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Full Length Article

Analyzing Phytoecological Significance of Floral Biodiversity in Rahim Abad, District Gilgit, Pakistan

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Abstract

A comprehensive study was conducted in the year 2022 and 2023 at Rahim Abad valley, District Gilgit, Pakistan, situated 33 km from Gilgit city along the Karakoram Highways, with an elevation ranging from 1440m to 2670m. The study area was surveyed, phytosociological research was carried out to determine dominant species, habit categories, and life forms. The research site was divided into three stands, thirty quadrates in each case were used to compute the Importance Value Index (IVI) for ascertaining dominant species. This research documented the baseline inventory of 111 phanerogams species, which comprised 93 unique genera were followed 43 diverse plant families. The valley's plant life-forms exhibited a rich diversity, comprising 55 Hemicryptophytes (49.55%), 22 Phanerophytes (19.82%), 33 Therophytes (29.73%) and one Geophyte. The hemicryptophytes were the largest life form which contributed 49.55% of the vegetation in the study area. Similarly, the recorded flora spanned various habit categories, with 79 herbs (71.17%), 20 trees (18.02%), 11 shrubs (9.91%), and one sub-shrub, all contributing to the region's botanical tapestry. Through this approach, *Solanum tuberosum* L emerged the most dominant species, boasting the higher IVI value of (23.24) among herbaceous plants.

Keywords: Biological spectrum; Rahim abad; Gilgit; Phytosociology; Floristic structure

Introduction

The analysis of plant species diversity and distribution in an area can be analyzed by examining its floristic composition (Ali *et al.* 2018; Bano *et al.* 2018). Studying floristic composition within a specific environment reveals valuable insights into vegetation traits (Saxena *et al.* 1982; Batalha and Martins 2002). It reflects the ecological characteristics, the physical appearance of plants, and the effects of living organisms. It encompasses the interaction of ecological features, plant visual traits, and biological influences. The study of flora is a common global endeavor aimed at acquiring further insights into the world of plants. It is a universally practiced approach to amass additional knowledge about various plant species (Gul *et al.* 2018; Hussain *et al.* 2020).

Plant taxonomists utilize flora checklists to maintain comprehensive and organized global records of plant species (Badshah *et al.* 2013; Arif and Haider 2022). This checklist serves as a vital repository of data for future scientific investigations. It plays a key role in facilitating the identification and formation of nomenclature for various plant species, aiding researchers and botanists in their studies. This systematic listing of flora is an essential resource for the broader understanding of plant diversity and taxonomy (Mehmood *et al.* 2015; Arif and Haider 2022). The distribution of plant species provides valuable insights into both living (biotic) and non-living (abiotic) factors, and their direct or indirect contributions to ecosystem services in a specific location (Flores-Argüelles *et al.* 2022; Magray *et al.* 2022; Shannon *et al.* 2022; Wani *et al.* 2022a, b) The presence of all plant species in a particular region characterizes its flora, whereas vegetation encompasses the significance of these species, their life forms, population dynamics, and their interactions within a specific environment. A floristic inventory can enhance our comprehension of vegetation characteristics. (Mehmood *et al.* 2015, 2017; Rahman *et al.* 2016; Zhao *et al.* 2021). The biological spectrum of a given locality additionally serves as a valuable indicator of its climatic conditions, elucidating the intricate patterns of weather, with a particular focus on precipitation and temperature fluctuations, and their annual distribution (Manan *et al.* 2022).

Floristic diversity indicates the vegetation variety in a region, supporting plant species identification and sustainable use (Rafay *et al.* 2013). The biological spectrum reveals both local climates and human impacts in an engaging manner (Al-Yemeni and Sher 2010). It reveals the

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plants in an area and the environment they have influenced. Same biological spectra can help to identify the climates in different regions (Yatsenko *et al*. 2021). The climate has undergone significant changes (Majhi *et al*. 2023). As per the findings of Blasi *et al.* (1990), life forms are classified according to the arrangement of buds in relation to their strategies for surviving the winter. The presence of similar biological spectrum features in various parts of the world indicates a likeness in both the vegetation and the micro and macroclimatic conditions that influence the area (Khan and Khan 2017; Arif and Haider 2022). Understanding the plant life in an area is key to assessing biodiversity and environmental conditions, supporting informed conservation and land management choices (Ali *et al.* 2022). Studying the functional traits of plants in a particular area provides insights into how environmental factors impact the composition and arrangement of plant communities, ultimately shedding light on the specific roles of individual species within these ecosystems (Vakhlamova *et al.* 2016; Ullah *et al.* 2023). These studies provide vital local plant data and a starting point for further research, as plants are grouped by their adaptations to the environment. Plants are categorized into life-forms based on their functions, structures, and responses to prevailing environmental conditions (Yatsenko *et al.* 2021). This study reports an overall and scientifically rigorous exploration of the area's plant diversity while also examining the specific biological spectrum within floral biodiversity.

