Tree Diversity of the Fatehpur Beed Area, Sikar, Rajasthan, India

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Abstract

This article presents a comprehensive ecological study conducted in the Fatehpur Beed area of Sikar District, Rajasthan, focusing on the plant species composition, diversity and distribution patterns. The study encompassed tree diversity andanalyzing their families, abundance, frequency and ecological significance. Through rigorous field excursions and systematic data collection, the study identified a total of 26 tree species. Diversity indices, including the Shannon index, Simpson index and evenness index, were calculated to assess the ecological dynamics of study area. The findings reveal a rich diversity of species within the region, with balanced distribution and moderate evenness. Notable families, classes and species densities were identified, shedding light on the ecological intricacies. These results contribute to a deeper understanding of the local biodiversity of tree and hold implications for conservation and management strategies. The study underscores the importance of continued research in preserving the unique ecological balance of the Beed area.

Keywords: Tree diversity, Ecological study, Species composition, Diversity indices, Conservation

Introduction:

The term “biodiversity” was first introduced by Walter G. Rosen in 1986 and has since gained widespread recognition (Caillon&Degeorges, 2007). It refers to the diverse array of living organisms present on Earth, including plants, animals, invertebrates and microorganisms. Scientists estimate that there may be over 50 million species on our planet, yet only a small fraction of these, approximately two million, have been scientifically documented (May, 1988). With recent advancements in science and technology, our understanding and appreciation of the complexity and richness of biodiversity continues to grow.

Biodiversity refers to the variety of life on Earth, including the genetic differences among species and the taxonomic richness of ecosystems (Colwell, 2009). It can be described at various levels, such as the biodiversity of a specific region, ecosystem, group of individuals, or even a single species. There are different perspectives on biodiversity among various segments of society, including environmentalists, biologists, naturalists and ethnobiologists. The recognition of biodiversity’s importance in supporting life on Earth and providing essential resources serves as a common cause, uniting diverse groups. However, the rapid pace of development and human activities is putting immense pressure on biodiversity, leading to imbalances in ecosystems and causing the extinction of various plant and animal species.

The concept of biological diversity encompasses three fundamental levels: genetic diversity, species diversity and community and ecosystem diversity. These levels, though interconnected, can be studied independently to comprehend the intricate relationships that support life on Earth. Genetic diversity pertains to variations within a species, crucial for adaptation and evolution, influenced by factors like alleles, genes and chromosomal structures. Species diversity encompasses the array of unique species in a habitat, measured by species richness and evenness, with taxonomically unrelated species contributing to greater diversity. Community and ecosystem diversity concern the intricate interplay of species within habitats and ecosystems, quantified through alpha, beta and gamma diversity measures. Ecosystem diversity highlights the complexity of species interactions, niches, trophic levels and ecological processes within local ecosystems, while the diversity of habitats across regions also contributes to overall biodiversity (Gardner et al., 2008).

Numerous studies have highlighted the importance of biodiversity in arid and semi-arid ecosystems, such as those found in Rajasthan, India. Studies by Sharma, (2019) and Solanki et al., (2021) explored plant species diversity in arid zones, revealing that harsh climatic conditions in these regions favor the growth of drought-resistant species. Similarly, Sweta &Dharmveer, (2018) examined floristic composition in Rajasthan, underscoring the adaptation of native plant species to extreme water scarcity. Research on the vegetation of Rajasthan has consistently emphasized the significance of xerophytic plants that thrive in the state's arid conditions, such as ***Acacia senegal*** and ***Prosopis cineraria***. These species not only support biodiversity but also contribute to the local economy through their use in traditional medicine and agriculture (Kaur et al., 2020).

