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Research

Phytodiversity of trees and shrubs in Vindhyavasini Sacred grove, Girwan, Banda, Uttar Pradesh

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Abstract

Sacred groves are the storehouse of medicinal plants, trees, shrubs, and important useful plants for the locals. The present study was conducted to study the diversity of woody vegetation across the topography (pediment, slope and hilltop.) in Vindhyavasini sacred grove, Girwan Banda Uttar Pradesh. The vegetation data were quantitatively analyzed for community characteristics such as species richness, dominance, diversity and distribution pattern by using the quadrat method. A total of 68 sample plots of 32.5×32.5m² for trees and 136 sub-plots of 5×5m² for shrubs were laid down. A total of 32 plant species (18 trees and 14 shrubs) belonging to 20 families were recorded and identified during the study. The highest species diversity and species richness for both trees (0.93, 14) and shrubs (1.77, 11) were recorded in pediment and species richness of the family Combretaceae was the highest (79.56) followed by Lamiaceae (36.78) and Apocynaceae (29.26). *Terminalia pendula* (IVI -187.80) and *Carissa spinarum* (IVI-86.89) were the most dominant tree and shrub species respectively. This sacred grove may work as a vital pool for the preservation of endemic and local plant species.

Keywords: Sacred grove, species diversity, species richness, endemic.

Introduction

Sacred groves are more or less pockets of climax vegetation serving as repositories of medicinal, ethnobotanical, mythological and ecological importance. Sacred Grove did not have federal legislation for its protection in India. These are traditionally protected by indigenous communities under their religious beliefs (Sudha et al., 1998). Sacred groves are designated in honour of village deities or saints and are preserved meticulously on socio-religious grounds (Vartak and Gadgil, 1981). Sacred groves might serve as refugia for threatened and rare species (Joshi and Gadgil, 1991). The total number of sacred groves in India could range from 100,00-150,000 (Malhotra et al., 2007). As regular events, local people arrange cultural and religious festivals in these grooves and call such festivals "*Mela*" (Solanki and Kotia, 2021).

The Vindhyavasini sacred grove is a unique and precious ecosystem located in the Akbarpur block of Banda district in the state of Uttar Pradesh, India. This forest grove has a rich floristic diversity, making it an important location for ecological research and conservation efforts. It is situated in the Vindhya range, and it is home to a diverse range of flora and fauna. The vegetation in the grove is predominantly made up of tropical dry deciduous forests, with a mix of semi-evergreen trees. The diversity of flora in the grove is not only important from an ecological perspective but also from a sociocultural perspective. The local communities residing in and around the grove depend on the plants for various purposes, such as medicine, timber, fuel, and food. The grove also has cultural and religious significance, with several local festivals and rituals associated with the plants found in the grove.

The floristic diversity of the grove also plays a crucial role in supporting local communities. Many local communities depend on the region's plant species for food, medicine, and other resources. The region's forests are a source of timber and other forest products. These areas are essential grazing areas for local livestock, providing a livelihood for many local communities. However, despite the importance of floristic diversity in the region, there are several challenges facing the sacred grove. Deforestation, mining, grazing and urbanization are the primary human activities that pose a threat to the region's plant diversity. Deforestation, in particular, has been known to cause habitat loss and fragmentation, leading to a decline in plant species richness. The groves are home to a wide range of tree species, shrubs, and herbs, which play a crucial role in maintaining the ecological balance of the region. Baseline information about plant diversity from the area is not available; therefore, the present study was conducted to document the diversity of tree and shrub species of the Vindhyavasini sacred grove.

Material and Methods

Study area

The area under the present investigation is located in Girwan, Banda district of Uttar Pradesh. Banda is one of the seven districts of the Bundelkhand region of Uttar Pradesh. It is situated 250 18′ 07.92″ N and 800 21′ 29.34″ E and 244 m from sea level (Fig.1). The region experiences a tropical climate, characterized by high temperatures and humidity throughout the year. The zone has a harsh climate with large variations in temperature and mean annual rainfall (800mm-900mm) the maximum temperature reaches up to 48°C in May-June and the minimum temperature falls to 10°C in December-January. The region's warm and humid conditions, combined with the varied topography, provide a range of habitats, which allow for a vast range of plant species to thrive. The grove is characterized by red and black soil. These soils are generally fertile and support a variety of plant species. Red soil is the most dominant soil type in the grove and is found on the hill. These soils are formed from weathered igneous rocks and are characterized by their reddish-brown colour.