Materials and Methods

Investigation site

Rahim Abad, a picturesque hill station in the Gilgit District of Gilgit-Baltistan, sits 33 km away from Gilgit city along the Karakoram Highway, amidst towering mountains. Nestled in a lush green valley beside the Hunza river. It lies 36°6'20.15" N, 74°17'56.3" E, elevation ranges 1800–2000 m above sea level. Clear days offer views of Mt. Rakaposhi. Summers are warm, with June and July as the hottest months. Map of study area is shown in (Fig. 1).

Field survey

Biodiversity in the study area was probed during well-planned and effective field surveys from July to August (Khadim and Khan 2021; Yatsenko *et al.* 2021; Hyder and Ibrahim 2022).

Materials and equipment

The equipment used during the field survey were Cutter, Plastic bag, Field notebook (Schmidt *et al.* 2005), pencil, gloves, inch tape, steel nail, string, mobile camera, presser and drier.

Data collection and species identification

During the field survey, we collected significant qualitative and quantitative data, which included field observations, plant specimens, and altitudes to identify ecological zones. Then pressed the collected plant specimens using a presser and dried by dryer. The preserved species were affixed to herbarium sheets of a standardized size measuring 11.5 × 17.5 inches (Yatsenko *et al.* 2021). The plant identification was done with the help of flora of Pakistan (Ali and Qaiser 1986).

Phytosociological studies

We used the quadrat method for phytosociological studies, taking thirty (30) quadrats randomly in each stand (Onoda *et al*. 2017). Each stand had 10 plots for tree sampling and 20 for herbs and shrubs, with trees sampled in 10 m × 10 m plots and herbs and shrubs in 5 m × 5 m quadrats. The following formulas were used to calculate different attributes (Arif and Haider 2022):

$$\text{Absolute density} = \frac{\text{Total number of all individual of a species in all quadrats}}{\text{Total area of the sample plots}}$$

$$\text{Relative density} = \frac{\text{Number of individuals of a species}}{\text{Total area of all individuals of a species}} \text{x100}$$

$$\text{Absolute frequency} = \frac{\text{Number of quadrats which occur}}{\text{Total points taken}}$$

$$\text{Relative frequency} = \frac{\text{Absulote frequancy of a species}}{\text{Sum of absulte frequancy of all species}} x100$$

$$\text{Absoulte cover} = \frac{\text{Total cover of a species}}{\text{Total number of plant of a species}}$$

$$\text{Relative cover} = \frac{\text{Total cover of all plants of a species}}{\text{Total cover of all species}} x100$$

Importance value index (IVI) = Relative density + Relative frequency + Relative dominance.

Results

Floristic composition

The floristic composition of the study site is very diverse, 111 different plant species across 93 genera belonging to 43 families (Table 1). In terms of life form classes, there were five specified categories. Our results demonstrated that the flora was dominated by Hemicryptophytes, with 55 species (49.5%). Therophytes comprised 33 species (29.7%), Phanerophytes had 22 species (19.8%), there was 1 species of Geophyte (0.9%), and Chamaephytes were not observed. Plant habit category in the study falls into four distinct classes. The most prevalent habit category was herb, with 79 occurrences (71.17%), followed by trees 20 (18.01%), shrubs 11 (9.90%), and sub-shrubs 1(0.90%) (Fig. 2).

