J. Phytol. Res. **25**(2) : 177-182, 2012

WOODY VEGETATION OF THE DIFFERENT FOREST AREAS IN THE ALWAR DISTRICT OF RAJASTHAN

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Density and frequency of woody species of 24 reserve forest areas were estimated in Alwar district of Rajasthan (27°4' to 28°4' north latitude and 76°7' to 76°13' east longitude). Forty five woody species consisting of 25 tree and 20 shrub species were recorded in the study samples. *Anogeissus pendula is* the dominant tree with highest density varying from 17.4 per 100m² in the Rajgarh to 7.9 per 100m² in the Laxmangarh forest range. It is uniformly distributed with 100 per cent frequency in 5 out of 6 forest ranges.Among the shrubs, *Capparis sepiaria, C. decidua* and *Grewia flavescens* grow in almost all the forest ranges. *Acacia catechu, Commiphora wightii, Mimosa hamata, Sterculia urens* and *Tecomella undulata* are the rare species of these forests. *A* gymnosperm, *Ephedra foliata* grows in the Jakharana forest of the Behror range. The alien invasive species, *Prosopis juliflora* has invaded with density varying from 6.9 to 2.0 per 100m² almost all forest areas in Alwar district.

Keywords: Density; Forest range; Frequency.

Introduction

Tropical dry deciduous forests occupy 54 percent of the 86 percent of the tropical forest area in India[1]. However, Dixit[2] have reported that the tropical dry decidouous forest occupy 38 percent of the total forest area in India. These forests are commonly found in the plains of Rajasthan and Madhaya Pradesh. In Rajasthan, the hilly topography provides a wide variety of micro-habitats in the Aravalli mountain ranges which support rich biodiversity of plant species. However, the forests of Jakhrana in Behror range and Methna in Laxmangarh range are example of torpical dry deciduous thorn forest in plain areas in Rajasthan.

The preliminary floristic study of the Alwar district was initiated by Vyas[3]. The systematic description of most of the plant species of this region is presented in the Flora of North-East Rajasthan[4]. The first serious attempt to enumerate the plant species of the Sariska Tiger Project was made by Parmar[5] who reported 403 plant species belonging to 86 families of vascular plants. Yadav[6] studied the flora of permanent sandy pathways of Alwar district which may reporesent the relics of the past vegetation of the region. Yadav[7] discovered the new habitat of *Tephrosia collina* var. *lanuginocarpa* in the Bala-fort forest in Alwar which was earlier reported to be confined to hills within a small area at Todgarh in Ajmer[8]. Twenty species of Angiosperms have been added to the flora of North-East Rajasthan[9]. Yadav and Yadav[10] have investigated the vasuclar flora of the Bala-fort forest in which they have reported 190 plant speices belonging to 47 families from an area of about 2 km² of this forest.

Besides floristic studies, the distribution and natural regeneration of *Holoptelea integrifolia* has been evaluated[11]. The effect of micro-environment and human disturbance on the plant diversity of the Sariska Tiger Projected was evaluated[12,13]. They observed that the spatial heterogeneity created by the Aravalli mountain range supports high species diversity of the plants; and once the vegetation is disturbed by human interfence it is almost impossible to restore original vegetation structure even if the disturbing factor has been removed. Yadav and Yadav[14] analysed the vegetation composition and species diversity of the Bala-fort reserve forest. The population structure of the tree species of the Sariska reserve forest and the Bala fort reserve forest have been evaluted[14,15]. The phenology of the selected woody species of the Bala fort forest and the Sariska reserve forest have been evaluated[16,17] . The natural regenration of tree species in the Sariska Tiger Project is very poor becuase of the lengthy dry period, frequent droughts which occur in this region and grazing by wild animals[18]. Hence, it was suggested that these forest ecocystems should be preserved as such without any anthropogenic disturbance. Although considerable work has been done to analyse the composition and plant species diversity of the Sariska

reserve forest and the Bala-forest reserve forest, further investigation is required to understand the vegetation composition of other kinds of forest habitats present in this region. Hence, the survey of the different forest regions was carried out to understand the distribution of woody vegetation of the forest areas of Alwar district of Rajasthan.

