Phytosociological Study of Mimosaceae family in Balaram-Ambaji Wildlife Sanctuary

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Abstract- **Mimosaceae species play an important role in stabilizing the soils and fixation of nitrogen to the dry deciduous ecosystems; however, invasive ones such as Prosopis juliflora endanger native species. To evaluate the phytosociological attributes of Mimosaceae in Balaram-Ambaji Wildlife Sanctuary (BAWS), Gujarat. There were 50 quadrats that were surveyed in various habitats. The density, frequency, basal area and Importance Value Index (IVI) of the species were calculated and the ShannonWiener, Simpson and evenness indices were computed. Seven species were recorded. P. juliflora was predominant (IVI = 82.5), and then there was Acacia nilotica (74.3). The ecological importance of the native taxa (A. catechu, Albizia lebbeck, P. cineraria) was demonstrated by the basal area and dominance even with lower densities. The level of diversity was moderate (H' = 1.92) and the distribution of species was uneven (E = 0.72) and contagious among the dominants. The BAWS Mimosaceae community is not very rich but shows an imbalance towards invaders. The control of P. juliflora and the restoration of the native species should be a priority in conservation.**

Keywords: Phytosociology; Mimosaceae; *Prosopis juliflora*; *Acacia nilotica*; Diversity indices; Gujarat.

I.   INTRODUCTION

A diverse range of trees, shrubs, and woody climbers that are ecologically significant in tropical and subtropical environments are part of the Mimosaceae family, now referred to as the mimosoid clade within the Fabaceales [1]. This group comprises Albizia, Acacia/Vachellia (Bedebbia), Mimosa and Prosopis which are known for their nitrogen fixing ability, drought tolerance as well as ecological roles in soil stabilization and habitat structure [2]. These areas are crucial for the production of fodder, fuelwood and timber, as well as tannins (yam) and gum, and they also support a diverse range of faunal species [3].

Species of the family of lichens called Mimosaceae come as key elements for rural lives and agroforestry systems, and their influence is felt on the nature of vegetation dynamics in western India, mostly in Gujarat and Rajasthan [4]. While the families stand important, they go upstream into over-fishing, habitat destruction, and biological invasion. Naturalized species like Prosopis juliflora have brought about changes in the structure of native communities and have displaced native species in many areas [5].

The Balaram-Ambaji Wildlife Sanctuary (BAWS) is defined as a dry deciduous ecoregion situated in the Banaskantha district of Gujarat, spreading about 542 km2 over two enclosures [6]. The site is characterized by hilly terrain, rocky formations, and varied microhabitats with abundances of flora and fauna. Floristic surveys report the presence of more than 480 plant species, including many Mimosaceae [7]. While the overall floristic diversity has been widely described, quantitative data pertaining to the distribution, dominance, and community associations of mimosoid species remain scant. Phytosociology is basically an analysis of plant communities on a quantitative basis in order to assess species density, frequency, dominance patterns, and ecological significance using indices such as the Importance Value Index (IVI) [8]. Such indices are used in biodiversity. Findings of these studies give clues about ecosystem functioning, succession patterns, and conservation requirements, apart from showing how the structural dominance of species affects community composition [9].

With the increasing ecological and economic importance of the Mimosaceae due to anthropogenic pressures, threats from invasive species (BAWS) [10], and other issues relevant to ecology and biological diversity, it becomes very pertinent to conduct focused phytosociological assessments [11]. Identification of

the dominant as well as rare taxa through accurate documentation of mimosoid species' abundance, distribution, and community relationships will also facilitate the detection of ecological imbalances induced by invasive species [12] along with providing data on forest management and restoration. On the other hand, information on soil-vegetation relationships and habitat preferences of species can offer a valuable baseline for future monitoring in response to climate change scenarios [13-15]. Habitat restoration projects may utilize this information to prioritize reforestation of native mimosoid trees and erosion control. Ecological recognition between native and invasive mimosoids will further guide the balancing of biodiversity with maintaining the sanctuary as a resilient ecosystem [16]. The study thereby intends to provide a systematic account of the phytosociology of Mimosaceae in Balaram [17].

