Plants Profile of Sultan Khail Valley, Hindukush Range of Pakistan: Floristic Composition, Biological Spectrum and Its Seasonal Variation

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Article

Plants Profile of Sultan Khail Valley, Hindukush Range of Pakistan: Floristic Composition, Biological Spectrum and Its Seasonal Variation

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Abstract: The present study was conducted to explore the floristic composition, life form, and leaf size spectrum of vegetation, seasonality, and habitat condition of the Sultan Khail valley, Hindu Kush range, Pakistan. Regular trips were arranged during 2017–2019 to collect plant specimens and prepare a checklist of the flora of the area. The life form and leaf size spectrum of vegetation were determined. The plant species were also classified based on their habitat. The area is home to 332 species belonging to 234 genera and 96 families. Asteraceae (32 species) was the dominant family in the area, followed by Rosaceae (28 species) and Lamiaceae (21 species). Therophytes were found to be dominant in the area, followed by phanerophytes, while microphylls were the dominant leaf size class, followed by nanophylls. Seasonal variation in life forms showed that the spring, autumn, and winter seasons' flora was dominated by phanerophytes, while therophytes were dominant in the summer season. Seasonal variation in leaf size spectra showed that microphylls were dominant in the spring and summer, while in the autumn and winter seasons, nanophylls were dominant. The highest numbers of species were found in dry places, followed by forests. The flora of the study area is diverse. The habitat condition of the area is dry. The area's phytoclimate is thero-phanerophytic. The flora of the area is subjected to severe anthropogenic stress and needs proper conservation.

Keywords: floristic composition; biological spectrum; seasonality, Sultan Khail Valley; Pakistan

1. Introduction

Flora is an assembled checklist of all plant species growing in a particular geo-graphical region [1]. The floristic composition of a region represents the type, number, composition, population size, and distribution of plant species. For the study of biodiversity and understanding the prevailing climate, the knowledge of the flora of any area is important [2] and offers an effective starting point for more systematic studies [3]. A Floristic inventory is a taxonomic analysis of a major division of flora in a given area [4]. Floristic diversity describes physiognomy and ecological relations in a variety of environments [5]. The life form of the plant is defined as the form that the vegetative body of the plant takes as a result of all life processes affected by the climate, whereas the biological spectrum is the proportion of various life form classes combined [6]. The life form reflects the adaptation of plant species to particular ecological conditions. Species that have identical morphological characteristics are grouped under the same life form in response to environmental factors [7]. Life form and leaf size spectra are the key physiognomic features that indicate the micro and macroclimatic state and association of plants, as well as the anthropogenic disturbance in a specific region [8]. Comprehensive life form research gives an idea of the physiological processes of plant communities [9]. The leaf size spectrum also provides an understanding of the floristic version, which is useful for exploring plant relationships about dominant climatic features and for studying flora at the local level [10]. The physiognomic properties of plants, such as life form and leaf size spectra, have been frequently used in vegetation research [7]. The life form represents climate adaptability and, therefore, the entire vegetation will be an indication of the dominant climate in particular [11]. However, biotic impacts such as overgrazing, agricultural operations, trampling, and deforestation may alter the percentage of different life forms [12]. Various researchers have investigated the floristic and biological spectrum in Pakistan and abroad [6,11,13–20]. However, no such work has been conducted in the Sultan Khail valley, Dir Upper, Pakistan. The present study aimed to explore the floristic inventory, ecological characteristics, and biological spectrum of vegetation in the Sultan Khail valley and Hindu Kush range of Pakistan. Such information is scanty, and so no such study is conducted in the target area. This study provides baseline information on the flora of the area and will be helpful for further research in the fields of forestry, taxonomy, ecology, ethnobotany, and conservation of vegetation.

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2. Materials and Methods

2.1. Description of Study Area

The beautiful Sultan Khail valley is situated in Dir Upper, Khyber Pakhtunkhwa, Pakistan. It lies in Pakistan's subtropical dry temperate zone [21]. It lies between 34°59′339", 35°59′870" North latitude and 71°00′176", 72°00′036"East longitude. The area is mostly dominated by hills and mountains that are a part of the Hindu Kush range of Pakistan. The altitude of the area varies from 1015 meters to 3230 meters. The highest peak in the valley is Shekly Top. The valley is bordered by the rivers Panjkoro and Nehag Dara in the East, Dir Lower (Maidan) in the West, Jelar Valley in the South, and Kair Dara in the North (Figure 1). The climate of the study area is influenced by various topographic and ecological variables. Spring, summer, autumn, and winter are the four distinct seasons of the year in the area. The winter season is very cold and severe and starts in the middle of November when the temperature falls abruptly. The summer season in the valley is typically moderate, with June and July being the hottest months of the year. The average maximum temperature reaches 35.5 C to 35.9 C in June and July, while in January the mean minimum temperature falls below zero (-1.3) degrees centigrade. The relative humidity is moderately high throughout the year. The area receives maximum rainfall in February (6.7mm), March (8.2mm), and August (8.6mm). Snow usually begins to fall in the upper parts of the valley in December and gradually descends as the temperature decreases in January and February. Depending on elevation, snowmelt starts in the valley in March and continues into April [22].

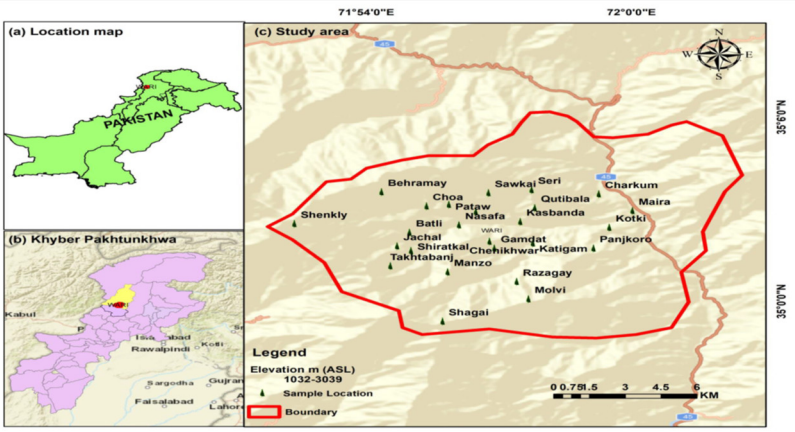

Figure 1. Location map of Sultan Khail valley, Dir Upper, Pakistan, representing detailed information such as sampling sites, elevation range, boundaries and area in Km2.

2.2. Data Collection and Analysis

From 2017 to 2019, regular trips were arranged in different seasons of the year to conduct data for the preparation of a floristic checklist of Sultan Khail valley, Dir Upper, Pakistan. The collected specimens of plant species were preserved and identified with the help of the flora of Pakistan, compiled in alphabetical order, and deposited at the Herbarium, Department of Botany, Islamia College, and Peshawar, Pakistan. The collected plant species were divided into different life form classes [23,24] using the formulas:

$$\textbf{Life form spectra} = \frac{\textbf{(Number of species in each life form class)}}{\textbf{Total number of species}} \textbf{x100}$$

$$\textbf{Leaf size spectra} = \frac{\textbf{Number of species found in a specific leaf size class}}{\textbf{Total number of species}} \textbf{x100}$$

Plant species were also classified based on their habitat [16].