Stand-1

The assessment of plant diversity in stand 1 revealed 43

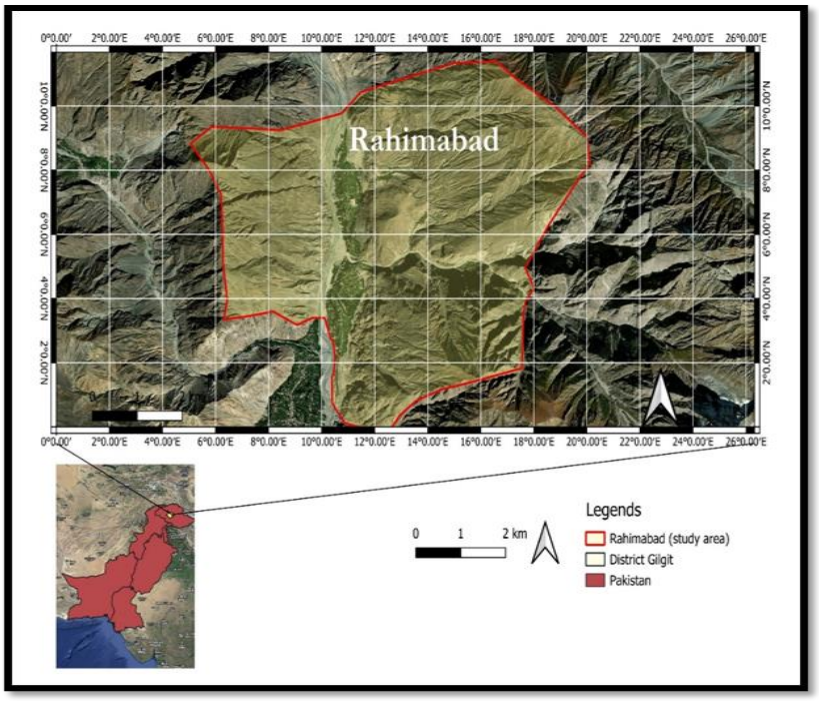

Fig. 1: Map of the study area

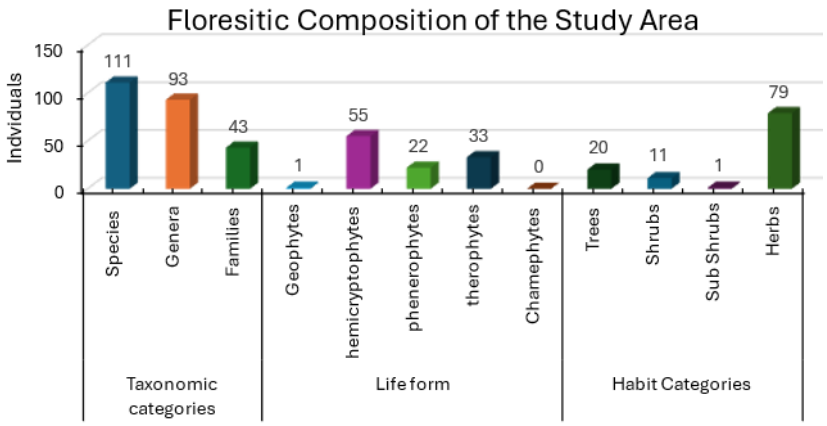

Fig. 2: Floristic composition of the study area

diverse plant species from 40 genera representing 22 families. The inventory of plant life forms was; herbs 34 (79.07%), shrubs 7 (16.28%), trees 1 (2.33%), and sub-shrubs 1 (2.33%). Additionally, the study indicated the different life forms of the plants, revealing percentages for each category as: hemicryptophytes 24 (55.81%), therophytes 13 (30.23%), phanerophytes 5 (11.63%), geophytes 1 (2.33%), and chaemephytes (0%) depicted in (Fig 3).

Stand-2

In stand 2, the plant inventory identified a total of 37 plant species, across 36 genera and representing 20 diverse families. In the context of plant habits in this area, herbs dominated with 25 (67.57%) of the species, followed by trees at 7 (18.92%), shrubs at 3 (8.11%), and sub-shrubs at 2 (5.41%). Regarding the life form categories, hemicryptophytes were the most prevalent with 17 (45.95%), followed by therophytes at 10 (27.03%), and phanerophytes at 9 (24.32%), geophyte 1 (2.70%) and no chaemephyte of the documented species (Fig. 4).

Stand-3

The research conducted within stand 3 comprises of diverse vegetation, a total of 22 distinct plant species were identified. These species were taxonomically distributed across 19 genera and encompassed taxa from 12 different plant families.