Material and Methods

*Study site:*The Alwar district covers an area of about 8400 km^2, is situated between 27°4' to 28°4' north latitude and 76°7' to 76°13' east longitude in the north eastern part of Rajasthan state. The characteristic feature of the district is the Aravalli mountain range which runs for about 81 km from south to north. The Aravalli hills cover the whole of theThanagazi and Rajgarh tehsils and about one third of Alwar tehsil and form important features in Bansur, Kishangarh and Tijara tehsils[19]. The valleys and plateaus are at a height of 377-380 m and the peaks of the world's oldest Aravalli mountain range are as high as 640m above sea level. The remarkable characteristics of the hills are their homogeneitic regularity of height, level summits and uniform appearance, stretching out from north-east to south-west in more or less parallel lines[20]. The largest and most consipicuous rock groups of the district are named as Delhi system as these belong to the famous ridge at Delhi, which is composed of quartzite belonging to this formation. Geologically the Aravalli formations are less observable features throughout the district. They consists of mica, schists, granite, schistos, quartzite and marble or crystalline limestone. The rocks of Aravalli formations are much older than the Delhi system. Indeed, they appear to have been subjected to an enormous amount of erosion[19].

There is great spatial heterogeneity due to the presence of Aravalli mountain rnage in the Alwar district. The forest areas can be divided in three chief kind of habitats :

(i) The hilly terrain areas which include the forest regions of Behror, Thanagazi, Rajgarh, Laxmangarh and Tijara forest ranges. (ii) The sandy plain area is represented by the Jakhrana forest area is the Behror and Indore in Tijara forest range. (iii) The sandy loam plain area in Methna in Laxmangarh forest range. These habitats have many specific species adapted to various edaphic factors.

The climate is hot and dry with three distinct seasons in a year. The summer season is from mid March to June is extremely hot with temperature soaring to 47°C, the hot westerly winds blow during the month of May and June known as 'loo' during this season. The rainy season is from July to mid September with 90 percent of average annual rainfall (620mm) occuring during this period. The dry cold winter season is from October to February with temperature dropping to 0°C in December and January months and the light showers of rainfall also occurs in these months.

Methods : The survey of forest areas in Alwar district was carried out in six forest ranges, *i.e.* Behror, Kishangarh Bas, Rajgarh, Thanagazi, Laxmangarh and Alwar. The behror forest range includes Banhar, Tasing, Jakharana, Renanagar, Beroje, Hamirpur and Nangal singhalka forest areas.Similarly the Kishangarh Bas forest range includes Jajorbas, Nimali, Indore, Tijara, Ismilepur; the Rajgarh forest range includes Rajpura, Bighota, Kundla, Machari, Bhulari; the Thanagazi forest range includes Malutana, Narayanpur, Garhbasai: the Laxmangarh forest range includes Methna, Kirori kund, Mojpur: the Alwar forest range includes the Bala-fort forest. Thus the botanical surey was carried out in 24 forest areas of the Alwar district.In each forest area 10quadrats of 10mx10m were laid down at random to evaluate the density and frequency of the woody plant species in 2011-2012.

Results and Discussion

The vegetation of the Alwar district is mainly tropical dry deciduous thorn forest type according to Champian and Seth[21], however, the species composition varies depending upon the type of habitat.

(i)The hilly terrain: The vegetation of these forest areas is dominated by *Zizyphus nummularia, Butea monosperma, Acacia leucophloea* and *Prospoes juliflora* at the base of the slopes and *Anogeissus pendula, Boswellia serrata, Acacia senegal* and *Euphorbia caducifolia* on the hill slopes . The common shrubs are *Capparis sepiaria, Grewia flavescens* and *Grewia tenax* throughout the region.

(ii) The sandy plain forest area: There two habitats, one at Jakhrana covering an area 35.6 hectares and the other at Indore in Tijara covering an area of 2290 hactares . The dominant tree species at Jakhrana forest are *Salvadora oleoides, Prosopis cineraria, Acacia nilotica* and *Capparis decidua.* The shrubs are *Lycium barbarum, Mimosa hamata* and *Zizyphus nummularia.* A gymnosperm, *Ephedra foliata* grows among the shrubs in this forest. The sandy base of hills at Indore and Tijara in the Kishangarh forest range are dominated by *Zizyphus nummularia* whereas on the hill slopes *Anogeissus pendula* is more common .

(iii)The sandy loam plain forest area : This habitat is situated at Methna forest on the border of Bharatpur district. The dominant tree and tree like species are *Salvadora oleoides* and *Capparis decidua.* The other

Table 1. Density ($100m^{-2}$) of woody species in different forest ranges of Alwar district, Rajasthan.