3. Results

3.1. Floristic Diversity

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The flora of Sultan Khail Valley is found to be diverse and home to 332 species belonging to 234 genera and 96 families (Table S1). Gymnosperms (8 species, 3 families) and pteridophytes (22 species, 6 families) were less prevalent in the area. Angiosperms were represented by 302 species belonging to 215 genera and 87 families, including dicots (275 species, 76 families) and monocots (27 species, 11 families). Asteraceae was the dominant family in the area (32 species, 9.7%), followed by Rosaceae (28 species, 8.5%), Lamiaceae (21 species, 6.4%), Fabaceae, and Poaceae (12 species, 3.6%) (Figure 2). In gymnosperms, Pinaceae was the leading dominant family while Dryopteridaceae was the richest family of Pteridophytes (Table 1). The herbaceous flora was dominant (220 species, 66.3%), followed by shrubs (54 species, 16.3%), and trees (48 species, 14.5%) (Table 1).

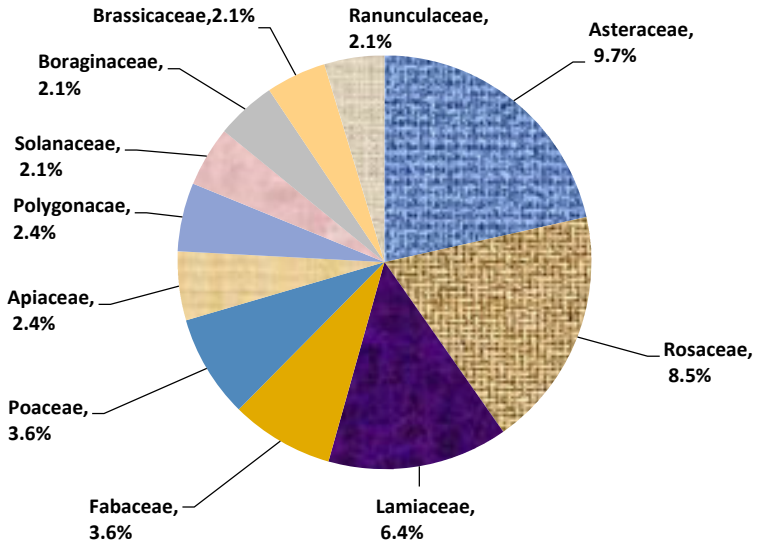

Figure 2. Top twelve plant families and their contribution to species in the study area.

3.1. Subsection

Table 1. This table represents floristic composition of the valley, biological spectrum, seasonality and habitat conditions of Sultan Khail valley, Hindukush range of Pakistan.

S. no.	Taxon	Habit	Life form	Leaf form	Habitat	Seasonality			
						Spring	Summer	Autumn	Winter
	Pteriddophytes								
1	**Adiantaceae**								
1	*Adiantum capillus-veneris* L.	H	Hem	Nan	Mp-Rc	+	+	+	+
2	*Adiantum incisum* Forssk.	H	Hem	Lep	Mp-Rc	+	+	+	+
3	*Adiantum venustum* D.Don.	H	Hem	Nan	Mp-F	+	+	+	+
2	**Aspleniaceae**								
4	*Asplenium adiantum-nigrum* L.	H	Hem	Nan	Mp-Rc	+	+	+	+
5	*Asplenium septentrionale* (L.) Hoffmann.	H	Hem	Lep	Wp	+	+	+	-
6	*Asplenium trichomanes* L.	H	Hem	Lep	Mp-Rc	+	+	+	+
7	*Ceterach dalhousiae* (Hk.) C. Chr.	H	Hem	Nan	Mp-F	+	+	+	+
3	**Cystopteridaceae**								
8	*Cystopteris fragilis* (L.) Bernh.	H	Geo	Mic	Wp	+	+	+	+
4	**Dryopteridaceae**								

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9	*Dryopteris odontoloma* (Moore.).	H	Hem	Lep	Mp-F	+	+	+	+
10	*Dryopteris serrato-dentata* (Bedd.) Hayata.	H	Hem	Lep	Mp-Rc	+	+	+	-
11	*Dryopteris sieboldii* L.	H	Hem	Lep	Wp	+	+	+	-
12	*Hypodematium crenatum* (Forssk.) Kuhn.	H	Hem	Lep	Mp	+	+	+	-
13	*Polystichum discretum* (D. Don) J. Sm.	H	Hem	Nan	Mp-Rc	+	+	+	+
14	*Polystichum lonchitis* (L.) Roth.	H	Hem	Nan	Mp-Rc	+	+	+	+
15	*Polystichum wilsonii* Christ.	H	Hem	Nan	Wp-Rc	+	+	+	+
5	**Equisetaceae**								
16	*Equisetum arvense* L.	H	Hem	Lep	Wp	+	+	+	-
17	*Equisetum ramossimum* Desf.	H	Geo	Aph	Mp	+	+	+	-
6	**Pteridaceae**								
18	*Pteridium aquilinum* (L.) Kuhn.	H	Geo	Mic	Wp-F	+	+	+	+
19	*Pteris cretica* L.	H	Hem	Mic	Mp	+	+	+	+
20	*Pteris vitata* L.	H	Hem	Mic	Mp-Rc	+	+	+	+
21	*Onychium Contiguum* Wall ex. Hope	H	Geo	Mic	Wp	+	+	+	-
22	*Cheilanthes pteridioides* (Reichard.) C. Chr.	H	Hem	Nan	Wp	+	+	+	+
	Gymnosperm								
1	**Cupressaceae**								
23	*Cupressus sempervirens* L.	T	Phen	Lep	CU	+	+	+	+
24	*Juniperus communis* L.	S	Phen	Lep	F	+	+	+	+
2	**Pinaceae**								
25	*Picea smithiana* (Wall.) Boiss.	T	Phen	Nan	F	+	+	+	+
26	*Pinus roxburghii* Sargent	T	Phen	Nan	Drp-Rp	+	+	+	+
27	*Pinus wallichiana* A.B. Jackson.	T	Phen	Nan	F	+	+	+	+
28	*Abies pindrow* Royle.	T	Phen	Nan	F	+	+	+	+
29	*Cedrus deodara* (Roxb. Ex. D. Don) G. Don	T	Phen	Nan	F	+	+	+	+
3	**Taxaceae**								
30	*Taxus wallichiana* Zucc.	T	Phen	Nan	F	+	+	+	+
	Angiosperm								
	Monocotyledonae								
1	**Alliaceae**								
31	*Allium cepa* L.	H	Geo	Mes	CU	+	+	-	+
32	*Allium sativum* L.	H	Geo	Mes	CU	+	+	-	+
2	**Amaryllidaceae**								
33	*Narcissus tazetta* L.	H	Geo	Mic	G	+	-	-	+
3	**Araceae**								
34	*Arisaema flavum* (Forssk.) Schott	H	Geo	Mes	Mp-Sp	+	+	-	-

