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Woody Species Composition and Phytosociological Characters of Sawai Mansingh Sanctuary, Rajasthan, India

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Abstract

Ranthambhor tiger reserve is a milestone in conservation ecology as it is the first and the largest tiger reserve in Rajasthan in terms of tiger population as well as area. The research was conducted at 4 different sites in Sawai Mansingh sanctuary, an important part of the tiger reserve to delineate its tree diversity status. The sanctuary lies on the Kalibhat road at a distance of around 9 km from Sawai Madhopur district headquarters and covers a total area of 113.07 sq km. The study was conducted throughout the year, in every season, and data was collected from all possible habitats like plateaus, hills, hill slopes, valleys, ground, and river banks. For data collection quadrates of 100m×100m were drawn randomly at study sites within the sanctuary and the data was collected in form of a total number of families, individuals, and dbh. A total number of 19613 trees belonging to 42 tree species among 37 genera and 23 families were recorded during the study. Most of the tree species are thorny and show xerophytic characteristics. *Anogeissus pendula* Edgew was recorded as the most dominant species of the forest and *Fabaceae* was the most dominant family.

Keywords: Dominant; Species; Tiger Reserve

Introduction

The biodiversity of forests generates a variety of resources that serves mankind for a time indefinite, by providing food, timber, construction and agricultural materials, medicine, and tourism Verma [1] India's forests were classified by Champion & Seth [2] into 5 major groups: Tropical forests, Montane Subtropical Forests, Montane wet tropical forests, Subalpine forests, and Alpine scrub. Due to variations in annual temperature, rainfall, and dry period among the forests they further divide forest types into 16 sub-types or groups Champion & Seth [2]. They define forest type as a unit of vegetation with physiognomic and structural features so pronounced that it appears distinct from one another. The biodiversity of various ecosystems is not uniformly distributed across the globe Barthlott [3]. Tropical and sub-tropical forests are known to have more than half of the world's species by covering a mere land area of 7% May & Stumpf [4] and tropical dry forests are almost 40% of the total tropical forests of the world Murphy & Lugo [5]. Out of a total of 86% of India's tropical forests, 54% is classified as dry deciduous and 37% as moist deciduous Kaul & Sharma [6] Singh & Kushwaha [7]. The small-scale variations in environmental variables are what determine the distribution of woody species in dry deciduous forest groups and it results in patchiness in communities Chaturvedi [8]; Chaturvedi & Raghubanshi [9]; Chaturvedi & Raghubanshi [10]. The Patchy distribution of tree assemblages is the cause of the uneven distribution of above-ground tree biomass, carbon density, and carbon accumulation in tropical dry forests Chaturvedi [11]; Chaturvedi [12]; Chaturvedi [13]; Chaturvedi [14]. The deciduous forests are believed to be poor in terms of species they harbor, but they have been present in form of a mosaic of communities with distinct species composition; each of these communities is distributed in non-contiguous patches resulting in enormous diversity Jha & Singh [15]. Usually biogeography, habitat, and extent of disturbance play key roles in deciding the tree species diversity of a forest Whitmore [16].

The population explosion while increasing our demands from different ecosystems also exerted a significant impact on diversity and all the ecosystems in all regions of the country but unfortunately, of all the ecosystems these forests are the most disturbed and least protected ecosystem of the world Murphy & Lugo [17]; and are disappearing at alarming rates, facing extreme deforestation and unsustainable exploitation Hare [18]; Raghubanshi & Tripathi [19]. In the past time, there has been remarkable habi-

tat loss, forest fragmentation, and, changes in land use patterns all over the world. An increase in the number of patches formed due to forest fragmentation with a corresponding reduction in mean area and mean perimeter of patches during ten years in the Vindhyan dry tropical forest was observed by Jha and co-workers Jha [20]. These forest fragments have the highest number of tree species. Maintenance and periodic assessment of various ecosystems and biodiversity are thus crucial for the long-term survival of human beings Malik [21]; Malik [22]. Diversity and stability of a community have proportional relations i.e., stability increases with diversity Rahman [23]. However, most of these forests are under great anthropogenic pressure and seeking careful management practices to maintain overall biodiversity and sustainability Kumar [24]. But it's quite unfortunate that most of the tropical countries furnished with such huge biodiversity are economically weak, which results in major challenges for biodiversity conservation Teshager [25]. Information on species richness and composition of any area is vital because it helps in determining the importance of the region for conservation Rahman [23]. The main objective of this study is to reveal the overall status of species composition and structural diversity of trees in Sawai Mansingh Sanctuary. This research work intends to help different stockholders including policymakers, local government authorities, and tribal communities to take action in direction of conservation.

