Diversity and Adaptation of Plant Life Forms in Bassi Wildlife Sanctuary: A Phytoclimatic Analysis

Abstract

Bassi Wildlife Sanctuary (BWS) is located in the South-Eastern part of Rajasthan, India. This study resulted in plant life form diversity and distribution using Raunkiaer's classification system. Extensive field surveys were conducted in BWS between April 2017 and March 2019 to identify and record plant species.The collected specimens were identified by using state and regional floras.A total of 468 plant species belonging to 322 genera and 85 families were recorded. The results indicate that therophytes (55.8%) are the dominant life form, followed by phanerophytes (23.5%), hemicryptophytes (7.3%), cryptophytes (6.8 %) and chamaephytes (6.6%). On comparison with Raunkiaer's normal spectrum, the present study area depicts Thero-phanerophytic type of phytoclimate. This study also provides valuable insights into the plant ecology of BWS and contributes to the understanding of the region's biodiversity.

Keywords: Bassi Wildlife Sanctuary, Biological spectrum, Plant life forms, Raunkiaer classification, Thero-phanerophyticphytoclimate

Introduction

Plant life forms, reflecting plant adaptations to their environment, are crucial in plant ecology (Grime, 2001). Life forms are classified based on the adaptations of their perennating organs to survive unfavorable conditions. A plant's life form represents the sum of all its life processes and evolves directly in response to the environment (Cain, 1950). Humboldt (1886) first formulated the concept of life forms, considering the location of perennating buds or organs. Raunkiaer (1934) used it as a descriptive tool to classify plant life forms based on the position and protection of renewing buds that allow plants to regenerate during favorable seasons. According to this system, plant species can be grouped into five main classes: such as phanerophytes, chamaephytes, hemicryptophytes, cryptophytes, and therophytes. The combined percentage of these life form classes is known as the biological spectrum.

In India, several researchers have studied the biological spectrum of different regions (Singh and Arora, 1994; Rana *et al.*, 2002; Reddy *et al.*, 1999; Jamir *et al.*, 2006; Pattanaik *et al.*,

2007;Thakur *et al.*, 2012; Maitreya, 2015; Shahid & Joshi,2018; Srivastava & Shukla, 2019; Sen &Bhakat, 2021). In Rajasthan, a few attempts have been made in this direction, with notable contributions of Pandey and Parmar (1993), Sarup (1952) and Reddy *et al*., (2011).Realizing this study aims to investigate the diversity and distribution of plant life forms within Bassi Wildlife Sanctuary (BWS), India.

Study Area

Bassi Wildlife Sanctuary (BWS) is situated in Rajasthan's southeastern Chittorgarh District, covering an area of 138.69 km² (Figure 1). Its geographical coordinates are 74° 47' to 74° 57' E longitude and 24° 55' to 25° 07' N latitude. The study area encompasses Begu and Chittorgarh tehsils. The temperature varies from 23.8°C to 43.8°C in summer, while from 11.6°C to 28.4°Cin winter. Annual precipitation varies between 600-850 mm. The Sanctuary area consists of wide range of habitats such as hilly terrain, aquatic zones, plains etc. Geology of Bassi WLS is an admixture of complex geological formations belonging to Archean and Purana group of Algonkian, Archean and tori dean age and consists of upper Vindhayan and Aravalli systems. The topography, soil and bio-climate have resulted in different kinds of vegetation types in the Sanctuary area. The vegetation of the Sanctuary chiefly comprises of the Tropical deciduous forests intermixed with grasslands. The vegetation of the Wildlife Sanctuary is classified in to 5 types as per Champion & Seth (1966) viz.,1. II-Dry Tropical forest type, (sub classes as follows: Group 5B-northern tropical dry deciduous forest, E1-Anogeissus pendula forest, E2-Boswellia serrata forest).2. Riverine forests, 3. Tree savannah, 4.Scrublands and 5. Grasslands.

The *Anogeissus pendula* (*Terminalia pendula*) forest, locally known as Dhauk forest, represents an edaphic climax forest (6/E1). These forests are mainly found in the northern parts of the Sanctuary, covering the Bichore, Meghpura, and Parsoli forest areas. Other common tree species associated with *Terminalia pendula* include *Senegalia catechu* (Khair), *Vachellia leucophloea* (Rainj), *Albizia odoratissima* (Siris), *A. procera* (Safed Siris), *Anogeissus latifolia* (Safed Dhok), *Bauhinia racemosa* (Jhinja), *Butea monosperma* (Khakhro, Chola), *Cassia fistula* (Karmala, Amaltas), *Diospyros melanoxylon* (Timru, Bidi-patta), *Ehretia laevis* (Tambolia),

Erythrina suberosa (Dhobi-Palas, Dhed-Khakro), *Flacourtia indica* (Kantia), *Wrightia tinctoria* (Dudhia, Khirni), and *Ziziphus mauritiana* (Bordi), etc.