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35	*Arisaema jacquemontii* Blume.	H	Geo	Mes	F	+	+	+	-
36	*Sauromatum venosum* (Dryand. ex Aiton) Kunth	H	Geo	Mes	Drp	+	+	-	-
4	**Asparagaceae**								
37	*Asparagus gracilis* Royle	S	Ther	Lep	Drp	+	+	+	+
5	**Colchicaceae**								
38	*Colchicum luteum* Baker.	H	Geo	Nan	Drp	+	-	-	+
6	**Commelinaceae**								
39	*Commelina benghalensis* L.	H	Ther	Mic	Mp-Sp	-	+	-	-
7	**Cyperaceae**								
40	*Cyperus rotundus* L.	H	Ther	Nan	Mp	+	+	-	-
8	**Liliaceae**								
41	*Gagea elegans* Wall. ex Royle	H	Geo	Nan	Af-Drp	+	-	-	-
42	*Polygonatum verticillatum* All.	H	Geo	Mic	Mp	+	+	-	-
43	*Tulipa stellata* HK.	H	Geo	Lep	Af	+	-	-	-
9	**Orchidaceae**								
44	*Aristida cyanantha* Nees ex steud.	H	Hem	Mic	Drp	+	+	-	-
10	**Poaceae**								
45	*Apluda mutica* L.	H	H	Nan	Af-Drp	-	+	-	-
46	*Avena fatua* L.	H	Ther	Mic	Af	+	+	-	-
47	*Cynodon dactylon* (L.) Pers.	H	H	Lep	Drp-Af	-	+	+	-
48	*Dicanthium annulatum* (Forssk.) Stapf.	H	Hem	Nan	Af	+	-	-	+
49	*Hordeum vulgare* L.	H	Hem	Mic	Af	+	-	-	+
50	*Oryza sativa* L.	H	Ther	Mic	CU	-	+	+	-
51	*Setaria viridis* (L.) P. Beauv.	H	Ther	Nan	Drp	-	+	+	-
52	*Sorgham helipense* (L.) Persoon	H	Hem	Mic	Af	+	+	-	-
53	*Themeda anathera* (Nees) Hack.	H	Hem	Nan	Drp	-	+	+	-
54	*Triticum aestivum* L.	H	Ther	Mic	CU	+	-	-	+
55	*Zea mays* L.	H	Ther	Mes	CU	-	+	-	-
56	*Cenchrus ciliaris* L.	H	Ther	Nan	Drp	+	+	+	+
11	**Smilacaceae**								
57	*Smilax glaucophylla* Klotzsch.	C	Phen	Mes	Epi	+	+	+	+
	ii. Dicotyledonae								
1	**Acanthaceae**								
58	*Dicliptera bupleuroides* Nees	H	Hem	Mes	Wap	+	+	+	-
2	**Aceraceae**								
59	*Acer Caesium* Wall ex Brandis	T	Phen	Mac	G	+	+	+	+
3	**Amaranthaceae**								
60	*Achyranthes bidentata* Blume.	H	Ther	Mic	Wap	+	-	-	+

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61	*Alternanthera pungens* Kunth.	H	Ther	Mic	Wap	+	+	-	-
62	*Amaranthus caudatus* L.	H	Cham	Mic	Wap	-	+	+	-
63	*Amaranthus spinosus* L.	H	Therer	Mic	Wap	+	+	-	-
64	*Amaranthus viridis* L.	H	Therer	Mic	Drp	+	+	-	-
4	**Anacardiaceae**								
65	*Pistacia chinensis* Bunge.	T	Phen	Mic	F-G	+	+	+	+
66	*Rhus punjabensis* J. L.	T	Phen	Mes	F	+	+	+	+
5	**Apiaceae**								
67	*Aegopodium burttii* Nasir.	H	Hem	Mic	F	-	+	+	-
68	*Bupleurum atroviolaceum* (O.E.Schulz) Nasir	H	Ther	Mic	F	-	+	+	-
69	*Bupleurum falcatum* L.	H	Ther	Mic	F	-	+	+	-
70	*Bupleurum longicaule* Wall. ex DC. var. ramosum Nasir	H	Ther	Mic	Drp	-	+	+	-
71	*Chaerophyllum Reflexum* Aitch.	H	Hem	Mic	Rc	+	+	-	+
72	*Coriandrum sativum* L.	H	Ther	Lep	CU	-	+	+	-
73	*Foeniculum vulgare* Mill.	H	Ther	Nan	CU	-	+	+	-
74	*Scaligeria indica* Wolff	H	Cham	Nan	F	+	+	-	-
6	**Apocynaceae**								
75	*Nerium oleander* L.	S	Phen	Mes	Mp	+	+	+	+
7	**Araliaceae**								
76	*Hedera nepalensis* K. Koch.	C	Phen	Mes	F	+	+	+	+
8	**Asclepiadaceae**								
77	*Oxystelma esculentum* R. Br.	H	Cham	Lep	Drp	-	+	+	+
78	*Calotropis procera* (Willd.) R. Brown	S	Cham	Mes	Drp	+	+	+	+
79	*Periploca aphylla* Dcne.	S	Phen	Aph	Rp	+	+	+	+
9	**Asteraceae**								
80	*Anaphalis boissieri* E. Georg.	H	Ther	Nan	Drp	-	+	+	-
81	*Anaphalis margaritacea* (L.) Benth.	H	Hem	Nan	Af-Drp	+	+	+	-
82	*Anaphalis nepalensis* (spring). Hangs.-Mazz	H	Ther	Nan	Drp	+	+	+	-
83	*Anaphalis triplinervis* (Sims.) C.B. Clarke.	H	Geo	Mes	Af-Drp	-	+	+	-
84	*Artemisia absintnium* L.	H	Cham	Nan	Drp	-	+	+	-
85	*Artemisia biennis* Wild.	H	He	Mic	Drp	+	+	+	-
86	*Artemisia dubia* Wall.ex Besser	H	Cham	Lep	Drp	+	+	+	-
87	*Artemisia santolinifolia* Turez ex Krasch	H	Cham	Nan	Rp-G	-	+	+	-
88	*Artemisia scoparia* Waldst. & Kit.	H	Ther	Nan	Drp	+	+	-	+
89	*Aster flaccidus* Bunge	H	Ther	Nan	Drp	+	+	+	-
90	*Aster mulliuscus* Wall.	H	Ther	Mic	Drp	+	-	-	-
91	*Bidens biternata* (Lour.) Merrill &	H	Ther	Mic	Mp	+	+	+	-

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	Scheriff								
92	*Calendula arvensis* L.	H	Ther	Mic	Drp	+	-	-	-
93	*Cirsium falconeri* (Hook. F.) Petrak	H	Ther	Mes	Drp	+	+	-	+
94	*Cirsium vulgare* (Savi) Ten.	H	Ther	Mes	Drp	+	+	-	+
95	*Conyza canadensis* (L.) Corgn.	H	Ther	Nan	Mp-Wap	+	+	+	-
96	*Erigeron multiradiatus* (Lindl.) Benth	H	Ther	Lep	Drp	-	+	+	-
97	*Filago hardwarica* (Wall ex DC.) Wagenitz	H	Ther	Lep	Drp	+	+	+	-
98	*Galinosoga parviflora* Cav.	H	Ther	Mic	Af	-	+	+	-
99	*Helianthus anus* L.	H	Ther	Mes	CU	-	+	-	-
100	*Helianthus tuberosus* L.	H	Ther	Mes	Drp	+	+	+	+
101	*Lentopodium himalayanum* DC.	H	Hem	Lep	F	-	+	+	-
102	*Onopordum acanthium* L.	H	Ther	Mes	Af-Dp	+	+	-	-
103	*Prenanthes stewartii* Roohi Bano & Qaiser	H	Ther	Nan	F	+	+	+	-
104	*Senecio chrysanthemoides* DC.	H	Ther	Mes	Rp	+	+	-	-
105	*Solidago virgaurea* L.	H	Hem	Mic	Wap	-	+	-	-
106	*Sonchus arvensis* L.	H	Ther	Mes	Af	-	+	-	-
107	*Sonchus asper* (L.) Hill.	H	Ther	Mes	Mp-Wap	+	+	-	-
108	*Sonchus oleraceus* L.	H	Ther	Mic	Wp-Mp	+	+	-	-
109	*Tagetes minuta* L.	H	Ther	Mic	Drp and F	+	+	-	-
110	*Taraxacum officinale* Weber.	H	Ther	Mic	Wap	+	+	-	-
111	*Xanthium strumarium* L.	H	Ther	Mes	Wap	+	+	-	-
10	**Balsaminaceae**								
112	*Impatiens bicolor* Royle.	H	Ther	Mes	Mp-Rp	-	+	+	-
113	*Impatiens brachycentra* Kar. & Kir.	H	Ther	Mic	Mp-Rp	-	+	-	-
114	*Impatiens egeworthii* Hook. f.	H	Ther	Mes	Wp	+	+	-	-
115	*Impatiens fliemingii* Hook. F.	H	Ther	Mes	Mp	-	+	+	-
11	**Berberidaceae**								
116	*Berberis lycium* Royle	S	Phen	Nan	Rp-F	+	+	+	+
117	*Berberis pseudumbellata* Parker ssp pseudumbellata	S	Phen	Nan	Rp-F	+	+	+	+
12	**Betulaceae**								
118	*Alnus nitida* (Spach). Endl.	Tree	Phen	Mes	Wp	+	+	+	+
119	*Betula utilis* D. Don.	T	Phen	Mes	F-Rp	+	+	+	+
13	**Boraginaceae**								
120	*Cynoglossum glochidiatum* Wall. Ex	H	Ther	Mic	Drp	+	+	-	-

