

FLORA OF THE KURRAM VALLEY (TRIBAL AREA), PAKISTAN: DIVERSITY, PHYSIOGNOMY AND CONSERVATION ISSUES

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Abstract

Pakistan-Afghan border is famous for diverse flora harbouring substantial endemic, medicinal and wild food plant species. The current study presents the results of floristic study conducted in the Valley of Kurram Pak-Afghan border from 2015-2018. The study documented 365 plant species belonging to 244 genera and 86 families. Asteraceae was the leading family with 40 species (10.96%), followed by Lamiaceae (31 spp., 8.49%) and Fabaceae (26 spp., 7.12%). Endemic and rare species, such as *Seriphidium kurramense*, *Pseudomertensia anjumiae*, *Rhododendron collettianum*, *Rhododendron afghanicum*, *Nepeta kurramensis*, *Vincetoxicum cardiostephanum* were sampled. Herbaceous growth form was prevailed with 237 species with 77 shrubs and 47 tree taxa. Therophytes include 114 taxa (31.23%), hemicryptophytes 67, (18.36%) and nano-phanerophytes 60 (16.44%). One hundred fifty-eight (22.47%) nanophyllous species were recorded with 82 (22.47%) leptophyll, 65 (17.29%) microphylls. Being a topographically and climatically varied valley, the study area presents a diverse flora with significant number of endemic taxa. However, it accounts for several environmental degradation activities due to burgeoning population and unsustainable utilization of plant resources such as deforestation, overgrazing. Moreover, the area remained war-afflicted continuously for two decades for local, national and international concerns causing direct habitat destruction. Therefore, current study articulates the ecological health, species diversity and conservation issues. The outcomes emphasize the tangible conservation measures for the ecological restoration of the region for national and global interest.

Key words: Kurram, Floristic diversity, Ecological traits, Plant adaption, Pak-Afghan border.

Introduction

The study on floristic diversity is a common taxonomic practice that provides the baseline data for further research dedicated to plant ecology and conservation (Amjad *et al.*, 2017). Floristic studies of isolated phyto-geographic regions are prerequisite to develop management plans for the conservation and preservations of biological diversity of any region (Phillips *et al.*, 2003). It is crucial to understand the ecological health, biological diversity, conservation issues and management plans of any aquatic and terrestrial ecosystem. Ecological features, such as biological spectra and phenological patterns, can be used as references for current and future phyto-climatic conditions (Hussain *et al.*, 2015). So far, an estimated 300,000 known vascular plant species were known globally (Jackson & Miller, 2015). Phytodiversity serves as primary producers and is integral to any ecosystem. Plant mortality and loss of plant species with abrupt environmental changes is substantially severe for any region particularly for those harbouring low plant diversity and low vegetation cover (Sudharsan & Hussain, 2003; De Fries *et al.*, 2004). Pakistan is rich in biodiversity, maintaining an array of ecosystems from the coast to high alpine mountain ranges (Abbas *et al.*, 2021). According to Ali (2008), in Pakistan various areas are yet to be explored floristically such as Khyber Pass, Koh-i-Suleman Range, Kirther Mountain range, Deosai Plains, Hunza, Baltistan. Botanical institutes and herbaria lack inventory of various areas despite continuous effort for floristic investigation

and publication of national flora. However, the so far known flora indicates the country's varied climatic, edaphic and multiple ecological systems (Alam, 2010).

The Kurram Valley exhibits incredible mountain ecosystem with diverse topographic, edaphic and climatic conditions from bottom to high elevations. So far, little botanical work has been relating to ecology, biodiversity, conservation and phytosciology. The remote geography, law and order situation, and persistent internal conflicts may be the basic handicaps for research activities in the region. The first monograph was presented by Aitchison (1880) in the era of British India. Badshah *et al.*, (2013) conducted the floristic inventory of upper areas of Kurram Agency. Gilani *et al.*, (2003), Ajaib *et al.*, (2014), Hussain *et al.*, (2013), Muhammad *et al.*, (2016), Hussain *et al.*, (2018), and Muhammad *et al.*, (2019) worked on the ethnobotany of different areas of Kurram Agency. But literature on the floristic and ecological traits of Kurram Valley is scarce describing the ecological traits and physiognomic features. The unceasing urbanization, burgeoning population, anthropogenic activities and environmental degradations make the ecological and floristic studies urgent (Ali *et al.*, 2022). Moreover, the rapid regional ecological and environmental damages of this war-torn area also urge to explore the post war geo-ecological conditions of the Kurram Valley. Therefore, the current work was conceived with the objectives 1) to make an inventory of plant diversity 2) to examine the biological spectrum of collected taxa 3) to address the conservation issues of the region.

