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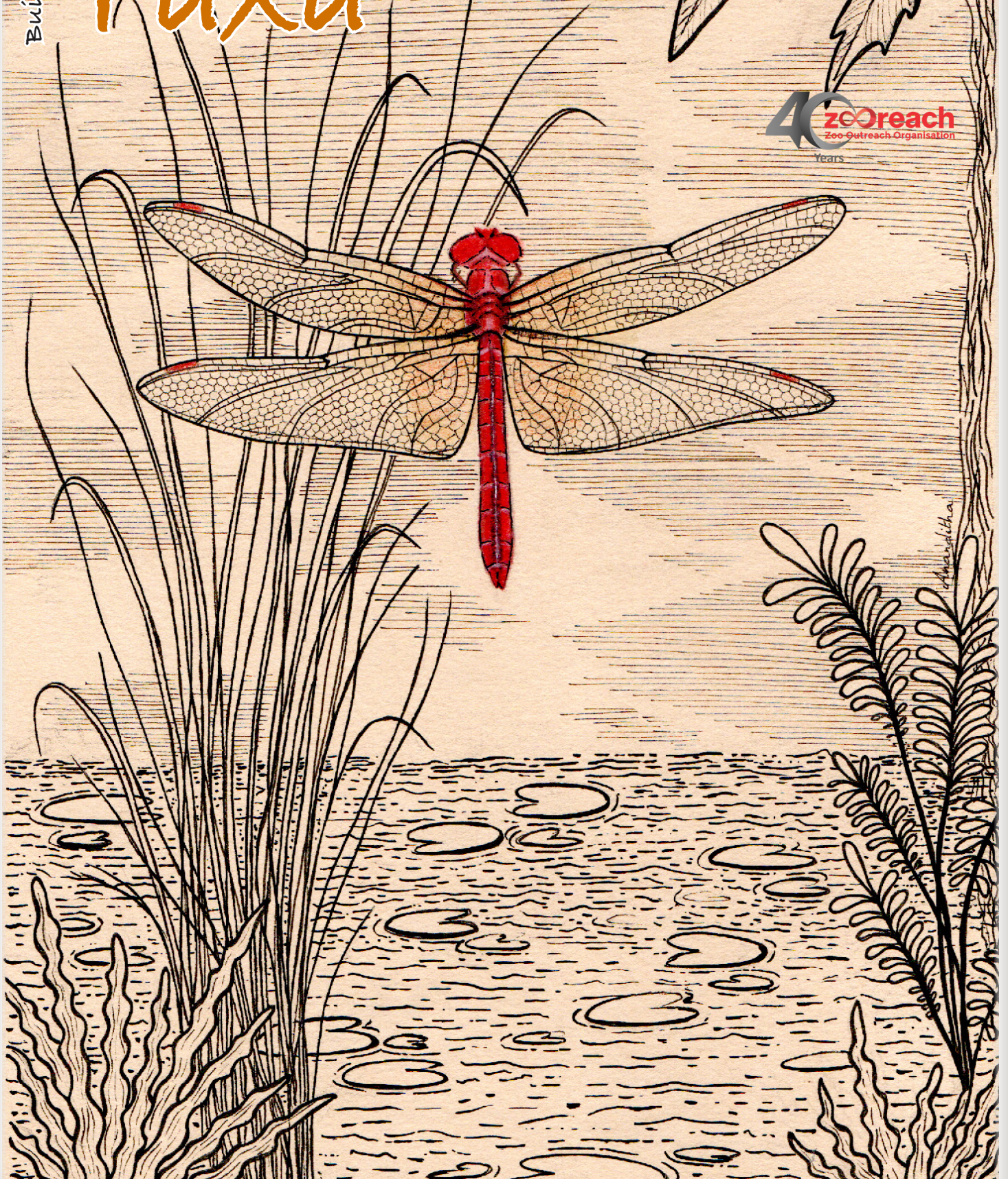
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Cover: A male Scarlet Skimmer perching on vegetation by the banks of a waterbody. Ink and watercolour illustration by Ananditha Pascal.

INTRODUCTION

Biodiversity refers to the variety and variability of biological organisms. It is a fundamental indicator of ecosystem health, directly reflecting its vitality, resilience, and stability (Byrnes et al. 2015; Wagg et al. 2022). The richness of plant diversity within an ecosystem not only enhances the aesthetic value of the landscape but also significantly contributes to the overall productivity of the ecosystem by providing essential resources such as food, medicine, fuel, and shelter that are crucial for the survival and well-being of both wildlife and humans (Singh et al. 2005). In arid and semi-arid regions, plant diversity is essential for regulating the water cycle, stabilizing soil, and combating desertification, thereby maintaining ecological balance (Ayangbenro & Babalola 2021). The loss of biodiversity in such fragile environments could lead to severe environmental degradation and disrupt ecosystem services that sustain local communities. Therefore, preserving plant diversity is essential for maintaining ecological balance and ensuring the long-term sustainability of human life in these regions. In recent years, increased anthropogenic activities, including mining, agricultural expansion, habitat fragmentation, and changes in land use, have been observed in these regions, underscoring the urgent need for conservation efforts (Islam & Rahmani 2011; Ram 2021).

Arid and semi-arid ecosystems exhibit pronounced spatiotemporal variability in vegetation composition due to changes in rainfall, temperature, and grazing pressure, making them highly vulnerable to climatic variability (Chapungu et al. 2020; Wu et al. 2023; Sur et al. 2024; Al-Mutairi 2025). These environmental factors strongly influence net primary productivity and ecosystem CO₂ exchange, affecting vegetation dynamics across temporal scales (Knapp & Smith 2001; Huxman et al. 2004a,b). Continuous, systematic plant monitoring in such landscapes provides essential time-series data to track changes in community composition and species resilience (Bagchi et al. 2017; Reddy et al. 2020; Tiruvaimozhi 2024). Such periodic assessments also effectively capture ephemeral species limited to short favourable conditions and enable early detection of invasive species like *Prosopis juliflora*, facilitating timely management interventions in these ecosystems (Kumar et al. 2021; Burke 2023).

To date, numerous studies across western Rajasthan have significantly contributed towards understanding regional plant diversity, including notable works by Gupta & Sharma (1977), Singh et al. (1997), Sharma

& Aggarwal (2008), Sharma & Purohit (2013), Parihar & Choudhary (2017), Meena & Khan (2023), and Sanadya et al. (2023). Moreover, in the past five years, three floristic surveys have been conducted in the Tal Chhapar Wildlife Sanctuary representing a significant shift in shrub and herbaceous plant diversity within the sanctuary from 2015 to 2023. These are Kaur et al. (2020) reporting 78 species, Bagoriya et al. (2021) 139 species, and Karel & Gena (2023) 132 species. These changes are likely driven by environmental factors (Wu et al. 2021, 2023) and adaptive management practices. Despite this evidence of ecological dynamism, long-term and repeated monitoring remains limited, constraining our understanding of species turnover, vegetation resilience, and ecosystem stability. The present study therefore aims to bridge this gap through a biennial floristic reassessment of Tal Chhapar, focusing on documenting current plant diversity, detecting species additions or losses relative to prior records, and revalidating taxonomic designations under the APG IV classification. This study aims to provide a comprehensive checklist of angiosperm diversity within the sanctuary, offering valuable insights to inform conservation efforts and management strategies that preserve biodiversity and promote the well-being of local communities.

MATERIALS AND METHODS

Study area

Tal Chhapar Wildlife Sanctuary (TWS) (27.840° N, 74.484° E), situated in Sujangarh Tehsil of Churu District in northwestern Rajasthan, covers an area of 719 ha, as shown in Figure 1. It is divided into two unequal halves by the Chhapar-Sujangarh state highway. Located within the 3-A Thar Desert (Rodger et al. 2002), the sanctuary experiences extreme temperatures, ranging from -1 °C in December–January to 50 °C in May–June, with 95% of its annual rainfall occurring during the monsoon season, July–September. According to Champion & Seth (1968), the vegetation of the study area is classified as “the desert thorn forest (6B/C1).” The sanctuary landscape features grass species such as *Cenchrus setigerus*, *Cynodon dactylon*, *Desmostachya bipinnata*, *Dichanthium annulatum*, *Lasiurus scindicus*, and *Sporobolus marginatus*, interspersed with tree species like *Acacia nilotica*, *Azadirachta indica*, *Capparis decidua*, *Prosopis cineraria*, *Neltuma juliflora*, *Salvadora persica*, and *Ziziphus mauritiana* creating a savannah-like ecosystem (Kaur et al. 2020).