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	Benth.								
121	*Cynoglossum lanceolatum* Forssk.	H	Ther	Mic	Drp	+	+	-	-
122	*Heliotropium undulatum var. suberosa* Clarke. ·	H	Geo	Lep	Drp	-	+	+	-
123	*Myosotis alpestris* F. W. Schmidt var. albicans (H.Riedl) Y.Nasir.	H	Hem	Mic	F	+	+	-	-
124	*Onosma dichronata* Boiss.	H	Ther	Mic	Drp	+	-	-	+
125	*Onosma hispida* Wall e G. Don, Gen.	H	Ther	Mic	Drp	+	-	-	+
126	*Pseudomertensia nemorosa* (A. DC.) Stewart & Kazmi	H	Ther	Nan	F	+	+	+	-
14	**Brassicaceae**								
127	*Coronopus didymus* (L.) Sm.	H	Ther	Nan	Wap-Af	+	+	+	+
128	*Farsetia jaquemontii* Hook.f. & Thomson.	H	Cham	Nan	F	+	+	-	+
129	*Nasturtium officinale* R. Br.	H	Geo	Mic	Wp	+	+	+	+
130	*Raphanus sativus* L.	H	Ther	Mac	CU	+	-	-	+
131	*Thlaspi arvense* L.	H	Ther	Nan	Wap	+	+	-	+
132	*Thlaspi griffithianum* Boiss	H	Ther	Nan	Wap	+	+	-	+
133	*Verbascum thapsus* L.	H	Ther	Meg	Drp	+	-	-	+
15	**Buxaceae**								
134	*Sarcococca saligna* (Don) Muell.	S	Phen	Mic	Mp-Sp	+	+	+	+
16	**Caesalpinaceae**								
135	*Cleome viscosa* L.	H	Ther	Mic	Mp	+	+	+	-
17	**Campanulaceae**								
136	*Campanula aristata* Wallich	H	Hem	Nan	Af-Dr p	+	+	-	-
18	**Cannabaceae**								
137	*Cannabis sativa* L.	H	Ther	Mic	Wap	+	+	+	-
19	**Caprifoliaceae**								
138	*Viburnum grandiflorum* Wall. ex DC.	S	Phen	Mes	F	+	+	+	+
139	*Viburnum cotinifolium* D.Don.	S	Phen	Mic	F	+	+	+	+
140	*Viburnum mullaha* Buch. Ham . ex D.Don.	S	Phen	Mes	F	+	+	+	+
20	**Caryophyllaceae**								
141	*Arenaria serpyllifolia* L.	H	Ther	Lep	Mp	-	+	+	-
142	*Gypsophila cerastioides* D.Don	H	Ther	Nan	Mp	+	+	+	-
143	*Silene vulgaris* (Moench) Garcke	H	Ther	Nan	Drp	+	+	-	-
21	**Celastraceae**								
144	*Maytenus royleanus* (Wall. ex Lawson.) Cufedintis.	S	Phen	Mic	Drp	+	+	+	+
145	*Maytenus Wallichiana* (Springe) Raju	S	Phen	Mic	Drp	+	+	+	+

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	& Bull.								
22	**Chenopodiaceae**								
146	*Chenopodium foliosum* Aschers.	H	Ther	Nan	Drp	+	+	-	-
147	*Chenopodium album* L.	H	Ther	Mes	Wap	+	+	-	-
148	*Chenopodium ambrosioides* L	H	Ther	Mes	Wap	+	+	-	-
149	*Chenopodium botrys* L.	H	Ther	Mic	Wap	+	+	-	-
23	**Crassulaceae**								
150	*Sedum hispanicum* L.	H	Hem	Nan	Mp	-	+	-	-
24	**Cucurbitaceae**								
151	*Luffa cylindrica* (L) Roem	C	Ther	Mes	CU	-	+	+	-
152	*Cucumis melo var. agrestis* Naudn, Ann.	C	Ther	Mic	Drp	-	+	+	-
153	*Cucumis sativus* L.	C	Ther	Mac	CU	-	+	-	-
154	*Cucurbita maxima* Duch. Ex Lam.	C	Ther	Meg	CU	-	+	-	-
155	*Cucurbita pepo* L.	C	Ther	Meg	CU	-	+	-	-
25	**Ebenaceae**								
156	*Diospyros kaki* L.	T	Phen	Mes	Mp	+	+	+	+
157	*Diospyros lotus* L.	T	Phen	Mes	Mp	+	+	+	+
26	**Ericaceae**								
158	*Gaultheria trichophylla* Royle	S	Cham	Lep	F	+	+	+	+
159	*Rhododendron hypenanthum* Balf. f.	S	Phen	Mic	F	+	+	+	+
27	**Euphorbiaceae**								
160	*Chrozophora tinctoria* (L.) Raf.	H	Ther	Mic	Drp	+	+	-	+
161	*Euphorbia helioscopia* L.	H	Ther	Nan	Af-Drp	-	-	+	+
162	*Euphorbia peplus* L.	H	Ther	Lep	Af-Drp	-	-	+	-
163	*Andrachne cordifolia* (Wall.ex Dcne.) Muell. Avg.	S	Phen	Mic	Mp-Sp	+	+	+	+
164	*Ricinus communis* L.	S	Phen	Mic	Drp	+	+	+	+
28	**Fagaceae**								
165	*Quercus baloot* Griffth.	T	Phen	Mic	F-Drp	+	+	+	+
166	*Quercus dilatata* Royle.	T	Phen	Mic	Drp-Rp	+	+	+	+
167	*Quercus incana* Roxb.	T	Phen	Mic	F-Drp	+	+	+	+
29	**Fumaraceae**								
168	*Fumaria indica* (Hausskn.) H.N.	H	Ther	Lep	Drp	+	-	-	+
30	**Gentianaceae**								
169	*Swertia cordata* (G.Don) Clarke	H	Ther	Lep	Drp-F	-	+	+	-
31	**Geraniaceae**								
170	*Erodium cicutarium* L.	H	Ther	Mes	Wp	+	+	-	+
171	*Geranium colinum* Sweet.	H	Hem	Mic	F	-	+	+	-