Plant species	Forest ranges					
	Behror	Kishangarh Bas	Rajgarh	Thanagazi	Laxmangarh	Alwar
Acacia catechu				1.33		
Acacia leucophloea	2.47	0.8	0.8	0.83	0.83	0.03
Acacia nilotica	0.28	0.4	1.6	0.33	2	
Acacia senegal	2.12	0.8	2.2	0.73	2	1.77
Acacia tortilis	0.88	0.56		0.33	0.33	
Anogeissus acuminata						0.83
Anogeissus pendula	10.56	13.36	17.38	12.43	7.9	8.9
Balanites aegyptiaca	0.48	1.2		1	1.33	
Boswellia serrata	1	1	4.3	8.96		0.67
Butea monosperma	0.66	1.3	2	0.66	6.6	0.2
Capparis decidua	1.54	0.58	0.6	0.33	3.6	0.1
Capparis sepiaria	1.75	2.12	0.8	3.16	2.5	0.76
Clerodendrum phlomidis	0.28	0.2			0.03	0.65
Commiphora wightii	0.03		0.02	0.4		0.08
Cordia Dichotoma						0.19
Dendrocalamus strictus	4.28					
Dichrostachys cinerea	1.16		1	0.33		0.14
Diospyros kanjilali		0.6				
Ehretia laevis	0.86					0.06
Ephedra foliata	0.18					
Eupporbia caducifolia	0.01		0.8	1.93		
Feronia limonia					0.03	
Ficus mollis	0.01	0.02				0.01
Flacourtia indica	0.63	0.02		3.3		0.01
Grewia flavescens	1.28	1.9	0.9	3.66		5.56
a tenax	0.72	1	1	0.83		1.87
a tilifolia	0.47					
ntelea integrifolia	0.21	0.52	0.22	0.1		0.29
oromandelica	0.18	0.02	0.2	1	3.4	0.21
arbarum	2.18	2.2	1	2.16	0.66	
Ma. enus emarginatus	0.31			0.76		
Melia azadirachta	0.03		0.4		0.33	0.01
Mimosa hamata	0.36	0.2				
Mitragyna parviflora	0.01				0.7	
Moringa oleifera					0.03	0.01
Nyctanthes arbor-tritis		1.5				
Phoenix sylvestris		0.2	0.2		-	
Prosopis cineraria	0.86	0.2			0.76	
Prosopis juliflora	5.8	5.3	2	3.43	6.86	
Rhus mysurensis	5.04		0.8	9.43		
Salvadora oleoides	0.17	0.2			1.03	
Sterculia urens	0.03			0.33		0.02
Tecomella undulata					0.03	
Wrightia tinctoria	0.14	0.2	1.4		0.33	0.13
Zizyphus nummularia	11.18	16.5	25.16	2.06	13.86	0.38

Table 2. The frequency (%) of woody species in various forest areas in Alwar district of Rajasthan.

Plant species	Forest ranges					
	Behror	Kishangarh Bas	Rajgarh	Thanagazi	Laxmangarh	Alwar
Acacia catechu				33.3		75
Acacia leucophloea	28.6	80	60	66.6	33.3	100
Acacia nilotica	28.6	20	60	33.3	100	
Acacia senegal	85.71	60	60	33.3	100	100
Acacia tortilis	28.6	20		33.3	33.3	
Anogeissus acuminata						25
Anogeissus pendula	100	100	100	100	66.6	100
Balanites aegyptiaca	42.9	100		33.3	66.6	
Boswellia serata	14.3	40	80	100		75
Butea monosperma	28.6	60	60	66.6	33.3	75
Capparis decidua	85.71	20	60	33.3	100	25
Capparis sepiaria	85.71	80	60	66.6	100	75
Clerodendrum phlomidis		20			33.3	25
Commiphora wightii	14.3		20	33.3		75
Cordia dichotoma						100
Dendrocalamus strictus	14.3					
Dichrostachys cinerea	14.3		60	33.3		50
Diospyros kanjilali		20				
Ehretia laevis	14.3					75
Ephedra foliata	14.3					
Euphorbia caducifolia	14.3		60	100		
Feronia limonia					33.3	
Ficus mollis	14.3	20				25
Flacourtia indica	42.9	20		33.3		25
Grewia flavescens	14.3	80	40	100		100
Grewia tenax	28.6	40	60	33.3		100
Grewia tilifolia	14.3					
Holoptelea integrifolia	42.9	40	40	33.3		100
Lannea coromandelica	14.3	20	20	66.6	66.6	75
Lycium barbarum	85.7	60	20	66.6	66.6	
Maytenus emarginatus	28.6			33.3		
Melia azadirachta	28.6		20		33.3	25
Mimosa hamata	14.3	20				
Mitragyna parviflora	14.3				66.6	
Moringa oleifera					33.3	25
Nyctanthes arbor-tritis		20				
Phoenix sylvestris		20	20			
Prosopis cineraria	14.3	20			66.6	
Prosopis juliflora	57.1	60	60	100	100	
Rhus mysurensis	28.6		40	100		
Salvadora oleoides	42.9	20			66.6	
Sterculia urens	14.3			33.3		50
Tecomela undulata					33.3	
Wrightia tinctoria	14.3	20	40		33.3	75
Zizyphus nummularia	100	100	100	100	100	75

[illegible] tree species are *Acacia nilotica, Prosopis juliflora, Prosopis cineraria* and *Acacia senegal*. The [illegible] include *Zizyphus nummularia* and *Dichrostachys cinerea*.