The common trees in Dry Deciduous forests as per species dominance are: *Senegalia catechu* (Khair), *Vachellia leucophloea* (Rainj), *Albizia odoratissima* (Siris), *A. procera* (SafedSiris), *Terminalia anogeissiana* (SafedDhok), *Bauhinia racemosa* (Jhinja), *Butea monosperma*(Khakhro, Chola), *Cassia fistula* (Karmala, Amaltas), *Diospyros melanoxylon* (Timru, Bidi-patta), *Ehretia laevis* (Tambolia), *Erythrina suberosa*(Dhobi-palas, Dhed-Khakro), *Flacourtia indica* (Kantia), *Wrightia tinctoria* (Dudhia, Khirni) and *Ziziphus mauritiana* (Bordi), etc.

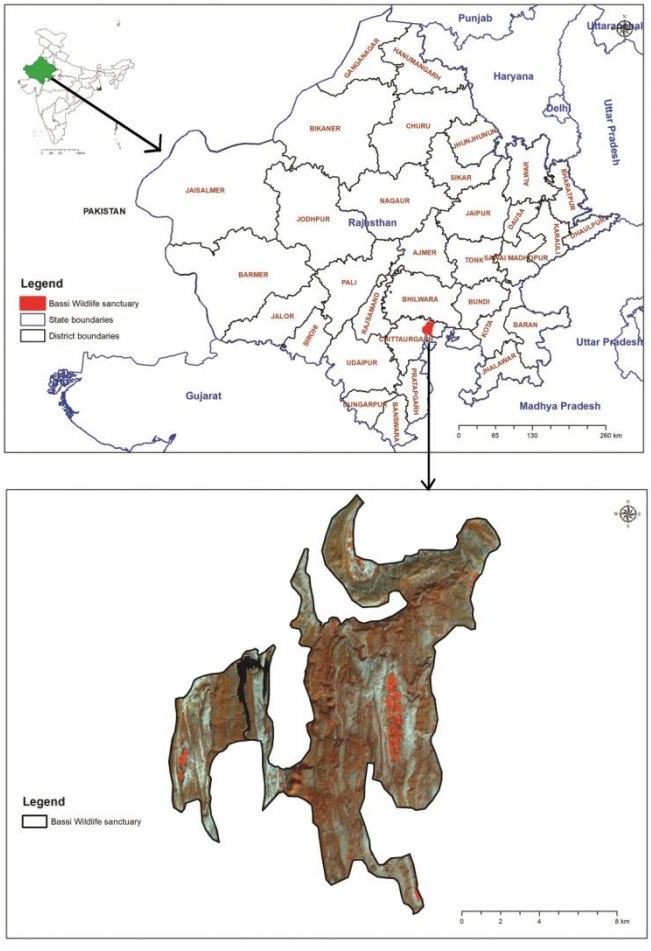

Figure 1. Map of the Study area(Sentinal-2 Satellite image)

Materials and Methods

Extensive field surveys were conducted in BWS between April 2017 and March 2019 to identify and record plant species. Field trips of 10 to 15 days duration were planned, taking into consideration the flowering and fruiting seasons of the plants inhabiting the area. Four exhaustive botanical explorations were conducted during different seasons of the year. For each plant, two voucher specimens were collected and duly tagged. In all, 964 field numbers of plant specimens were collected (Table 1). Data on habit, habitat, locality, latitude, longitude, altitude, associated plants, distribution pattern, abundance and phenology were recorded in the field note book. A wet preservation technique was used for preserve the plants.The collected specimens were identified by using state and regional floras (Shetty& Singh, 1987, 1991, 1993) and processed, deposited at BSJO, Jodhpur (Botanical Survey of India, Arid Zone Regional Centre Herbarium). Raunkiaer's classification system was used to categorize the recorded species into different life forms. The relative abundance of each life form was calculated as a percentage of total species richness.

Results

A total of 468 plant species belonging to 322 genera and 85 families were recorded in BWS. Therophytes (annuals) were the dominant life form, accounting for 55.8% of the total species richness, followed by phanerophytes (23.5%), hemicryptophytes (7.2%), cryptophytes (6.8%), and chamaephytes (6.6%) (Table 1).