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172	*Geranium ocellatum* Camb.	H	Ther	Mic	F	+	+	-	-
173	*Geranium pussillum* Burm.	H	Ther	Mic	F	+	+	-	-
174	*Geranium wallichianum* D. Don. Ex Sweet	H	Ther	Mic	F	+	+	+	-
32	**Grossulariaceae**								
175	*Ribes alpestre* Dcne.	S	Phen	Nan	F	+	+	+	+
33	**Hamamelidaceae**								
176	*Parrotiopsis jacquemontiana* (Dcne.) Rehder.	S	Phen	Mes	F	+	+	+	+
34	**Hippocastinaceae**								
177	*Aesculus indica* (Wall Ex. Camb.)Hk. F.)	T	Phen	Mes	Mp	+	+	+	+
35	**Hypericaceae**								
178	*Hypericum oblongifolium* Choisy	S	Phen	Nan	F	+	+	+	+
179	*Hypericum perforatum* L.	H	Cham	Nan	F	-	+	+	-
36	**Juglandaceae**								
180	*Juglans regia* L.	T	Phen	Mic	Drp	+	+	+	+
37	**Lamiaceae**								
181	*Ajuga bracteosa* Wall. ex Benth.	H	Hem	Mic	Drp	+	+	+	-
182	*Calamintha umbrosa* (M.Bieb.) Fisch. & Mey.	H	Ther	Nan	Mp-F	+	+	+	-
183	*Mentha arvensis* L.	H	Ther	Mic	Drp-Wap	-	+	+	-
184	*Clinopodium umbrosum* (M. Bieb.) C. Koch.	H	Hem	Nan	Mp	+	+	-	-
185	*Clinopodium vulgare* L.	H	Hem	Mic	Drp	+	+	-	-
186	*Leucas cephalotes* (Roth.) Spreng.	H	Ther	Mic	Drp	+	+	-	-
187	*Lycopis europis* L.	H	Cham	Mes	Drp	+	+	-	-
188	*Marrubium vulgare* L.	H	Ther	Mic	F	+	+	-	-
189	*Mentha longifolia* (L.) Huds.	H	H	Nan	Mp	+	+	+	-
190	*Micromeria biflora* Benth.	H	Cham	Lep	M-Sp	+	+	+	-
191	*Nepeta discolor* Royle ex Benth.	H	Cham	Mic	Mp-F	-	+	+	-
192	*Ocimum basilicum* L.	H	Cham	Nan	Drp	+	+	+	+
193	*Origanum vulgare* L.	H	Hem	Nan	Rp	-	+	+	-
194	*Phlomis spectabilis* Falc. ex Benth.	H	Phen	Mic	Drp	+	+	+	+
195	*Salvia moorcroftiana* Wall. ex Bth.	H	Ther	Mac	Drp	+	-	-	+
196	*Salvia nubicola* Wall. Ex Sweet.	H	Ther	Mes	Drp	-	+	+	+
197	*Teucrium royleanum* Wall. ex Bth.	H	Ther	Mic	Drp	+	+	-	-
198	*Teucrium stocksianum* Boiss.	H	Ther	Mic	Drp	+	+	-	-
199	*Thymus linearis* Bth. Ssp. linearis Jalas	H	Hem	Nan	Mp	-	+	+	-
200	*Isodon rugosus* (Wall. ex Bth.) Codd.	S	Phen	Mes	Drp	+	+	+	+
201	*Rabdosia rugosa* Benth.	S	Phen	Mes	Drp-F	+	+	+	+
38	**Malvaceae**								

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202	*Abelmoschus esculentus* (L.) Moench.	H	Ther	Mes	CU	-	+	+	-
203	*Malva neglecta* Wallr.	H	Ther	Mic	Wap-Af	+	+	-	-
39	**Meliaceae**								
204	*Cedrela serrata* Royle	T	Phen	Mic	Mp	+	+	+	+
205	*Melia azedarach* L.	T	Phen	Nan	Drp	+	+	+	+
40	**Moraceae**								
206	*Ficus johanis* Boiss.	T	Phen	Mes	Drp	+	+	+	+
207	*Ficus palmata* Forssk.	T	Phen	Mes	Drp	+	+	+	+
208	*Morus alba* L.	T	Phen	Mes	Mp	+	+	+	+
209	*Morus macroura* Miq.	T	Phen	Mes	Mp	+	+	+	+
210	*Morus nigra* L.	T	Phen	Mes	Mp	+	+	+	+
41	**Myrsinaceae**								
211	*Myrsine africana* L.	S	Phen	Nan	Drp-F	+	+	+	+
42	**Myrtaceae**								
212	*Myractis wallichii* Less.	H	Ther	Nan	F	-	+	+	-
213	Myrtus communis L.	S	Phen	Mic	Mp	+	+	+	+
43	**Nyctaginaceae**								
214	*Boerhavia procumbens* Banks ex Roxb.	H	Hem	Nan	Mp	-	+	+	-
215	*Mirabilis jalapa* L	H	Ther	Mes	Drp	+	+	-	-
44	**Oleaceae**								
216	*Fraxinus hookeri* Wenzig	T	Phen	Mes	F	+	+	+	+
217	*Jasminum humile* L.	S	Phen	Mic	Mp	+	+	+	+
218	*Jasminum officinale* L.	S	Phen	Nan	Drp-F	+	+	+	+
219	*Olea ferruginea* Royle.	T	Phen	Mic	Drp-G	+	+	+	+
45	**Onagraceae**								
220	*Epilobium hirsutum* L.	H	H	Nan	M-Sp	+	+	+	-
221	*Oenothera rosea* L.her.ex.Ait.	H	Hem	Mic	Wp	-	+	+	-
46	**Oxalidaceae**								
222	*Oxalis corniculata* L.	H	Ther	Nan	M-Sp	+	+	+	-
47	**Papaveraceae**								
223	*Desmodium elegans* DC.	S	Phen	Mes	Drp	+	+	+	+
48	**Fabaceae**								
224	*Vicia sativa* L.	C	Ther	Nan	Af	+	-	-	+
225	*Lespedeza juncea* (L.F.) Persoon.	H	Ther	Lep	Drp	+	+	+	+
226	*Medicago minima* (L.) Grufb.	H	Ther	Nan	Af	+	-	-	+
227	*Medicago sativa* L.	H	Hem	Nan	Mp-F	+	+	-	+
228	*Melilotus officinalis* (Linn.) Desr.	H	Ther	Nan	Mp-F	-	+	+	-
229	*Phaseolus vulgare* L.	H	Cham	Mes	CU	-	+	-	-
230	*Pisum sativum* L.	H	Ther	Mic	CU	+	-	-	-
231	*Trifolium repens* L.	H	Ther	Nan	F	+	+	-	+
232	*Trigonella gracilis* Benth.	H	Ther	Nan	Mp-Af	+	+	-	-