Table 1: Checklist of floristic diversity in the study area

S. No	Family name	Specie name	Habit	Habitat	[1]Life form	Altitude	Status (+/-)	Remarks
1	Adiantaceae	*Actaea* L.	Herb	Moist	H	1767m	-	Wild
2	Adoxaceae	*Adoxa moschatellina* L.	Herb	Moist	H	1706m	-	Wild
3	Alliaceae	*Allium cepa* L.	Herb	Moist	Ge	1687m	+	Cultivated
4	Amaranthaceae	*Amaranthus retroflexus* L.	Herb	Moist	Th	1683 m	+	Wild
5	Apiaceae	*Coriandrum sativum* linnaeus.	Herb	Moist	Th	1720m	+	Cultivated
6	Apocynaceae	*Nerium oleander* L.	Shrub	Moist	H	1501m	-	Wild
7	Asclepiadaceae	*Cynachum acutum*	Herb	Sandy	H	1867m	+	Wild
8	Asteraceae	*Anthemis arvensis* L.	Herb	Moist	Th	1708m	-	Wild
9	Asteraceae	*Artemisia rutifolia spreng, syst.veg*.	Sub shrub	Dry	H	1898m	+	Wild
10	Asteraceae	*Artimisa cappillaris* Miq.	Herb	Moist	Ph	1796m	-	Wild
11	Asteraceae	*Artimisia* vulgaris L.	Herb	Moist	H	1701m	+	Wild
12	Asteraceae	*Cichorium intybus* L.	Herb	Moist	H	1709m	+	Wild
13	Asteraceae	*Cirsium vulgare* (*savi*)*ten.*	Herb	Moist	H	1654m	+	Wild
14	Asteraceae	*Conyza* sumantrensis (retz.) E. Walker	Herb	Moist	H	1721m	+	Wild
15	Asteraceae	*Crepis flaxosas*	Herb	Moist	H	1790m	+	Wild
16	Asteraceae	*Crepis pulchra* L.	Herb	Moist	H	1678m	+	Wild
17	Asteraceae	*Echinops sphaerocephalus*	Herb	Dry	H	1780m	+	Wild
18	Asteraceae	*Erigon hetertresus* L.	Herb	Moist	Th	1666m	-	Wild
19	Asteraceae	*Galinsoga parviflora* Cav.	Herb	Moist	Th	1760m	+	Wild
20	Asteraceae	*Helianthus annus* L.	Herb	Dry	H	1772m	+	Cultivated
21	Asteraceae	*Hieracium* L.	Herb	Moist	H	1700m	+	Wild
22	Asteraceae	*Hieracium* L.	Herb	Moist	H	1689m	+	Wild
23	Asteraceae	*Inula helenium* L.	Herb	Moist	H	1701m	+	Wild
24	Asteraceae	*Lactuca serriola* L.	Herb	Dry	Th	1670m	+	Wild
25	Asteraceae	*Ligularia thomsonii* (C.B. Clarke)	Herb	Moist	H	1987m	+	Wild
26	Asteraceae	*Scorzonera virgata* dc.	Herb	Moist	H	1698m	+	Wild
27	Asteraceae	*Sonchus asper* L.	Herb	Moist	Th	1610m	+	Wild
28	Asteraceae	*Tagetes erecta* L.	Herb	Moist	Th	1660m	+	Cultivated
29	Asteraceae	*Taraxacum officinale*	Herb	Moist	H	1632m	+	Wild
30	Boraginaceae	*Heliotropium dasycarpum* Ledeb.	Herb	Dry	H	1824m	+	Wild
31	Boraginaceae	*Lindelofia spectabilis var.falconeri c.b. Clarke*	Herb	Moist	H	2104m	+	Wild
32	Brassicaceae	*Capsella bursa pastoris* (L.) Medik.	Herb	Moist	Th	1756m	+	Wild
