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

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Bassi Wildlife Sanctuary 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 (Shetty & Singh, 1987, 1991, 1993; Tiagi and Aery, 2007; Yadav& Meena, 2011; Harikrishna *et al*., 2022). 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.

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Keywords: Wildlife sanctuary; biological spectrum; plant life forms; Raunkiaer classification; Thero-phanerophytic phytoclimate.

1. 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.

1.1 Study Area

The Bassi Wildlife Sanctuary is situated in the Southern part of Aravalli ranges in District Chittorgarh, Rajasthan and is spread across 138.69 km². It lies between 74° 47' to 74° 57' E Longitude and 24° 55' to 25° 07' N Latitude. It was notified by the Wildlife Protection Act of 1972, vide the Gazette notification no. F(11)/41/Raj./8/86, dated 28.08.1988. The study area encompasses the Begu and Chittorgarh tehsil areas (Fig. 1). The study area covers Begu and Chittorgarh thesils.

The sanctuary landscape is described as a mosaic of habitat, which consists of hilly terrain and plains with aquatic zones. Complex interplay of Archean and Purana formations forms the bedrock consisting of older rocks such as phyllite, sandstone, and limestone. Laterite deposits and lithomergic clays are also mentioned in some parts of the region. There are very wide differences in soil types, from clayey to gravelly loam, sometimes related to the underlying geology and topography. Some areas contain patches of black or gray cotton soil, but the slopes and plateaus are overwhelmed by less fertile moormy soils.

The topography of the sanctuary is significantly undulating as represented by hills and hillocks, spreading a network of valleys and streams. The altitude varies between 250 and 600 meters, with the higher elevations characterized by diverse vegetation and unique microclimates.

The subtropical climate within this region is characterized by clear-cut seasons, hot dry summers, cool dry winters, and erratic monsoon season with heavy unseasonal rain. The summer temperature can go as high as 46°C whereas in the case of winter, temperature goes up to 11.6°C only. This region receives copious and much-needed rainfall during the monsoon season, mainly during June to September, and July is the wettest month. Still, the distribution of rainfall over the year is extremely uneven, and consequently, vegetation and water availability follow seasonal patterns.

The diverse geological, topographical, and climatic environment offers a rich tapestry of habitats for an incredibly wide range of flora and fauna. The coming together of these factors has moulded the special ecological character of the Bassi Wildlife Sanctuary, making it a vital refuge for biodiversity within the region.

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 (1968) 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