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233	*Indigofera gerardiana* (Wall. ex Baker) Ali	S	Phen	Lep	Drp	+	+	+	+
234	*Indigofera heterantha* Wall. ex Brand.	S	Phen	Lep	Drp	+	+	+	+
235	*Robinia pseuo-acacia* L.	T	Phen	Mic	CU	+	+	+	+
49	**Philadelphaceae**								
236	*Deutzia staminea* R. Br .ex Wall.	S	Phen	Mic	Drp	+	+	+	+
50	**Plantaginaceae**								
237	*Plantago himalaica* pilger.	H	Ther	Mic	Drp	-	-	+	-
238	*Plantago lanceolata* L.	H	Ther	Mic	Mp	-	+	-	-
239	*Plantago major* L.	H	Ther	Mes	Mp	-	+	+	-
51	**Platanaceae**								
240	*Platanus orientalis* L.	T	Phen	Mes	F	+	+	+	+
52	**Plumbaginaceae**								
241	*Limonium cabulicum* (Boiss.) O. Kuntze.Rev.gen.	H	Phen	Mes	Drp	+	+	+	+
53	**Polygalaceae**								
242	*Polygala abyssinica* R. Br. ex Fresen.	H	Cham	Nan	F	+	+	+	-
243	*Polygala sibirica* L.	H	Ther	Nan	F	+	+	+	-
54	**Polygonaceae**								
244	*Rumex dentatus* L.	H	Hem	Mes	Mp	-	+	+	+
245	*Rumex hastatus* D.Don	H	Cham	Nan	Drp	+	+	-	+
246	*Bistorta amplexicaulis* (D. Don) Green	H	H	Mes	Mp-F	-	+	+	-
247	*Polygonum aviculare* L.	H	Ther	Nan	Wp	-	+	+	-
248	*Polygonum barbatum* L.	H	Ther	Nan	Mp	-	+	+	-
249	*Polygonum capitatum* Buch.-Ham. Ex D. Don.	H	Ther	Nan	Wap	-	+	+	-
250	*Polygonum maculosa* S. F. Gay.	H	Ther	Mic	Wap	-	+	+	-
251	*Polygonum paronchioides* C. A. Mey. Ex Hohen.	H	Hem	Nan	Mp	-	+	+	-
55	**Primulaceae**								
252	*Androsace rotundifolia* Hardwicke	H	Hem	Mes	Drp-F	+	+	-	-
253	*Primula denticulata* Wight.	H	Hem	Mes	Mp-F	+	-	-	+
254	*Primula floribunda* Wall.	H	Hem	Mes	Wp-Mp	-	+	+	-
255	*Primula vulgaris* Huds	H	There	Mic	F-Mp	+	+	+	-
56	**Punicaceae**								
256	Punica grantaum L.	T	Phen	Mic	Drp	+	+	+	+
57	**Ranunculaceae**								
257	*Clematis graveolens* Roxb. ex. D.C.	C	Ther	Mic	Drp	+	+	+	-
258	*Aconitum heterophyllum* Wall. Ex Royle	H	Cham	Mes	F	-	+	+	-
259	*Actaea spicata* L.	H	Hem	Mac	F	+	+	+	-

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260	*Anemone obtusiloba* D.Don	H	Hem	Lep	F	-	+	+	-
261	*Ranunculus hirtellus* Royle.	H	Ther	Nan	Wp	-	+	-	-
262	*Ranunculus laetus* Wall. Ex Hk. F. & Thoms.	H	Geo	Nan	Wp	-	+	-	-
263	*Ranunculus muricatus* L.	H	Geo	Mic	Wp	+	+	-	-
58	**Rhamnaceae**								
264	*Rhodiola himalensis* (D. Don) S. H. Fu	H	Ther	Nan	F	-	+	+	-
265	*Rhamnus pentapomica* Fisch. & C.A.Mey.	S	Phen	Nan	Drp-F	+	+	+	+
266	*Sageretia thea* (L.) Brongn.	S	Phen	Nan	Drp	+	+	+	+
267	*Ziziphus nummularia* (Burm. f.) Wight & Arn.	S	Phen	Nan	Drp	+	+	+	+
268	*Ziziphus mauritiana* Lam.	T	Phen	Nan	Drp	+	+	+	+
59	**Rosaceae**								
269	*Duchesnea indica* (Andr.) Focke	H	Ther	Mic	M-Sp	+	+	+	+
270	*Filipendula vestita* (Wall. ex G. Don.) Maxim.	H	Ther	Mes	F	-	+	+	-
271	*Fragaria nubicola* Lindl.	H	Hem	Nan	M-Sp	-	+	+	-
272	*Potentilla nepalensis* Hook.	H	Hem	Mic	F	-	+	-	-
273	*Poterium sanguisorba* Waldst.& Kit.	H	Ther	Nan	Wp	+	+	-	-
274	*Sibbaldia cuneata* Edgew.	H	Cham	Nan	Mp-F	-	+	-	-
275	*Cotoneaster bacillaris* Wall.ex Lindl.	S	Phen	Mic	F	+	+	+	+
276	*Cotoneaster microphyllus* Wall. Ex Lindl.	S	Phen	Nan	F	+	+	+	+
277	*Cotoneaster affinis* (Lindl.) Schn.	S	Phen	Nan	Drp	+	+	+	+
278	*Cotoneaster nummularia* Fish and Mey.	S	Phen	Nan	F	+	+	+	+
279	*Prunus jacquemontii* Hk. f.	S	Phen	Nan	F	+	+	+	+
280	*Rosa alba* L.	S	Phen	Nan	CU	+	+	+	+
281	*Rosa brunonii* Lindl.	S	Phen	Nan	Wp	+	+	+	+
282	*Rosa canina* L.	S	Phen	Nan	Mp-F	+	+	+	+
283	*Rosa webbiana* Wall. ex Royle	S	Phen	Nan	F	+	+	+	+
284	*Rubus ellipticus* Smith	S	Phen	Nan	F	+	+	+	+
285	*Rubus fruticosus* L.	S	Phen	Mes	Mp	+	+	+	+
286	*Rubus sanctus* Schreber	S	Phen	Mic	Mp	+	+	+	+
287	*Rubus ulmifolius* Schott	S	Phen	Mic	Mp	+	+	+	+
288	*Sorbaria tomentosa* (Lindl.) Rehdr	S	Phen	Mic	Wp	+	+	+	+
289	*Spiraea vaccinifolia* D.Don.	S	Phen	Mic	F	+	+	+	+
290	*Malus pumila* Mill.	T	Phen	Mes	CU	+	+	+	+
291	*Prunus armeniaca* L.	T	Phen	Mes	CU	+	+	+	+
292	*Prunus cornuta* (Wall. Ex. Royle.) Steud.	T	Phen	Mes	F	+	+	+	+
293	*Prunus domestica* L.	T	Phen	Mes	CU	+	+	+	+
294	*Prunus persica* L. Batsch.	T	Phen	Mes	CU	+	+	+	+