33	Brassicaceae	*Sinapis arvensis* L.	Herb	Dry/moist	Th	1702m	+	Wild
34	Capparidaceae	*Capparis spinosa* linn.	Herb	Moist/dry	H	1950m	+	Wild
35	Chenopodiaceae	*Chenopodium album linneaus.*	Herb	Sandy	Th	1681m	+	Wild
36	Chenopodiaceae	*Kochia prostrate* L.	Herb	Dry	H	1463m	+	Wild
37	Chenopodiaceae	*Kochia scoparia (L Schard.1)*	Shrub	Moist	Th	1745m	+	Wild
38	Convolvulaceae	*Convolvulus arvensis* L.	Herb	Moist	H	1712m	+	Wild
39	Cupressaceae	*Cupressus arizonica* greene.	Tree	Dry	Ph	2254m	-	Wild
40	Cupressaceae	*Juniperus communis* L.	Tree	Moist/dry	Ph	2205m	-	Wild
41	Cupressaceae	*Juniperus excelsa* Mill.	tree	Dry	Ph	2223m	+	Wild
42	Cupressaceae	*Thuja occidentalis* L.	Tree	Moist/dry	Ph	1645m	+	Wild
43	Cyperaceae	*Cyperus* linnaeus.	Herb	Moist	H	1754m	-	Wild
44	Elaeagnceae	*Hippophae rhamnoides* Mill.	Shrub	Moist	Ph	2235m	+	Wild
45	Ephedraceae	*Ephedra intermedia schrenk and meyer in* c.a.	Shrub	Dry	H	1881m	+	Wild
46	Equisetaceae	*Equisetum fluviatile* L.	Herb	Moist	H	1665m	-	Wild
47	Equisetaceae	*Equisetum variegatum*	Herb	Dry/moist	H	1801m	+	Wild
48	Euphorbiaceae	*Euphorbia peplus* L.	Herb	Moist	Th	1703m	+	Wild
49	Fabaceae	*Phaseolus vulgaris* L.	Herb	Moist	Th	1697m	+	Cultivated
50	Fabaceae	*Pisum sativum* L.	Herb	Moist	Th	1724m	+	Cultivated
51	Fabaceae	*Trifolium angulatum*	Herb	Moist	H	1659m	+	Cultivated
52	Fabaceae	*Trifolium pratense* L.	Herb	Moist	H	1518m	+	Wild
53	Fabaceae	*Vicia tetresperma*	Herb	Moist	Th	1709m	+	Wild
54	Geraniaceae	*Geranium pratense* L.	Herb	Moist	H	1532m	+	Wild
55	Iridaceae	*Iris lactea* Pall.	Herb	Dry	Th	1677m	-	Wild
56	Juglandaceae	*Juglans regia* L.	Tree	Dry/moist	Ph	1782m	+	Cultivated
57	Labiatae	*Mentha arvensis* L.	Herb	Moist	H	1622m	+	Cultivated
58	Labiatae	*Mentha long folia* L.	Herb	Moist	H	1443m	+	Wild
59	Labiatae	*Nepta cataria* L.	Herb	Dry	H	1630m	+	Wild
60	Labiatae	*Nepta clarkie* Hook.f.	Herb	Moist	H	1780m	-	Wild
61	Labiatae	*Prunella vulgaris* L.	Herb	Moist	H	1621 m	+	Wild
62	Malvaceae	*Alcea rosea* L.	Herb	Sandy	Th	1745m	-	Cultivated
63	Malvaceae	*Malva verticillata* L.	Herb	Moist	Th	1697m	+	Cultivated
64	Moraceae	Ficus carica L.	Tree	Moist	Ph	1725m	+	Cultivated
65	Moraceae	*Morus alba* L.	Tree	Moist	Ph	1535m	+	Cultivated