Study area

Figure 1: Satellite map of Sawai Mansingh Sanctuary.

Sawai Madhopur district of Rajasthan owns the oldest and largest tiger reserve in Rajasthan, Ranthambhor Tiger reserves. It is situated in southeast Rajasthan where water is not the limiting factor. Ranthambhor tiger reserve includes 3 reserve forests viz. Ranthambhor national park, Kaila Devi sanctuary, and Sawai Mansingh sanctuary. The Ranthambhor tiger reserve of Rajasthan lies at an elevation of 215m (Bodal)-505m (Gazella peak) above sea level. It has an area of 1334 square km with 282 km of a core area. The reserve situated on the plateau lies between the hills of Vindhya and the Aravalli range. River Banas bounds it from the north and river Chambal from the south. Tropical dry deciduous forests lying in Aravalli's were identified as one of the world's most threatened ecosystems Gentry [26] and are being converted into scrub and savanna in the upcoming future Sagar [27]. The Ranthambhor tiger reserve represents an ecological island surrounded by farmlands and an overgrazed landscape, as the areas surrounding it have been completely deforested. It also provides an important wildlife passage between a chain of protected areas from the northeast i.e. Dholpur to the southwest i.e. Kota. Around 2 dozen villages have been relocated from the national park. Due to the tremendous anthropogenic pressure on the reserve, the buffer zone faces a great threat of degradation which is a serious concern for management. In the present research work, Sawai Mansingh Sanctuary has been selected as the study area. A survey of the overall reserve in 2007 Figure 1 reported 539 species of higher plants Singh & Shrivastav [28]. The present study focuses on vegetation characteristics of the Sawai Mansingh sanctuary (25°53'43" N, 76°20'34" W). It lies on the Kalibhat road at a distance of around 9 km from Sawai Madhopur district headquarters and covers a total area of 113.07 sq. km (Rajasthan Forest

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Department). The area is located in the conjunctional area of 2 major hill ranges of India i.e., Aravalli's and Vindhyan ranges. The temperature ranges from 9°C (January) to 41°C (May), and it receives 653mm/25.7-inch average rainfall. Water requirements of the sanctuary are fulfilled by the Devpura irrigation dam, Chambal and Chakal rivers, seasonal drains, and artificial water bodies constructed by the forest department. Its geographical location along with water efficiency flourish it with diverse life forms including many rare species of plants and animals. Sawai Mansingh Sanctuary is divided into 6 checkpoints viz. Neem chauki, Todra, Devpura, Aamli, Kalibhat, and Bodal. Out of 10 tourism zones of Ranthambhor tiger reserve, 4 zones (zone-7 to zone-10) lie in the sanctuary.

Materials and Methods

Data collection and analysis

Tree species were surveyed in the study area to evaluate structure, composition, and biodiversity status. Four sampling sites; Neem chauki range, Bodal range, Devpura range, and Kalibhat range were selected for the study. Sampling was done from July 2021-June 2022, and a total of 80 quadrates (20 at each site) of 100m ×100m were studied by random sampling method. In each plot, data was collected in terms of diameter at breast height (dbh, 1.3 meters above the ground), and all the species present within the plot were identified and recorded by local and scientific names. Plant samples of unidentified species were collected to identify with expert assistance. Different phytosociological attributes like relative species density, relative frequency, relative abundance, relative dominance, and importance value index (IVI) were calculated for each site.