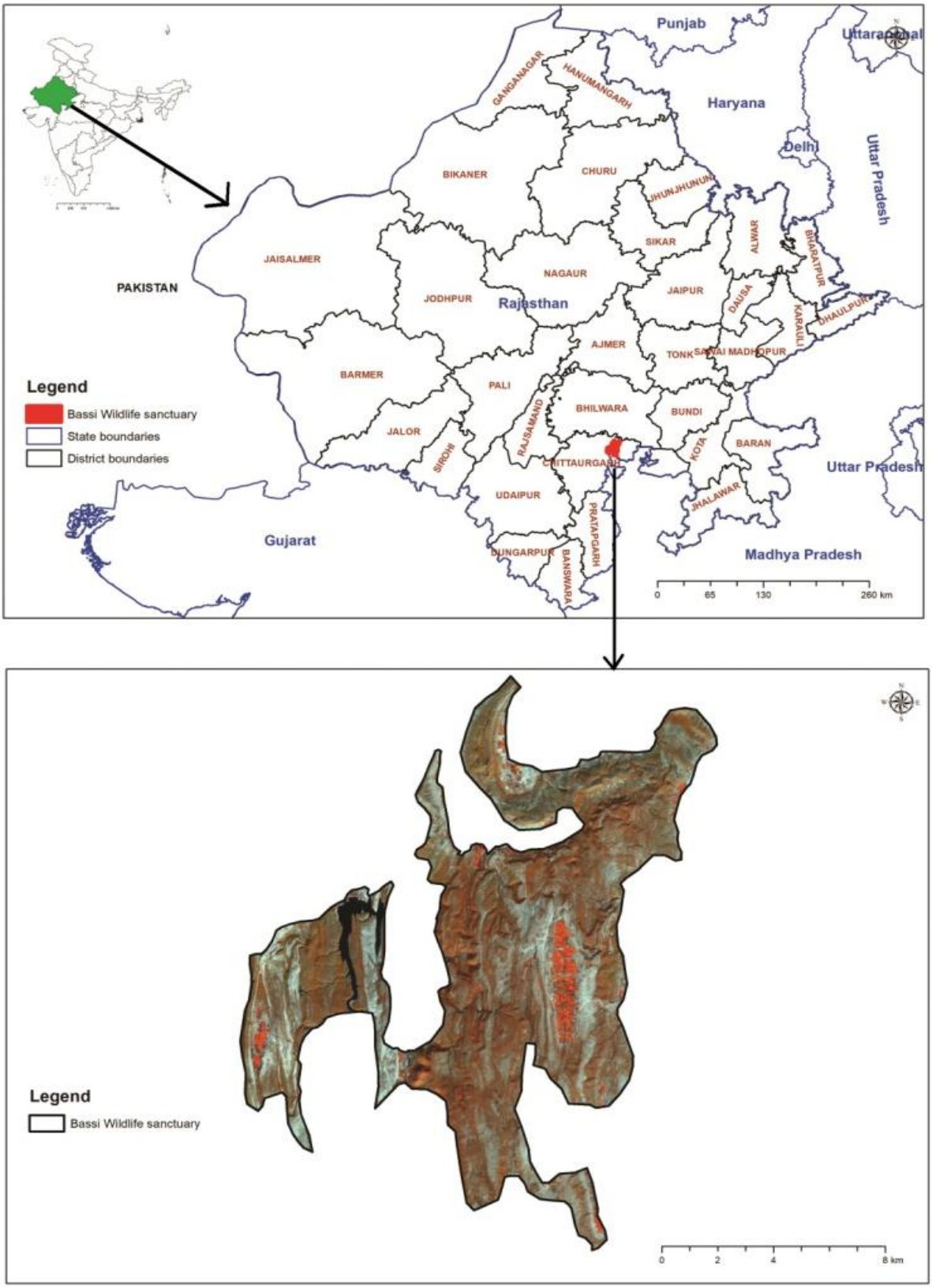

Fig. 1. Map of the Study area (Sentinal-2 Satellite image)

forests, 3. Tree savannah, 4. Scrublands and 5. Grasslands.

Bassi Wildlife Sanctuary is primarily characterized by Dry Deciduous Forests dominated by species like *Anogeissus pendula, Diospyros melanoxylon*, and *Senegalia catechu*. Riverine forests, dominated by *Mitragyna parvifolia* and *Terminalia arjuna*, are found along water bodies. Scrub vegetation, grasslands, and savannahs are also present. The sanctuary's unique *Anogeissus pendula* forests, locally known as Dhauk forests, are a significant feature, especially in the northern parts (Harikrishna & Kumar, 2024).

2. 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. 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; Tiagi and Aery, 2007; Yadav & Meena, 2011; Harikrishna *et al.,* 2022) 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.

3. RESULTS

The total indigenous and widely naturalised angiosperm flora of the sanctuary comprises about 468 species, belonging to 322 genera in 85 families (Table 1). Of these, 346 taxa are eudicots belonging to 243 genera and 68 families, and 117 taxa are Monocots belonging to 75 genera and 14 families, Basal angiosperms are represented by 5 taxa belongs to 4 genera under 3 families respectively. Which have been classified into different life form classes based on the Raunkiaer's system of classification (Table 2). 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 2 & Fig. 2).

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

Table 1. Statistical synopsis of the flora of Bassi Wildlife Sanctuary

Category	Families		Genera		Taxa	
	No.	%	No.	%	No.	%
Basal Angiosperms	3	3.4	4	1.2	5	1.1
Monocots	14	16.2	75	23.3	117	25.0
Eudicots	68	80.2	243	75.5	346	73.9
Total	85	100	322	100	468	100