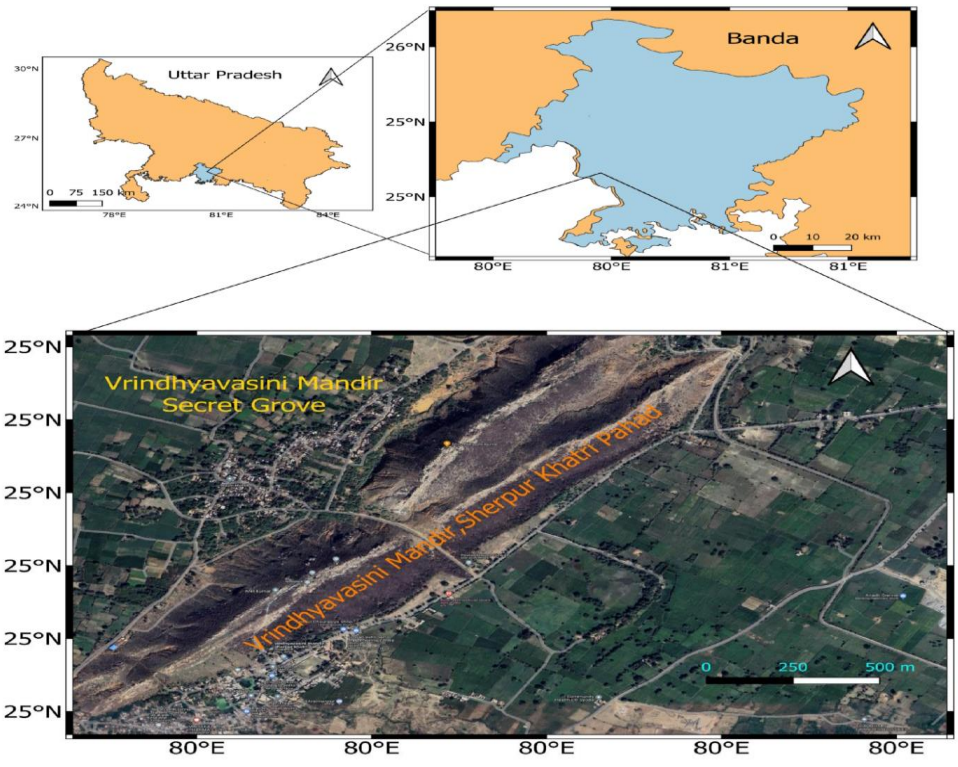

Figure 1. Geographical Location of Vindhyavasini Sacred Grove, Girwan

Vegetation study

In the present study vegetation sampling was carried out during January-April, 2023. Systematic sampling was laid down following the quadrat method (Mishra, 1968). A total of 68 sample plots of 32.5×32.5m² size were laid down to study the tree diversity. For estimation of shrub diversity 136 sub-plots of 5×5m² within the plots laid out for tree species. The species were identified using standard literature (Verma et al., 1993; Duthie, 1929; Kanjilal, 1933).

Calculation method

The vegetation data were quantitatively analyzed for community characteristics such as species richness, dominance, diversity and distribution pattern by using prescribed methods

The species richness is based solely on the number of species found in the given area (Magurran, 1988): R=S Where, R = species richness, S = Total number of species

The importance value index (IVI) was used to determine the overall importance of each species in the community structure. While calculating IVI, the percentage values of the relative frequency, relative density and relative dominance are summed up together for individual species (Curtis, 1959): Importance Value Index (IVI) = RD + RF + RDom

Where, RD= Relative dominance, RF= Relative frequency and RDom= Relative dominance.

These figures are calculated as:

The species diversity (H) was determined using Shannon Weiner's diversity index (Shannon and Weiner, 1963):

$$H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right)\ln\left(\frac{ni}{N}\right)$$

Where, H' = Shannon-Wiener diversity index, ni = Total number of individuals of a species in the quadrate and N = Total number of individuals of all species in the quadrate.

Data Analysis

The data collected from the field survey was added in MS Excel and calculated for various values of plant diversity, such as species richness, species population, species diversity and Importance Value Index (IVI).