Materials and Methods

Study area: The Kurram Valley lies 33°20' to 34°10' N and 69°50' to 70°50' E covering an area of 3,380 Km². It borders with Afghanistan by mountain chain of Safed Koh in the North-West of Pakistan. Parachinar is the regional capital city while Bagan and Sadda are major developing towns. Based on physical settings and climate, the study area may be divided in central, lower, and upper Kurram (Fig. 1). The Kurram River is the main water body and drains the southern flanks of the Safed Koh and Indus plains of Bannu District. The geology of the valley is highly varied and complex and divided into three tectonic blocks. Samana block in the middle, Kurram block in the south while, Spin Ghar block located in the north. The climate is generally favorable in the lower and gets cooler with respect to elevation. Most of the precipitation is received in the form of rain and snow from December to February. Climate is almost moderate from mid-June to mid-August. High landscape diversity and the altitudinal gradient cause correspondingly adapted plant taxa. In the study area two floristic regions Irano-Turanian (Western Sulaiman Mountain Range) and Sino-Japanese (Eastern Hindukush Mountain Range) are recognized. The major vegetation formation includes alpine pastures, sub-alpine forest, moist-temperate forests, dry-temperate forests, and dry-subtropical

scrubs. These vegetation types harbor rich floral diversity with high endemism. Upper conifers and lower scrub are the dominant vegetation formation. *Artemisia scoparia* and *Nepeta incisa* are the dominant and well distributed species of the region.

Data collections: Field surveys were conducted in the area from 2015 to 2018 from bottom to elevated areas of the Kurram Valley. For plant sampling walk and collect method was adapted. The plants were photographed, and the detail of habitat and phenological stage of each species were recorded. The collected specimens were carefully examined for life form and leaf classes according to Raunkiaer (1934) & Oosting (1950) respectively. Habit, biological spectra, and phenology of each plant species and anthropogenic impacts were determined, following Raunkiaer (1934). Plant species identification was performed out using the Flora of Pakistan (Nasir & Ali *et al.*, 1972-1993; Ali & Nasir, 1989-1994; Ali & Qaiser, 1995-2020), and Flora Iranica (Rechinger, 1956-2015). Name of the species with authority and family were verified by using the online database Tropicos (<https://www.tropicos.org>) and The Plant List (<http://www.theplantlist.org>). All species were passed through proper herbarium techniques. The voucher specimens of all collected plants were submitted to the Herbarium of the Hazara University Mansehra, Pakistan.

