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Research article

Floristic composition, life-forms and biological spectrum of tropical dry deciduous forest in Sagar District, Madhya Pradesh, India

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Abstract: Floristic studies were conducted in Baraytha forest. A total of 82 species belonging to 72 genera and 33 families of angiosperm were recorded during the sampling of vegetation. Based on species contribution Fabaceae, Asteraceae, Rubiaceae, Combretaceae, Malvaceae, Mimosaceae and Euphorbiaceae were found as dominant families. Life-forms in order of importance were Phanerophytes (55%), Therophytes (32.5%), Chamaephytes (6.25%), Geophytes (3.75%), Hemicryptophytes and Epiphytes both (1.25%). The dominance of phanerophytes and therophytes reveals that phytoclimate of the area as phanero-therophytic.

Keywords: Floristic composition - Life-forms - Biological spectrum - Phytoclimate.

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INTRODUCTION

Floristic richness of an area gives the design and functioning of the natural communities and also adds to complete understanding of the pattern and process of their structure. The floristic richness of an area depends upon the type, quality and stratification of its vegetation Whittaker (1972). Quantitative floristic inventories of forest ecosystems provides necessary context for understanding, planning and interppreting long-term ecological research (Phillips *et al*. 2003, Baithalu *et al*. 2013). The information resulting from forest inventories not only provides data on the floristic composition and abundance of individual species, but also on detailed structural attributes of the vegetation (Palomino & Alvarez 2009). The information also serves as an invaluable research base for diverse aspects of tropical ecology while providing information crucial for their conservation and management (Ayyappan & Parthasarthy 1999).

Raunkier (1934) defined the life-forms as the sum of adaptions of plants to climate and Raunkier's system of classification of life-forms is the most widely accepted one and has been universally followed. The ratio of life-forms of different species in term of number or percentage in any floristic community is called Biological spectrum or the spectrum of life-forms (Milne & Milne 1971), which can be used to indicate the stratification and layering pattern of the community (Rao 1968, Krebs 1994), to indicate the prevailling environment (Kotiwar *et al*. 1996), its aridity or humidity (Meher-Homji 1964), to monitor the impact of ambient stress factors on climate (Palit *et al*. 2002), and to determine the nature of bioclimate or phytoclimate (Malik *et al*. 2006).

Several workers have studied floristic composition and biological spectrum of different regions in India (Meher-Homji 1964, 1981, Pandey & Parmar 1993, Sharman & Dhakre 1993, Singh & Arora 1994, Reddy *et al*. 1999, 2002, Rana *et al*. 2002, Thakur 2003, Jamir *et al*. 2006, Shukla & Mishra 2006, Patel *et al*. 2010, Pharswan *et al*. 2010, Thakur & Khare 2011, Reddy *et al*. 2011, Bajpai *et al*. 2012, Desai & Ant 2012, Thakur *et al*. 2012a, Thakur *et al*. 2012b, Sindhuja *et al*. 2012, Vediya & Kharadi 2012, Sarkar & Devi 2014, Ashwini *et al*. 2014, Radha 2014, Chauhan *et al*. 2014, Kargjam 2014, Kensa & Pramila 2014, Sharma *et al*. 2014, Mohammad & Joshi 2015 and Sundarapandian & Subbiah 2015).

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MATERIALS AND METHODS

The present study was conducted in Baraytha located 62 Km in north of Sagar. It lies at 24°17'N latitude and 78°56' E longitude. Altitude ranges from 400 to 425 meter and highest peak is 455 meters. On the basis of rock formations and their characteristics, the site subdivided into four sub sites. i. Sandstone quartzite ii. Bijawar sedimentary iii. Bundelkhand granite and iv. Banded iron formation. The area enjoys a typical monsoonic climate with three well recognized seasons *viz*.-rainy, winter and summer. Average annual rainfall is about 1200 mm, chiefly received during the rainy season from the month of late June to early September. Winter rains are of common occurrence. Summer season is from March to mid-June and very hot with maximum temperature of 45°C. Winter season is pleasant and dry with mean minimum temperature of 12.5°C.