Table 1. Biological spectrum of Bassi Wildlife Sanctuary

Sl.No.	Life Form	Number of species	Percentage of life-form in Present study	Percentage of life-form in Raunkiaer's normal spectrum
1	Therophytes	261	55.8	13.0
2	Phanerophytes	110	23.5	46.0
3	Hemicryptophytes	34	7.2	26.0
4	Cryptophytes	32	6.8	6.0
5	Chamaephytes	31	6.6	9.0
	Total	**468**	**100.0**	**100**

A comparison of the observed biological spectrum with Raunkiaer's normal spectrum revealed a Thero-phanerophyticphytoclimate for BWS. This indicates a dominance of annuals and perennials, characteristic of a relatively dry climate.

Table 2.Comparison of life forms of study area with other areas having similar climatic conditions in Rajasthan

Sl. No.	**Life Form**	**Ajmer (Reddy *et al.*, 2011)**	**SariskaTiger Reserve (Pandey & Parmar, 1993)**	**Mount Abu (Sarup, 1952)**	**Bassi WLS (Present Study)**
1	Therophytes	50.5	48.1	46.3	55.8
2	Phanerophytes	23.2	26.1	30.2	23.5
3	Hemicryptophytes	14.5	13.4	11.7	7.3
4	Cryptophytes	10	11.2	8.4	6.8
5	Chamaephytes	1.8	1.2	3.4	6.6
	Total	**100**	**100**	**100**	**100**

BWS life form spectrum was compared with Raunkiaer's normal spectrum as well as spectra of adjacent areas to evaluate its phytoclimate. Observed life form distribution in BWS resembles other regions in Rajasthan that have similar climatic conditions (Pandey & Parmar, 1993; Reddy *et al.*, 2011). As represented in Table 2, Therophytes are also dominant in Ajmer flora with a percentage of 50.5% and Sariska Tiger Reserve with 48.1%. This could be due to regional character ruled by the arid climate of this part of Rajasthan. This makes it rather interesting that Mount Abu shows a different composition of life form with a small percentage of Therophytes (46.3%) and high percentage of Hemicryptophytes as compared to BWS (Reddy et al., 2011).

Discussion

This study investigated the plant life forms present in Bassi Wildlife Sanctuary, Rajasthan, India. There were a total of 468 species recorded, out of the species, Therophytes-annuals dominated at 55.8%. Such dominance is much more than that of Raunkiaer's normal spectrum, meaning that the phytoclimate of BWS would be Thero-phanerophytic. This is one of the phytoclimates that tend to have dry conditions and are matched by the high proportion of therophytes with a few perennials in them (Phanerophytes - 23.5%). The high proportion of

therophytes in BWS would suggest there is a dry spell wherein a majority of plants take their whole life spans in a single year (Walter & Ellenberg, 1974). So many phanerophytes could exist to show that the area receives enough rains too to support the growth of woody plants (Whittaker &Niering, 1975). The Thero-phanerophyticphytoclimate observed corresponds to the general climatic conditions of the area (Mishra & Singh, 2008).

While the therophytes are much more dominant, the presence of phanerophytes indicates that the sanctuary is capable of supporting woody vegetation. These plants have adaptations that enable them to withstand dry periods, such as developing deep roots to access groundwater or leaves that are drought-tolerant. The balance between therophytes and phanerophytes in BWS suggests a dynamic ecosystem resilient to seasonal variations in precipitation. BWS showed presence of the thero-phanerophyticphytoclimate characteristic of many arid and semi-arid regions in India (Pattanaik *et al.*, 2007; Reddy *et al.*, 2011; Desai & Ant, 2012). This phytoclimate reflects that fine-tuning between plant adaptations and environmental conditions exists, thus it is essential to study the dynamics of these ecosystems.

This study contributes to our understanding of BWS's plant ecology and provides valuable information to efforts in its conservation and management. Several recent studies have highlighted climate change factors, affecting the composition and distribution of plant communities in many areas around the world (De, M. & Dhote, 2021; Sato*et al.*, 2024). Further studies are needed to assess the factors influencing the distribution of plant life forms in BWS and the impact of climate change on this community.

Conclusion

This study provides a comprehensive analysis of plant life forms that exist in BWS, Rajasthan, India. Dominance of Therophytes shows the arid nature of this region, characterized by a pronounced dry season. However, a considerable number of Phanerophytes also calls for periods of adequate rainfall in this area to support the growth of woody plants. This Thero-phanerophyticphytoclimate thus observed has conformed to the regional climatic conditions and is a typical adaptation to semi-arid environments.

The findings of this study coincide with earlier studies indicating the same processes to occur in other arid regions of Rajasthan. However, greater climatic changes like high temperatures and altered rainfall distribution pose a great threat danger to the ecological balance of BWS. Future researches in this region should monitor the long-term impacts of climatic changes on the composition and distribution of plant communities in this region.

Understanding the ecological significance of this area and its challenges, effective conservation strategies for BWS will preserve its unique biodiversity, such as restoring habitats and sustainable water management practices and mitigating climate change.

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