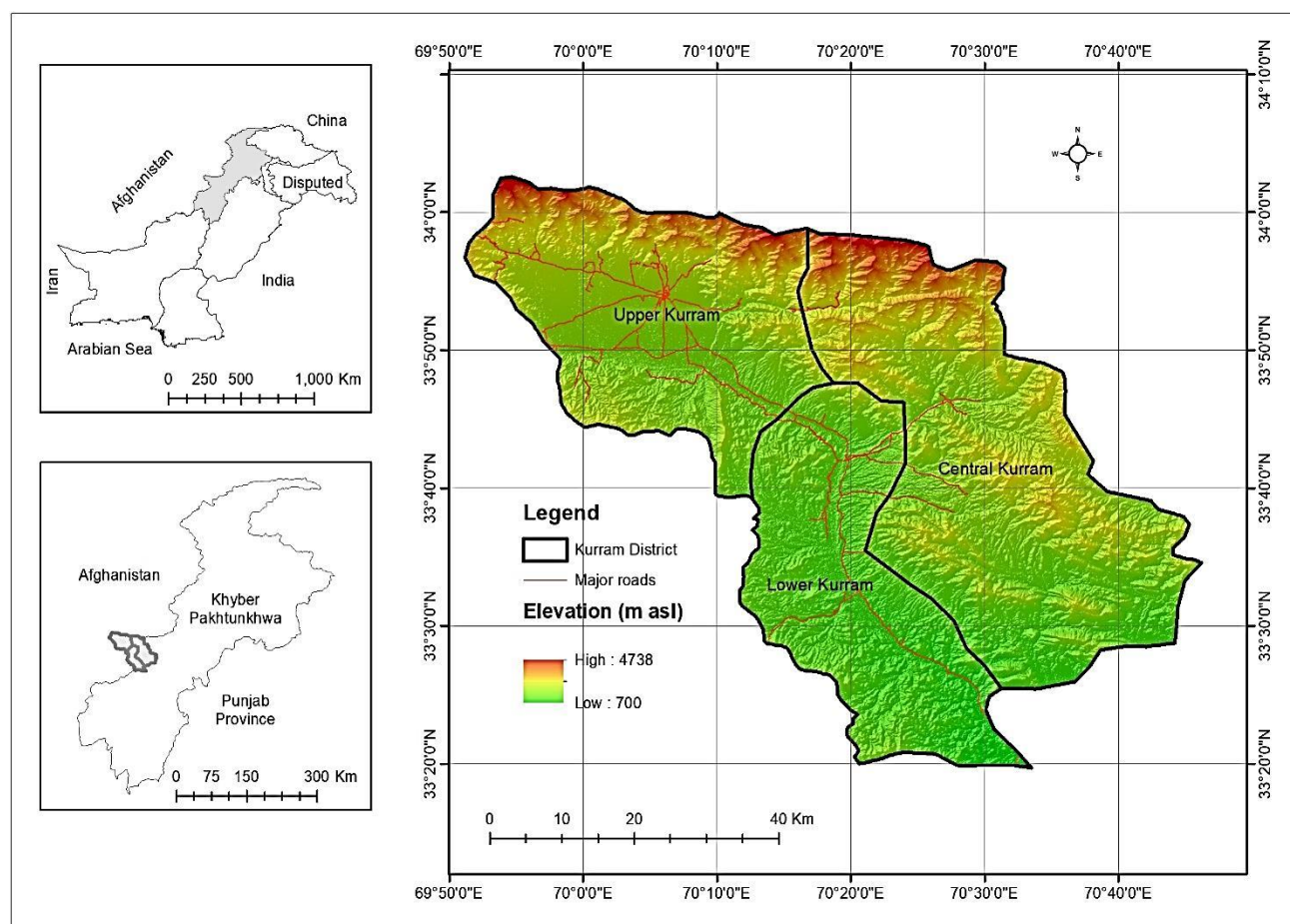


Fig. 1. Map of the research area divided into three sub-regions.

Results

Floristic diversity: In the study, 365 plant taxa in 244 genera and 86 families were documented. Asteraceae was recorded as dominant family with 40 species (10.96%) followed by Lamiaceae 31 (8.49%), Fabaceae 26 (7.12%), Poaceae 26 (7.12%), Rosaceae 16 (4.38%), Caprifoliaceae 12 (3.29%), and Primulaceae 11 (3.01%). Remaining families presented less than ten species (Table 1; Fig. 2). Out of 86 families 34 families were monotypic. Among the 244 genera, *Astragalus* and *Nepeta* are most common showing 8 species. *Silene* consist of 6 species, *Androsace*, *Salix*, and *Lonicera* of 5 species, and *Corydalis*, *Primula*, *Rosa* and *Typha* of 4 species (Fig. 3).

Table 1. Plant families, number of species and percentage of the Kurram Valley.

Plant families	No. of species	Percentage (%)
1. Asteraceae	40	10.96
2. Lamiaceae	31	8.49
3. Fabaceae	26	7.12
4. Poaceae	26	7.12
5. Rosaceae	16	4.38
6. Caprifoliaceae	12	3.29
7. Primulaceae	11	3.01
8. Apiaceae	9	2.47
9. Caryophyllaceae	9	2.47
10. Ranunculaceae	8	2.19
11. Salicaceae	8	2.19
12. Solanaceae	7	1.92

Habit, biological spectra and phenology: Habit, biological spectra, and phenology of plant species presented in (Table 2). Herbaceous plants prevailed with 237 species followed by shrubs (77 species) and trees (47 species). The dominant life form were Therophytes (114 spp.; 31.23%), followed by Hemicryptophytes (67 spp.; 18.36%), Nanophanerophytes (60 spp.; 16.44%), Geophytes (42 spp.; 11.51%), Microphanerophytes (26 spp.; 7.12%), Chamaephytes (23 spp.; 6.30%), Mesophanerophytes (17 spp.; 4.66%), and Megaphanerophytes (16 spp.; 4.38%) (Table 3). Based on leaf size, Nanophyll (158 spp.; 42.29%) were abundant, followed by Leptophyll, (82 spp.; 22.47%), Microphyll (65 spp.; 17.81%), Mesophyll (53 spp.; 14.52%), Aphylla (5 spp.; 1.37%) and Microphyll (2 spp.; 0.55%) (Table 4). The phenological phases of plant species ranged from spring to autumn. The highest flowering time was documented during April (77 spp.; 21.10%), followed by May (74 spp.; 20.27%), June (66 spp.; 18.08%), March (51 spp.; 13.97%), and July (43 spp.; 11.78%) (Table 5). The highest fruiting time was recorded in the months of July (74 spp.; 20.27%), August (64 spp.; 17.53%), September (55 spp.; 15.07%), June (45 spp.; 12.33%) and October (37 spp.; 10.14%). 12 species grow round the year (Table 5).

Endemism: In the surveys several endemic taxa were collected. *Astragalus* and *Nepeta* were rich genera having endemism of 8 species each. *Seriphidium kurramense*, *Pseudomertensia anjumiae*, *Rhododendron afghanicum*, *Nepeta kurramensis*, *Vincetoxicum cardiostephanum*, *Aquilegia moorcroftiana* var. *afghanica* (Bruehl) H.Riedl, *Clematis robertiana*, *Oxygraphis shaftoana*, and *Ranunculus afghanicus* were endemic taxa (Table 6).