Forest communities were analysed by selecting uniform stands at study sites. Specimen of all species occurring in these plots belonging to trees, shrubs, herbs, climbers and epiphytes were collected and identified. These species provided a general floristic view of the vegetation. However, the collections are underestimate the floristics as the species occurring outside the sample plots were not considered. The generic coefficient of flora was calculated according to Jacord (1912). Biological spectrum was prepared on the basis of percentage species composition in each life-form following Raunkier (1934) and Muller-Dombois & Ellenberg (1974).

RESULTS AND DISCUSSION

Table 1. Habit classification and life forms of plants observed at Baraytha forest.

S. No.	Name of plant species	Family	Habit	Life form	Sub-sites				Baraytha forest
					I	II	III	IV	
1	*Acacia catechu* (L. f.) Willd.	Mimosaceae	Tree	Ph			+		+
2	*Acacia leucophloea* Willd.	Mimosaceae	Tree	Ph			+		+
3	*Achyrathes aspera* Linn.	Amranthaceae	Herb	Th		+		+	+
4	*Adina cordifolia* Hook. f.	Rubiaceae	Tree	Ph	+	+		+	+
5	*Aegle marmelos* Correa.	Rutaceae	Tree	Ph	+	+	+	+	+
6	*Ageratum conyzoides* Linn.	Asteraceae	Herb	Th	+	+			+
7	*Albizia lebbek* Benth.	Mimosaceae	Tree	Ph	+				+
8	*Albizia odoratissima* (L. f.) Benth.	Mimosaceae	Tree	Ph			+		+
9	*Alysicarpus monilifer* DC.	Fabaceae	Herb	Th	+	+	+	+	+
10	*Anogeissus latifolia* (Roxb. ex DC) Wall.	Combretaceae	Tree	Ph	+	+	+		+
11	*Anogeissus pendula* Edgew.	Combretaceae	Tree/Shrub	Ph		+	+		+
12	*Barleria prionitis* Linn.	Acanthaceae	Herb	Ch	+				+
13	*Bidens biternata* (Lour.) Merr. & Sherff.	Asteraceae	Herb	Ch	+			+	+
14	*Biophytum sensitivum* DC.	Geraniaceae	Herb	Th		+	+	+	+
15	*Blepharis boerhaaviaefolia* Pers.	Acanthaceae	Herb	Ch	+				+
16	*Boerhaavia diffusa* Linn.	Nyctaginaceae	Herb	G		+			+
17	*Borreria stricta* Linn. F.	Rubiaceae	Herb	Th	+	+	+	+	+
18	*Boswellia serrata* Roxb. ex Colebr.	Burseraceae	Tree	Ph	+				+
19	*Bridelia retusa* (L.) Spreng.	Euphorbiaceae	Tree	Ph	+		+		+
20	*Buchanania lanzan* Spreng.	Anacardiaceae	Tree	Ph	+			+	+
21	*Butea monosperma* (Lamk.) Taub.	Fabaceae	Tree	Ph		+	+		+
22	*Carissa spinarum* Linn.	Apocynaceae	Shrub	Ph		+	+	+	+
23	*Casearia graveolens* Dal.	Bixaceae	Tree	Ph				+	+
24	*Cassia fistula* Linn.	Caesalpiniaceae	Tree	Ph	+	+	+	+	+
25	*Cassia pumila* Lamk.	Caesalpiniaceae	Herb	Th	+	+			+
26	*Cassia tora* Linn.	Caesalpiniaceae	Herb	Th	+	+	+		+
27	*Celosia argentea* Linn.	Amaranthaceae	Herb	Th				+	+
28	*Corchorus actangulus* Lam.	Tiliaceae	Herb	Th	+	+	+	+	+
29	*Cordia vestita* Hook. f. & Thoms.	Boraginaceae	Tree	Ph	+				+
30	*Crotalaria prostrata* Roxb.	Fabaceae	Herb	Th	+				+
31	*Desmodium gangeticum* DC.	Fabaceae	Herb	Ch	+				+
32	*Desmodium triflorum* DC.	Fabaceae	Herb	Th	+	+	+	+	+
33	*Diospyros melanoxylon* Roxb.	Ebenaceae	Tree	Ph	+	+	+	+	+
34	*Ehretia laevis* Roxb.	Boraginaceae	Tree	Ph	+				+
35	*Elaeodendron glaucum* Pers.	Celastraceae	Tree	Ph	+	+	+		+
36	*Elephantopus scaber* Linn.	Asteraceae	Herb	G	+	+	+	+	+
37	*Eragrostis pilosa*	Poaceae	Herb (Grass)	Th	+	+	+		+
38	*Erythrinia variegata* L.	Fabaceae	Tree	Ph	+				+