Table 2. 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

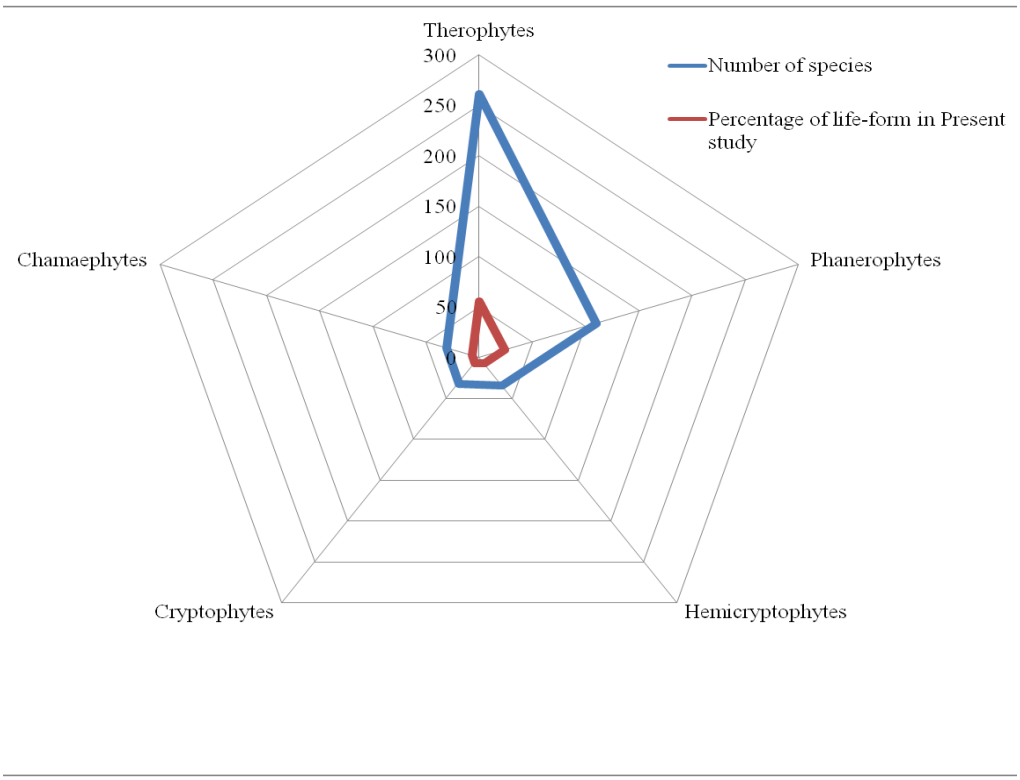

Fig. 2. Raunkiaer's biological spectrum of Bassi wildlife sanctuary

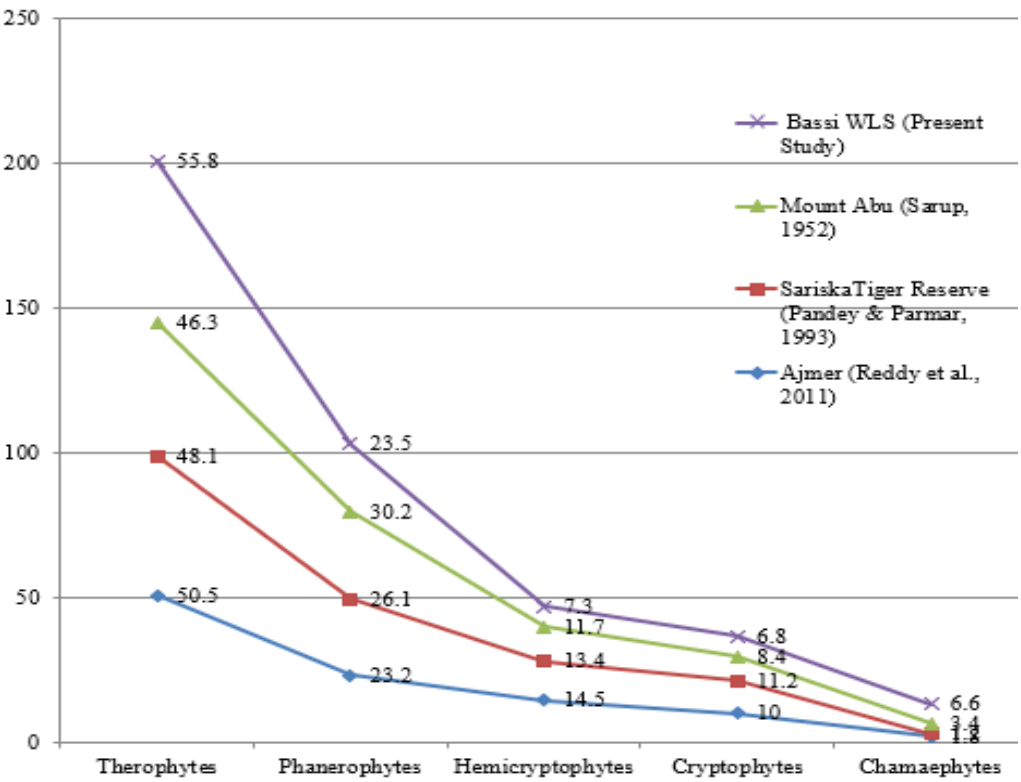

Fig. 3. Comparison of life forms of study area with other areas having similar climatic conditions in Rajasthan

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 Fig. 3, 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, Walter 1974).