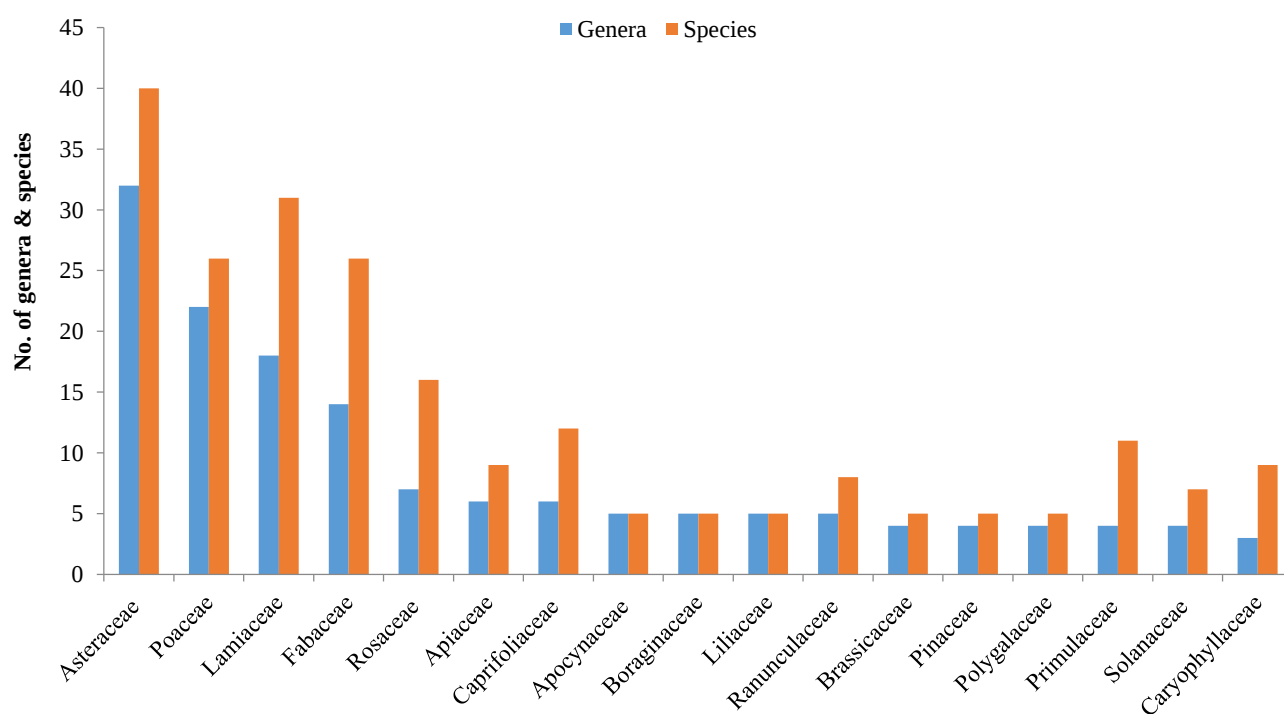


Fig. 2. Number of genera and species in different families.

Table 2. Floristic diversity, habit, biological spectra, and phenology of the Kurram valley.