Aim

This research will analyze the phytosociology (habitat status) and species composition, dominance, distribution attributes, and ecological role of the Mimosoid clade in the Balaram-Ambaji Wildlife Sanctuary, as well as their influence on dry deciduous forest communities.

OBJECTIVES

➢ To document and categorize the various species of Mimosaceae present in the Balaram-Ambaji Wildlife Sanctuary.

➢ To assess the sociable characteristics of the captured Mimosaceae species such as density, frequency, dominance, and Importance Value Index.

➢ To analyze the distribution and co-occurrence patterns of mimosoid species in different habitat categories on the Sanctuary.

➢ To provide information and conservation recommendations for the management of the dominant, distinct, and invasive species of Mimosaceae using ecological principles.'

II. REVIEW OF LITERATURE

Patel and Patel., (2025) Conducted an Eco-floristic study of tree species in Satlasana taluka, Mehsana district, Gujarat. The project aimed to document the diversity, distribution and ecological characteristics of tree species in the area. A complete survey was conducted in diverse environments, along with information about tree species composition, density, frequency and abundance, and was recorded. We found 107 tree species in 36 families. The study indicated an ecological variation in the diversity and composition of tree species in different environments. The results of this study suggest ecological characteristics of tree species present in the area, which may provide implications for conserving and sustainably managing forest resources in Satlasana taluka [18].

Thakor V et al., (2025) reported 101 species of plants from Chandkheda's wetlands; of these, 91 were identified in the Vada talav wetland and represented 77 genera and 34 families, while 50 were identified in the Visatmata wetland and represented 41 genera and 24 families. The Vada talav wetland, based on our study, had an estimated Shannon-Wiener diversity index (H') of 4.021; Simpson's index (D) of 0.9714; and Evenness index (e) of 0.6193. Also, Fisher's Alpha diversity index (S) was assessed at 24.05. For the Visatmata wetland, there were 3.09 calculated Shannon-Wiener diversity indexes, 0.9171 estimated Simpson's indexes, and 13.83 estimated Fisher's Alpha diversity indexes, and 0.4397 estimated evenness indexes. The floral -population of the Vada talav wetland, Chandkheda and Visatmata wetlands are characterized by moderate to high species diversity. This study will help aid management and conservation of urban wetlands found in Ahmedabad [19].

Malek SS et al., (2024) examined the phytosociological alterations resulting from human disturbances along the forest edge of the Goima forest in Valsad district, Gujarat. The study area was divided into different classes of tree canopy density and disturbance, and ecological metrics were calculated for each class using the quadrate survey method. In total, 772 individual plants, representing 141 species and 53 families, were recorded based on quadrate sampling, where measures of feature differences were found to have considerable predictive power of biotic richness. The study showed that the most tree taxa (30), herb taxa (24), and grass taxa (7) were observed in the high disturbance class while the highest shrub taxa (16) and climber taxa (10) were seen in the moderate disturbance class. Domination (D) was higher in the moderate density forest and moderate disturbance class for trees (0.11, 0.13), shrubs (0.24, 0.21), and herbs (0.13, 0.12) but for climbers D was

greatest in the dense forest (0.40) and moderate disturbance class (0.22) while for grasses it was most significant in the moderate density forest (0.69) and low disturbance class (0.58) [20].

Patel S., (2023) assessed the plant life in the Hathidhara marsh in the Palanpur taluka of the Banaskantha district using phytosociological methods. The study was conducted during the months of January and December of 2022. Each species' important value index (IVI), together with its frequency, density, abundance, and relatedness to other species, served as the evaluation factor. This investigation uncovered 102 species, which were subsequently classified into 82 genera and 38 families. Tephrosia purpurea (L.) Pers. had the greatest IVI at 8.74, while the Asteraceae family had the highest IVI at 42.78%. Every plant species was documented using its scientific name, as well as its local name, family, habit, and habitat [21].