S. No.	Name of plant species	Family	Habit	Life form	Sub-sites				Baraytha forest
					I	II	III	IV	
39	*Euphorbia hirta* Linn.	Euphorbiaceae	Herb	Th	+	+	+	+	+
40	*Flacourtia indica* (Burm. F.) Merr.	Bixaceae	Tree	Ph	+	+	+	+	+
41	*Gardenia latifolia* Aiton.	Rubiaceae	Tree	Ph	+	+	+	+	+
42	*Helicteres isora* Linn.	Sterculiaceae	Shrub	Ph	+				+
43	*Hemidesmus indicus* (Linn.) Schultz	Asclepiadaceae	Climber	Ph					+
44	*Hibiscus solandra* L. Herist.	Malvaceae	Herb	Th	+	+	+	+	+
45	*Holarrhena antidysentrica* Wall.	Apocynaceae	Shrub	Ph	+		+	+	+
46	*Ipomaea coccinea* Linn.	Convolvulaceae	Climber	G					+
47	*Iseilema anthephoroides* Hack.	Poaceae	Herb (Grass)	H	+				+
48	*Justicia simplex* Don.	Acanthaceae	Herb	Th	+	+	+	+	+
49	*Kydia calycina* Roxb.	Malvaceae	Tree	Ph	+				+
50	*Lagascea mollis* Cav.	Asteraceae	Herb	Th		+	+	+	+
51	*Lagerstroemia parviflora* Roxb.	Lythraceae	Tree	Ph	+	+	+	+	+
52	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Tree	Ph	+	+	+	+	+
53	*Lantana camara* Linn.	Verbenaceae	Shrub	Ph		+	+	+	+
54	*Loranthus longiflorus* Desr.	Proteaceae	Epiphyte	E					+
55	*Madhuca indica* Gmel.	Sapotaceae	Tree	Ph	+			+	+
56	*Malvastrum tricuspidatum* A. Grey.	Malvaceae	Herb	Th	+				+
57	*Miliusa tomentosa* (Roxb.) J. Sinclair.	Annonaceae	Tree	Ph	+			+	+
58	*Mitragyna parvifolia* (Roxb.) Korth.	Rubiaceae	Tree	Ph	+	+			+
59	*Mitreola oldenlandioidea* Wall.	Loganiaceae	Herb	Th	+	+	+		+
60	*Ophlismemus burmannii* (Retz.) P. Beauv.	Poaceae	Herb (Grass)	Th	+	+	+	+	+
61	*Ougeinia oojeinensis* (Roxb.) Hochr.	Fabaceae	Tree	Ph	+				+
62	*Phyllanthus debilis* Ham.	Euphorbiaceae	Herb	Th	+	+	+		+
63	*Phyllanthus urinaria* Linn.	Euphorbiaceae	Herb	Th	+	+	+	+	+
64	*Randia spinosa* (Thumb.) Keay.	Rubiaceae	Shrub	Ph	+	+	+		+
65	*Schleichera oleosa* (Lour.) Oken.	Sapindaceae	Tree	Ph		+	+	+	+
66	*Sida spinosa* Linn.	Malvaceae	Herb	Th	+	+	+	+	+
67	*Sida veronicaefolia* Lamk.	Malvaceae	Herb	Ch	+	+	+	+	+
68	*Sporobolus diander* (Retz.) P. Beauv.	Poaceae	Herb (Grass)	Th	+	+	+	+	+
69	*Tectona grandis* Linn.	Verbenaceae	Tree	Ph	+	+	+	+	+
70	*Terminalia arjuna* W. & A.	Combretaceae	Tree	Ph			+		+
71	*Terminalia belerica* (Gaearth.) Roxb.	Combretaceae	Tree	Ph	+	+	+		+
72	*Terminalia tomentosa* (DC.) W.& A.	Combretaceae	Tree	Ph	+		+	+	+
73	*Tridax procumbens* Linn.	Asteraceae	Herb	Th	+	+	+	+	+
74	*Ventilago maderaspatana* Gaerth.	Rhamnaceae	Climber	Ph					+
75	*Vernonia cinerea* Linn.	Asteraceae	Herb	Th	+		+	+	+
76	*Wendlandia puberula* DC.	Rubiaceae	Tree	Ph	+				+
77	*Xanthium strumarium* Linn.	Asteraceae	Herb	Th		+			+
78	*Xylia xylocarpa* (Roxb.) Taub.	Fabaceae	Tree	Ph			+		+
79	*Zizyphus oenoplia* Mill.	Rhamnaceae	Shrub	Ph	+	+	+	+	+
80	*Zizyphus xylopyrus* Willd.	Rhamnaceae	Tree/Shrub	Ph	+				+