Table 1: Continued

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66	Nitrariaceae	*Peganum harmala* L.	herb	Dry	H	1698m	-	Wild
67	Orchidaceae	*Dactylorhiza hatagirea D.don*	Herb	Moist	H	2265m		Wild
68	Oxalidaceae	*Oxalis cornculata* L.	Herb	Moist	H	1677m	+	Wild
69	Papilionaceae	*Colutea nepalensis* Sims.	Shrub	Dry	Th	1943m	+	Wild
70	Papilionaceae	*Meliotus alba* Desv.in lam.encycl.	Herb	Dry	Th	1709m	+	Cultivated
71	Papilionaceae	*Robinia pseudo-acacia* L.	Tree	Dry/moist	Ph	1790m	+	Wild
72	Papilionaceae	*Rumax nepalesis* Spreng.	Herb	Moist	H	1784m	+	Wild
73	Papilionaceae	*Trifolium pratense* L.	Herb	Moist	H	1643m	+	Wild
74	Papilionaceae	*Trigonella foenum-graecum* linn.	Herb	Moist	Th	1707m	+	Cultivated
75	Pinaceae	*Cedrus deodara (*roxb. Ex d.don)g.don	Tree	Dry	Ph	2265m	+	Wild
76	Pinaceae	Pinus wallichiana a.b jaccks.	Tree	Dry	Ph	2155m	-	Wild
77	Plantaginaceae	Veronica scutllata L.	Herb	Moist	H	1783m	+	Wild
78	Platanaceae	*Platanus orientalis* L.	Tree	Dry/moist	Ph	2102m	-	Wild
79	Poaceae	*Avena sativa*	Herb	Moist/dry	Th	1703m	+	Cultivated
80	Poaceae	*Dactylon* sp	Herb	Moist	H	1710m	+	Wild
81	Poaceae	*Melissa*	Herb	Moist	H	1687m	+	Wild
82	Poaceae	*Phelum alpinum* L.	Herb	Dry	H	1705m	+	Wild
83	Poaceae	*Phragmites karka (retz.)Trin.ex steud.*	Herb	Moist	H	1921m	+	Wild
84	Poaceae	*Saccharum filifolium nees ex steud.*	Herb	Moist	H	1855m	+	Wild
85	Poaceae	*Saccharum filifolium ness ex steud.syn.*	Herb	Moist	H	1885m	+	Wild
86	Poaceae	*Setaria viridis* L. P. Beavu.	Herb	Moist	Th	1760m	+	Wild
87	Poaceae	*Sorghum halepense* (L.) Pers.	Herb	Dry	H	1708m	+	Wild
88	Poaceae	*Stipa grotis* Nees.	Herb	Dry	H	1708m	+	Wild
89	Poaceae	*Triticum aestivum* L.	Herb	Moist	Th	1604m	+	Cultivated
90	Poaceae	*Triticum indicum*	Herb	Moist	Th	1706m	+	Cultivated
91	Poaceae	*Zea mays* L.	Herb	Moist	Th	1673m	+	Wild
92	Polygonaceae	*Persicaria orientalis* L.	Herb	Moist	Th	1720m	+	Wild
93	Polygonaceae	*Rumax patientia* L.	Herb	Moist	H	1765m	-	Wild
94	Polygonaceae	*Rumex hastatus* d.	Shrub	Dry	Th	1812m	+	Wild
95	Rosaceae	*Cydonia oblonga* Mill.	Tree	Moist	Ph	1560m	-	Cultivated
96	Rosaceae	*Fragaria x ananassa* duchesne ex weston.	Herb	Moist	H	1706m	+	Cultivated
97	Rosaceae	*Malus pumila* Mill.	Tree	Moist	Ph	1765m	+	Cultivated
98	Rosaceae	*Prunus avium* L.	Tree	Moist	Ph	1750m	+	Cultivated
99	Rosaceae	*Prunus dulcis*	Tree	Moist	Ph	1744m	+	Cultivated
100	Rosaceae	*Rosa macrophylla* Lindl.	Shrub	Moist	H	1835m	-	Wild
101	Rutaceae	*Citus* sp	Tree	Moist	Ph	1780m	+	Cultivated
102	Salicaceae	*Populous nigra linnaeus.*	Tree	Moist	Ph	1639 m	+	Wild
103	Simaroubaceae	*Ailanthus* altissimusm mill *swingle.*	Tree	Moist	Ph	1503m	+	Wild
104	Solanaceae	*Datura stramonium* L.	Herb	Moist/sandy	Th	1689m	-	Wild
105	Solanaceae	*Lycopersicon esculentum* Mill.	Shrub	Moist	Ph	1586m	+	Cultivated
106	Solanaceae	*Solanum nigrum var.villosum* L.	Shrub	Moist	Th	1732m	+	Wild
107	Solanaceae	*Solanum tubersum* L.	Herb	Moist	H	1671 m	+	Cultivated
108	Ulmaceae	*Celtis tetrandra* Roxb.	Tree	Moist	Ph	1669m	+	Wild
109	Umbelliferae	*Daucus corota* L.	Herb	Moist	Th	1711m	+	Cultivated
110	Vitaceae	*Vitis alba*	Tree	Moist	Th	1709m	+	Cultivated
111	Vitaceae	*Vitis vinifera* L.	Shrub	Moist	H	1845m	+	Cultivated

[1]H (hemicryptophytes), Ph (Phanerophytes), Ge (Geophytes), Th (Therophytes)

The investigation revealed that the documented plant species exhibited various habits with 17 (77.27%) classified as herbs, 3 (13.64%) as shrubs, 1 (4.55%) as trees, and 1 (4.55%) as subshrubs. In terms of life forms, the species composition featured 17 (77.27%) hemicryptophytes, 3 (13.64%) therophytes, 1 (4.55%) phanerophytes, 1 (4.55%) geophyte, and no representation of chamaephytes (Fig. 5).