Das L et al., (2019) described the coastal regions and islands of the Devbhoomi Dwarka District in the Gulf of Kachchh, concerning the phytosociological features and variety of plant species (trees, plants, and herbs). A random sample approach was used in this inquiry. Thirty kinds of trees and plants were among the 243 plant species that were discovered. In addition, 29 species were climbers, and 30 were grasses and sedges. From the tree and shrub species that were evaluated, Prosopis juliflora had the highest density (373.51 ind. /ha), frequency (63.50.67%), relative density (30.19.7%), relative frequency (24.41%), and relative abundance (7.68%). Among plant species, Aristida redacta had the highest density (3.97 ind./sq.m.) and frequency (30.02%). Furthermore, among trees and shrubs, Prosopis juliflora had the highest important value index at 62.28, while among herbs; Aristida redacta had the highest at 31.51. Tree, shrub, and herb species showed a contagious distribution pattern in the research region with respect to the abundance/frequency ratio. The coastal terrestrial plants' α diversity (Shannon diversity index, Simpson's Index, species richness, evenness index) is also incorporated in the current study [22].

III. METHODOLOGY

This research took the form of a prospective observational cross-sectional design in the evaluation of the phytosociological parameters of the Mimosaceae family in the Balaram-Ambaji Wildlife Sanctuary. The design allowed gathering of the quantitative and qualitative ecological data, where the emphasis was laid on the richness, density, frequency, dominance, and community associations of species. Habitat features and cohabitation pattern could also be evaluated within a variety of ecological niches within the sanctuary using the framework. Research was carried out in the Balaram-Ambaji Wildlife Sanctuary (BAWS) located in Banaskantha district, Gujarat. Covering an area of about 542 km2, the sanctuary is characterized by a dry deciduous forest ecosystem that incorporates hilly terrain, rocky formations, river valleys and semi-arid climatic conditions. There are over 480 recorded species of plants in the area, including many taxa that belong to the Mimosaceae family. Representative plots were chosen from forest patches, grassland areas, and riverine zones to illustrate the differences in vegetation structure and composition.

3.1 Study Population

The population of the study was all the naturally occurring Mimosaceae (trees, shrubs, herbs, and climbers) that were in the chosen quadrats of the sanctuary. Field surveys were aimed at documenting their abundance, form of growth and community associations.

❖ Inclusion Criteria:
  ➢ Species belonging to the Mimosaceae family.
  ➢ Naturally occurring plants within selected quadrats.
  ➢ Both mature and juvenile individuals.

❖ Exclusion Criteria:
  ➢ Non-Mimosaceae species (recorded separately but not included in core analysis).
  ➢ Individuals outside the demarcated quadrat area.
  ➢ Damaged or unidentifiable specimens.

3.2 Sample Size

Based on survey aesthetics and customary methods, they were able to establish 50 quadrats to adequately represent the ecological range of the sanctuary in question. Tree and shrub data were collected using 10 m x 10 m quadrats, while herb and seedling data were collected in 1 m x 1 m sub-quadrats nested within the larger quadrats. These sampling attempts fulfilled the

species coverage in both dominant and rare Mimosaceae species. It used a systematic random sampling method. Different habitats and forest patches were chosen as the sampling sites, with transect locations. To capture ecological heterogeneity, quadrats were arranged at fixed intervals to avoid bias. Every person belonging to the group of Mimosaceae species was identified, counted, and measured in each quadrat. The specimens of herbariums were gathered for species confirmation.

3.3 Data Collection

The collection of data was done through the field measurements and secondary sources:

- Field Data:
  - Species name (scientific and local).
  - Number of individuals (abundance).
  - Basal area (measured as girth at breast height for trees/shrubs).
  - Occurrence across quadrats (frequency).
  - Notes on habitat type, soil condition, canopy cover, and associated vegetation.
- Secondary Data:
  - Floristic records and identification keys from published literature.
  - Verification with herbarium specimens.