Density: Forty five woody species which includes 25 tree and 20 shrub species were recorced in the study samples in various forest areas of Alwar district. The density of dominant tree, *Anogeissus pendula* was highest in the Rajarh (17.4 per 100m^2) and lowest in the laxamangarh forest range (7.9 per 100m^2). This is followed by *Boswellia serrata* from 8.9 per 100m^2 in the Thanagazi to 0.7 per 100m^2 in Alwar range and *Acacia leucophloea* density varying from 2.5 per to 0.03 per 100m^2 in different forest ranges. *Acacia nilotica, A. senegal, Lannea coromandelica, Holoptelea intergrifolia, Prosopis cineraria, Salvadora oleoides* and *Wrightia tinctoria* is less than 2 per 100m^2. The rare tree species are *Cordia dichotoma, Ficus mollis, Feronia limonia, Sterculia urens* and *Tecomella undulata* are represented by one or a few individuals. Among the shrubs, the dominant species is *Zizyphus nummularia* with density varying from 25 to 0.38 per 100m^2 followed by *Capparis sepiaria* with density varying fro 3.2 to 0.8 per 100m^2 and *Grewia flavescens* from 5.6 to 0.9 per 100m^2 in different forest ranges (Table 1). The other common shrubs are *Lycium barbarum, Capparis decidua, Clerodendrum phlomidis, Flacourtia indica* and *Dichrostachys cineria*. The rare shrubs are *Commiphora wightii, Maytenus emarginatus* and *Mimosa hamata*. The alien invasive tree species, *Prosopis juliflora* has density varying from 6.9 to 2 per 100m^2 in different forest areas in this district.

Frequency: *Anogeissus pendula* is uniformly distributed in all the forest ranges with frequency 100 per cent except Laxmangarh range where its frequency is 66.6 per cent (Table 2). It is followed by *Boswellia serrata, Acacia leucophloea, A. senegal, Butea monosperma, Lannea coromandelica* and *Holoptelea integrifolia*. The alien species, *Prosopis juliflora* is also comonly distributed in all the forest ranges with frequency varying from 100 to 57 per cent. The shrub *Zizyphus nummularia* is most uniformly distuributed with frequency ranging from 100 to 75 per cent followed by *Capparis sepiaria, C. decidua* and *Grewia flavescens* with frequency varying from 100 to 25 per cent in different forest ranges (Table 2).The other shrubs have irregular distribution such as *Flacourtia indica, Balanites aegyptiaca* and *Dichrostachys cinerea* occur in four forest ranges whereas *Clerodendrum phlomidis, Maytenus emarginatus* and *Mimosa hamata* grow only in two forest ranges.

Economically important plant species: Biodiversity is a very valuable resource. Besides providing various forest ecosystem services, the plants are used daily by man to meet food, energy, medicine, timber and other requirements. Several woody species of tropical dry deciduous thorn forests of Alwar district are used as source of food, for example, fruits of *Zizyphus nummularia, Rhus mysurensis, Flacourtia indica, Phoenix sylvestris* and *Salvadora oleoides* are eaten by man and other animals. The leaves of *Anogeissus pendula, Boswellia serrata, Prosopis cineraria* and *Zizyphus nummularia* are highly nutritious and used as fodder. *Acacia nilotica, Prosopis juliflora, Anogeissus pendula* and *Prosopis cineraria* are also used as fire wood by the local population. The dried leaves of *Salvadora oleoides* are used for baking bricks. The timber is obtained from *Tecomella undulata, Melia azadirachta, Acacia nilotica*. The local people also use wood of *Prosopis cineraria* and *Holoptelea integrifolia* as a low quality timber. The forests of Alwar district have several plants which are used as source of medicine, such as *Commiphora wightii*.

It may be concluded that the forest areas of Alwar distict are rich in diversity of woody species with about 25 tree and 20 shrub species. The dominant tree species is *Anogeissus pendula* followed by *Boswellia serrata* and *Acacia* spp. The dominant shrubs includes *Zizyphus nummularia, Capparis* spp. and *Grewia flavescens*.There are many rare species represented by only a few indivuduals. Many of these woody species are of immense economic value.

Acknowledgements

The author is grateful to Shri B P Pareek, the then Deputy Conservator of Forest, Alwar for providing inspiration and all faclities in accomplishing this task. The financial assistance received from the Department of Forest, Government of Rajasthan is gratefully acknowledged.

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