Family/Plant species	Habit	Life form	Leaf class	Phenology
Acanthaceae				
<i>Justicia adhatoda</i> L.	Shrub	NanP	Mic	Nov-Apr
<i>Celosia argentea</i> L.	Herb	The	Mes	Jun-Oct
Amaranthaceae				
<i>Amaranthus viridis</i> L.	Herb	The	Mic	Jun-Aug
Amaryllidaceae				
<i>Allium carolinianum</i> DC.	Herb	Geo	Lep	Jul-Aug
<i>Allium griffithianum</i> Boiss.	Herb	Geo	Lep	Mar-Apr
<i>Allium jacquemontii</i> Kunth	Herb	Geo	Lep	Mar-Apr
Anacardiaceae				
<i>Pistacia atlantica</i> subsp. <i>cabulica</i> Rech. f.	Tree	MesP	Nan	May-Jul
<i>Cotinus coggygia</i> Scop.	Shrub	NanP	Mic	Apr-May
<i>Pistacia atlantica</i> Desf.	Shrub	MicP	Nan	Mar-Jun
<i>Schinus molle</i> L.	Shrub	MicP	Mic	Feb-Mar
Apiaceae				
<i>Bupleurum candollei</i> Wall. ex DC.	Herb	The	Nan	May-Jul
<i>Pleurospermum corydalifolium</i> Aitch. and Hemsl.	Herb	HemC	Nan	Jun-Sep
<i>Pleurospermum stylosum</i> C.B. Clarke	Herb	HemC	Nan	Jun-Aug
<i>Prangos pabularia</i> Lindl.	Herb	HemC	Lep	Jun-Aug
<i>Zosima absinthifolia</i> (Vent.) Link	Herb	HemC	Nan	Aug-Oct
<i>Bupleurum aitchisonii</i> H. Wolff	Herb	The	Nan	May-Jun
<i>Eryngium caeruleum</i> M. Bieb.	Herb	HemC	Nan	Apr-Jul
<i>Pimpinella acuminata</i> (Edgew.) C.B. Clarke	Herb	The	Nan	May-Sep
<i>Pimpinella diversifolia</i> DC.	Herb	The	Lep	Aug-Nov
Apocynaceae				
<i>Calotropis procera</i> (Aiton) W.T. Aiton	Herb	Che	Mes	May-Dec
<i>Caralluma tuberculata</i> N.E. Br.	Herb	HemC	aphylus	Jan-Jun
<i>Nerium oleander</i> L.	Shrub	NanP	Nan	Apr-Oct
<i>Periploca aphylla</i> Decne.	Shrub	NanP	aphylla	Mar-May
<i>Vincetoxicum cardiostephanum</i> (Rech. f.) Rech. f.	Herb	Geo	Nan	May-Aug
Araceae				
<i>Arisaema jacquemontii</i> Blume	Herb	Geo	Mic	Jun- Jul
Araliaceae				
<i>Hedera nepalensis</i> K. Koch	Parasite	Che	Mic	Oct-Apr
Arecaceae				
<i>Nannorrhops ritchieana</i> H. Wendl.	Tree	NanP	Mes	May-Oct
<i>Phoenix dactylifera</i> L.	Tree	MegP	Mes	Mar-Apr
Asparagaceae				
<i>Asparagus officinalis</i> L.	Herb	The	Lep	May-Jun
<i>Polygonatum verticillatum</i> (L.) All.	Herb	Geo	Nan	May-Jun
Asteraceae				
<i>Blumea axillaris</i> (Lam.) DC.	Herb	The	Nan	Year round
<i>Blumea membranacea</i> DC.	Herb	The	Mes	Feb-Jun
<i>Cichorium intybus</i> L.	Herb	The	Nan	Jul- Oct
<i>Erigeron acer</i> L.	Herb	HemC	Nan	Apr-Aug
<i>Erigeron canadensis</i> L.	Herb	HemC	Mes	Jul-Oct
<i>Inula koelzii</i> Dawar and Qaiser	Herb	Che	Mic	Sep-Nov
<i>Inula racemosa</i> Hook. f.	Herb	The	Nan	Jul-Sep
<i>Launaea procumbens</i> (Roxb.) Ramayya and Rajagopal	Herb	The	Mes	Jun-Oct
<i>Leontopodium leontopodium</i> Hand. -Mazz.	Herb	HemC	Nan	Jul-Sep
<i>Phagnalon pycnophyllum</i> Rech. f.	Herb	NanP	Nan	Apr-Jul
<i>Senecio krascheninnikovii</i> Schischk.	Herb	The	Mes	Jun- Sep
<i>Seriphidium kurramense</i> (Qazilb.) Y.R. Ling	Shrub	HemC	Nan	Nov-Jan
<i>Serratula pallida</i> DC.	Herb	Geo	Nan	Apr-Jul
<i>Tanacetum parthenium</i> (L.) Sch. Bip.	Herb	Che	Nan	Jul-Sep
<i>Taraxacum officinale</i> F.H. Wigg.	Herb	The	Mic	Apr-Jun
<i>Tricholepis stewartii</i> C.B. Clarke ex Hook.f.	Herb	The	Lep	Jul-Sep
<i>Parthenium hysterophorus</i> L.	Herb	HemC	Nan	May-Nov
<i>Ainsliaea aptera</i> DC.	Herb	The	Mic	Apr-Sep
<i>Anaphalis contorta</i> (D. Don) Hook. f.	Herb	HemC	Lep	Jun-Oct
<i>Anaphalis nepalensis</i> (Spreng.) Hand.-Mazz.	Herb	HemC	Nan	Sep-Oct
<i>Anaphalis roseo-alba</i> krasch	Herb	HemC	Lep	Jul-Sep
<i>Anthemis cotula</i> L.	Herb	Che	Lep	Mar-Sep
<i>Artemisia absinthium</i> L.	Herb	HemC	Nan	Jun-Sep
<i>Artemisia incisa</i> Pamp.	Herb	HemC	Mic	Jul-Aug

Table 2. (Cont'd.).