4. DISCUSSION

This study investigated the plant life forms present in Bassi Wildlife Sanctuary (BWS), Rajasthan, India. Therophytes appeared to be the dominant life forms, accounting for 55.8%. The high percentage of therophytes corresponds to the subtropical features of the region and reflects the soil and climatic conditions (Subramani et al., 2007; Reddy et al., 2011; Sharma et al., 2014; Thakur, 2015; Shahid & Joshi, 2015). The dominance of therophytes greatly exceeds Raunkiaer's normal spectrum, indicating that the phytoclimate of BWS should be classified as thero-phanerophytic. Such a phytoclimate, usually typical of dry conditions, is characterized by a noticeable predominance of therophytes together with a much smaller but still noticeable predominance of phanerophytes (23.5%).

A relatively high percentage of phanerophytes suggests that BWS also receives adequate rain to support woody growth. This is supported by the literature on an interaction between rain and vegetative growth (Whittaker & Niering, 1975). The overall implication of this study is that therophytes may be the dominant component but phanerophytes add to the structural heterogeneity and strength of the ecosystem. Such adaptations, such as drought-resistant leaves or deep root systems to access ground water, allow phanerophytes to survive alongside therophytes in an environment with periodic seasonal shortage of water (Sato et al. 2024).

The thero-phanerophytic phytoclimate observed in BWS is reflective of the general climatic and ecological trends found in many arid and semi-arid regions within India (Pattanaik et al., 2007; Reddy et al., 2011; Desai & Ant, 2012). This balance of short-lived, opportunistic therophytes and perennial, drought-adapted phanerophytes presents a very dynamic relationship between plant adaptations and environments. These dynamics are important to understand when examining ecosystem resilience and responses to seasonal and long-term climatic variability.

This study contributes valuable insights into plant ecology and conservation and management. The composition of plant forms is an indicator of the ecological health of the region and how it reacts to environmental pressures. Emerging research demonstrates climate change as the central driver in reshaping plant community composition and distribution worldwide (De & Dhote, 2021; Sato et al., 2024). More research studies are hence necessary in determining factors influencing plant life forms distribution in the BWS, such as soil properties, microclimatic variations, and anthropogenic impacts. Evaluating the impact of climate change on this particular ecosystem can provide a basis of the projection of these trends and likely create adaptive management strategies in that specific ecosystem (Mishra & Singh 2008, De & Dhote 2021).

5. CONCLUSION

This study lays emphasis on therophytes dominating Bassi Wildlife Sanctuary, indicating a thero-phanerophytic phytoclimate characteristic of arid and semi-arid regions. Thus, despite the dominance of therophytes reflecting the dry conditions of the area, a significant proportion of phanerophytes in the region lays emphasis on the ability of that region to support woody vegetation owing to seasonal rainfall. This balance of therophytes and phanerophytes proves that plant communities in the local environment are dynamically adapted. The strength of BWS's ecosystem resilience to climatic variability is proven.

The results shed additional light on ecological dynamics within BWS, which serve as a basis for conservation and management activities. In light of this, future research should be directed toward understanding those specific environmental factors that are shaping the life forms comprising plant communities and determining the implications of changing climatic conditions. Such information will be important for developing appropriate strategies for preserving the

ecological integrity of BWS and similar systems as continued environmental changes take their toll.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Cain, S.A. (1950). Lifeforms and phytoclimate. *Bot. Rev.*Claredon press, Oxford. 16(1): 1-32.

Champion, H.G. and S.K., Seth (1968). *A Revised Survey of the Forest Types of India*. Manager of Publications, Delhi.

De, M. & Dhote, M (2021). Impact of Climate Change on Arid Region: Case Study of Rajasthan. *International Journal of Environment and Climate Change*, 11(12): 474- 478.

Desai, R. K. and H. M. Ant. (2012). Life Forms And Biological Spectrum Of The Flora Of Vadali Range Forest. *Life Sciences Leaflets,* 26: 60-63.

Grime, J. P. (2001). *Plant strategies and vegetation processes*. Wiley.

Harikrishna, P. and R. Kumar (2024). *Floristic diversity in Bassi Wildlife Sanctuary*, *Rajasthan*. Botanical Survey of India, Kolkata.

Harikrishna, P., R.K. Arigela, and C.S. Reddy. (2022). Floristic Diversity and Landscape of Aravallis, Rajasthan (India). Scientific Publishers, Jodhpur.

Humboldt, A. (1886). *Ideen zu einer Physiognomik der Gewechra*. Tubingeon.

Jamir, S.A., Upadhaya, K. and Pandey, H.N. (2006). Life form composition and stratification of montane humid forests in Meghalaya, northeast India. *Trop. Ecology* 47(2), pp 183-190.

Maitreya, B.B. (2015).Biologicalspectrumof vegetation in Maharaja Krishnakumarsinghji Bhavnagar University campus, Bhavnagar, India. *Indian journal of applied research*, 5(6): 2249-555.