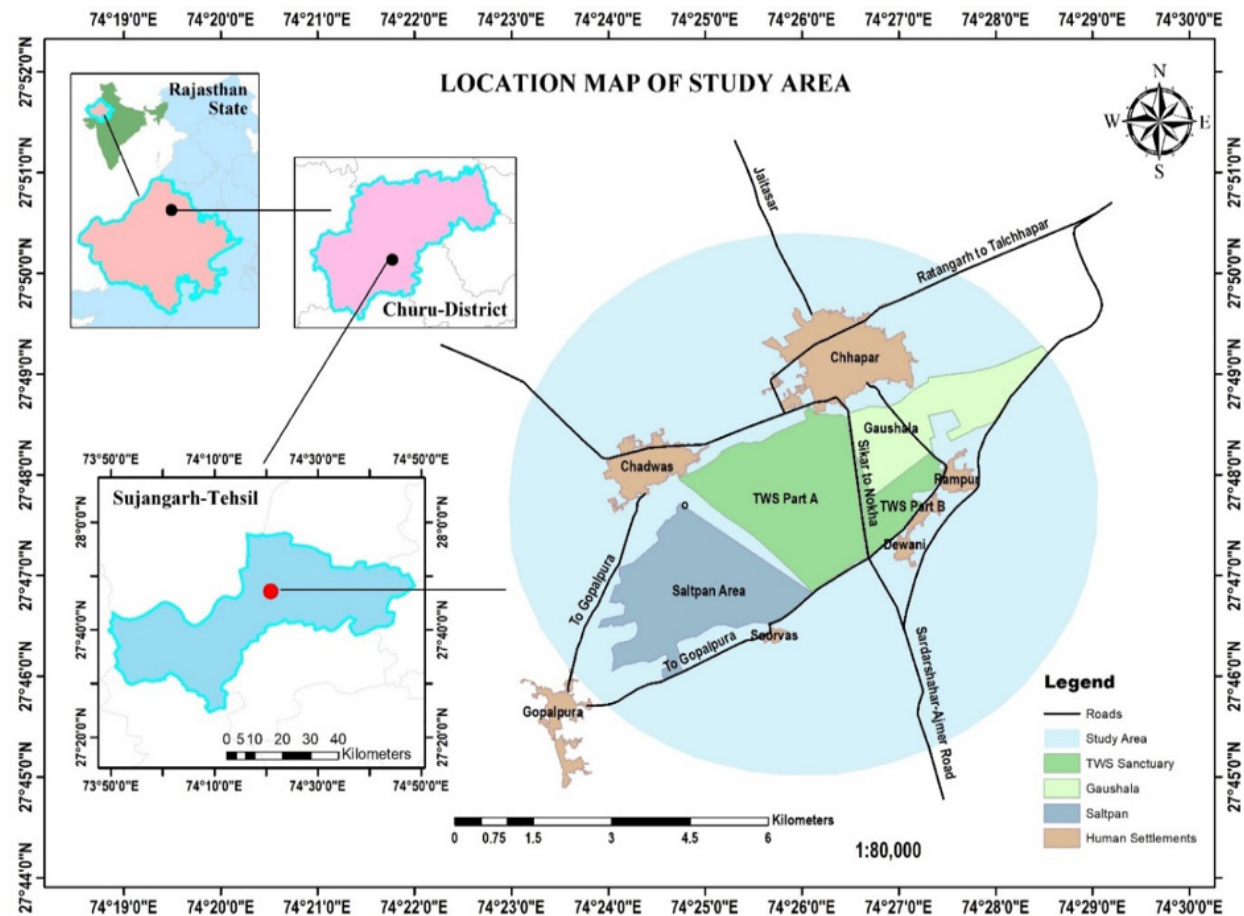


Figure 1. Location map of the study area: Tal Chhapar Wildlife Sanctuary, Churu, Rajasthan.

Methods

The present study was conducted from August 2022–March 2024, spanning the post-monsoon, winter, and spring seasons, which are known for peak plant diversity in this region. This time frame was strategically chosen to capture maximum diversity, as species diversity is typically lowest during the summer, while evenness remains relatively stable throughout the year (Kaur et al. 2020). The sanctuary was surveyed every 15 days using a random search approach to collect plant samples. The researcher moved systematically through the study area without following predetermined routes or fixed sampling points, ensuring unbiased sampling across diverse microhabitats. The voucher specimens were tagged, prepared as herbarium specimens following the standard procedure (Rao & Sharma 1990), and deposited at the Herbarium of the Department of Wildlife Science, Aligarh Muslim University, Uttar Pradesh. Plant specimens were identified in the field using the existing Flora of Rajasthan and relevant published literature (Shetty & Singh 1987, 1991, 1993; Bhandari 1995; Peddi

et al. 2014; Charan & Sharma 2016; Sanadya et al. 2023). The species nomenclature was updated according to the latest standards of the International Plant Name Index (IPNI), with binomial names and author citations sourced from trusted databases such as Plants of the World Online (POWO 2025) and World Flora Online (WFO 2025). Angiosperm classification followed the Angiosperm Phylogeny Group IV (2016) system, with plants categorized into magnoliids, monocots, and eudicots. To ensure clarity and ease of reference, families, their respective genera, and the species within each genus have been organized in alphabetical order in each angiosperm group. A comprehensive checklist of the flora in TWS Sanctuary was compiled, detailing species' vernacular names, angiosperm types, growth habits, plant life forms as classified by Raunkiaer's system (Raunkiaer 1934), and their distribution.

RESULTS

Floristic diversity of TWS

Table 1 summarizes the findings from the floristic survey carried out in TWS, revealing a total of 211 identified species belonging to 49 families and 146 genera. Eudicots dominated the flora, with 44 families, 116 genera, and 154 species. Asteraceae emerges as the most diverse eudicot family, with 16 genera and 17 species, followed by Amaranthaceae (10 genera, 17 species), and Fabaceae (13 genera, 16 species). Monocots were represented by only four families, contributing significantly to the flora, with 29 genera and 56 species. Within monocots, Poaceae stands out as the dominant family, with 26 genera and 49 species, thereby enriching the sanctuary's floristic diversity, as illustrated in Figure 2. In the present survey, the family Annonaceae was the sole representative of the magnoliids, comprising a single species.

Furthermore, *Eragrostis* was identified as the most diverse genus, comprising eight species, followed by *Amaranthus*, with six species, and *Cyperus* and *Sporobolus*, each with five species. These four genera together accounted for 11.37% of the total flora, highlighting the sanctuary's ecological complexity and plant diversity across various genera, as shown in Table 1.

Classification of plants based on their growth habits and Raunkiaer's Life forms

The composition and adaptation strategies of the sanctuary's flora were analyzed using growth habits and Raunkiaer's life form classification. Growth habit analysis revealed that herbaceous plants were the most dominant, accounting for 40% of the total flora (84 species), followed by grasses at 23% (49 species), trees 12% (26 species), and shrubs 12% (26 species) also contributed significantly, while climbers 5% (10 species), succulents 5% (11 species), and sedges 3% (two species) represented smaller proportions, as illustrated in Figure 3.

Similarly, Raunkiaer's classification, based on the position of perennating organs, identified therophytes (annuals surviving as seed) as the most prevalent category, constituting 49.8% (105 species) of the flora. Phanerophytes (perennial trees and shrubs with buds located over 25 cm above ground) accounted for 18% (38 species), while hemicryptophytes (buds at or just above the soil surface) represented 16.59% (35 species). Chamaephytes (buds up to 25 cm above ground) and geophytes (plants with underground storage organs) collectively formed 16% of the flora, with 11 and two species, respectively, as shown in Figure 4.