Family/Plant species	Habit	Life form	Leaf class	Phenology
<i>Artemisia roxburghiana</i> Besser	Herb	HemC	Lep	Aug-Oct
<i>Artemisia scoparia</i> Waldst. and Kit.	Herb	HemC	Nan	Jul-Nov
<i>Aster altaicus</i> Willd.	Herb	The	Lep	May-Jul
<i>Carpesium nepalense</i> Less.	Herb	HemC	Nan	Apr-Sep
<i>Centaurea iberica</i> Trevir. ex Spreng.	Herb	The	Nan	Jun-Aug
<i>Cousinia thomsonii</i> C.B. Clarke	Herb	HemC	Nan	Jul-Sep
<i>Doellia bovei</i> (DC.) Anderb.	Herb	HemC	Nan	Mar-Jul
<i>Hertia intermedia</i> Kuntze	Shrub	NanP	Nan	Year Round
<i>Inula obtusifolia</i> A. Kern.	Herb	HemC	Nan	Jun-Aug
<i>Lactuca dissecta</i> D. Don	Herb	The	Nan	Jun-Jul
<i>Onopordum acanthium</i> L.	Herb	Geo	Mes	Jun-Sep
<i>Pertya aitchisonii</i> C.B. Clarke	Shrub	NanP	Nan	Jun-Oct
<i>Phagnalon schweinfurthii</i> var. <i>androssovii</i> (B. Fedtsch.) Qaiser and Lack	Herb	NanP	Lep	Apr-Aug
<i>Saussurea chondrilloides</i> C. Winkl.	Herb	Che	Nan	Jul-Sep
<i>Sonchus asper</i> (L.) Hill	Herb	The	Mic	May-Oct
<i>Xanthium strumarium</i> L.	Herb	The	Nan	Jul-Aug
Berberidaceae				
<i>Berberis calliobotrys</i> Bien. ex Koehne	Shrub	MicP	Lep	Apr-Jun
<i>Berberis lycium</i> Royle	Shrub	MicP	Nan	Apr-Jun
Betulaceae				
<i>Betula utilis</i> D. Don	Shrub	MicP	Mic	May-Jun
Bignoniaceae				
<i>Incarvillea emodi</i> Chatterjee	Herb	HemC	Lep	Apr- May
Boraginaceae				
<i>Cynoglossum wallichii</i> var. <i>glochidiatum</i> (Wall. ex Benth.) Kazmi	Herb	HemC	Nan	Jun-Aug
<i>Myosotis caespitosa</i> Schultz	Herb	HemC	Lep	Jun-Jul
<i>Onosma hispida</i> Wall. ex G. Don	Herb	The	Mic	Jun-Jun
<i>Pseudomertensia anjumiae</i> Kazmi	Herb	The	Nan	May-Sep
<i>Trichodesma indicum</i> (L.) Lehm.	Herb	The	Nan	Year Round
Brassicaceae				
<i>Arabis saxicola</i> Edgew.	Herb	The	Nan	Apr-Jul
<i>Capsella bursa-pastoris</i> (L.) Medik.	Herb	The	Lep	Mar- Jun
<i>Draba affghanica</i> Boiss.	Herb	The	Lep	Jun-Aug
<i>Draba oreades</i> Schrenk ex Fisch. and C.A. Mey.	Herb	The	Lep	Jun -Jul
<i>Isatis tinctoria</i> subsp. <i>koelzii</i> Jafri	Herb	The	Lep	May-Jun
Buxaceae				
<i>Buxus wallichiana</i> Baill.	Shrub	NanP	Mic	Mar-May
Campanulaceae				
<i>Codonopsis clematidea</i> (Schrenk ex Fisch. and C.A. Mey.) C.B. Clarke	Herb	The	Nan	Jul-Aug
<i>Campanula cashmeriana</i> Royle	Herb	The	Lep	Jul-Aug
<i>Campanula pallida</i> Wall.	Herb	HemC	Mes	Apr-Jul
Cannabaceae				
<i>Cannabis sativa</i> L.	Herb	The	Mic	Apr-Sep
<i>Celtis australis</i> L.	Tree	MegP	Mic	Apr-Jun
<i>Celtis australis</i> subsp. <i>caucasica</i> (Willd.) C. Towns.	Tree	MegP	Mic	Apr-Jun
Capparaceae				
<i>Capparis cartilaginea</i> Decne.	Shrub	Che	Nan	May-Aug
Caprifoliaceae				
<i>Lonicera griffithii</i> Hook.f. and Thomson	Shrub	NanP	Nan	Apr-Jul
<i>Lonicera heterophylla</i> Decne.	Shrub	NanP	Nan	Jun-Jul
<i>Abelia triflora</i> R. Br.	Shrub	MicP	Nan	May-Aug
<i>Abelia triflora</i> var. <i>parviflora</i> C.B. Clarke	Shrub	MicP	Nan	May-Aug
<i>Dipsacus inermis</i> var. <i>mitis</i> (D. Don) Nasir	Herb	HemC	Mes	Aug-Sep
<i>Lonicera caucasica</i> subsp. <i>govani</i> H. Hara	Shrub	NanP	Lep	May-Jul
<i>Lonicera quinquelocularis</i> Hard.	Shrub	NanP	Lep	Apr-Jul
<i>Lonicera webbiana</i> Wall. ex DC.	Shrub	NanP	Lep	May-Jul
<i>Morina persica</i> L.	Herb	HemC	Mes	May -Jun
<i>Scabiosa olivieri</i> Coult.	Herb	The	Nan	Apr-May
<i>Valeriana fedtschenkoi</i> Coincy	Herb	Geo	Lep	Mar-May
<i>Valeriana jatamansi</i> Jones	Herb	Geo	Nan	Mar-May
Caryophyllaceae				
<i>Silene kunawarensis</i> Benth.	Herb	The	Lep	Aug-Sep
<i>Silene longicarpophora</i> (Kom.) Bocquet	Herb	HemC	Nan	Jul-Aug
<i>Silene ovalifolia</i> (Regel and Schmalh.) Melzh.	Herb	The	Mic	Mar-Apr
<i>Silene vulgaris</i> (Moench) Garcke	Herb	The	Nan	Jun-Jul

Table 2. (Cont'd.).