The vegetation of Rajasthan's arid regions, including the study area, consists predominantly of xerophytic species adapted to survive in low-water and high-temperature environments. The Sikar district, where the current study is based, is classified under the arid and semi-arid zone, characterized by sparse vegetation dominated by shrubs and drought-resistant plants. Key species in the region include ***Tecomellaundulata***, ***Capparis decidua***, ***Cenchrus ciliaris*** and***Dactylocteniumaegyptium***. Several studies have detailed the floristic composition of Rajasthan's semi-arid regions, pointing to the importance of these species for maintaining ecological balance and supporting local communities (Sodhi et al., 2004; Watt et al., 2019).

Nestled within the Sikar district of Rajasthan, Fatehpur is part of the Shekhawati region and located at coordinates 27.98° North and 74.95° East, with an elevation of 324 meters. The region's dry climatic conditions, including high summer temperatures and minimal, erratic rainfall, shape the area's vegetation, favoring the growth of drought-tolerant species. The Fatehpur Beed forest block, encompassing approximately 3796.2 hectares, is a significant natural area within the region, known for its ecological and floristic diversity. The present study aims to conduct a comprehensive investigation into the flora and vegetation of this area, along with an evaluation of key ecological parameters.

The present study, conducted from 2018 to 2022, endeavors to conduct a detailed investigation and analysis of the flora under consideration, while simultaneously evaluating diverse ecological parameters and ensuring accurate identification of the plants.

Materials and Method:

The study wasemploy the quadrat method as described by (Tripathi &Misra, 1971) to investigate the tree diversity of Fatehpur beed area. This research builds upon the extensive ecological study conducted in this particular district. Field excursions will be conducted two times a year, ensuring comprehensive coverage of the entire Fatehpur beed area (Figure 1). During these excursions, careful documentation will be carried out. All collected plant specimens will be assigned sequential numbers for identification and reference. Detailed

field notes will be recorded, capturing information about the plant's habit, habitat and the number of plants observed within each quadrat. For trees, quadrats measuring 10 x 10 meters was be utilized.

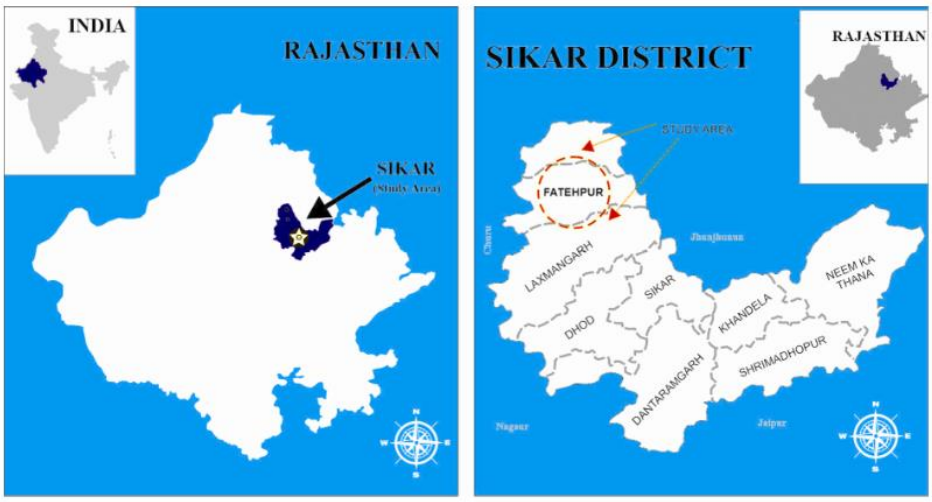

Figure 1: Map of study area

The methodology of this study aims to gather comprehensive data on the flora of the district, including details on species distribution, abundance and habitat preferences, allowing for an in-depth ecological analysis of the area. **Species richness**, as defined by Magurran, 1(988), refers to the count of different species present within a community, landscape, or region. It provides an estimation of the total species richness, including those species that may not have been directly observed but are likely to exist based on the available data. Species richness focuses on the number of distinct species within a given area, offering insights into the diversity of species present.