Note: + = Presence, Ph = Phanerophyte, Ch = Chamaephyte, H = Hemicryptophyte, G = Geophyte, Th = Therophyte, E = Epiphyte

A total of 82 species belonging to 72 genera and 33 families of angiosperm were encountered during the sampling of vegetation (Table 1). Out of these total 36 tree species belongs to 31 genera; 08 shrubs species to 07 genera and 34 herbs species to 30 genera. Three climbers and one of epiphyte species also recorded. The number of herb species is less than expected it is due to that only those species included in sampling that fell within the sampling unit and sampling was done after the rainy season when dry period began. The dicotyledons comprise 32 families 68 genera and 78 species and monocotyledons comprise 01 family 04 genera and 04 species. Out of the total 82 species dicotyledons represents 96.96% and monocotyledons 03.03%. The ratio of monocotyledons to dicotyledons family, genera and species were 1:03, 1:05 and 1:05 respectively (Table 2). Out of total 33 families of angiosperms in study area, the dominant families were Fabaceae (08species), Asteraceae (07), Rubiaceae (06), Combretaceae (05), Malvaceae (05), Mimosaceae (04) and Euphorbiaceae (04) accounted for 39 (47.56%) species and 31 (43.05%) genera. Among the total families 17 families were monogeneric (Table 3).

Table 2. Comparative account of floristic composition of Baraytha forest.

Category	Dicotyledons		Monocotyledons		Monocots to dicots Ratio	Dicots to Monocots (%)	Total
	Number	%	Number	%			
Family	32	96.96	01	3.03	1:03	96.96	33
Genera	68	94.44	04	5.55	1:05	94.44	72
Species	78	95.12	04	4.87	1:05	95.12	82