3.4 Phytosociological Analysis

The collected data were analyzed using standard ecological formulas:

- Frequency (%) = (count of species-containing quadrats ÷ total quadrats examined) × 100.
- Density (ind./ha) is calculated by dividing the total area sampled by the number of individuals of a species.
- Abundance is calculated by dividing the total number of individuals of a species by the number of quadrats where the species is found.
- DBH is the diameter at breast height, and the formula for basal area (m²/ha) is ($\pi \times DBH^2$) by 4.
- The relative values for dominance, density, and frequency were computed.
- The IVI, or Importance Value Index, was calculated as:

IVI= Relative Frequency + Relative Density + Relative Dominance

3.5 Diversity Indices

To assess community structure and diversity, the following indices were calculated:

- Shannon-Wiener Diversity Index (H') – for species diversity.
- Simpson's Dominance Index (D) – to identify dominance patterns.
- Evenness Index (E) – to evaluate the distribution of individuals among species.

3.6 Statistical Analysis

Data gathered were subjected to normal phytosociological formulas:

- Basal Area, Abundance, Frequency, and Density.
- Relative Frequency, Relative Density, and Relative Dominance.
- Relative frequency plus relative density plus relative dominance equals the importance value index (IVI).

The community's diversity was measured using the Shannon-Wiener index (H), Simpson index (D), and Evenness index (E). A statistical analysis and graphical depiction were carried out using PAST program and Microsoft Excel.

3.7 Ethical Considerations

All the surveys were conducted with the required license of the Forest Department, Government of Gujarat. The fieldwork reduced inconveniences to plants and animals. Voucher samples were limited to specimen collection to be used in taxonomic confirmation. The data generated will be utilized in ecological studies and in conservation planning of biodiversity and ecological integrity of the sanctuary will be preserved.

IV. RESULTS

Mimosaceae in Balanam-Ambaji Wildlife Sanctuary exhibits their specialization and habitat sensitivity, as illustrated in Table 1. The species composition of these families is indicative of their diversity. Prosopis juliflora, an invasive exotic species, is prevalent in scrublands and open areas due to its aggressive colonization of new habitats and competition with

native florescent plants. In comparison, Acacia nilotica and Acachia catechu are significant trees of the dry deciduous forests and rocky slopes that contribute to forest structure by stabilizing the soil. Within the sanctuary, there is a diverse range of habitat types, with some species like Albizia lebbeck and Albicia odoratissima inhabiting deciduous regions while others prefer more temperate environments.

Prosopis cineraria, a species of endemic scarcity found in dry areas, is only found on sandy soil, while Mimosa pudica thrives in damp, shaded areas. Overall, the composition accentuates the presence of Mimosaea species, including native, invasive and habitat-specific varieties, which have an impact on the dynamics of the sanctuary's ecosystem.

Table 1: Species Composition of Mimosaceae in Balaram-Ambaji Wildlife Sanctuary

Sr. No.	Species Name	Local Name	Habit (Tree/Shrub/Herb)	Habitat Type
1	*Prosopis juliflora*	Gando Baval	Tree/Shrub	Scrublands, open areas
2	*Acacia nilotica*	Babul	Tree	Dry deciduous forest
3	*Acacia catechu*	Khair	Tree	Rocky slopes, dry forest
4	*Albizia lebbeck*	Siris	Tree	Moist deciduous patches
5	*Albizia odoratissima*	Kala Siris	Tree	Riparian habitats
6	*Prosopis cineraria*	Khejri	Tree	Sandy soils, arid patches
7	*Mimosa pudica*	Lajwanti	Herb/Climber	Moist shaded patches

According to Table 2, in the Mimosaceae community of Balaram-Ambaji Wildlife Sanctuary, the most dominant species were Prosopis juliflora and Acacia nilotica, which had high density, frequency, and Importance Value Index (IVI), and their effect on the ecological impact was considerable in the sanctuary. The other species, Acacia catechu and Albizia lebbeck also played a significant role as their values were greater in terms of basal area which indicates their contribution to the canopy development. Even though Prosopis cineraria and Albizia odoratissima had relatively lower densities and frequencies, they had high relative dominance values and therefore, fewer individuals of the two species have a strong ecological impact because of the big girth and canopy cover. Mimosa pudica is not very dense, with a low basal area, but with moderate IVI due to its adaptation to the shady environment and the formation of patches. All in all, the phytosociological characteristics reveal the presence of a mixed community with the invasion of Prosopis juliflora among native Acacia and Albizia species, which provide the forest with such dynamics as density, dominance, and distribution.