Result

Floristic composition

A total of 32 angiosperm species belonging to 20 families were recorded and identified during the study of which 18 were trees, and 14 were shrubs However, few plant species were not encountered in the quadrats on account of their sparse distribution in the study site. The highest species richness in the pediment was probably due to high resource availability as compared to the slope and top of the hill.

Table 1. Tree species and their importance value index and distribution pattern.

S. N	Tree species	Family	RD	RDo	RD	IVI
1	*Aegle marmelos*	Rutaceae	0.07	0.03	0.03	0.13
2	*Alangium salviifolium*	Cornaceae	0.74	0.12	0.12	0.98
3	*Terminalia pendula*	Combretaceae	79.56	54.12	54.12	187.8
4	*Azadirachta indica*	Meliaceae	4.71	5.66	5.66	16.04

5	*Butea monosperma*	Fabaceae	4.26	2.45	2.45	9.17
6	*Diospyros melanoxylon*	Ebenaceae	3.24	3.25	3.25	9.74
7	*Lemonia acidissima*	Rutaceae	0.37	2.59	2.59	5.54
8	*Ficus religiosa*	Moraceae	0.07	14.22	14.22	28.5
9	*Madhuca longifolia*	Sapotaceae	0.81	11.25	11.25	23.3
10	*Melia azdirach*	Meliaceae	0.07	0.27	0.27	0.61
11	*Morinda coreia*	Rubiaceae	0.37	0.43	0.43	1.22
12	*Phoenix sylvestris*	Arecaceae	0.22	3.19	3.19	6.60
13	*Prosopis juliflora*	Fabaceae	0.74	0.47	0.47	1.67
14	*Stereospermum chelonoides*	Bignoniaceae	0.59	0.66	0.66	1.90
15	*Vachellia leucophloea*	Fabaceae	0.07	0.25	0.25	0.57
16	*Vachellia nilotica*	Fabaceae	1.47	0.04	0.04	1.54
17	*Wrightia tinctoria*	Apocynaceae	2.43	0.91	0.91	4.25
18	*Ziziphus mauritiana*	Rhmnaceae	0.22	0.10	0.10	0.42

RD: Relative density, RDo: Relative dominance, RF: Relative frequency

Table 2. Shrub species and their importance value index and distribution pattern.

S. N	Tree species	Family	RD	RDo	RF	IVI
1	*Acacia concinna*	Mimosaceae	0.36	13.77	0.75	14.89
2	*Justicia adhatoda*	Acanthaceae	3.54	2.67	2.26	8.46
3	*Dendrocalamus strictus*	Poaceae	3.40	1.33	0.75	5.48
4	*Capparis sepiaria*	Capparaceae	15.10	26.41	15.79	57.30
5	*Capparis zeylanica*	Capparaceae	0.72	3.08	0.75	4.56
6	*Carrisa spinarum*	Apocynaceae	29.26	25.30	32.33	86.89
7	*Croton bonplandianum*	Euphorbiaceae	0.43	1.64	1.50	3.58
8	*Flacortia indica*	Salicaceae	3.18	7.75	6.77	17.70
9	*Hyptis suaveolens*	Lamiaceae	0.65	2.98	1.50	5.13
10	*Ipomowa carnea*	Convolvulaceae	2.75	2.76	2.26	7.76
11	*Tephrosia purpurea*	Fabaceae	3.83	0.04	6.77	10.64
12	*Vitex negundo*	Lamiaceae	36.78	12.27	28.57	77.62

RD: Relative density, RDo: Relative dominance, RF: Relative frequency

Dominance pattern

Among tree species, *Terminalia pendula* (IVI -187.80) was found to be the most dominant species followed by *Ficus relegiosa* (IVI-28.51) and *Madhuca longifolia*. Whereas, *Azadirachta indica* was the least dominant species followed by *Diospyros melanoxylon*, *Butea monosperma, Phoenix sylvestris, Lemonia acidissima* respectively (Table 1). Among shrubs, *Carissa spinarum* (IVI-86.89) was the most dominant species

followed by *Capparis sepiaria* and *Vitex nigundo*, whereas *Croton bonplandianum* was the least dominant (Table 2).

Tree Species Diversity

Maximum tree species population documented in middle (P=7410 per ha), pediment (P=5350 per ha) and top (P=840 per ha) respectively. Maximum tree species diversity (H=1.70) was recorded at the top of the hill, whereas it was lowest recorded in the middle (H=0.65) of the hill, Maximum tree richness (14) was found at the foothills of the hill whereas it was lowest (4) at the top of the hill. The maximum species dominance was recorded at the slope (0.73) and lowest (0.20) at the top of the hill.