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295	*Pyrus communis* L.	T	Phen	Mic	CU	+	+	+	+
296	*Pyrus pashia* Ham. Ex. D.Don.	T	Phen	Mic	CU	+	+	+	+
60	**Rubiaceae**								
297	*Galium aparine* L.	H	Ther	Nan	Wap-Af	+	+	+	-
61	**Rutaceae**								
298	*Skimmia laureola* (DC.) Sieb. & Zucc. ex Walp	S	Phen	Mes	F	+	+	+	+
299	*Citrus sinensis* (L.) Osbeck.	T	Phen	Mes	CU	+	+	+	+
300	*Zanthoxylum armatum* DC.	T	Phen	Mes	Drp	+	+	+	+
62	**Salicaceae**								
301	*Salix denticulata var. hazarica* (R. Parker) Ali	S	Phen	Mes	Mp-F	+	+	+	+
302	*Populus alba* Wall.	T	Phen	Mes	CU	+	+	+	+
303	*Populus nigra* L.	T	Phen	Mac	CU	+	+	+	+
304	*Salix babylonica* L.	T	Phen	Mic	Wp	+	+	+	+
305	*Salix tetrasperma* Roxb.	T	Phen	Mes	Wp	+	+	+	+
63	**Sambucaceae**								
306	*Sambucus wightiana* Wall Ex Wight and Arn	H	Ther	Mes	F	-	+	-	-
64	**Sapindaceae**								
307	*Dodonaea viscosa* (L.) Jacq.	S	Phen	Mic	Drp	+	+	+	+
65	**Saxifragaceae**								
308	*Bergenia ciliata* (Haw.) Sternb.	H	Geo	Mes	Mp-F	+	+	-	-
309	*Bergenia stracheyi* (H. & T.) Engl.	H	Geo	Mes	Mp-F	+	+	-	-
66	**Scrophulariaceae**								
310	*Scrophularia umbrosa* Dumort.	H	Cham	Nan	Drp	-	+	+	-
311	*Veronica polita* Fries.	H	Ther	Nan	Mp	+	+	+	-
67	**Simaroubaceae**								
312	*Ailanthus altissima* (Mill.) Swingle	T	Phen	Mes	Wap	+	+	+	+
68	**Solanaceae**								
313	*Datura innoxia* Mill.	H	Ther	Mes	Wap	-	+	+	-
314	*Datura stramonium* L.	H	Ther	Mes	Wap	-	+	+	-
315	*Lycopersicon esculentum* Miller	H	Ther	Mes	CU	+	+	+	-
316	*Solanum nigrum* L.	H	Ther	Mic	Drp-Wap	+	+	+	-
317	*Solanum pseudo-capsicum* L.	H	Ther	Mic	G	-	+	+	-
318	*Solanum surattense* Burm. f.	H	Ther	Mic	Wap	+	+	-	-
319	*Solanum tuberosum* L.	H	Geo	Mes	CU	-	+	-	-
69	**Thymeleaeceae**								
320	*Wikstroemia canescens* Meisn.	S	Phen	Nan	F	+	+	+	+
321	*Daphne mucronata* Royle	S	Phen	Nan	Rp	+	+	+	+

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70	**Trilliaceae**								
322	*Trillium govanianum* Wall. ex Royle.	H	Cham	Mes	F	-	+	-	-
71	**Ulmaceae**								
323	*Celtis australis* L.	T	Phen	Mic	Drp	+	+	+	+
324	*Celtis caucasica* Willd.	T	Phen	Mic	Drp	+	+	+	+
72	**Urticaceae**								
325	*Gerardinia palmata* Blume.	H	Ther	Meg	M-Sp	+	+	+	-
326	*Urtica dioica* L.	H	Ther	Mic	Mp	+	+	+	-
327	*Debregessia salcifolia* (D. Don) Rendle.	S	Phen	Mic	Mp-Wp	+	+	+	+
73	**Valerianaceae**								
328	*Valeriana jatamansi* Jones.	H	Geo	Mic	Mp-F	+	+	-	-
74	**Verbenaceae**								
329	*Verbena officinalis* L.	H	Ther	Mic	Mp-Rp	+	+	+	+
75	**Violaceae**								
330	*Viola canescens* Wall. Ex Roxber	H	Hem	Mic	M-Sp	+	+	+	-
76	**Vitaceae**								
331	*Vitis vinifera* L.	C	Phen	Mes	CU	+	+	+	+
77	**Zygophyllaceae**								
332	*Tribulus terrestris* L.	H	Hem	Lep	Wap	-	+	-	-

3.2. Raunkiaer Life Form and Leaf Size Classification of Vegetation

In the present study area, therophytes (126 species, 38.0%) were found dominant, followed by phanerophytes (104 species, 31.3%) and hemicryptophytes (58 species, 17.5%) (Table 2), indicating that the phytoclimate of the area is of the thero-phanerophytic type. The results of leaf size spectrum of vegetation revealed that the area was dominated by microphylls (107 species, 32.2%), while megaphylls and aphyllous were the least abundant leaf size classes (Table 2).

Table 2. Summary of ecological characteristics of vegetation of Sultan Khail valley Dir, Upper, Pakistan.

S.No.	Characteristics	Number	Percentage
1	**Vegetation**		
	Families	97	-
	Genera	234	-
	Species	332	-
2	**Habit**		
	Herbs	220	66.3
	Shrubs	54	16.3
	Trees	48	14.5
	Climbers	10	3.0
3	**Seasonality**		
	Spring	251	26.4
	Summer	308	32.4
	Autumn	231	24.3
	Winter	162	17.0
4	**Life form spectra**		

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	Therophytes	126	38.0
	Phanerophytes	104	31.3
	Hemicryptophytes	58	17.5
	Chamaephytes	21	6.3
	Geophytes	23	6.9
5	**Leaf size spectra**		
	Microphylls	107	32.2
	Nanophylls	99	29.8
	Mesophylls	83	25.0
	Leptophylls	31	9.3
	Macrophylls	6	1.8
	Megaphylls	4	1.2
	Aphyllous	2	0.6
6	**Habitat type**		
	Wet places	25	6.4
	Rock crevices	10	2.5
	Forests	83	21.1
	Moist places	79	20.1
	waste places	27	6.9
	Agriculture fields	23	5.9
	Graveyards	6	1.5
	Rocky places	16	4.1
	Dry places	92	23.4
	Epiphytes	1	0.3
	Cultivated	31	7.9

Key: Habit: T= Tree, S= Shrub, H= Herb, C= Cliber. Life form: Ther= Therophyte, Phen= Phanerophyte, Hem= Hemicryptophyte, Geo= Geophytes, Cham= Chamaephyte. Leaf form: Lep= Leptophyll, Mes= Mesophyll, Mic= Microphyll, Meg= Megaphyll, Nan= Nanophyll, Mac= Macrophyll, Aph= Aphyllous. Habitat type: Wap= Waste places, CU= Cultivated, Mp- Moist places Sp= shady places, Rp= rocky places, F= Forest, Drp= Dry places, G= Graveyards, Af= Agricultural fields, Rc= Rock crevies, EPI= Epiphyte, WP= Wet places.

3.2.1. Seasonal Variation in Life Form and Leaf Size Spectra of Vegetation

Seasonal variation in life form reveals that Phanerophytes (104 species, 41.4%) dominated the spring flora, followed by Therophytes (80 species, 31.9%), and Hemicryptophytes (38 species, 15.1%). In summer, therophytes (109 species, 35.4%) were the most abundant life form class, while in autumn and winter, phanerophytes were dominant (Figure 3). Seasonal variation in leaf size spectra shows that microphylls were dominant in the spring (34.3%) and summer (31.2%) seasons, while in autumn and winter, nanophylls were dominant (Figure 4).

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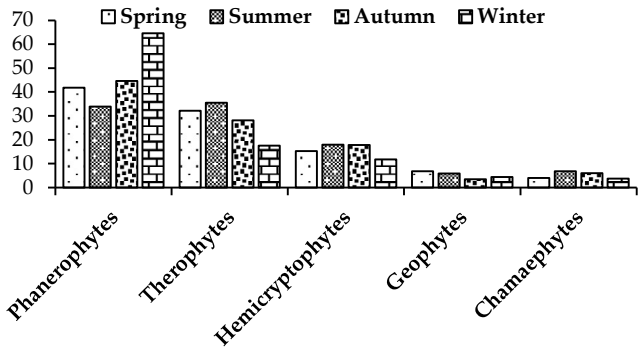

Figure 3. This figure represents the seasonal variations in life form and Leaf size spectrum of vegetation of Sultan Khail valley, Hindu Kush range of Pakistan.