Table 2: Phytosociological Attributes of Mimosaceae Species

| Species	Density (Ind./ha)	Frequency (%)	"Basal Area (m²/ha)"	"Relative Density (%)"	"Relative Frequency (%)"	"Relative Dominance (%)"	IVI
Prosopis juliflora	412	68	4.8	30.6	28.1	23.8	82.5
Acacia nilotica	265	54	4.9	24.2	22.3	27.8	74.3
Acacia catechu	198	47	5.6	18.1	19.4	30.7	68.2
Albizia lebbeck	142	38	4.1	12.3	15.7	27.7	55.7
Prosopis cineraria	95	26	3.1	7.4	8.3	25.7	41.4
Albizia odoratissima	84	21	2.8	5.6	6.1	25.2	36.9
Mimosa pudica	61	19	0.9	1.8	4.2	23.6	29.6
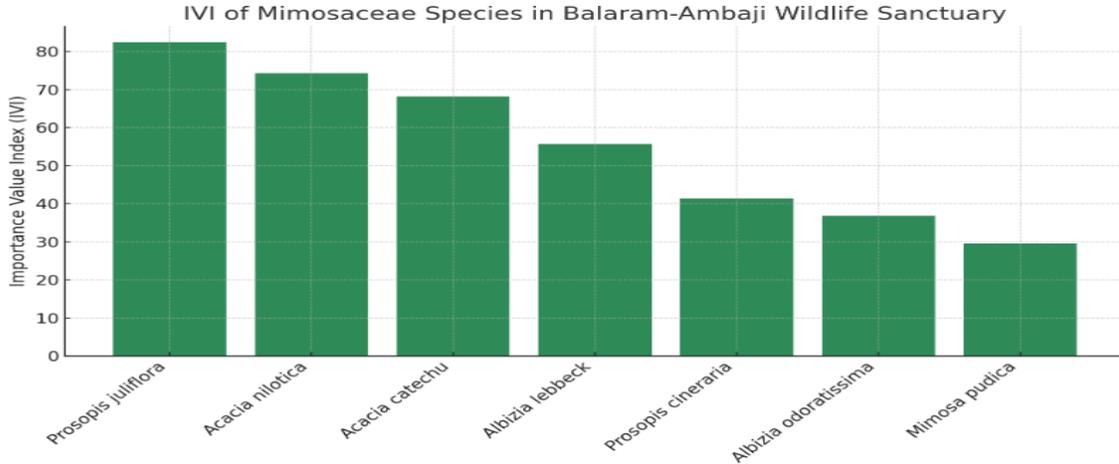
Graph 1: Importance Value Index (IVI)

Table 3 shows that Mimosaceae community in Balaram-Ambaji Wildlife Sanctuary has moderate diversity as indicated by the Shannon-Wiener Index (H' = 1.92), which represents a balanced but not very diverse community. The Simpson Dominance Index (D = 0.68) indicates that the community structure is moderately dominated but is mainly dominated by Prosopis juliflora and Acacia nilotica that have strong ecological impact on other taxa. Evenness Index (E = 0.72) also shows that the abundance of individuals among the species is not even, and greater number of individuals is concentrated in the most common species than in the less abundant species such as Mimosa pudica and Albizia odoratissima. The diversity indices in general indicate that there is co-existence of native and invasive species in the community, but that ecological stability is imbalanced towards a small number of dominant taxa, with consequences in biodiversity and habitat stability in the long term.