Species density, on the other hand, refers to the number of individuals of a species found within a specific unit area. As noted by Oosting& Billings, (1942), density helps in understanding the concentration or abundance of species within a given space and the level of competition that may exist among them. This measure allows for insights into how closely packed or dispersed individuals are, providing an assessment of potential competition for resources.

Abundance, as defined by Roberts &Oosting, (1958), represents the number of individuals of any species per sampling unit, helping to gauge the prevalence of each species in the study area.

To further quantify species diversity, the **Shannon and Weaver index of species diversity (H')** was calculated using the formula provided by Shannon & Weaver (1949). This index accounts for both the number of species and their abundance, offering a measure of biodiversity. Additionally, the **Simpson index of species dominance (D)** was calculated following Simpson, (1949), which emphasizes the dominance of certain species within a community. Lastly, **species evenness (e)**, which measures how evenly individuals are distributed across different species, was calculated using the formula by Pielou, (1966). Together, these metrics provide a thorough analysis of the species diversity, dominance and evenness within the study area.

The Importance Value Index (IVI) is a key measure in plant ecology that helps determine the ecological significance of a species within a specific plant community. It provides a holistic assessment by integrating three parameters: relative density, relative frequency and relative dominance (or basal area). These factors are combined to calculate the IVI using the formula: IVI = RF + RD + RDom. This comprehensive approach allows ecologists to evaluate not only how common a species is but also its relative abundance and dominance within the community, offering insights into its overall ecological importance.

Results and Discussion:

The Fatehpur Beed area in Sikar exhibits a rich diversity of tree species, as evidenced by the comprehensive phytosociological data provided. The results of the phytosociological study highlight the variations in density, frequency, abundance and dominance of different plant species within the study area. ***Acacia senegal*** recorded the highest density (1.5), frequency (80) and abundance (1.88), with a dominance value of 491.471, making it one of the most prominent species, reflected in its highest importance value index (IVI) of 32.353. ***Ficus religiosa*** also showed a significant presence with a density of 0.9, frequency of 70 and dominance of 2014.627, resulting in the highest IVI of 46.633. Other notable species include ***Dalbergia sissoo*** and ***Tecomellaundulata***, with IVIs of 27.235 and 26.074, respectively, due to their relatively higher dominance and density values. These species contribute notably to the overall plant community structure in the area.

Table 1. Phytosociological aspect of Tree species at Fatehpur Beed area

Sr. No.	Plant Species	**Density**	**Frequency**	**Abundance**	Dominance	Rdom	RF	RD	IVI
1	*Acacia jacqemontii*	0.3	30	1.00	70.483	0.999	3.896	3.000	7.895
2	*Acacia nilotica*	0.2	20	1.00	102.892	1.458	2.597	2.000	6.055
3	*Acacia senegal*	1.5	80	1.88	491.471	6.963	10.390	15.000	32.353
4	*Acacia tortilis*	0.1	10	1.00	26.346	0.373	1.299	1.000	2.672
5	*Ailanthus excelsa*	0.1	10	1.00	26.867	0.381	1.299	1.000	2.679
6	*Albizia lebbeck*	0.1	10	1.00	63.315	0.897	1.299	1.000	3.196
7	*Azardirachta indica*	0.2	20	1.00	155.092	2.197	2.597	2.000	6.795
8	*Balanites aegyptiaca*	0.3	30	1.00	72.122	1.022	3.896	3.000	7.918
9	*Bauhinia racemosa*	0.1	10	1.00	39.741	0.563	1.299	1.000	2.862
10	*Cordia dichotoma*	0.1	10	1.00	63.315	0.897	1.299	1.000	3.196
11	*Cordia gharaf*	0.1	10	1.00	70.650	1.001	1.299	1.000	3.300
12	*Dalbergia sissoo*	0.9	60	1.50	737.084	10.443	7.792	9.000	27.235
13	*Eucalyptus camaldulensis*	0.1	10	1.00	109.803	1.556	1.299	1.000	3.854
14	*Ficus bengalensis*	0.1	10	1.00	154.055	2.183	1.299	1.000	4.481