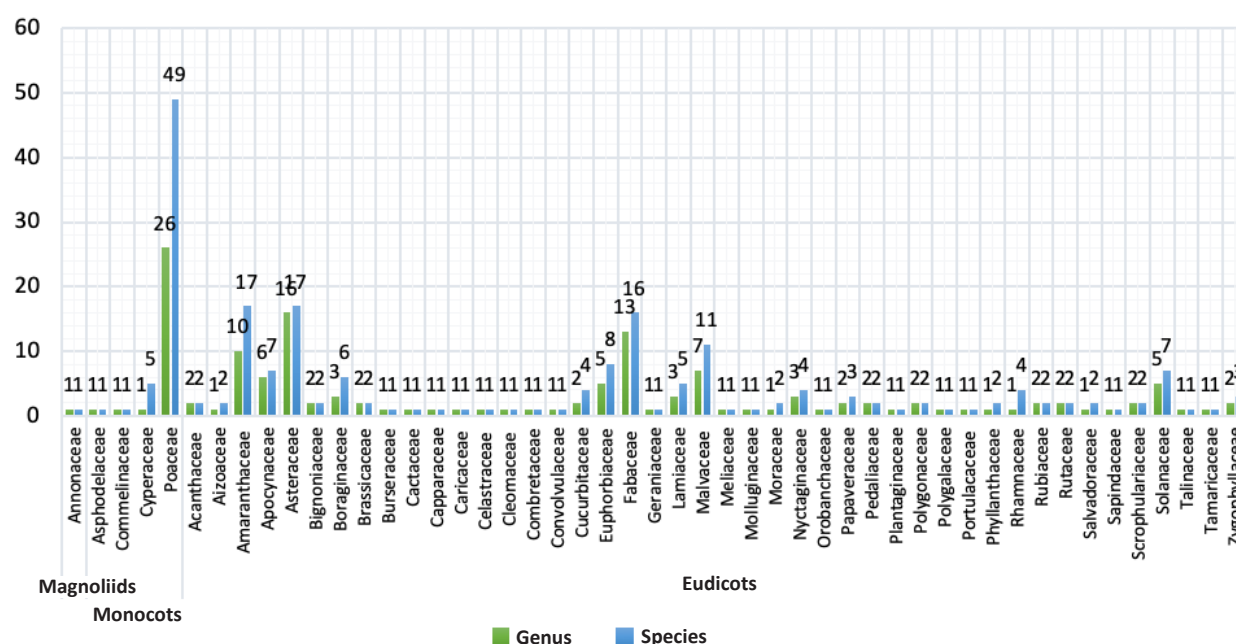


Figure 2. Angiosperm diversity of Tal Chhapar Wildlife Sanctuary, Rajasthan.

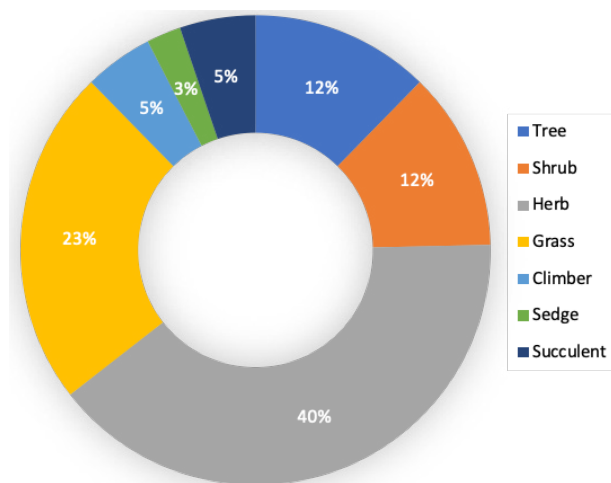


Figure 3. Vegetation composition of Tal Chhapar Wildlife Sanctuary, Rajasthan.

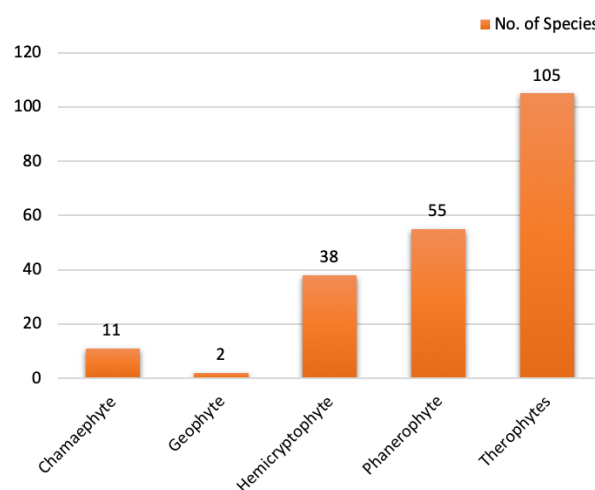


Figure 4. Classification of plants based on their Raunkiaer's Life forms.



Image 1. Plant species of conservation importance: a—*Commiphora wightii* | b—*Tecomella undulata*.

Ecological importance and conservation priorities of the sanctuary

As outlined in Table 1, the sanctuary is home to 211 identified species, of which 72.51% (153 species) are native and 27.49% (58 species) are introduced. The species are nearly evenly distributed, with 49.76% (105 species) being annuals and 50.24% (106 species) perennials, as shown in Figure 5. Additionally, the sanctuary hosts two IUCN Red Listed species: *Commiphora wightii*, classified as 'Critically Endangered' (Ved et al. 2015), and *Tecomella undulata*, classified as 'Endangered' (Plummer 2021), also depicted in Images 1a&b.

DISCUSSION AND CONCLUSION

This study recorded 211 angiosperm species within the sanctuary, showing a significant increase compared to previous reports of 78 species (Kaur et. al. 2020), 139 species (Bagoriya et al. 2020), and 102 species (Karel & Gena 2023). Among these, 108 species were recorded for the first time in the sanctuary. This increase in the species' number may be attributed to habitat changes influenced by management practices such as removing invasive species like *Neltuma juliflora*, maintaining waterholes during dry periods, implementing controlled burns, and

Table 1. Updated floristic diversity of Tal Chhapar Wildlife Sanctuary, Churu in Rajasthan.