Table 3: Diversity Indices of Mimosaceae Community

| Diversity Index	Value	Interpretation
Shannon-Wiener Index (H')	1.92	Moderate diversity
Simpson's Dominance Index (D)	0.68	Moderately dominated by *P. juliflora*, *A. nilotica*
Evenness Index (E)	0.72	Uneven distribution of species
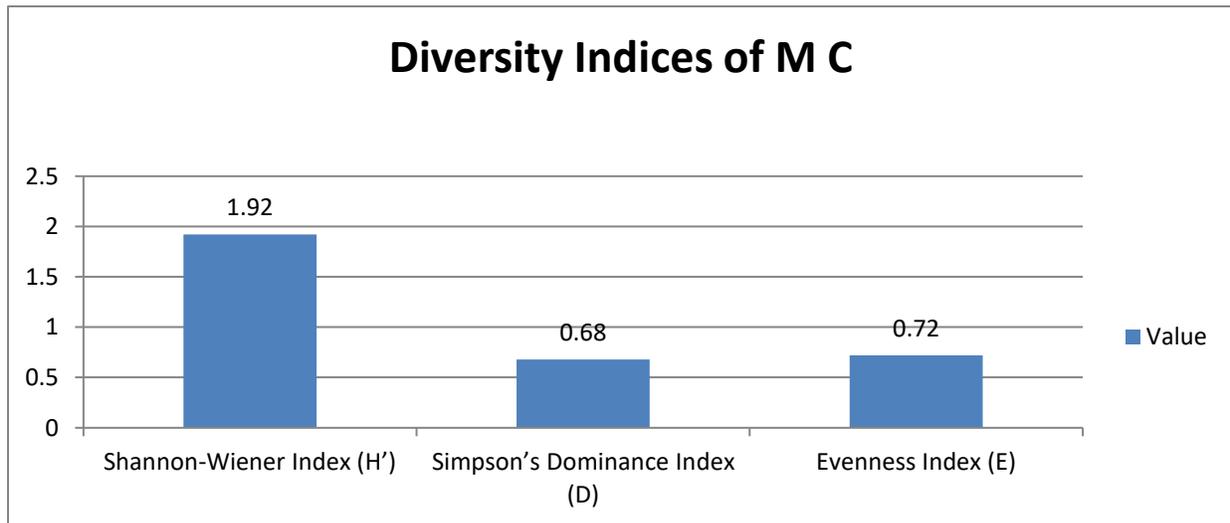
Graph 2: Diversity Indices of M C

Table 4 suggests that "the ratio of abundance to frequency (A/F)" points toward the different distribution patterns of the Mimosaceae species within Balaram-Ambaji Wildlife Sanctuary. The most abundant species, Prosopis juliflora and Acacia nilotica, had the highest abundance values, and A/F ratios of more than 0.10, which proves their contagious distribution, which is a characteristic feature of the species that create dense clustering as a result of favourable regeneration and adaptive ability. The same was also evident in Acacia catechu, Prosopis cineraria as well as Mimosa pudica which had contagious distribution albeit in lesser abundance indicating that these species tend to form patches as opposed to being evenly distributed within habitats. Alternatively, the abundance of Albizia lebbeck and Albizia odoratissima was relatively lower with A/F ratios of 0.08-0.09 and so was the pattern of random distribution, which could be relevant to habitat selectivity and restricted regeneration in niches. In general, the findings indicate that the majority of the species assume a contagious form due to ecological adaptation and habitat characteristics, with only a few exhibiting an unbiased pattern, thus, leading to the heterogeneity of the community.

Table 4: Abundance and Distribution Pattern (A/F Ratio)