Observation & Results

The study area represents tropical dry deciduous forests with the domination of thorny xerophytes. A total of 19613 trees belonging to 42 tree species among 39 genera and 23 families were enumerated. Most dominant species (in terms of IVI of the study area is *Anogeissus pendula Edgew* followed by *Prosopis juliflora (L.)* Druce, *Butea monosperma (Lam.)* Taubert, and Acacia leucophloea (Roxb.) Wild. While the least dominant species include Cytisus villosus Pourr., *Madhuca longifolia (L.)* J.F. Macbr, and *Kigelia pinnata (Lam.)* Benth. The high IVI of *Anogeissus pendula Edgew* species indicates its stability and adaptability to the present site. The first site selected is the range area of neem chauki, this area lies adjacent to the Sawai Madhopur city. The topographical features of this area range from planes to shallow valleys and plateaus. This area possesses 19 tree species belonging to 18 genera and 12 families. *Anogeissus pendula Edgew* is the most dominant species in the area with an IVI value of 108.13 followed by *Butea monosperma (Lam.)* Taubert (IVI = 42.76), and *Balanites aegyptiaca (L.)* Delile (IVI= 24.86). The second site is Bodal range area, which is quite rich in water availability. The topographical range includes mostly grounds and plateaus. This area has 25 tree species belonging to 23 genera and 15 families. The most prominent species of this area is *Anogeissus pendula Edgew* with a 90.33 IVI value, followed by *Prosopis juliflora (L.)* Druce (IVI= 51.89), and *Acacia leucophloea (Roxb.)* Wild (IVI= 36.23). The third site is the Devpura range, through this area flows the Chakal river. This area also possesses the ecotourism site 'Qualji'. Topography ranges from high hills to deep valleys, grounds, and plateaus. This area has 19 tree species, 18 genera, and 11 families. The most dominant species of the area is *Anogeissus pendula Edgew* (IVI= 138.35) followed by *Prosopis juliflora (L.)* Druce (IVI= 38.48) and Butea monosperma (Lam.) Taubert (IVI= 26.92). Forth site is Kalibhat range, with mostly plateaus and a little ground, and almost no valleys. This area possesses 35 tree species from 30 genera and 18 families. The most dominant species in the area is *Anogeissus pendula Edgew* (IVI= 124.12) followed by *Prosopis juliflora (L.)* Druce (IVI= 30.23) and *Butea monosperma (Lam.)* Taubert (IVI= 16.03).

The number of species in each family varied from 1- 14. Nearly 74 % of the families are monotypic i.e., are represented by a single species. Taxonomically family *Fabaceae* emerges as the most dominant family with 14 species, it accounts for 33.33% of the total tree species; followed by *Moraceae* (3 species), *Myrtaceae* (2 species), *Rhamnaceae* (2 species), *Rubiaceae* (2 species), *Sapotaceae* (2 species); and *Combretaceae, Ebenaceae*, *Salvedoraceae, Balanitaceae, Steculiaceae, Arecaceae, Ulmaceae, Meliaceae, Burseraceae, Anarcardiaceae, Dipterocarpaceae, Euphorbiaceae, Annonaceae, Simaroubaceae, Boraginaceae, Moringaceae, and Bignoniaceae* with single species each. Family *Fabaceae* is the third largest group of plants, with 730 genera and 19,400 species worldwide Rahman & MIA [29]. *Fabaceae* holds an image of a successful family due to its flexibility to adjust to a variety of environmental stress conditions Rundel [30]. The dominance of the family *Fabaceae* is an adaptive feature in drier conditions Givnish [31], this fact was further proven by the dominance of thorny tree species. Native plants of the family *Fabaceae* can serve as good pioneer species on degraded lands or in restoration projects Jaiswal & Dadhich [32]. The calculated phytosociological attributes of the Sawai Mansingh Wildlife Sanctuary are presented in Table 1. IVI is used to determine the overall importance of each species in the community, i.e., the species with the highest IVI is considered dominant in the community Arshad [33]; Noraimy [34]. IVI is useful to compare the ecological significance of species Lamprecht [35] as it gives a more realistic figure of dominance from the structural point of view Curtis and McIntosh [36]. The high value of IVI indicates that *Anogeissus pendula Edgew* has a high sociological structure in the community.

All 4 study sites Figure2 show a similar pattern of dominance of species among the community, i.e., some species like *Anogeissus pendula Edgew*, *Butea monosperma (Lam.)* Taubert, *Acacia leucophloea (Roxb.)* Wild, *Dichrostachys cineria (L.)* Wight & Am. show the highest dominance and showing leading ecological significance. *Prosopis juliflora (L.)* Druce also show dominance in 3 study sites except for Neem ki Chauki while Diospyros melanoxylon Roxb. was absent from Devpura site and show negligible IVI in Bodal site. Some species have IVI values ranging from 20-40, the