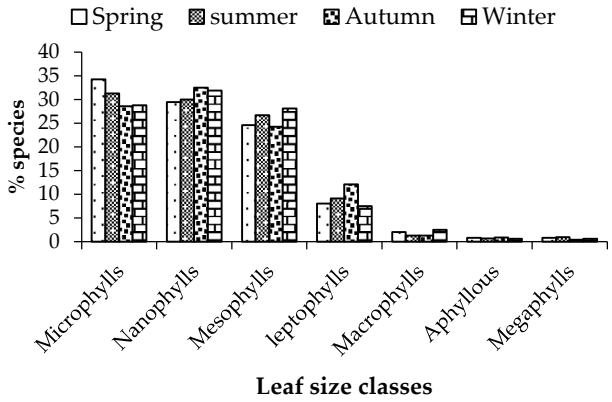

Figure 4. This figure represents seasonal variations in leaf size spectra of vegetation of Sultan Khail valley, Hindukush range of Pakistan.

3.3. Habitat Types

The plants species were also classified on their habitat. The results revealed that the maximum number of species (92 species) was found in dry places, followed by forests (83 species), and moist places (78 species) (Figure 5).

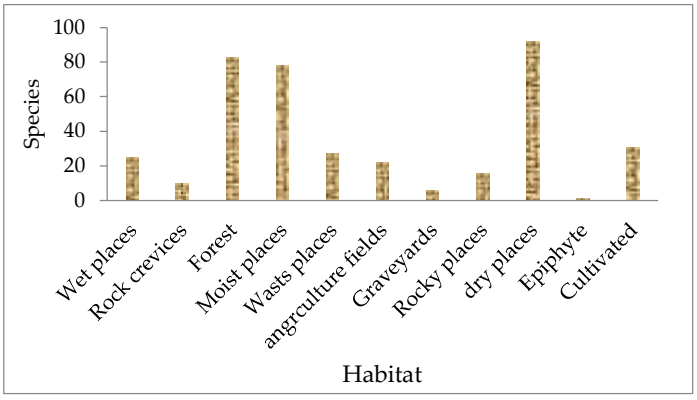

Figure 5. Classification of plants species of Sultan Khail valley, Dir Upper Pakistan based on their habitat.

4. Discussion

The total number of wild and cultivated plants species found in any geographical area is called the floristic composition. Floristic study provides baseline information for further detailed taxonomical and ecological research and planning for sustainable management and conservation of plants resources [25]. The flora of Sultan Khail valley is

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found to be diverse as compared to other areas [16,17,26,27] and homed to 332 species belonging to 234 genera and 96 families. Gymnosperms and pteridophytes were less predominant in the area. Asteraceae was the dominant family in the area with 32 species (9.7%) followed by Rosaceae, Lamiaceae, Fabaceae and Poaceae. A similar study was conducted by [11] in the Riyadh region Saudia Arabia and Asteraceae (17.4%) was reported as the most widespread family, followed by Poaceae, Brassicaceae and Fabaceae, while [18] reported 154 plant species from Karkhasa (Baluchistan) with Asteraceae being the predominant family, followed by Poaceae. [17], explored the flora of Takht Bhai and listed 140 species, 63 families. Asteraceae was found to be the dominant family in the area, followed by Poaceae and Solanaceae, while [28] conducted similar research in Lajbouk (Dir Lower). [16] reported 250 species within 77 families, in which Asteraceae and Lamiaceae were the leading dominant families. Our findings strongly coincide with those of [6], who found Asteraceae as a dominant family followed by Rosaceae, Lamiaceae, and Poaceae in Jammu and Kashmir. Similarly, [29] also found Rosaceae, the largest family, followed by Asteraceae and Lamiaceae in the Keran Valley, in the northwestern Himalaya. The dominance of Asteraceae families in the target area as well as in the world represents its wide range of ecological amplitude [11,30,31]. In the present study area herbaceous flora was dominant, followed by shrubs and trees. The dominance of herbaceous flora is due to the overexploitation of trees and shrubs species by the inhabitants of the valley, due to which the population of trees and shrub species is decreasing day by day. Similar findings were also reported by [3] while exploring the flora of Swat Ranizai, [32] from district Nowshera, [33] from Ghalegay Hills, Swat, [34] from Karak, [35] from darra Adam Khel, [36] from Miandam, Swat, [16] from Jelar Valley, and [18] from Baluchistan.

The biological spectrum is an indicator of the physiognomy of flora, vegetation and their relation to the prevailing climatic conditions of the region [37–39]. In the present study area, therophytes were found dominant, followed by phanerophytes (Table 3.2), indicating that the phytoclimate of the area is thero phanerophytic type. Normally therophytes are the indicators of arid phytoclimate [40], hemicryptophytes of temperate region [6] while, chamaephytes are the indicator of high altitudinal zones and arctic regions [41] while Phanerophytes are the indicators of moist regions [42]. The dominance of therophytes in the area reflects that the flora is under heavy biotic pressure such as deforestation, overgrazing, and overexploitation [26] of the plants species for fuel, timber, medicinal purposes, and agricultural practices [43]. [11] conducted a similar study, and therophytes and chamaephytes were reported dominant. [44], conducted similar research and found therophytes dominant, followed by phanerophytes, and stated that the environmental condition of the area is dry and hot. Similar results were also reported from Koont [45], Gadoon, Swabi by [46]. The present findings are strongly supported by [16,28,29] who reported the dominance of therophytes in the area and stated that the flora is under heavy biotic pressure such as deforestation, overgrazing, and overexploitation of the plants species for fuel, timber, and medicinal purposes.

Leaf size is also an important physiognomic trait that influences different functions of plants, such as photosynthesis and transpiration. The knowledge of leaf size among plants species may help to know about the physiological processes of plants and their communities [9]. The results revealed that the vegetation of Sultan Khail valley is dominated by microphylls, while megaphylls and aphyllous were least contributed leaf size classes in the area (Table 3.4). The present findings are in line with [34,47] who also reported microphylls and nanophylls as the dominant leaf size classes. Our results are strongly supported by [16] who reported microphylls as dominant, followed by nanophylls and mesophylls, in Jelar Valley. The present findings are also in line with [43,48], who reported the same leaf size classes dominant in Kashmir and Quetta. Seasonal variation in leaf size spectra shows that in the spring and summer seasons, microphylls were dominant, while in the autumn and winter seasons, nanophylls were dominant.

Seasonal variation in life forms shows that phanerophytes dominated the spring flora. In summer, therophytes were the most abundant life form class, while in the autumn and winter seasons, phanerophytes were dominant. The seasonal variation in life forms is due to the presence of short-lived species. The present findings are line with [12,35,37], [16,28,49]. The difference in seasonal variation of leaf size classes is due to the presence of geophytes and short lived therophyte species; however, altitude also plays an important role in the distribution of leaf size classes, as reported by [16,28,48,50]. The habitat condition of the area is mostly dry as maximum numbers of species were found in dry habitat followed by forests. Various researchers such as [16,51,52] also conducted similar studies. They classified plants species based on habitat types. Therefore, our findings are in correlation with them.

5. Conclusions

From the present study, it is concluded that the flora of the Sultan Khail valley is diverse. The phytoclimate of the area is of the therophytic type. The vegetation of the investigated area is under heavy biotic pressure in the form of

grazing, fuel wood collection, medicinal plant collection, timber smuggling to other areas, and some natural phenomena such as soil erosion and land sliding, due to which the vegetation of the area is decreasing day by day and needs proper conservation. The habitat condition of the area is mostly dry, as the maximum numbers of species were found in dry habitats. This study provides baseline information on the flora of the Sultan Khail valley, and further studies will be needed to assess the conservation status of wild flora and obtain quantitative information on vegetation.

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