Species	Abundance (Ind./Quadrat)	Frequency (%)	A/F Ratio	Distribution Pattern
Prosopis juliflora	8.1	68	0.12	Contagious
Acacia nilotica	6.2	54	0.11	Contagious
Acacia catechu	4.3	47	0.09	Contagious
Albizia lebbeck	3.1	38	0.08	Random
Prosopis cineraria	2.2	26	0.08	Contagious
Albizia odoratissima	2.0	21	0.09	Random
Mimosa pudica	1.5	19	0.07	Contagious
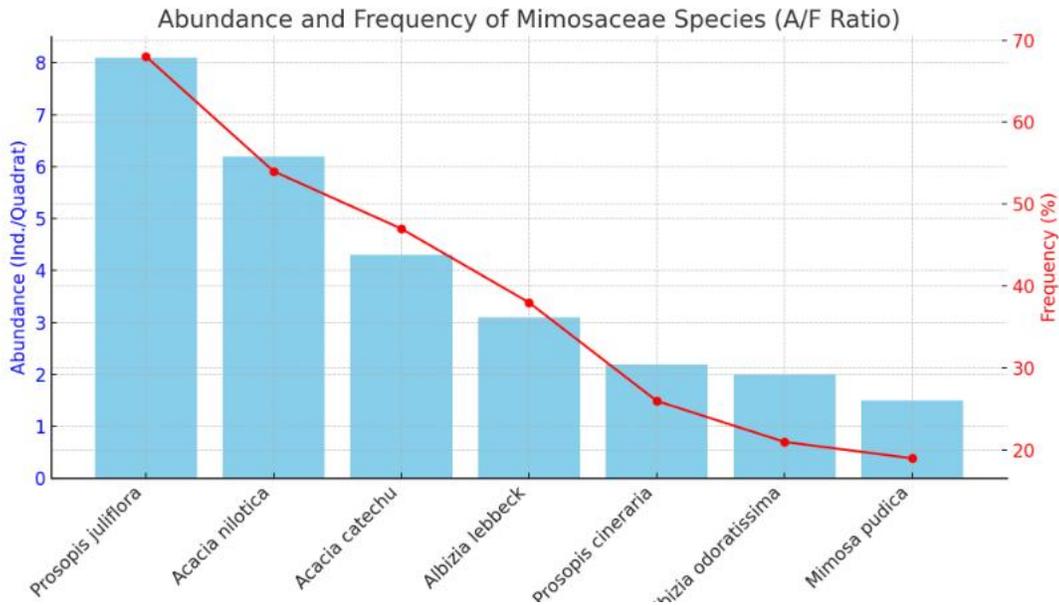
Graph 3: Abundance and Distribution Pattern (A/F Ratio)

V. DISCUSSION

A vegetational study of Mimosaceae conducted in the Balaram-Ambaji Wildlife Sanctuary (BAWS) showed that the Invasive Plants species, Prosopis juliflora had the highest Importance Value Index (IVI) of 82.5 while Acacia nilotica, had an IVI of 74.3.10. Das et al. (2019) [22], and Malek d. (2024) [20] again noted the growth of P. juliflora in the disturbed forests of Valsad, respectively after their previous report. P. juliflora is an invasive species and can spread quickly and replace native vegetation, which is now common in Rajasthan and Gujarat.

Acacia nilotica was an ecologically significant plant, contributing to the structure of forests and stabilizing

soil, as noted by Patel & Patels (2025) [18] and Thakor et al. (2025), [19] who observed its ability to adapt to semi-arid and wetland habitats. Patel (2023) [21] highlights the importance of Acacia catechu and Albizia lebbeck in determining their canopy size, with other native species showing moderate densities but high basal area values. This is also true for these species. Despite its low density, Prosopis cineraria demonstrated significant relative dominance, which supports previous research by Das et al. (2019) and Patel & Patels (2025).

Diversity indices (H' = 1.92, E = 0.72) suggested moderate levels of species diversity with an even distribution, lower than Thakor et al.'s (2025) findings on wetlands, but similar to description of dry deciduous forests. According to Das et al. (2019) [22], abundance-frequency ratios indicated that dominant species such as P. juliflora and A. nonregularis displayed widespread distribution patterns, while Albizia species displayed random patterns associated with habitat specificity or low biodiversity.

VI. CONCLUSION

In conclusion, the BAWS plant community has moderate diversity but is dominated by invasive P. juliflora. Indigenous species still hold ecological value but are progressively excluded. Comparative evidence implies that uncontrolled invasives spread has the potential to destabilize dry deciduous ecosystems. Management interventions such as selective invasive removal of P. juliflora and restoration planting of indigenous Mimosaceae are thus critical to ensure ecological balance and biodiversity resilience in the sanctuary.

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