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rest of the species have IVI less than 20, and most of these species show negligible IVI. This type of pattern signifies that though a community is rich in terms of diversity only a few species dominate the community and the rest of the species show no significant contribution to IVI. Figure 3 represents the pattern of distribution of species within a community which is expressed with the Dominance-Diversity curve. It shows that in all the 4 sites, *Anogeissus pendula Edgew* has highest Importance value index. In Neem chauki, *Butea monosperma (Lam.)* Taubert rank second whereas in other 3 study sites, Bodal, Devpura and Kalibhat, *Prosopis juliflora (L.)* Druce rank second in IVI. In Neem chauki out of total 19 species recorded only two species *Anogeissus pendula Edgew* and *Butea monosperma (Lam.)* Taubert share almost 50% of the IVI and rest 50% is shared by 17 species. In case of Bodal, Devpura and Kalibhat, *Anogeissus pendula Edgew* and *Prosopis juliflora (L.)* Druce contribute to nearly 45%, 59% and 51% of the IVI with species richness 25, 19 and 35 respectively. In terms of species richness, Kalibhat site is more diverse but in terms of dominance Devpura site show dominance of only 2 plant species. Same trend is followed in all the sites [37]. Of all the sites Kalibhat, Neem chauki and Devpura show a similar steep fall in the dominance-diversity curve. These areas are dominated by only 1 to 3 species, and other present species do not share the dominance. While in the case of Bodal a gradual fall is observed, although this site is also dominated by a few species others also have contributed to dominance. By studying the dominance-diversity curve and the number of species in Devpura and Neem chauki we can interpret that these two sites are the most disturbed of all the 4 sites [38].

Table 1: Phyto-sociological characters of tree species (IVI of 4 study sites).

S.no.	Species	Family	Neem chauki	Bodal	Devpura	Kalibhat
1	*Anogeissus pendula Edgew*	*Combretaceae*	106.13	87.33	138.65	124.12
2	*Butea monosperma (Lam.) Taubert*	*Fabaceae* (sub- family: *Papilionoideae*)	42.76	27.69	26.92	16.03
3	*Prosopis juliflora (L.) Druce*	*Fabaceae* (sub- family: *Mimosoideae*)	4.37	48.89	38.48	30.23
4	*Acacia leucophloea (Roxb.) Wild*	*Fabaceae* (sub- family: *Mimosoideae*)	24.24	32.23	25.41	15.9
5	*Diospyros melanoxylon Roxb.*	*Ebenaceae*	13.25	1.7	0	14.38
6	*Dichrostachys cineria (L.) Wight & Am*	*Fabaceae* (sub- family: *Mimosoideae*)	20.36	12.18	14.72	4.79
7	*Acacia catechu (L.f.) Wild*	*Fabaceae* (sub- family: *Mimosoideae*)	0	7.36	10.79	1.88
8	*Salvedora oleoides Decne*	*Salvedoraceae*	3.32	8.96	5.02	4.06
9	*Balanites aegyptiaca (L.) Delile*	*Balanitaceae*	24.86	18.52	0	7.93
10	*Streculia urens Roxb.*	*Streculiaceae*	4.37	2.22	5.47	8.03
11	*Acacia tortilis (Forssk.)*	*Fabaceae* (sub- family: *Mimosoideae*)	0	0	0	13.41
12	*Bauhinia racemose Lam.*	*Fabaceae* (sub- family: *Caesalpinioideae*)	2.8	2.9	4.43	5.93
13	*Cassia fistula L.*	*Fabaceae* (sub- family: *Caesalpinioideae*)	11.12	3.64	1.56	4.65
14	*Holoptelea integrifolia (Roxb.) Planch*	*Ulmaceae*	12.61	4.2	3.71	1.59
15	*Neolamarckia cadamba (Roxb.) Bosser*	*Rubiaceae*	0	1.97	5.27	2.22
16	*Azadirachta indica A. juss.*	*Meliaceae*	11.19	4.81	3.6	1.21
17	*Baswellia serrata Roxb. Ex. colebr*	*Burseraceae*	0	0	0	7.56
18	*Mangifera indica L.*	*Anacardiaceae*	4.02	0	0	0
19	*Pithecellobium dulce (Roxb.) Benth.*	*Fabaceae* (sub- family: *Caesalpinioideae*)	0	0	1.56	3.45
20	*Ficus regiosa L.*	*Moraceae*	2.79	3.45	0	1.51
21	*Ziziphus nummularia Lam.*	*Rhamnaceae*	0	3.46	1.2	0.69
22	*Phoenix sylvestris (L.) Roxb.*	*Arecaceae*	2.79	2.22	0	1.58
23	*Ficus benghalensis L.*	*Moraceae*	0	2.67	0	1.97
24	*Depterocarpus turbinatus Gaertn. F.*	*Dipterocarpaceae*	0	2.23	0	1.95
25	*Tamarindus indica L.*	*Fabaceae* (sub- family: *Caesalpinioideae*)	0	1.21	1.2	1.33
26	*Syzygium cumini (L.) Skeels*	*Myrtaceae*	0	0	0	3.84
27	*Dichrostachys cineraria (L.) Wight &Am.*	*Fabaceae* (sub- family: *Mimosoideae*)	0	3.82	0	0
28	*Manilkara hexandra (Roxb.) Dubard*	*Sapotaceae*	0	0	1.56	0.7
29	*Albizia lebbeck (L.) Denth.*	*Fabaceae* (sub- family: *Mimosoideae*)	0	11.21	0	1.24
30	*Acacia nilotica (L.) Wild ex*	*Fabaceae* (sub- family: *Mimosoideae*)	5.42	0	0	2.05
31	*Ficus racemose L.*	*Moraceae*	0	0	0	1.69