15	*Ficus religiosa*	0.9	70	1.29	2014.627	28.542	9.091	9.000	46.633
16	*Maytenusemarginata*	0.9	60	1.50	354.493	5.022	7.792	9.000	21.814
17	*Melia azedarach*	0.1	10	1.00	76.415	1.083	1.299	1.000	3.381
18	*Moringa oleifera*	0.4	40	1.00	234.021	3.315	5.195	4.000	12.510
19	*Parkinsonia aculeata*	0.1	10	1.00	26.289	0.372	1.299	1.000	2.671
20	*Prosopis cineraria*	0.1	10	1.00	86.578	1.227	1.299	1.000	3.525
21	*Prosopis juliflora*	0.1	10	1.00	77.398	1.097	1.299	1.000	3.395
22	*Salvadoraoleoides*	0.6	50	1.20	407.114	5.768	6.494	6.000	18.261
23	*Salvadora persica*	0.5	40	1.25	164.948	2.337	5.195	5.000	12.532
24	*Tamarixaphylla*	0.7	50	1.40	246.967	3.499	6.494	7.000	16.992
25	*Tecomellaundulata*	0.7	50	1.40	888.014	12.581	6.494	7.000	26.074
26	*Zizyphusmauritiana*	0.7	50	1.40	298.318	4.226	6.494	7.000	17.720

Table 2 Various ecological indices for tree species at Fatehpur Beed area

Index of Species diversity (H')	**Index of Species dominance (D)**	**Index of Species Evenness (e)**
2.859	0.073	0.939

Among the dominant species, *Acacia nilotica*and *Prosopis cineraria* stand out with high frequency and species density, indicating their prevalence and ecological importance in the region. Conversely, species like *Tamarixaphylla* and *Moringa oleifera* exhibit lower densities, suggesting a more limited presence within the ecosystem. The calculated ecological indices further characterize the tree diversity of the Fatehpur Beed area. With an Index of Species diversity (H') of 2.859, the area showcases a considerable variety of species. However, the Index of Species dominance (D) of 0.073 suggests that no single species overwhelmingly dominates the ecosystem, contributing to a balanced distribution of flora (Table 2). The Index of Species

Evenness (e) at 0.939 indicates a relatively even distribution of species, highlighting a healthy and stable ecological community.

In contrast, several species, such as ***Acacia nilotica***, ***Cordia gharaf***, ***Prosopis cineraria*** and***Prosopis juliflora***, exhibited lower densities (0.1) and frequencies (10), leading to lower IVIs in the range of 2.671 to 3.525. Although these species have low individual representation, their presence adds to the overall diversity. Species like ***Salvadoraoleoides*** and ***Tecomellaundulata*** also recorded moderate to high values for abundance, dominance and IVI, indicating their ecological significance. Overall, the study area is characterized by a mix of dominant species like ***Ficus religiosa*** and ***Acacia senegal***, alongside less abundant species, which together contribute to the area's biodiversity and ecological balance.

Overall, the phytosociological assessment reveals a diverse and balanced tree community in the Fatehpur Beed area of Sikar. This diversity not only enhances the aesthetic appeal of the region but also contributes to its ecological resilience and functionality. Understanding the composition and dynamics of tree species in this area is crucial for effective conservation and management strategies, ensuring the preservation of its unique biodiversity for future generations.

The results of this ecological study provide valuable information regarding the plant species composition and distribution in the Fatehpur Beed area of Sikar District, Rajasthan. The dominance of certain families, the prevalence of specific classes and the abundance variations among different species highlight the ecological dynamics within the region. These findings contribute to our understanding of the local biodiversity and can serve as a basis for future conservation and management efforts in the area.

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Author contribution: NK conceived the idea and designed the research plant, execute the research, write original draft and data analysis. JBK supervised the complete work.

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1