Discussion

The current study focused on exploring the region's plant diversity and finding the biological spectrum of the floral biodiversity. The research area revealed that 111 distinct plant species, which followed 93 genera from 43 families. Manan *et al.*, (2022) in Bin Dara Dir, his research revealed 140 species from 47 families, which differed from our findings (Manan *et al.* 2022). A study conducted in Swat Ranizai where the recorded plant species were 246 from 202 genera which belongs to 90 families (Khan and Khan 2017), which differed from our findings. While similar research was conducted in Kanayannur, Kannur District, which was quite similar to our findings (Theertha *et al.* 2021). The habit categories included herbs, shrubs, sub-shrubs and trees. Herbs with 79 (71.17%) species were considered as dominant habit category in the study site followed by shrub 11 (9.91%), sub-shrub 1 (0.90%), and tree were with 20 (18.02%). A study conducted by Khan and Khan (2017) displayed quite parallel results.

Hemicryptophyte consisted of 55 species, dominant life form in the study area was: Therophyte with 33, phanerophyte include 22 species, geophyte 1 and no chaemephyte were recorded depicted in (Fig. 2).

Table 2: Top three dominant taxas in each stand based on Importance Value Index (IVI)

Stand No.	Family	Species	F3	D3	C3	IVI
Stand-1	Amaranthaceae	*Amaranthus retroflexus* Linn.	3.63	3.56	2.24	9.43
	Fabaceae	*Trifolium pratense* L.	5.46	5.88	2.1	13.44
	Oxalidaceae	*Oxalis corniculata L.*	4.64	3.17	1.47	9.28
Stand-2	Moraceae	*Ficus carica* L.	5.1	3.7	6.62	15.42
	Polygonaceae	*Persicaria orientalis* (L.) Spach	5.02	6.17	1.64	12.83
	Simaroubaceae	*Ailanthus altissimus* (Mill.) Swingle.	5.22	5.73	2.43	13.38
Stand-3	Amaryllidaceae	*Allium cepa* L.	9.51	7.14	2.05	18.7
	Rosaceae	*Malus pumila* Mill.	4.85	4.54	12.3	21.69
	Solanaceae	*Solanum tuberosum* L.	11	8.11	4.1	23.24