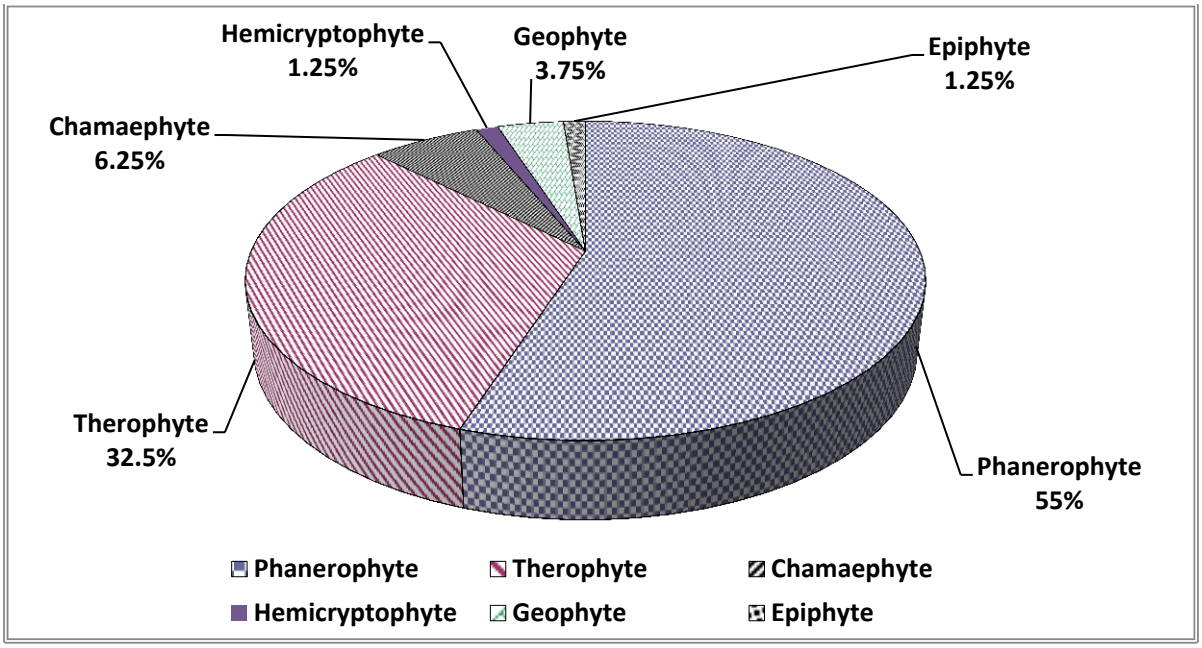

Figure 1. Biological spectrum of Baraytha forest.

Table 3. Arrangement of taxa of Baraytha forest.

S.No.	Family	Genera	Species	S.No.	Family	Genera	Species
Dicotyledons				17	Annonaceae	01	01
1	Fabaceae	07	08	18	Asclepidaceae	01	01
2	Asteraceae	07	07	19	Burseraceae	01	01
3	Rubiaceae	06	06	20	Celastraceae	01	01
4	Malvaceae	04	05	21	Ebenaceae	01	01
5	Euphorbiaceae	03	04	22	Geraniaceae	01	01
6	Acanthaceae	03	03	23	Convolvulaceae	01	01
7	Combretaceae	02	05	24	Loganiaceae	01	01
8	Mimosaceae	02	04	25	Lythraceae	01	01
9	Rhamnaceae	02	03	26	Nyctaginaceae	01	01
10	Anacardiaceae	02	02	27	Proteaceae	01	01
11	Amaranthaceae	02	02	28	Rutaceae	01	01
12	Apocynaceae	02	02	29	Sapindaceae	01	01
13	Bixaceae	02	02	30	Sapotaceae	01	01
14	Boraginaceae	02	02	31	Sterculiaceae	01	01
15	Verbenaceae	02	02	32	Tiliaceae	01	01
16	Caesalpiniaceae	01	03	**Monocotyledons**			
				33	Poaceae	04	04

Present study area falls in a comparatively drier climate and most of the species shed their foliage during the winter season, render these forests naked. Comparative analysis of floristic composition with other studies done in Central India (Prasad & Pandey 1992, Thakur & Khare 2009) envisaged that in this region floristic composition is poor. On the whole, it appears that long dry spell is perhaps the one of the major reason for the poor floristic structure.

Generic coefficient as 87.80% was determined for the vegetation of Baraytha forest. On the basis of high percentage of generic coefficient, it can be inferred more intergeneric competitions exist in the area.

The vegetation of Baraytha forest showed highest percentage of Phanerophytes (55%), other groups of Life-forms in order of importance were Therophytes (32.5%), Chamaephytes (6.25%), Geophytes (3.75%), Hemicryptophytes and Epiphytes both (1.25%) (Table 1 & Fig. 1). The Phanerophytes and Therophytes together constitute 87.5% of the life-forms proportion. Phanerophytes showed maximum divergence from the normal spectrum as given by Raunkier, accordingly the phytoclimate of the area may be termed as phanero-therophytic. Similar phytoclimatic association has also been reported by other workers (Rajendraprasad *et al*. 1998, Lakshmanan 1962, Misra *et al*. 1979, Saxena 1980, Saxena *et al*. 1982, Khatri 2000, Thakur & Khare 2011).

According to Meher-Homji (1964) the life-forms are reflected by bioclimate of the area. Thus in humid regions the bioclimate should be phanerophytic, and in arid regions therophytic. Jamir *et al*. (2006) observed that the montane humid forests of Meghalaya receives annual rainfall of 5500mm and represent 51% of phanerophytes, so rainfall appears to be most important operative factor in the evolution of biological spectrum. Structurally and floristically the tropical dry forests are less complex than wet forests, comprising about half or less of the tree species of wet forest (Murphy & Lugo 1986). In this regard the study area is floristically poor. However, it may be due to the area sampled being very small. In the present study, both phanerophytes and therophytes share considerably importance in depicting the phytoclimate of dual character extremes *i.e.* warm-moist and warm-dry climate. The study area experiences alternation of long dry period with moderate rainfall, warm dry and warm moist climate are characteristics of this area and these climatic condition are responsible for phanero-therophytic phytoclimate.