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
1. Annonaceae						
<i>Monoon longifolium</i> (Sonn.) B.Xue & R.M.K.Saunders (2012) *	Ashok	Ma	P	T	Ph	N
2. Asphodelaceae						
<i>Aloe vera</i> (L.) Burm.f. (1768)	Guarpatta	M	P	Su	Ch	I
3. Commelinaceae						
<i>Commelina benghalensis</i> L. (1753)	Moriyabati, Bakhana	M	A	H	Th	N
4. Cyperaceae						
<i>Cyperus bulbosus</i> Vahl (1805)	Mothh	M	P	Se	Ge	N
<i>Cyperus compressus</i> L. (1753)	Mothio	M	A	Se	Th	N
<i>Cyperus flavidus</i> Retz. (1788)	Peeli-mutha	M	A	Se	Th	N
<i>Cyperus iria</i> L. (1753)	Moth	M	A	Se	Th	N
<i>Cyperus rotundus</i> L. (1753)	Motha	M	P	Se	Ge	N
5. Poaceae						
<i>Acyrhne racemosa</i> (B.Heyne ex Roth) Ohwi (1947)	Jaran, Chinki	M	A	G	Th	N
<i>Aristida adscensionis</i> L. (1753)	Lampro	M	A	G	Th	N
<i>Aristida funiculata</i> Trin. & Rupr. (1842)	Lamp	M	A	G	Th	N
<i>Aristida mutabilis</i> Trin. & Rupr. (1842)	-	M	A	G	Th	N
<i>Aristida setacea</i> Retz. (1786)	Danta	M	A	G	Th	N
<i>Bothriochloa pertusa</i> (L.) A.Camus (1931)	Chhoti-jergi	M	P	G	He	N
<i>Cenchrus biflorus</i> Roxb. (1820)	Bhurut	M	A	G	Th	N
<i>Cenchrus ciliaris</i> L. (1771)	Dhaman, Anjan	M	P	G	He	N
<i>Cenchrus prieurii</i> (Kunth) Maire (1931)	Lambio-bhurut	M	P	G	He	N
<i>Cenchrus setigerus</i> Vahl (1806)	Kala Dhaman	M	P	G	He	N
<i>Chloris barbata</i> Sw. (1797)	Boj-patra	M	A	G	Th	N
<i>Chloris flagellifera</i> (Nees) P.M.Peterson (2015)	Ganthil Ghas	M	P	G	He	N
<i>Chloris virgata</i> Sw. (1797)	Gharniaghas	M	P	G	He	I
<i>Cynodon dactylon</i> (L.) Pers. (1805)	Doob	M	P	G	He	N
<i>Dactyloctenium aegyptium</i> (L.) Willd. (1809)	Makaro	M	A	G	Th	N
<i>Dactyloctenium scindicum</i> Boiss. (1859)	Mansa	M	P	G	He	N
<i>Desmostachya bipinnata</i> (L.) Stapf (1900)	Dab	M	P	G	He	N
<i>Dichanthium annulatum</i> (Forssk.) Stapf (1917)	Karad	M	P	G	He	N
<i>Dichanthium aristatum</i> (Poir.) C.E.Hubb. (1940)	-	M	P	G	He	N
<i>Digitaria bicornis</i> (Lam.) Roem. & Schult. (1817)	Jheranio	M	A	G	Th	N
<i>Digitaria sanguinalis</i> (L.) Scop. (1771)	Baans Ghas	M	A	G	Th	N
<i>Echinochloa colonum</i> (L.) Link (1833)	Soma, Phunkia	M	A	G	Th	N
<i>Eleusine indica</i> (L.) Gaertn. (1788)	Ghoda-doob	M	A	G	Th	N
<i>Eleusine tristachya</i> (Lam.) Lam. (1792)	-	M	A	G	Th	I
<i>Enteropogon monostachyos</i> (Vahl) K.Schum. (1894)	-	M	P	G	He	N
<i>Eragrostis cilianensis</i> (All.) Vignolo ex Janch. (1907)	-	M	A	G	Th	N
<i>Eragrostis ciliaris</i> (L.) R.Br.(1818)	Burbudi	M	A	G	Th	N
<i>Eragrostis japonica</i> (Thunb.) Trin. (1830)	-	M	A	G	Th	N
<i>Eragrostis minor</i> Host (1827)	Poongyo	M	A	G	Th	N
<i>Eragrostis multiflora</i> Trin. (1830)	Chualio	M	A	G	Th	N

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
<i>Eragrostis pilosa</i> (L.) P.Beauv. (1812)	Chidi-pinkhia	M	A	G	Th	N
<i>Eragrostis tenella</i> (L.) P.Beauv. ex Roem. & Schult. (1817)	Bharburo	M	A	G	Th	N
<i>Eragrostis unioides</i> (Retz.) Nees ex Steud. (1854)	-	M	A	G	Th	N
<i>Lasiurus scindicus</i> Henrard (1941)	Sevan	M	P	G	He	N
<i>Melanocenchris jacquemontii</i> Jaub. & Spach (1851)	-	M	A	G	Th	N
<i>Panicum turgidum</i> Forssk. (1775)	Murantio Ghas	M	P	G	He	N
<i>Perotis indica</i> (L.) Kuntze (1891)	Lonki-puncho	M	A	G	Th	N
<i>Polypogon viridis</i> (Gouan) Breistr. (1966)	-	M	A	G	Th	N
<i>Saccharum spontaneum</i> L. (1771)	Kans	M	P	G	He	N
<i>Schoenefeldia gracilis</i> Kunth (1830)	Tarwaria	M	A	G	Th	N
<i>Sporobolus airoides</i> (Torr.) Torr. (1853)	-	M	P	G	He	I
<i>Sporobolus coromandelianus</i> (Retz.) Kunth (1829)	-	M	P	G	He	N
<i>Sporobolus diandrus</i> (Retz.) P.Beauv. (1812)	Chiria ka Dana	M	P	G	He	N
<i>Sporobolus indicus</i> (L.) R.Br. (1810)	-	M	P	G	He	I
<i>Sporobolus ioclados</i> (Nees ex Trin.) Nees (1841)	Poolongi	M	P	G	He	N
<i>Tetrapogon tenellus</i> (J.Koenig ex Roxb.) Chiov. (1907)	Lampada	M	A	G	Th	N
<i>Tragus berteronianus</i> Schult. (1824)	-	M	A	G	Th	I
<i>Triplidium bengalense</i> (Retz.) H.Scholz (2006)	Munja	M	P	G	He	N
<i>Urochloa ramosa</i> (L.) T.Q.Nguyen (1966)	Muret	M	A	G	Th	N
6. Acanthaceae						
<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees (1832)	Kalpnaath	E	A	H	Th	N
<i>Dicliptera paniculata</i> (Forssk.) I.Darbysh. (2007)	Kagjangha	E	A	H	Th	N
7. Aizoaceae						
<i>Trianthema portulacastrum</i> L. (1753)	Sato	E	A	Su	Th	N
<i>Trianthema triquetrum</i> Willd. ex Spreng. (1825)	Dhedosanto	E	A	Su	Th	N
8. Amaranthaceae						
<i>Achyranthes aspera</i> L. (1753)	Chirchita	E	P	H	He	N
<i>Aerva javanica</i> (Burm.f.) Juss. ex Schult. (1819)	Safed Bui	E	P	H	Ch	N
<i>Aerva tomentosa</i> Forssk. (1775)	Buari	E	P	H	Ch	N
<i>Amaranthus blitum</i> L. (1753) **	Lal Bhaji	E	A	H	Th	I
<i>Amaranthus blitoides</i> S.Watson (1877)	Chaulai	E	A	H	Th	I
<i>Amaranthus hybridus</i> L. (1753) **	Chaulai	E	A	H	Th	I
<i>Amaranthus polygonoides</i> L. (1759)	Kairee, Sevari	E	A	H	Th	I
<i>Amaranthus spinosus</i> L. (1753)	Chandelo	E	A	H	Th	I
<i>Amaranthus viridis</i> L. (1763)	Jangali Chaulai	E	A	H	Th	I
<i>Atriplex halimus</i> L. (1753)	-	E	P	Su	He	I
<i>Chenopodiastrum murale</i> (L.) S.Fuentes, Uotila & Borsch (2012)	Khartua	E	A	H	Th	N
<i>Chenopodium album</i> L. (1753)	Bathua	E	A	H	Th	N
<i>Dysphania pumilio</i> (R.Br.) Mosyakin & Clemants (2002)	-	E	A	H	Th	I
<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss. (1879)	Lana	E	P	S	Ph	N
<i>Soda stocksii</i> (Boiss.) Akhani (2020)	-	E	A	H	Th	N
<i>Suaeda fruticosa</i> Forssk. ex J.F.Gmel. (1776)	Lani	E	P	H	Ch	N
<i>Suaeda monoica</i> Forssk. ex J.F.Gmel. (1776)	-	E	P	S	Ch	N