Family/Plant species	Habit	Life form	Leaf class	Phenology
<i>Dianthus afghanicus</i> Rech. f.	Herb	The	Lep	Jun-Aug
<i>Dianthus crinitus</i> Sm.	Herb	The	Nan	May-Aug
<i>Dianthus orientalis</i> Adams.	Herb	The	Nan	Jul-Aug
<i>Silene citrina</i> Boiss.	Herb	The	Nan	May-Jun
<i>Silene conoidea</i> L.	Herb	The	Mic	Mar-Apr
Celastraceae				
<i>Gymnosporia royleana</i> Wall.	Shrub	NanP	Mic	Apr-Jul
Colchicaceae				
<i>Colchicum aitchisonii</i> (Hook. f.) Nasir	Herb	Geo	Nan	Jan-Feb
Convolvulaceae				
<i>Convolvulus arvensis</i> L.	Herb	The	Mes	Year Round
<i>Cuscuta reflexa</i> Roxb.	Parasite	Parasite	aphylus	Sep-Nov
Crassulaceae				
<i>Rhodiola pachyclados</i> (Aitch. and Hemsl.) H. Ohba	Herb	Geo	Lep	Aug-Oct
<i>Sedum ewersii</i> Ledeb.	Herb	HemC	Nan	Mar-Jun
Cupressaceae				
<i>Juniperus communis</i> L.	Shrub	NanP	Lep	Apr-May
<i>Juniperus excelsa</i> M.Bieb.	Tree	NanP	Lep	Apr-Jun
Cyperaceae				
<i>Carex diluta</i> M. Bieb.	Herb	Geo	Nan	Apr-Aug
<i>Cyperus difformis</i> L.	Herb	Geo	Nan	Apr- Oct
<i>Cyperus niveus</i> Retz.	Herb	Geo	Nan	Apr-Jun
<i>Cyperus rotundus</i> L.	Herb	Geo	Nan	Apr-Oct
Ebenaceae				
<i>Diospyros lotus</i> L.	Tree	MegP	Mic	Oct-Nov
Elaeagnaceae				
<i>Elaeagnus angustifolia</i> L.	Tree	MicP	Nan	Apr-Oct
Ephedraceae				
<i>Ephedra ciliata</i> Fisch. and C.A. Mey.	Herb	Che	Nan	Jun-Sep
<i>Ephedra gerardiana</i> Wall. ex Stapf	Shrub	MicP	aphylus	May-Jul
Ericaceae				
<i>Rhododendron afghanicum</i> Aitch. and Hemsl.	Shrub	NanP	Mic	Apr-Jul
<i>Rhododendron collettianum</i> Aitch. and Hemsl.	Shrub	NanP	Mic	May-Aug
Euphorbiaceae				
<i>Euphorbia helioscopia</i> L.	Herb	The	Mic	Jan-July
<i>Euphorbia wallichii</i> Hook. f.	Shrub	The	Mic	July- Sept
Fabaceae				
<i>Trigonella cachemiriana</i> Cambess.	Herb	The	Lep	May-Sep
<i>Acacia modesta</i> Wall.	Tree	MicP	Lep	May-Jul
<i>Acacia nilotica</i> (L.) Willd. ex Delile	Tree	MicP	Lep	Jun-Jul
<i>Albizia lebbeck</i> (L.) Benth.	Tree	MesP	Mes	Apr-May
<i>Astragalus amherstianus</i> Benth.	Herb	HemC	Lep	Apr-Jun
<i>Astragalus congestus</i> Baker ex Aitchison	Shrub	MicP	Lep	Apr-May
<i>Astragalus grahamianus</i> Benth. Leguminosae	Shrub	MicP	Lep	Apr-Aug
<i>Astragalus kuramensis</i> Baker	Herb	HemC	Lep	May-Jun
<i>Astragalus lasiosemius</i> Boiss.	Herb	Che	Lep	Jun-Aug
<i>Astragalus psilocentros</i> Fisch.	Herb	The	Lep	Apr-Jun
<i>Astragalus rhizocephalus</i> Baker ex Aitchison	Herb	HemC	Lep	May-Aug
<i>Astragalus stewartii</i> Baker	Herb	The	Lep	Mar-May
<i>Caragana decorticans</i> Hemsl.	Shrub	HemC	Nan	Jun- Jul
<i>Cassia occidentalis</i> L.	Shrub	NanP	Nan	Oct-Mar
<i>Dalbergia sissoo</i> Roxb. ex DC.	Tree	MegP	Mic	Mar-May
<i>Ebenus stellata</i> Boiss.	Shrub	NanP	Nan	Apr-May
<i>Indigofera heterantha</i> var. <i>gerardiana</i> (Graham ex Baker in Hook. f.) Ali	Shrub	NanP	Nan	May-Jul
<i>Indigofera heterantha</i> Wall. ex Brandis	Shrub	NanP	Lep	May-Jul
<i>Prosopis glandulosa</i> Torr.	Tree	MesP	Lep	Mar-Sep
<i>Prosopis juliflora</i> (Sw.) DC.	Shrub	NanP	Lep	Mar- Jun
<i>Sophora mollis</i> (Royle) Baker	Shrub	NanP	Nan	Mar-May
<i>Trifolium pratense</i> L.	Herb	HemC	Nan	Apr-Jul
<i>Trigonella fimbriata</i> Royle ex Benth.	Herb	The	Lep	Jun-Jul
<i>Vicia bakeri</i> Ali	Herb	The	Nan	Jul-Aug
<i>Vicia sativa</i> L.	Herb	HemC	Mes	Apr-Jun
<i>Robinia pseudoacacia</i> L.	Tree	NanP	Nan	May-Jun
Fagaceae				
<i>Quercus baloot</i> Griff.	Tree	MesP	Nan	Apr-May

Table 2. (Cont'd.).