Mishra, A. K., &Singh,J. S. (2008). *Ecological analysis and management of plant communities*. CRC Press.

Pandey, R.P., and P.J. Parmar (1993). An assessment of biological spectrum of flora of Rajasthan, *J. Econ. Tax. Bot.* 17: 99-103.

Parmar, P.J. (1987). A contribution to the flora of Sariska Tiger Reserve, Alwar district, Rajasthan. Bull. Bot. Surv. India 27: 29-40.

Pattanaik, C., C.S. Reddy and A.K. Biswal (2007). Life Forms and Biological spectrum of Bhitarkanika National Park, Orissa, India. *Indian J. Forestry* 30(3): 307-313.

Rana, T.S., Datt, B. and Rao, R.R. (2002). Life forms and biological spectrum of the Flora of Tons Valley, Garhwal Himalaya (Uttaranchal), India. *Taiwania* 47(2): 164-169.

Raunkiaer, C. 1934. *Plant life-forms in relation to general ecology*. Clarendon Press.

Reddy CS, P. Hari Krishna, SL. Meena, R. Bharadwaj and KC. Sharma (2011) Composition of Life Forms and Biological Spectrum along Climatic gradient in Rajsthan, India. *International Journal of Environmental Sciences* 1(7): 1632–1639.

Reddy, C.S., M.R. Bhanja and V.S. Raju (1999). Angiospermic flora and Biological spectrum of Jakaram reserve forest, Warangal district, Andhra Pradesh. *Indian Forester* 125: 1152-1166.

Sarup, S. (1952). The biological spectrum of the flora of Mt. Abu. *Univ. Rajasthan. Stud.* (*Biol.Sci.*) 2: 10-19.

Sato H, Mizoi J, Shinozaki K and Yamaguchi-Shinozaki K. (2024) Complex plant responses to drought and heat stress under climate change. *The Plant Journal,* 117(6):1873-92.

Sen, U. K. and R. K. Bhakat, (2021). Floristic composition and biological spectrum of a sacred grove in West Midnapore district, West Bengal, India. *Acta EcologicaSinica*, 41(2): 106-119.

Shahid, M. and S. P. Joshi (2018). Life-forms and biological spectrum of dry deciduous forests in Doon Valley, Uttarakhand, *India. J. Am. Sci,* 14(5): 30-34.

Sharma, J., Raina, A.K., and Sharma, S. (2014). Lifeform classification and biological spectrum of Lamberi Forest Range, Rajouri, J&K, India*. Int. J. of Current microbiology and applied Sc.,* 3(11):234-239

Shetty, B.V. and V. Singh (1987). *Flora of Rajasthan*, Vol. 1. Botanical Survey of India, Kolkata.

Shetty, B.V. and V. Singh (1991). *Flora of Rajasthan*. Vol. 2. Botanical Survey of India, Kolkata.

Shetty, B.V. and V. Singh (1993). *Flora of Rajasthan*. Vol. 3. Botanical Survey of India, Kolkata.

Singh, B.P. and A. Arora (1994). Biological spectrum of the vegetation of Ganganagar district of Rajasthan, *Rheedea*:4: 74-78.

Srivastava, N. and A. N. Shukla (2019). Biological spectrum and life form studies of Chandra Prabha Wildlife Sanctuary, Chandauli district, Uttar Pradesh. *Indian Forester*, 145 (5) : 435-446.

Subramani, S. P., V. Jishtu, R. K. Verma and K. S. Kapoor (2007).Floristic composition, life forms and biological spectrum of Renuka Wildlife Sanctuary, Himachal Pradesh. *Indian Forester*, 133 : 79-92.

Thakur, A.S. (2015). Floristic composition, life-forms and biological spectrum of tropical dry deciduous forest in Sagar District, Madhya Pradesh, India. *Tropical Plant Research* 2(2): 112–119.

Thakur, M., V. K., Santvan and A. Nigam, (2012). Floristic composition and biological spectrum of Darlaghat wild life sanctuary Solan Himachal Pradesh, India. *New York Science Journal,* 5(12): 1-14.

Tiagi, B. And Aery, N.C. (2007). *Flora of Rajasthan (South and South-east Region)*. Himanshu Publications, New Delhi.

Walter, H. and H. Ellenberg (1974). *Ecological plant geography*. Springer.

Whittaker, R. H., and Niering, W. A. (1975). *Principles of community ecology*. American Society of Naturalists.

Yadav, B.L. and K.L. Meena (2011). *Flora of South Central Rajasthan*. Scientific Publishers, Jodhpur.

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