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
9. Apocynaceae						
<i>Calotropis gigantea</i> (L.) W.T.Aiton (1811)	Safed Aak	E	P	S	Ph	N
<i>Calotropis procera</i> (Aiton) W.T.Aiton (1811)	Aakado	E	P	Su	Ph	N
<i>Carissa carandas</i> L. (1767) *	Karonda	E	P	S	Ph	N
<i>Cascabela thevetia</i> (L.) Lippold (1980) *	Peeli Kaner	E	P	T	Ph	I
<i>Leptadenia pyrotechnica</i> (Forssk.) Decne. (1838)	Khimp	E	P	S	Ph	N
<i>Nerium oleander</i> L. (1753) *	Kaner	E	P	T	Ph	N
<i>Tabernaemontana divaricata</i> (L.) R.Br. ex Roem. & Schult. (1819) *	Chandini	E	P	S	Ph	N
10. Asteraceae						
<i>Blumea lacera</i> (Burm.f.) DC. (1834)	Kukrondha	E	A	H	Th	N
<i>Cyanthillium cinereum</i> (L.) H.Rob. (1990)	Sahadevi	E	A	H	Th	N
<i>Echinops echinatus</i> Roxb. (1832)	Unt-kantalo	E	P	H	He	N
<i>Eclipta prostrata</i> (L.) L. (1771)	Jal Bhangro	E	A	H	Th	I
<i>Erigeron bonariensis</i> L. (1753)	-	E	A	H	Th	I
<i>Helianthus annuus</i> L. (1753)	Surajmukhi	E	A	H	Th	I
<i>Lactuca serriola</i> L. (1756)	-	E	A	H	Th	I
<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajagopal (1969)	Janlee Gobi	E	P	H	He	N
<i>Parthenium hysterophorus</i> L. (1753)	Gajar Ghas	E	A	H	Th	I
<i>Pluchea lanceolata</i> (DC.) C.B.Clarke (1876)	Rasna	E	P	H	He	N
<i>Pseudoconyza viscosa</i> (Mill.) D'Arcy (1973)	Gandhana	E	A	H	Th	N
<i>Pulicaria undulata</i> (L.) C.A.Mey. (1831)	Sohanfali	E	A	H	Th	N
<i>Pulicaria wightiana</i> (DC.) C.B.Clarke (1876)	-	E	P	H	He	N
<i>Tridax procumbens</i> L. (1753)	Jayanti	E	A	H	Th	I
<i>Sonchus oleraceus</i> L. (1753)	Aakadio	E	A	H	Th	I
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.f. ex A.Gray (1876)	Jangali pSurajmukhi	E	A	H	Th	I
<i>Xanthium strumarium</i> L. (1753)	Aandheeda	E	A	H	Th	N
11. Bignoniaceae						
<i>Tecoma fulva</i> (Cav.) G.Don (1837) *	-	E	P	S	Ph	I
<i>Tecomella undulata</i> (Sm.) Seem. (1862)	Rohida	E	P	T	Ph	N
12. Boraginaceae						
<i>Cordia dichotoma</i> G.Forst. (1786) *	Goonda	E	P	T	Ph	N
<i>Euploca marifolia</i> (J.Koenig ex Retz.) Ancy & P.Javad (2020)	Choti Santari	E	P	H	He	N
<i>Euploca ovalifolia</i> (Forssk.) Diane & Hilger (2003)	Kunden	E	P	H	He	N
<i>Euploca strigosa</i> (Willd.) Diane & Hilger (2003)	Kamediya	E	A	H	Th	N
<i>Heliotropium europaeum</i> L. (1753)	-	E	A	H	Th	N
<i>Heliotropium zeylanicum</i> (Burm.f.) Lam. (1789)	-	E	A	H	Th	N
13. Brassicaceae						
<i>Brassica juncea</i> (L.) Czern. (1859) **	Rai	E	A	H	Th	I
<i>Farsetia stylosa</i> R.Br. (1826)	Hiran-chabo	E	A	H	Th	N
14. Burseraceae						
<i>Commiphora wightii</i> (Arn.) Bhandari (1965)	Guggal	E	P	S	Ph	N
15. Cactaceae						
<i>Opuntia elatior</i> Mill. (1768)	Nag-phani	E	P	Su	Ph	I

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
16. Capparaceae						
<i>Capparis decidua</i> (Forssk.) Edgew. (1862)	Kair	E	P	S	Ph	N
17. Caricaceae						
<i>Carica papaya</i> L. (1753) *	Papito	E	P	T	Ph	I
18. Celastraceae						
<i>Gymnosporia senegalensis</i> (Lam.) Loes. (1893) *	Kakero	E	P	T	Ph	N
19. Cleomaceae						
<i>Cleome viscosa</i> L. (1753)	Bagro	E	A	H	Th	N
20. Combretaceae						
<i>Combretum indicum</i> (L.) DeFilipps (1998)	Madhumati	E	P	C	Ph	N
21. Convolvulaceae						
<i>Cressa cretica</i> L. (1753)	Rudravanti	E	P	H	He	N
22. Cucurbitaceae						
<i>Citrullus colocynthis</i> (L.) Schrad. (1838) **	Tumba	E	A	C	Th	N
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai (1910) **	Matiro	E	A	C	Th	I
<i>Cucumis melo</i> L. (1753) **	Kaachri	E	A	C	Th	N
<i>Cucumis prophetarum</i> L. (1755)	Khat-khachro	E	P	C	Ch	N
23. Euphorbiaceae						
<i>Acalypha indica</i> L. (1753)	Khokali	E	A	H	Th	N
<i>Croton bonplandianus</i> Baill. (1864)	Kapur-kur	E	A	H	Th	I
<i>Euphorbia caducifolia</i> Haines (1914) *	Danda-thor	E	P	Su	Ph	N
<i>Euphorbia hirta</i> L. (1753)	Bara-dudhi	E	A	H	Th	I
<i>Euphorbia prostrata</i> Aiton (1789)	Dudhi	E	A	Su	Th	I
<i>Euphorbia thymifolia</i> L. (1753)	Choti-dudhi	E	A	H	Th	I
<i>Jatropha gossypifolia</i> L. (1753)	Ratanjoti	E	P	S	Ph	I
<i>Ricinus communis</i> L. (1753)	Arandio	E	P	S	Ph	I
24. Fabaceae						
<i>Clitoria ternatea</i> L. (1753)	Koyalri	E	A	C	Th	I
<i>Dalbergia sissoo</i> Roxb. ex-DC. (1825) *	Sheesham	E	P	T	Ph	N
<i>Medicago polymorpha</i> L. (1753)	Ghasar	E	P	H	He	I
<i>Neltuma juliflora</i> (Sw.) Raf. (1838) *	VilaytiKikar	E	P	T	Ph	I
<i>Parkinsonia aculeata</i> L. (1753)	Rambaval	E	P	T	Ph	I
<i>Pongamia pinnata</i> (L.) Pierre (1898) *	Karanj	E	P	T	Ph	N
<i>Prosopis cineraria</i> (L.) Druce (1914)	Khejri	E	P	T	Ph	N
<i>Tephrosia purpurea</i> (L.) Pers. (1807)	Dhamasa	E	A	H	Th	N
<i>Trifolium repens</i> L. (1753)	Barseem	E	P	H	He	N
<i>Senegalia senegal</i> (L.) Britton (1930)	Kumta	E	P	T	Ph	N
<i>Senna tora</i> (L.) Roxb. (1832)	Phunwad	E	A	H	Th	I
<i>Vachellia jacquemontii</i> (Benth.) Ali (2014)	Bu-banwali	E	P	T	Ph	N
<i>Vachellia leucophloea</i> (Roxb.) Maslin, Seigler & Ebinger (2013)	Roonjh, Urajio	E	P	T	Ph	N
<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb. (2008)	Banwal	E	P	T	Ph	N
<i>Vachellia tortilis</i> (Forssk.) Galasso & Banfi (2008)	Israeli Babool	E	P	T	Ph	I
<i>Vigna trilobata</i> (L.) Verdc. (1968)	Jangali Moth	E	A	C	Th	N