In the present study therophytes stand next to phanerophytes. The predominance of therophytes due to grazing is a common phenomenon (Yadav & Singh 1977). It is also an indicator of biotic pressures (Barucha & Dave 1944). Pandeya (1964) observed that the life-forms of the flora of different grassland association of Sagar were maintained by intensity of grazing. The high percentage of therophytes in grassland is due to overgrazing resulting in the introduction and spread of weedy grasses (Cain 1950, Down 1973) also recorded higher number of therophytes in bare and early successional stands. According to Dansereau (1957) the predominance of therophytes indicates warm climate. The growth of therophyte was much favoured in disturbed areas (Keeley & Albert 1977, Vora & George 1987).

It is experienced that vegetation in a stress of biotic pressure gradually increase the percentage of therophytes. It is pertient to state that composition of phanerophytes and therophytes is close in this area, an increase in biotic pressure would change the biological spectrum totherophytic-phanerophytic.

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REFERENCES

Ashwini HS, Avinash KS, ShravanaKumar S & Krishnamurthy YL (2014) Ecology and Phenology of Plant Communities of Gentianaceae in Montane Grasslands of Karnataka, Southern India. *Tropical Plant Research* 1(3): 43–48.

Ayyappan N & Parthasarathy N (1999) Biodiversity inventry of trees in a large scale permanent plot of tropical evergreen forest at Varagalaiar Anamalai, Western Ghats, India. *Biodiversity and Conservation* 8: 1533–1554.

Baithalu S, Anbarashan M & Parthasarthy N (2013) Two-decadal changes in forest structure and tree diversity in a tropical dry evergreen forest on the Coromandel Coast of India. *Tropical Ecology* 54: 397–403.

Bajpai O, Kumar A, Mishra AK, Sahu N, Pandey J, Behera SK & Chaudhary LB (2012) Recongregation of tree species of Katerniaghat wildlife sanctuary, Uttar Pradesh, India. *Journal of Biodiversity and Environmental Sciences* 2(12): 24–40.

Bharucha FR & Dave RN (1944) The biological spectrum of Grassland association. *Journal of University of Bombay* 13: 15–25.

Cain SA (1950) Life-form and Phytoclimates. *The Botanical Review* XVI(1): 1-32.

Chauhan SS, Tiwari A, Sheikh MA & Sharma S (2014) Study on Biological Spectrum of Madhav National Park, Shivpuri, Madhya Pradesh, India. *Journal of Biodiversity and Environmental Sciences* 4(3): 258–262.

Dansereau P (1957) *Biogeography – An Ecological Perspective*. The Ronald Press, New York.

Desai RK & Ant HM (2012) Life forms and biological spectrum of the flora of Vandali Range Forest. *Life Science Leaflets* 4: 60–63.

Down CG (1973) Life form succession in plant communities on colliery waste, *Environmental Pollution* 5: 19–22.

Jacord P (1912) The distribution of flora in the alpine zone. *The New Phytologist* 11: 37–50.

Jamir SA, Upadhaya K & Pandey HN (2006) Life form composition and stratification of montane humid forests in Meghalaya, northeast India. *Tropical Ecology* 47(2): 183–190.

Kargjam BD, Singh HB & Gupta A (2014) Life form in Hill Forest of Manipur, North-East, India. *Journal of Agroecology and Natural Resources Management* 1(1): 7-13.

Keeley SC & Albert WJ (1977) A Comparison of pattern of herb, shrub growth in comparable sites of chili and California. *The American Midland Naturalist* 97: 120–132.

Kensa M & Pramila SR (2014) Floristic, Phenological and Life form spectrum analysis in Vilathivilai area, Kanyakumari district Tamil Nadu, S. India. *Unique Journal of Medical and Dental Sciences* 2(3): 33–39.

Khatri PK (2000) *Study on biodiversity in tropical forest ecosystem of Satpura National Park, Madhya Pradesh, Ph.D. Thesis*. Forest Research Institute, Dehra Dun.

Kotiwar OS, Pandit BR & Pahurkar AJ (1996) Life forms and biological spectrum of the flora of Gir forest, Gujarat. *Geobios New Reports* 15: 17–20.

Krebs CJ (1994) *Ecology: The Experimental Analysis of Distribution and Abundance*. Harper Collins, California, 467 p.