Table 3. Tree species diversity variables in Vindhyavasini sacred grove

Diversity Variable	Pediment	Slope	Top
Species population	5350	7410	840
Species richness	14	09	07
Species diversity	1.70	0.93	0.65
Species dominance	0.65	0.73	0.20

Shrub Species Diversity

Maximum shrub species population documented in pediment (P=24440), slope (P=18,000) and top (P=8120) respectively. Maximum tree species diversity (H=1.77) was recorded at the pediment of the hill, whereas it was lowest recorded at the top (H=0.65) of the hill, Maximum tree richness (11) was found at foothills of the hill whereas it was lowest (7) at the top of hill. The maximum species dominance was recorded at the slope (0.41) and lowest at the Top (0.38) of the hill.

Table 4. Shrub species diversity variables of the Akbarpur block

Diversity Variable	Pediment	Slope	Top
Species population	24,440	18,000	8,120
Species richness	11	5	4
Species diversity	1.77	1.09	1.13
Species dominance	0.21	0.41	0.38

Discussion

Earlier, the Bundelkhand region was formerly a natural forested land that perhaps has suffered destruction due to anthropogenic activities. The lower number of tree species richness (14) and shrub (11) observed in this study may be an underestimation of the whole area in its natural state. Mining activities can also lead to rapid vegetation loss and soil degradation, affecting the diversity and health of the ecosystem. To protect and maintain the floristic diversity of the Akbarpur Forest block, several conservation and management strategies can be employed. These include the establishment of protected areas, restoration of degraded ecosystems, and sustainable use of natural resources. Verma et al. (1988) in his study also reported the phytodiversity of the Bundelkhand region of Uttar Pradesh, in which they reported the dominance of the patches of *Terminalia, Boswellia, Butea*, *Nyctanthes. Cochlospermum,* bamboo and grasslands. The diversity values of the study conducted by Uthappa et al. (2016) assessment of the tree diversity in Datia, Banda and Orai of Bundelkhand also very close to our diversity values for three sites showing a decreasing trend Datia (1.887)>Banda (1.871)>Orai (1.259). The highest species richness was recorded in Datia (S=9), and the maximum number of species was recorded, followed by Banda (S=8) and Orai (S=5). Further

analysis revealed that the relative density of *Terminalia pendula* was highest in Orai (40.16%) and Datia (38.18%), whereas *Holoptelea integrifolia* (27.72%) and *Balanites aegyptiaca* (21.85%) population was higher in Banda.

T. pendula is also reported as dominant tree species from the sacred groves of Pratapgarh, Bundi, Dausa, Alwar, Jaipur, Karauli, Sawai Madhopur and Banswara districts of Rajasthan (Brandis, 1897; Pandey, 1995; Singh, 2016). The high population of tree species is found at the pediment, followed by the slope and top of the hill. High population and species richness in pediment were probable due to high resource availability and altitudinal and climatic variables like temperature, and rainfall as compared to slope and top of the hill (Kharkwal et al., 2005). Species richness of the family Combretaceae was found to be highest (S=79.56) followed by Lamiaceae (S=36.78) and Apocynaceae (S=29.26). The highest species diversity was recorded on top of the hill (1.70) followed by pediment (0.93) and mid-slope (0.65). It was due to varying physiographic and soil conditions.

Conclusion

Based on the findings of this study, it may not be out of place to conclude that Vindhyavasini sacred grove is still in its natural state with considerable human disturbance. The floristic diversity of this grove is a crucial component of the local ecosystem. This will help ensure the survival of the unique plant species and maintain the overall biodiversity of the ecosystem for future generations. The impact of human activities on the floristic diversity of the region is a matter of concern. Anthropogenic activities such as deforestation, mining, agriculture, overgrazing and urbanization have been known to have negative impacts on biodiversity. In the case of the Vindhyavasini sacred grove, overgrazing, encroachment for agriculture and urbanization, could threaten the survival of the grove's unique plant species. Mining activities also have a significant impact on the local ecosystem, which destroys large areas of vegetation and disrupts the soil, leading to erosion and soil degradation as seen in nearby areas of the Girwan.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest

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