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
25. Geraniaceae						
<i>Geranium rotundifolium</i> L. (1753)	-	E	A	H	Th	N
26. Lamiaceae						
<i>Leucas aspera</i> (Willd.) Link (1822)	Thumbai	E	A	H	Th	N
<i>Leucas martinicensis</i> (Jacq.) R.Br. (1811)	Dargal	E	A	H	Th	N
<i>Ocimum americanum</i> L. (1755)	Bapchi	E	A	H	Th	N
<i>Ocimum tenuiflorum</i> L. (1753)	Ram Tulsi	E	P	H	Ph	N
<i>Premna resinosa</i> (Hochst.) Schauer (1847)	Ghitti	E	P	S	Ph	N
27. Malvaceae						
<i>Abutilon indicum</i> (L.) Sweet (1826)	Kanghi	E	P	S	Ch	N
<i>Abutilon pannosum</i> (G.Forst.) Schltl. (1851)	Khareti	E	P	H	Ch	N
<i>Abutilon ramosum</i> (Cav.) Guill. & Perr. (1831)	Ramo-saag	E	P	H	Ph	N
<i>Corchorus depressus</i> (L.) Peterm. (1845)	Chamghas	E	A	H	Th	N
<i>Corchorus tridens</i> L. (1771)	Kagnasha	E	A	H	Th	N
<i>Corchorus trilocularis</i> L. (1767)	Kagaroti	E	A	H	Th	N
<i>Gossypium arboreum</i> L. (1753) *	Dharira	E	P	S	Ph	N
<i>Grewia tenax</i> (Forssk.) Fiori (1912)	Gangeran	E	P	S	Ph	N
<i>Hibiscus × rosa-sinensis</i> L. (1753) *	Gudhal	E	P	S	Ph	I
<i>Malvastrum coromandelianum</i> (L.) Garcke (1857)	Khariniti	E	A	H	Th	I
<i>Sida cordifolia</i> L. (1753)	Bal, Khariniti	E	P	H	Ch	N
28. Meliaceae						
<i>Azadirachta indica</i> A.Juss. (1831)	Neem	E	P	T	Ph	I
29. Molluginaceae						
<i>Hypertelis cerviana</i> L. (2016)	Chirmori	E	A	H	Th	N
30. Moraceae						
<i>Ficus benghalensis</i> L. (1753) *	Bar	E	P	T	Ph	N
<i>Ficus religiosa</i> L. (1753)	Pipal	E	P	T	Ph	N
31. Nyctaginaceae						
<i>Boerhavia diffusa</i> L. (1753)	Chinawari, Santhi	E	P	H	He	N
<i>Boerhavia erecta</i> L. (1753)	Saanth	E	P	H	He	I
<i>Bougainvillea glabra</i> Choisy (1849) *	Bogan Bel	E	P	C	Ph	I
<i>Commicarpus plumbagineus</i> (Cav.) Standl. (1916)	Lal Sakhari	E	P	C	He	N
32. Orobanchaceae						
<i>Lindenbergia indica</i> (L.) Vatke (1875)	-	E	P	H	Ph	N
33. Papaveraceae						
<i>Argemone mexicana</i> L. (1753)	Satyanashi	E	A	H	Th	I
<i>Argemone ochroleuca</i> Sweet (1828)	-	E	A	H	Th	I
<i>Fumaria indica</i> (Hausskn.) Pugsley (1919)	Pitpapro	E	A	H	Th	N
34. Pedaliaceae						
<i>Sesamum indicum</i> L. (1753) **	Jagali Til	E	A	H	Th	N
<i>Pedaliium murex</i> L. (1759)	DakhaniGokhr	E	A	H	Th	N
35. Plantaginaceae						
<i>Bacopa monnieri</i> (L.) Wettst. (1891)	Brahmi	E	P	H	He	N

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
36. Polygonaceae						
<i>Calligonum polygonoides</i> L. (1753)	Phog	E	P	S	Ph	N
<i>Polygonum plebeium</i> R.Br. (1810)	Rakht-shankh Pushp	E	A	H	Th	N
37. Polygalaceae						
<i>Polygala erioptera</i> DC. (1824)	Johjhru, Boyasan	E	A	H	Th	N
38. Portulacaceae						
<i>Portulaca pilosa</i> L. (1753)	Lunkia	E	A	Su	Th	I
39. Phyllanthaceae						
<i>Phyllanthus amarus</i> Schumach. & Thonn. (1827)	-	E	A	H	Th	I
<i>Phyllanthus urinaria</i> L. (1753)	-	E	A	H	Th	N
40. Rhamnaceae						
<i>Ziziphus glabrata</i> (B.Heyne ex Schult.) B.Heyne ex Wight & Arn (1834)	-	E	P	T	Ph	N
<i>Ziziphus mauritiana</i> Lam. (1789)	Ber	E	P	T	Ph	N
<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn. (1833)	JhadBor	E	P	S	Ph	N
<i>Ziziphus oenopolia</i> (L.) Mill. (1768)	Eramdi	E	P	S	Ph	N
41. Rubiaceae						
<i>Hamelia patens</i> Jacq. (1760)	-	E	P	S	Ph	I
<i>Spermacoce articularis</i> L.f. (1782)	Agio	E	A	H	Th	N
42. Rutaceae						
<i>Bergera koenigii</i> L. (1767) *	Kadhi Patta	E	P	T	Ph	N
<i>Citrus × aurantiifolia</i> (Christm.) Swingle (1913) *	Nimboo	E	P	S	Ph	I
43. Salvadoraceae						
<i>Salvadora oleoides</i> Decne. (1844)	Kharo-jhaal	E	P	T	Ph	N
<i>Salvadora persica</i> L. (1753)	Peelu	E	P	T	Ph	N
44. Sapindaceae						
<i>Cardiospermum halicacabum</i> L. (1753)	Kanphuti	E	A	C	Th	N
45. Scrophulariaceae						
<i>Anticharis senegalensis</i> (Walp.) Bhandari (1965)	Dharno Ghas	E	A	H	Th	N
<i>Verbascum coromandelianum</i> (Vahl) HubMor. (1973)	-	E	A	H	Th	N
46. Solanaceae						
<i>Datura innoxia</i> Mill. (1768)	Daturo	E	A	S	Th	I
<i>Datura stramonium</i> L. (1753)	Bada Dhaturu	E	A	H	Th	I
<i>Lycium barbarum</i> L. (1753)	Morali	E	A	S	Th	I
<i>Physalis angulata</i> L. (1753)	Chipoti	E	A	H	Th	I
<i>Solanum nigrum</i> L. (1753)	Makoi	E	A	H	Th	N
<i>Solanum virginianum</i> L. (1753)	Adhkuntali	E	P	H	He	N
<i>Withania somnifera</i> (L.) Dunal (1852)	Asgandha	E	P	S	Ch	N
47. Talinaceae						
<i>Talinum fruticosum</i> (L.) Juss. (1789)	-	E	P	Su	He	I
48. Tamaricaceae						
<i>Tamarix dioica</i> Roxb. ex. Roth (1820)	Lai	E	P	S	Ph	N
49. Zygophyllaceae						
<i>Balanites aegyptiaca</i> (L.) Delile (1813)	Hingota	E	P	S	Ph	I
<i>Balanites roxburghii</i> Planch. (1854)	Ingoriyo	E	P	T	Ph	N

Name of species with its first publication year	Vernacular names	Angiosperm types	Nature	Growth habits	Life forms	Distribution
<i>Zygophyllum creticum</i> (L.) Christenh. & Byng (2018)	Dhamaso	E	P	Su	Ch	I
Angiosperm Type: M—monocot E—eudicot Ma—magnoliids						
Nature of Plant : A—annual P—perennial						
Growth Habit : T—tree S—shrub H—herb G—grass C—climber Su—succulent Se—Sedge						
Life forms : Th—therophyte Ph—phanerophyte He—hemicryptophyte Ch—chamaetophyte Ge—Geophyte						
Distribution : N—native I—introduced or non-native						
Note: (*)—Planted by Forest Department near Forest Rest House and along the sanctuary's boundaries.						
Note: (**)—Cultivated crops						