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32	*Moringa oleifera Lam.*	*Moringaceae*	0	0	2.64	0
33	*Ricinus communis L.*	*Euphorbiaceae*	0	0	0	1.51
34	*Annona squamosa L.*	*Annonaceae*	0	2.23	0	0
35	*Madhuca longifolia (L.) J.F. Macbr*	*Sapotaceae*	0	0	0	1.24
36	*Ailanthus excelsa Roxb.*	*Simaroubaceae*	2.79	1.21	0	0
37	*Morinda tomentosa B. Heyne ex Roth*	*Rubiaceae*	0	0	0	2.39
38	*Eucalyptus grandis W. Hill*	*Myrtaceae*	0	0	0	1.21
39	*Cordia dichotoma G. Forst*	*Boraginaceae*	0	0	1.92	0
40	*Ziziphus glabrata Henye ex Roth*	*Rhamnaceae*	0	0	0	1.04
41	*Cytisus villosus Pourr.*	*Fabaceae* (sub- family: *Papilionoideae*)	2.79	0	0	0
42	*Kigelia pinnata (Lam.) Benth.*	*Bignoniaceae*	0	0	0	0.87
	Total species		19	25	19	35

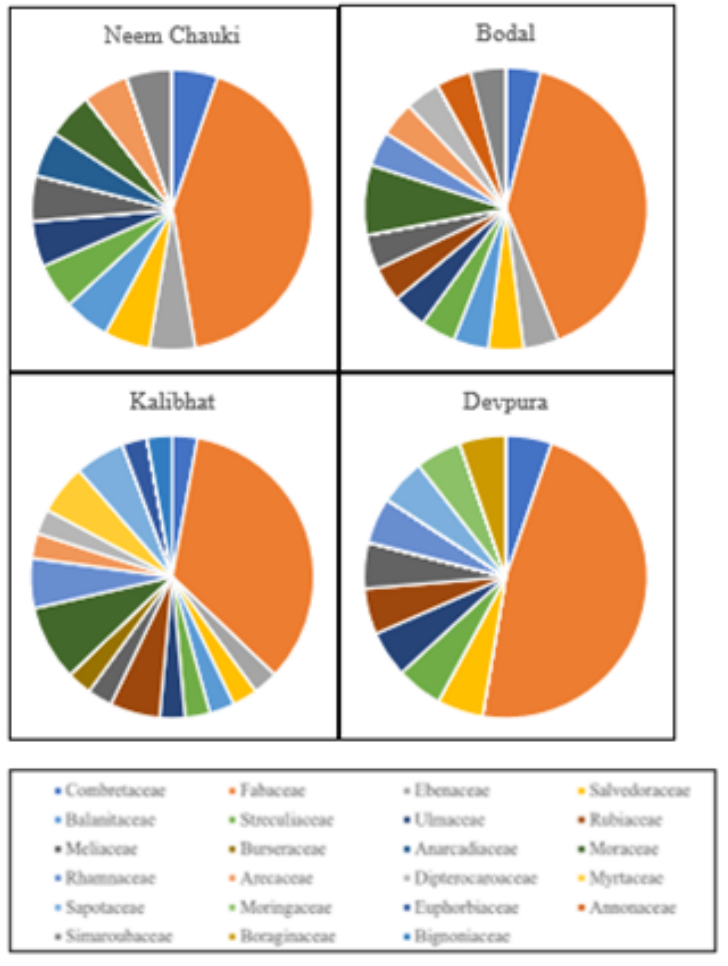

Figure 2: Family dominance of woody plants in 4 different sites.