F3 relative frequency, D3 relative density and C3 relative cover

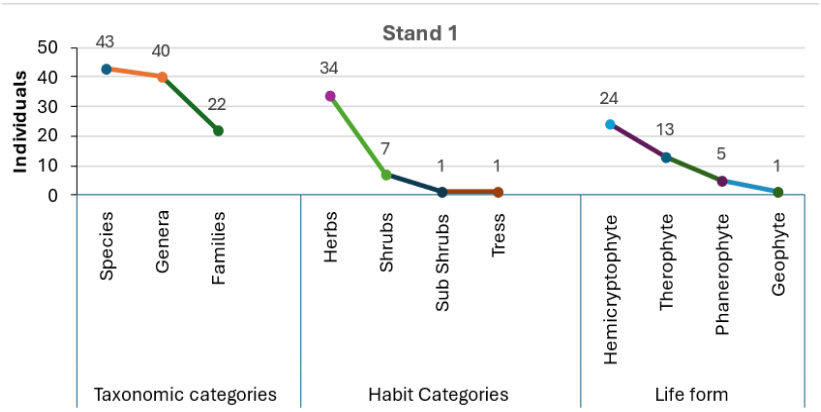

Fig. 3: Taxonomic breakup of stand-1

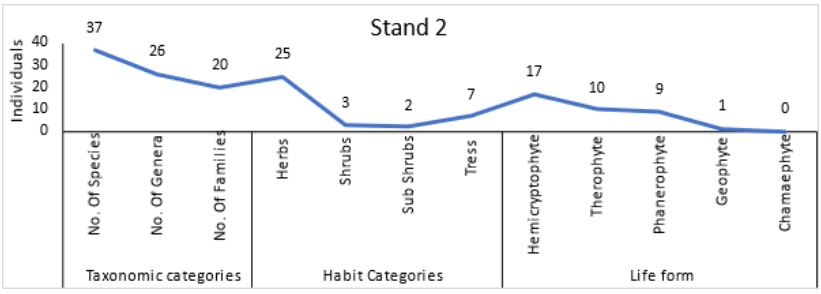

Fig. 4: Taxonomic breakup of stand 2

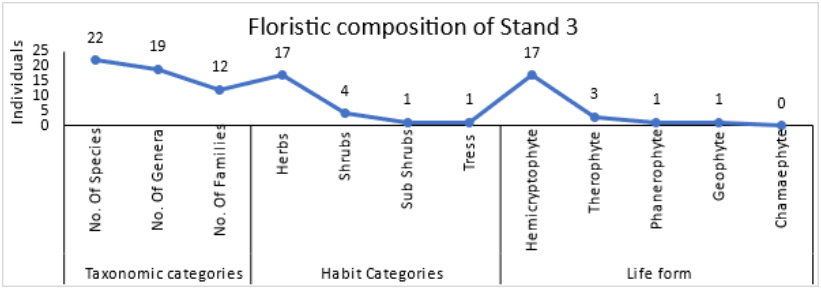

Fig. 5: Taxonomic breakup of stand 3

Manan *et al.* (2022) presented the different results as compared to our findings. Our study showed the life form within stand-1 was, hemicryptophyte were (55.81%), therophyte (30.23%), phanerophyte (11.63%), followed by geophyte (2.33%) and chaemephyte with 0 species. Habit category in stand-1, herb (79.07%), shrub (16.28%), tree (2.33%), and sub shrub (2.33%). In stand 2, we observed 37 distinct plant species belonging to 36 genera, from 20

different families. The recorded data indicated that hemicryptophytes accounted for 17 species (15.31%), therophytes for 10 species (9.00%), phanerophytes for 9 species (8.10%), and there were no chaemephyte species. In terms of habit categories, herbs comprised 25 plant species (22.63%), shrubs included 3 (2.70%), subshrubs 2 (1.80%), and trees 7 (6.30%). The study of Amjad 2017 was similar to our findings (Amjad 2017) (Fig. 4). In stand 3, the research revealed 22 different plant species, from 19 genera and belonging to 12 families. The life forms, hemicryptophytes, comprised (77.27 %), therophytes (13.64 %), phanerophytes (4.55 %), and geophytes (4.55 %) species, while no Chaemephytes were found. The distribution of habit categories included (77.27%) herb species, (13.64 %) shrub species, (4.55 %) tree species, and (4.55 %) subshrub species. Our findings were like (Khan and Khan 2017). The dominant species in each stand were determined based on their IVI values. In Stand-1, it was *Trifolium pratense* L. Stand-2 was dominated by *Ficus carica* L. and in Stand-3, *Solanum tubersum* L. showed dominance depicts in Table 2.

The current study yielded the bassline inventory of 111 phanerogams species followed by 93 genera belonging to 43 families. which provides the basic framework to understanding biodiversity in the study area. This also explored the dominant life form present in the study area was the Hemicryptophytes followed by Phanerophytes. The results of the studies were different from Raunkaier normal spectrum (Sharma 2018). The dominance of Hemicryptophytes shows the Harsh climatic conditions prevailing in the study area. Similarly, this study also focused on the dominant habit categories, and the dominant taxa present in the study area was recognized based on Important value index. Herbs were recognized as the dominant habit category which also supported the hemicryptophytes (Arif und Haider 2022). The ecological significance of the herbaceous vegetation to ecosystem by highlighting five aspects of herb-layer ecology:

(1) the contributions of the herb layer to forest biodiversity.
(2) the importance of the herb layer as the site of initial competitive interactions for the regeneration phases of dominant canopy species.
(3) the ability of the herb layer to form linkages with the overstory.
(4) the influence of the herb layer on ecosystem functions, such as energy flow and nutrient cycling; and (5) the multifaceted responses of the herb layer to various disturbances of both natural and anthropogenic origin (Hyder and Ibrahim 2022).

Conclusion

The results revealed significant biodiversity, especially for conserving endemic plant species. Identifying 111 plant species across 43 families. The dominance of hemicryptophytes highlights cold climatic conditions in the region.

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Author Contributions

K, SH, and SK led research design, specimen collection, and data analysis, contributing significantly to drafting and manuscript review until approval. Meanwhile, Z and AA made significant contributions by collecting plant specimens and taking images. The meticulous preservation of these specimens was entrusted to NZ, S, and RA, who diligently pressed, dried, and mounted the plants on standard herbarium sheets. The specific roles and expertise of each team member were essential to the success of our research endeavor.

Conflicts of Interest

The authors of this paper declare no conflict of interest.

Data Availability

The corresponding author will provide access to the data from this study upon a justifiable request.

Ethics Approval

Not applicable to this paper.

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