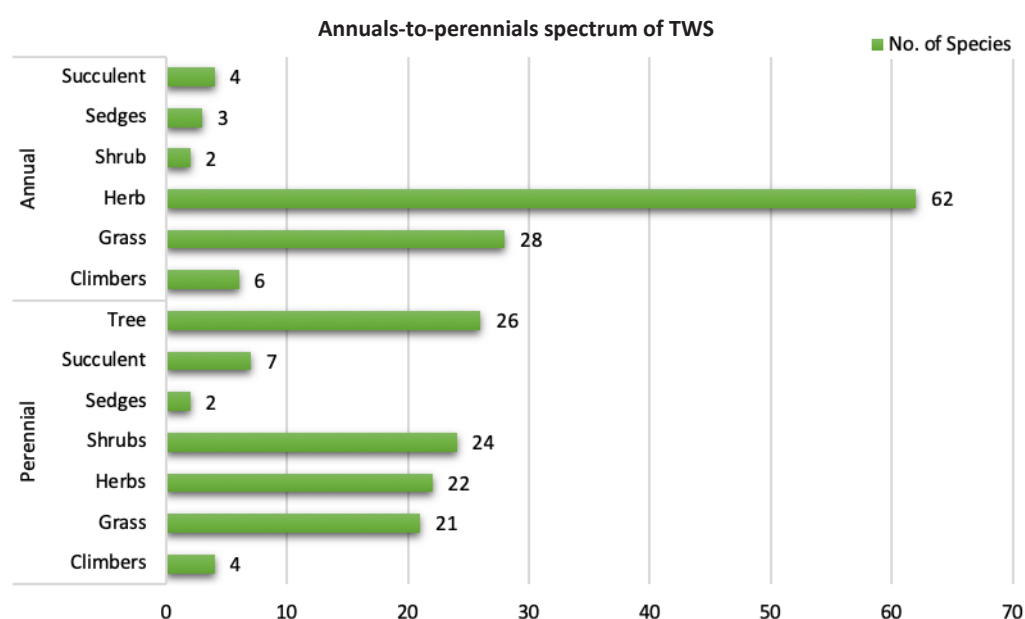


Figure 5. Habit and Nature of the plant species at Tal Chhapar Wildlife Sanctuary, Rajasthan.

regulating grazing. This warrants further investigation. This study also documented the absence of 51 species across 41 genera (Appendix I), comprising two aquatic plants, two ornamental plants, eight cultivated crops, and 40 wild species, which raises significant concern. This absence cannot be attributed to the exclusion of the summer season, as flowering and fruiting periods of these species overlapped with the study timeframe. If these species (particularly wild species) had been present in the sanctuary, they would have been observed during the study. Moreover, such patterns of species absence are not unprecedented in the sanctuary. Previous studies have also reported similar findings. For instance, Kaur et al. (2020) failed to document two previously recorded species, while Bagoriya et al. (2020), despite reporting 139 species, missed 27 species listed in earlier records. More alarmingly, Karel & Gena (2023) noted an increase in missing species, reporting the absence of 59 species.

We hypothesized that environmental factors, such as fluctuations in rainfall and temperature, which are key drivers of grassland ecosystems (Wu et al. 2023), along with the inherent climatic instability of the Thar Desert, a critical factor in the region's ecology, have contributed to these variations in species compositions.

In this study, Poaceae with 26 genera and 49 species emerged as the most dominant family, followed by Asteraceae (16 genera, 17 species) and Amaranthaceae (10 genera, 17 species). These findings were consistent with those of Kaur et al. (2020), who identified these families as the most diverse and highlighted their functional role in shaping the sanctuary's ecological structure. It was observed that perennial species were equal to annuals in the sanctuary, with herbaceous plants dominating and grass species thriving in the semi-arid climate. This highlights the sanctuary's ability to support both short-term resilience and long-term

ecosystem stability, which are fundamental to the sustained growth and health of the ecosystem (Gou et al. 2023). This may also account for the sanctuary's high proportion of native species, over 70%. Additionally, the sanctuary's high ecological resilience is evident from the presence of 49.76% therophytes—plants that endure unfavourable conditions, such as droughts and extreme temperatures, by surviving in seed form. The occurrence of introduced species, including cultivated crops and ornamental plants, merits attention. These species are mainly the result of anthropogenic influences, driven by the proximity of agricultural fields and human settlements to the sanctuary. In addition, forest management practices have contributed to their presence, with ornamental plants being deliberately introduced along boundaries and near rest houses to enhance the aesthetic appeal for visitors. Given their potential influence on native flora, these species have also been included in the sanctuary's plant checklist. In conclusion, the sanctuary's floral diversity, featuring both native and non-native species, is thriving, providing support to wildlife and local communities, while reflecting the sanctuary's strong ecological resilience. The absence of certain species suggests the need for further investigation. To sustain this growth and ensure the long-term stability of the ecosystem, ongoing conservation efforts by the forest department are essential.

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Appendix I. List of previously recorded plant species not encountered in surveys.

	Kaur et al. 2020	Bagoriya et al. 2020	Kare & Gena 2023	Present survey
1	<i>Portulaca oleracea</i>	<i>Balanites roxburghii</i>	<i>Ailanthus excelsa</i>	<i>Ailanthus excelsa</i> (W)
2	<i>Portulaca quadrifida</i>	<i>Blumea</i> spp.	<i>Albizia lebbeck</i>	<i>Albizia lebbeck</i> (W)
3		<i>Boerhavia elegans</i>	<i>Amaranthus spinosus</i>	<i>Arnebia hispidissima</i> (W)
4		<i>Celosia argentea</i>	<i>Anticharis senegalensis</i>	<i>Bergia odorata</i> (W)
5		<i>Cleome gracilis</i>	<i>Aristida funiculata</i>	<i>Boerhavia elegans</i> (W)
6		<i>Cleome gynandra</i>	<i>Arnebia hispidissima</i>	<i>Celosia argentea</i> (O)
7		<i>Cleome viscosa</i>	<i>Bergia odorata</i>	<i>Cicer arietinum</i> (C)
8		<i>Commicaps verticillatus</i>	<i>Urochloa ramosa</i>	<i>Cistanche tubulosa</i> (W)
9		<i>Cressa cretica</i>	<i>Cassia tora</i>	<i>Citrullus fistulosus</i> (C)
10		<i>Crotalaria medicaginea</i>	<i>Cenchrus prieurii</i>	<i>Cleome gracilis</i> (W)
11		<i>Croton bonplandianus</i>	<i>Chenopodium album</i>	<i>Cleome gynandra</i> (W)
12		<i>Dactyloctenium scindicum</i>	<i>Chenopodium murale</i>	<i>Commicarpus verticillatus</i> (W)
13		<i>Euphorbia prostrata</i>	<i>Cicer arietinum</i>	<i>Convolvulus arvensis</i> (W)
14		<i>Gnaphalium</i> spp.	<i>Cistanche tubulosa</i>	<i>Crotalaria burhia</i> (W)
15		<i>Heliotropium marifolium</i>	<i>Citrullus fistulosus</i>	<i>Crotalaria medicaginea</i> (W)
16		<i>Indigofera linnaei</i>	<i>Citrullus lanatus</i>	<i>Cuscuta hyaline</i> (W)
17		<i>Opuntia elatior</i>	<i>Clerodendrum phlomidis</i>	<i>Cuscuta reflexa</i> (W)
18		<i>Parthenium hysterophorus</i>	<i>Commicaps verticillatus</i>	<i>Cyamopsis tetragonoloba</i> (C)
19		<i>Portulaca pilosa</i>	<i>Convolvulus arvensis</i>	<i>Cyperus arenarius</i> (W)
20		<i>Pulicaria wightiana</i>	<i>Cucumis melo</i>	<i>Cyperus niveus</i> (W)
21		<i>Sporobolus marginatus</i>	<i>Cuscuta hyalina</i>	<i>Cyperus triceps</i> (W)
22		<i>Suaeda nudiflora</i>	<i>Cyamopsis tetragonoloba</i>	<i>Digera muricata</i> (W)
23		<i>Tamarix</i> spp.	<i>Cynodon dactylon</i>	<i>Gisekia pharnaceoides</i> (W)
24		<i>Trianthema triquetra</i>	<i>Cyperus iria</i>	<i>Gnaphalium</i> sp. (W)
25		<i>Tribulus terrestris</i>	<i>Dactyloctenium aegyptium</i>	<i>Grangea</i> sp. (W)
26		<i>Verbesina encelioides</i>	<i>Dalbergia sissoo</i>	<i>Heliotropium curassavicum</i> (W)
27		<i>Zaleya govindia</i>	<i>Digera muricata</i>	<i>Heteropogon contortus</i> (W)
28			<i>Eleusine compressa</i>	<i>Hydrilla verticillata</i> (A)
29			<i>Eragrostis ciliaris</i>	<i>Imperata cylindrica</i> (W)
30			<i>Eragrostis tremula</i>	<i>Indigofera cordifolia</i> (W)
31			<i>Euphorbia hirta</i>	<i>Indigofera linnaei</i> (W)
32			<i>Euphorbia microphylla</i>	<i>Ipomoea purpurea</i> (O)
33			<i>Heliotropium curassavicum</i>	<i>Momordica balsamina</i> (W)
34			<i>Heliotropium ellipticum</i>	<i>Nymphaea nouchali</i> (A)
35			<i>Heteropogon contortus</i>	<i>Orobancha cernua</i> (W)
36			<i>Imperata cylindrica</i>	<i>Panicum antidotale</i> (W)
37			<i>Indigofera cordifolia</i>	<i>Pennisetum typhoides</i> (C)
38			<i>Ipomoea purpurea</i>	<i>Phyllanthus niruri</i> (W)
39			<i>Maytenus emarginata</i>	<i>Polycarpaea corymbosa</i> (W)
40			<i>Nerium indicum</i>	<i>Salsola baryosma</i> (W)
41			<i>Nymphaea nouchali</i>	<i>Sonchus asper</i> (W)
42			<i>Orobancha cernua</i>	<i>Sorghum halepense</i> (C)
43			<i>Panicum antidotale</i>	<i>Striga angustifolia</i> (W)
44			<i>Panicum turgidum</i>	<i>Striga gesnerioides</i> (W)