Lakshmanan NK (1962) The application of Raunkiaer's life forms, *Journal of Indian Botanical Society* 41: 585–589.

Malik S, Bhattacharya A & Mukherjee A (2006) Biological spectrum of Chandur Forest in Hooghly District, West Bengal. *Indian Journal of Forestry* 29(2): 145–148.

Meher-Homji VM (1964) Life forms and biological spectra as epharmonic criteria of aridity and humidity in tropics. *Journal of Indian Botanical Society* 43(3): 424–430.

Meher-Homji VM (1981) Environmental implications of life form spectra form India. *Journal of Economic Taxonomic Botany* 2: 23–30.

Milne L & Milne M (1971) *The Arena of Life. The Dynamics of Ecology*. Double day Natural History Press, Gardern City, New York, 240 p.

Misra MP, Mishra PN & Pandey BN (1979) An ecological account of the vegetation of Brahmyoni Hills (Gaya), *Proceedings of Indian Science Congress* 3: 108–109.

Mohammad S & Joshi SP (2015) Life form and Biological Spectrum of Dry Deciduous Forests in Doon Valley, Uttrakhand, India. *International Journal of Environmental Biological* 5(1): 1–10.

Mueller-Dombois D & Ellenberg H (1974) *Aims and methods of vegetation ecology*. John Wiley and Sons, New York. 525 p.

Murphy PG & Lugo AE (1986). Ecology of tropical dry forests. *Annual Review of Ecology and Systematics* 17: 67–88.

Palit D, Ganguly G & Mukherjee A (2002) Ecological studies in Ramnabagan Wildlife Sanctuary Burdwan I. Biological Sepectrum. *Science and Culture* 68(5-6): 147–149.

Palomino RL & Alvarez SIP (2009) Structural patterns and floristics of a seasonally dry forest in Reserva Ecologica chaparri, Lambayeque, Peru. *Tropical Ecology* 50: 305–314

Pandey RP & Parmar PJ (1993) An assessment of biological spectrum of flora of Rajasthan. *Journal of Economic and Taxonomic Botany* 17: 99–103.

Pandeya SC (1964) Ecology of grassland of Sagar M.P. Composition of the fenced grassland association. *Journal of Indian Botanical Society* 43: 577–605.

Patel AH, Jain BK & Dabgar YB (2010) Life-form and phytoclimate of Sebhargog region North Gujrat, India. *Plant Archieves* 10(2): 965–966.

Pharswan K, Mehta JP & Subodh (2010) Floristic composition and biological spectrum of vegetation in Alpine Medows of Kedavnath, Garhwal Himalaya. *Nature and Science* 8(7): 109–115.

Phillips OL, Martinez RV, Vargas PN, Monteagudo AL, Zans MC, Sanchez WG, Cruz AP, Timana M, Yali-Halla & Rose S (2003) Efficient Plot based Floristic Assessment of Tropical forests. *Journal of Tropical Ecology* 19: 629–645.

Prasad R & Pandey RK (1992) An obcervation on plant diversity of Sal and Teak forest in relation to intensity of biotic impact at various distances from habitation in Madhya Pradesh: A case study. *Journal of Tropical Forestry* 8(1): 62–83.

Radha D (2014) Species composition and structure of Sal (*Shorea robusta* Gaertn. f.) forests along distribution gradients of Western Assam, Northeast India. *Tropical Plant Research* 1(3): 16–21.

Rajendraprasad M, Krishnan PN & Pushpangandan P (1998) The life from spectrum of sacred groves- a functional tool to analyse the vegetation *Tropical Ecology* 39(2): 211–217.

Rana TS, Datt B & Rao RR (2002) Life forms and biological spectrum of the Flora of Tons Valley, Garhwal Himalaya (Uttaranchal), India. *Taiwania* 47(2): 164–169.

Rao CC (1968) Biological spectrum of Karamnasa watershed flora. In: Misra R & Gopal B (eds) *Proceeding of Symposium on recent advances in Tropical Ecology*, Banaras Hindu University, Varanasi, India, Part-II .

Raunkiaer C (1934) *The life forms of Plant and Statistical plant Geography*. Oxford University press, Oxford, 632 p.

