(Piyal)	Tree	Anacardiaecae	2.02	Fruits, seeds, leaves, bark
Clerodendrum indicum (Linn.)O. Kuntze	(Ghentu)	Shrub	Verbenaceae	1.44	Whole plant
Zizyphus oenoplia Mill.	(Bhuikul)	Shrub	Rhamnaceae	2.16	Leaves,fruits
Zizyphus nummularia (Burm. f.) Wight. & Arn.	(Shiakul)	Shrub	Rhamnaceae	1.8	Roots,fruits
Hemisdesmus indicus R.Br.	(Anantamul)	Shrub	Asclepiadaceae	3.2	Roots
Smilax ovalifolia Roxb.	(Ramdatan)	Liana	Smilacaceae	0.88	Roots
Combretum decandrum Jacq.	(Antarilata)	Liana	Combretaceae	2.48	Whole plant
Dioscorea alata Linn.	(Kham alu)	Herb	Dioscoreaceae	1.52	Root tubers
Ichnocarpus frutescens R. Br.	(Shyamlata)	Liana	Apocynaceae	2.44	Whole plant
Rivea hypoctrateriformis Choisy.	(Banpui)	Shrub	Convolvulaceae	1.48	Leaves, roots
Jatropha gossypifolia Linn.	(Lal verenda)	Shrub	Euphorbiaceae	1.76	Leaves, latex
Butea superba Roxb.	(Latpalash)	Liana	Fabaceae	1.92	Leaves, seeds, gum
Cissus adnata Roxb.	(Panialata)	Liana	Vitaceae	1.6	Tubers, roots
Acacia pennata Willd.	(Kirikitikanta)	Shrub	Mimosaceae	1.4	Leaves,bark
Dioscorea bulbifera Linn.	(Ban alu)	Herb	Dioscoreaceae	1.36	Root tubers
Asparagus racemosus Willd.	(Satamul)	Shrub	Asparagaceae	1.36	Roots
Asparagus adscendens Roxb.	(Maha satabari)	Shrub	Asparagaceae	1.56	Root tubers

●*Cuculigo orchioides* Gaertn.	(Talmuli)	Herb	Amaryllidaceae	1.16	Roots
●*Mimosa pudica* Linn.	(Lajjabati)	Herb	Mimosaceae	1	Roots
●*Aristolochia india* Linn.	(Iswarmul)	Herb	Aristolochiaceae	1.38	Roots
●*Leea macrophylla* Roxb. Ex Hornem.	(Hatikan)	Herb	Vitaceae	1	Roots
●*Andrographis paniculata* (Burm. f.) Wall. Ex Nees	(Kalmegh)	Herb	Acanthaceae	2.8	Whole plant
●*Cynodon dactylon* (L.) Pers.	(Durbaghash)	Herb	Poaceae	2.72	Whole plant
●*Atylosia scarabaeoides* Benth.	(Ban kurti)	Herb	Fabaceae	1.28	Whole plant
●*Sida cordifolia* Linn.	(Berela)	Shrub	Malvaceae	1.36	Leaves, roots
●*Desmodium motorium* (Houtt.) Merr.	(Ban chandal)	Shrub	Fabaceae	1.56	Whole plant
●*Rungia pectinata* (Linn.)	(Nees Chhotosibjata)	Herb	Acanthaceae	1.64	Whole plant
●*Elephantopus scaber* Linn.	(Deshigajban)	Herb	Asteraceae	1.76	Whole plant
●*Ampelocissus latifolia* (Roxb.) Planch.	(Kumarlata)	Herb	Vitaceae	1.76	Leaves, roots

Conclusion:

The study undoubtedly proved the dependence of locals on the forests of Jhargram for the provisions of food, medicine, building materials, and others. Since the use of overstory plant species for food, other purposes, and total uses was greater than that of understory species and the finding was statistically significant, hence the first research hypothesis was partially retained. As both overstory and understory plant species make up the forest structure, more active community-based conservation is essential for sustainable availability and use of such resources. We recommend the least human interference in the natural regeneration of the forest in order to maintain its phyto-diversity. Also, women were richer in local ecological knowledge than men thus establishing our second hypothesis. But inspite of women's greater knowledge about forest ecosystem and involvement in forest activities, their participation in community associations for JFM in Bengal was not satisfactory (Sarker & Das, 2002). It is, therefore, the liability of the JFM Executive Committee (JFMC) members to moralize more women members towards forest conservation and management activities. Our third hypothesis was also accepted as there was a linear statistically significant relationship between use values and relative frequencies of plant species indicating the fact that the exploitable plants had greater probabilities of being conserved by the forest fringe people. Hence any operation of unsustainable extraction by private agencies should be thoroughly monitored and checked by the joint effort of foresters and JFMC members in order to maintain the forest ecosystem in good health.

Acknowledgements:

The researchers convey thanks to the official staff of West Bengal Forest Department, Government of West Bengal and local villagers for their cooperation and willingness to share their knowledge during field studies. The researchers are also thankful to the reviewers for their constructive comments for the betterment of the manuscript..

References:

Clements, F.E. (1904): **The Development and Structure of Vegetation**. Pub. by: Botanical survey of Nebraska. P. 175.

Clements, F.E. (1905): **Research Methods in Ecology**. Pub. by: Lincoln, Nebraska: The University publishing company. P. 366

Clements, F.E. (1907): **Plant Physiology and Ecology**. Pub. by: Henry Holt and company, New York. P. 348.

De R. (2014): An ethnozoological study on the tribes of Jhargram. Sci. Cul.,80 (7–8); 229-231 (ISSN 0036-8156)

Ghimire, S.K., McKey, D. & Aumeeruddy-Thomas, Y. (2004): Heterogeneity in ethnoecological knowledge and management of medicinal plants in the Himalayas of Nepal: implications for conservation. Ecol. Soc., 9(3): art-6.

Hoffman, B. & Gallaher, T. (2007): Importance Indices in Ethnobotany. Ethnobot. Res. Appl., 5:201-218.

Janzen, D.H. (1988): Tropical Dry Forests The Most Endangered Major Tropical Ecosystem, 130-137 pp. In, Wilson, E.O. & Peter, F.M. (eds.) **Biodiversity**. Pub. by: National Academies Press (US), Washington (DC)

Misra, S.N. (1996): **Forests of Midnapore. Centernary. Kolkata-1**. Pub. by: Forest Directorate, Govt. of West Bengal.

Phillips, O. & Gentry. A.H. (1993): The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Econ. Bot., 47(1):15-32.

Pound R & Clements FE (1898): A method of determining the abundance of secondary species. Minnesota Bot. Stud., 2: 19-24.

Pound, R. & Clements, F.E. (1900). The Phytogeography of Nebraska. Papers in System. Biol. Div., 18:53-55.

Prado, H.M. & Murrieta R.S.S. (2015): Ethnoecology in perspective: the origins, interfaces and current trends of a growing field. Ambiente & Soc., 18(4):139-160.

Prain, D. (1903). **Bengal Plants (Vol. 1& Vol.2). Calcutta, India,** 663:664-1319. Pub. by: West, Newman & Co. Hatton Garden. London. 1-

Sarker, D. & Das, N. (2002): Women's Participation in Forestry: Some Theoretical Issues. Eco. Pol. Week., 37(43):4407-4412.

Soil Survey Staff (1992): **Soils of West Bengal for Optimising land use. NBSS Publ. 27b (Soils of India Series 1)**. Pub. by: National Bureau of Soil Survey and Land Use Planning, Nagpur (India). 48pp.+4 sheet soil map.

Ticktin, T. & Johns, T. (2002): Chinanteco management of Aechmea magdalenae: implications for the use of TEK and TRM in management plans. Eco. Bot., 56(2):117–191.