	Kaur et al. 2020	Bagoriya et al. 2020	Kare & Gena 2023	Present survey
45			<i>Parkinsonia aculeata</i>	<i>Tribulus pentandrus</i> (W)
46			<i>Parthenium hysterophorus</i>	<i>Tribulus terrestris</i> (W)
47			<i>Pennisetum typhoideum</i>	<i>Urginea indica</i> (W)
48			<i>Phyllanthus niruri</i>	<i>Vigna aconitifolia</i> (C)
49			<i>Polycarpaea corymbosa</i>	<i>Vigna radiata</i> (C)
50			<i>Portulca oleracea</i>	<i>Vigna unguiculata</i> (C)
51			<i>Saccharum spontaneum</i>	<i>Zaleya govindia</i> (W)
52			<i>Sesamum indicum</i>	
53			<i>Sonchus asper</i>	
54			<i>Sorghum halepense</i>	
55			<i>Tridax procumbens</i>	
56			<i>Vigna aconitifolia</i>	
57			<i>Vigna radiata</i>	
58			<i>Vigna unguiculata</i>	
59			<i>Zaleya govindia</i>	
A—aquatic plants C—cultivated crops O—ornamental plants W—wild plants.				

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Articles

Morpho-taxonomic studies on the genus *Fissidens* Hedw. (Bryophyta: Fissidentaceae) in Senapati District, Manipur, India

– Kholi Kaini & Kazhuhrii Eshuo, Pp. 27787–27796

Ecology and conservation concerns of *Indianthus virgatus* (Marantaceae): an endemic species of the Western Ghats–Sri Lanka Biodiversity Hotspot

– Shreekara Bhat Vishnu, Vivek Pandi, Bhathiya Gopallawa, Rajendiran Gayathri, B. Mahim, Deepthi Yakandawala & Annamalai Muthusamy, Pp. 27797–27805

An updated floral diversity of Tal Chhapar Wildlife Sanctuary, Rajasthan, India

– Sneha Singh & Orus Ilyas, Pp. 27806–27821

An updated checklist of the family Rosaceae in Arunachal Pradesh, India

– Pinaki Adhikary & P.R. Gajurel, Pp. 27822–27841

Restoring biodiversity: case studies from two sacred groves of Kozhikode District, Kerala, India

– K. Kishore Kumar, Pp. 27842–27853

A preliminary investigation on wing morphology, flight patterns, and flight heights of selected odonates

– Ananditha Pascal & Chelmala Srinivasulu, Pp. 27854–27862

Phylogenetic confirmation of generic allocation and specific distinction of Mawphlang Golden-cheeked Frog *Odorrana mawphlangensis* (Pillai & Chanda, 1977) (Amphibia: Anura: Ranidae) and its updated distribution records

– Angshuman Das Tariang, Mathipi Vabeiryureilai, Fanai Malsawmdawngliana & Hmar Tlawmte Lalremsanga, Pp. 27863–27873

Phenotypic and genotypic variability in the Snowtrout *Schizothorax richardsonii* (Cypriniformes: Cyprinidae) wild populations from central Himalayan tributaries of the Ganga River basin

– Yasmeen Kousar, Mahender Singh & Deepak Singh, Pp. 27874–27888

Avian composition and distribution in the bird sanctuary planning zone of Can Gio Mangrove Biosphere Reserve, Ho Chi Minh City, Vietnam

– Huynh Duc Hieu, Huynh Duc Hoan, Bui Nguyen The Kiet, Dang Ngoc Hiep, Nguyen Thi Phuong Linh & Nguyen Dang Hoang Vu, Pp. 27889–27896

Bat echolocation in South Asia

– Aditya Srinivasulu, Chelmala Srinivasulu, Bhargavi Srinivasulu, Deepa Senapathi & Manuela González-Suárez, Pp. 27897–27931

A checklist of the mammals of Jammu & Kashmir, India

– Muzaffar A. Kichloo, Ajaz Ansari, Khurshed Ahmad & Neeraj Sharma, Pp. 27932–27945

Communications

Notes on distribution, identification and typification of the Elongated Sweet Grass *Anthoxanthum hookeri* (Aveneae: Poaceae) with comparative notes on *A. borii*

– Manoj Chandran, Kuntal Saha, Ranjana Negi & Saurabh Guleri, Pp. 27946–27953

Conservation significance of Yelakundli Sacred Grove: a relic population of the endemic dipterocarp *Vateria indica* L.

– G. Ramachandra Rao, Pp. 27954–27959

A preliminary study of fish diversity in Sirum River of East Siang District, Arunachal Pradesh, India

– Obinam Tayeng, Leki Wangchu & Debangshu Narayan Das, Pp. 27960–27969

Preliminary investigation on morphometrics and habitat of the Indian Flapshell Turtle *Lissemys punctata* (Bonnaterre, 1789) (Reptilia: Trionychidae) in rural wetlands of Alappuzha, Kerala, India

– Sajan Sunny, Appiyathu Saraswathy Vijayasree, Nisha Thomas Panikkaveetil & E. Sherly Williams, Pp. 27970–27975

A preliminary assessment of avifaunal diversity in Parwati Arga Bird Sanctuary, Uttar Pradesh, India

– Yashmita-Ulman & Manoj Singh, Pp. 27976–27984

Sightings of the Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) (Mammalia: Carnivora: Felidae) in Saurashtra Peninsula, Gujarat, India

– Raju Vyas, Pranav Vaghshiya & Devendra Chauhan, Pp. 27985–27991

Short Communications

Abundance and distribution of the Critically Endangered Giant Staghorn Fern *Platynerium grande* (A.Cunn. ex Hook.) J.Sm. in Maguindanao del Sur, BARMM, Philippines

– Marylene M. Demapitan, Roxane B. Sombero, Datu Muhaymin C. Abo, Nof A. Balabagan & Cherie Cano-Mangaoang, Pp. 27992–27996

***Bonnaya gracilis* a novel find for the flora of Uttarakhand, India**

– Monal R. Jadhav, Revan Y. Chaudhari & Tanveer A. Khan, Pp. 27997–28000

Notes

Crab eating crab: first record of the Horn-eyed Ghost Crab *Ocypode brevicornis* preying on the Mottled Light-footed Crab *Grapsus albolineatus* in Visakhapatnam, India

– Harish Prakash, M.K. Abhisree & Rohan Kumar, Pp. 28001–28003

First record of Greater Scaup *Aythya marila* in Farakka IBA near West Bengal & Jharkhand border, India

– Subhro Paul, Sudip Ghosh & J. Jiju Jaesper, Pp. 28004–28006

Filling the gap: first regional record of the Little Owl *Athene noctua ludlowi* (Strigiformes: Strigidae) from Uttarakhand, India

– Anuj Joshi, Dhanesh Ponnuru, Vineet K. Dubey & Sambandam Sathyakumar, Pp. 28007–28010

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