Reddy CS, Bhanja MR & Raju VS (1999) Angiospermic flora and Biological spectrum of Jakaram reserve forest, Warangal district, Andhra Pradesh. *Indian Forester* 125: 1152–1166.

Reddy CS, Hari Krishna P, Meena SL, Bharadwaj R & Sharma KC (2011) Composition of Life Forms and Biological Spectrum along Climatic gradient in Rajsthan, India. *International Journal of Environmental Sciences* 1(7): 1632–1639.

Reddy KN, Jadhav SN, Reddy CS & Raju VS (2002) Life forms and Biological spectrum of Marriguda Reserve Forest, Khammam district, Andhra Pradesh. *Indian Forester* 128(7): 751–756.

Sarkar M & Devi A (2014) Assessment of diversity, population structure and regeneration status of tree species in Hollongapar Gibbon Wildlife Sanctuary, Assam, Northeast India. *Tropical Plant Research* 1(2): 26–36.

Saxena AK (1980) *Ecology of vegetation complex of north western catchment of river Gola*. Progress report Ecology Research Circle. Dept. of Botany, Kuamaon University, Nainita, pp. 1–4.

Saxena AK, Pandey P & Singh JS (1982) Biological spectrum and other structural functional attributes of vegetation of Kumaun Himalaya. *Vegetatio* 49: 111–119.

Sharma J, Raina AK & Sharma S (2014) Life form classification and biological spectrum of Lamberi Forest range, Rajouri, J & K, India. *International Journal of Current Microbiology and Applied Sciences* 3(11): 234–239.

Sharma SC & Dhakre S (1993) Life form classification and biological spectrum of the flora of Shahjahapur district, Uttar Pradesh (India). *Indian Journal of Forestry* 15(4): 366–371.

Shukla CP & Mishra KN (2006) Floristic Composition, Biological Spectrum and Plant Diversity of burnt and unburnt grazing lands of Dewghat Forest, Koraon range (UP). *National Academy Science Letters India* 29(9-10): 345–349.

Sindhuja R, Rajendran A & Jayanthi P (2012) Herbaceous life forms of Maruthamalai Hills. Southern Western Ghats, India. *International Journal of Medicinal and Aromatic Plants* 2(4): 625–631.

Singh BP & Arora A (1994) Biological spectrum of the vegetation of Ganganagar district of Rajasthan. *Rheedea* 4: 74–78.

Sundarapandian SM & Subbiah S (2015) Diversity and tree population structure of tropical dry evergreen forests in Sivagangai district of Tamil Nadu, India. *Tropical Plant Research* 2(1): 36–46.

Thakur AS & Khare PK (2009) Composition of forest vegetation and floristics of Sagar district, Central India. *Journal of the Indian Botanical Society* 88(1&2): 11–17.

Thakur AS & Khare PK (2011) Study of life-forms and biological spectrum of forest of Sagar district, Madhya Pradesh. In: *Microbial Biotechnology and Ecology*. Daya Publishing House, New Delhi, pp. 729–740.

Thakur AS (2003) *Vegetation Ecology of Sagar District, Ph.D. Thesis*. Dr. H.S. Gour Vishwavidyalaya, Sagar.

Thakur K, Sahtran VK & Jagdeep V (2012a) Floristic composition and life-form spectrum of Bandli Wild Life Sanctuary, District, Mandi (Himachal Pradesh) India. *Plant Archieves* 12(1): 57–62.

Thakur M, Santvan VK & Nigam A (2012b) Floristic Composition and Biological Spectrum of Darlaghat Wild-Life Sanctuary, Solan, Himachal Pradesh, India. *New York Science Journal* 5(12): 1–14.

Vediya S & Kharadi H (2012) Biological spectrum of Ramgadhi (Megraj) range Forest, District Sabarkantha, North Gujrat, India. *International Journal of Pharmacy & Life Sciences* 3(7): 1868–1870.

Vora AB & George VC (1987) The distribution of various life forms in the ground flora under different canopies of Panchamahal forests: Gujarat, India. *Indian Journal of Forestry* 10: 223–225.

Whittaker RH (1972) Evolution and measurement of species diversity. *Taxon* 21: 213–251.

Yadav JSP & Singh JS (1977) *Grassland Vegetation, its structure, function utilization and management*. Today and Tomorrows Printers and Publishers, New Delhi, 132 p.