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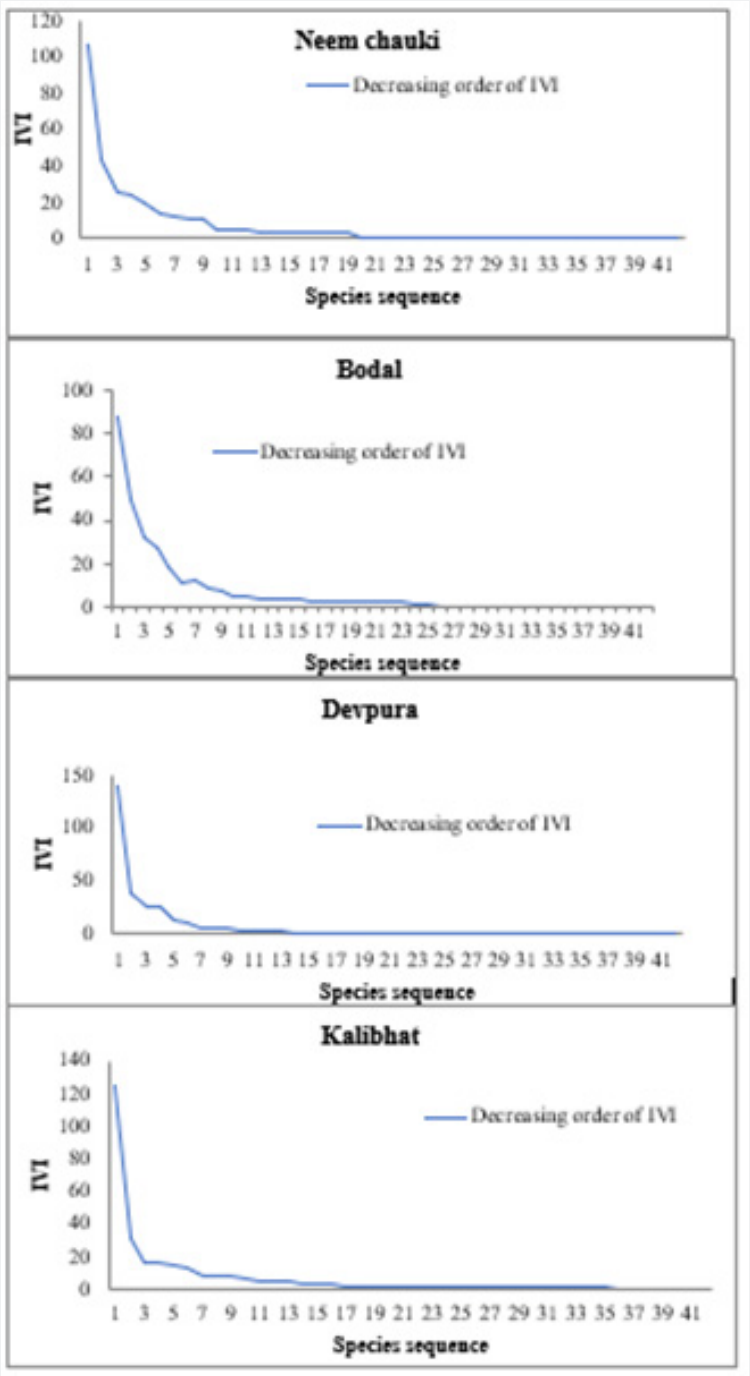

Figure 3: Dominance-diversity curve of woody plant species in 4 study sites Sawai Mansingh Wildlife Sanctuary.

Conclusion

Sawai Mansingh wildlife Sanctuary of Rajasthan has 42 tree species among 37 genera and 23 families. The most frequent species in the forest region is *Anogeissus pendula Edgew* followed by *Prosopis juliflora (L.)* Druce while the family *Fabaceae* shows the highest species richness and highest contribution in an importance value index. It has also been observed that the peripheral or buffer area of the sanctuary is facing a vast amount of anthropogenic pressure; are dominated by invasive species like *Prosopis juliflora (L.)* Druce. Of all the 4 sites Neem Chauki and Devpura show maximum disturbance while Bodal shows minimum disturbance and the highest diversity of plant species. Thus, there is an urgent need to focus on the region and tighten the laws and regulations.

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