Family/Plant species	Habit	Life form	Leaf class	Phenology
<i>Quercus incana</i> W. Bartram	Tree	MesP	Mic	May-Oct
<i>Quercus semecarpifolia</i> Sm.	Shrub	MesP	Mic	May-Jun
Gentianaceae				
<i>Swertia cordata</i> (Wall. ex G. Don) C.B. Clarke	Herb	The	Mes	Jul-Nov
<i>Gentiana kurroo</i> Royle	Herb	Geo	Nan	Sep-Nov
<i>Geranium wallichianum</i> D. Don ex Sweet	Herb	Geo	Mic	Jul-Sep
Grossulariaceae				
<i>Ribes orientale</i> Desf.	Shrub	NanP	Mic	Apr-Jun
Hamamelidaceae				
<i>Parrotiopsis jacquemontiana</i> (Decne.) Rehder	Tree	NanP	Mes	Mar- May
Iridaceae				
<i>Iris lactea</i> Pall.	Herb	Geo	Mes	Apr-Jun
Ixiolirionaceae				
<i>Ixiolirion tataricum</i> (Pall.) Herb.	Herb	Geo	Nan	Mar-Apr
Juglandaceae				
<i>Juglans regia</i> L.	Tree	MesP	Mes	Feb-Apr
Juncaceae				
<i>Juncus inflexus</i> L.	Herb	Geo	Nan	Jul-Sep
Lamiaceae				
<i>Scutellaria kotkaiensis</i> Rech. f.	Herb	The	Lep	Jun-Jul
<i>Thymus linearis</i> Benth.	Herb	Che	Nan	Jun-Aug
<i>Thymus linearis</i> subsp. <i>hedgeri</i> Jalas	Herb	Che	Nan	May-Jul
<i>Thymus linearis</i> subsp. <i>linearis</i> Jalas	Herb	Che	Nan	Jun-Aug
<i>Ziziphora clinopodioides</i> subsp. <i>afghanica</i> (Rech.f.) Rech.f.	Herb	The	Lep	Jun-Aug
<i>Ajuga bracteosa</i> Wall. ex Benth.	Herb	The	Mic	Mar-Dec
<i>Ajuga parviflora</i> Benth	Herb	The	Nan	Mar-Dec
<i>Clinopodium umbrosum</i> (M. Bieb.) K. Koch	Herb	The	Nan	May-Jul
<i>Isodon coetsa</i> (Buch.-Ham. ex D. Don) Kudô	Shrub	NanP	Mic	Mar-Oct
<i>Isodon rugosus</i> (Wall. ex Benth.) Codd	Shrub	NanP	Mic	Mar-Oct
<i>Mentha longifolia</i> (L.) L.	Herb	Geo	Mic	May-Nov
<i>Micromeria biflora</i> (Buch.-Ham. ex D. Don) Benth.	Herb	The	Lep	Year Round
<i>Nepeta cataria</i> L.	Herb	HemC	Nan	Jun-Jul
<i>Nepeta distans</i> Royle ex Benth.	Herb	HemC	Nan	Apr-Jul
<i>Nepeta erecta</i> (Royle ex Benth.) Benth.	Herb	HemC	Nan	Jun-Aug
<i>Nepeta kurramensis</i> Rech. f.	Herb	HemC	Nan	Jul-Sep
<i>Nepeta laevigata</i> (D. Don) Hand.-Mazz.	Herb	The	Nan	Jun-Aug
<i>Nepeta raphanorhiza</i> Benth.	Herb	The	Nan	Apr- Jun
<i>Nepeta suavis</i> Stapf	Herb	The	Nan	Sep-Nov
<i>Nepeta subincisa</i> Benth.	Herb	The	Nan	Jun-Jul
<i>Perovskia abrotanoides</i> Kar.	Shrub	NanP	Nan	Jun-Aug
<i>Perovskia atriplicifolia</i> Benth.	Shrub	NanP	Nan	Jun-Oct
<i>Phlomidioschema parviflorum</i> (Benth.) Vved.	Herb	HemC	Mic	May-Jul
<i>Phlomidioschema bracteosa</i> (Royle ex Benth.) Kamelin.	Herb	HemC	Mes	May-Sep
<i>Prunella vulgaris</i> L.	Herb	The	Nan	Jun-Aug
<i>Rydingia limbata</i> (Benth.) Scheen and V.A. Albert	Shrub	NanP	Nan	May-Jul
<i>Salvia nubicola</i> Wall. ex Sweet	Herb	HemC	Mic	Jun-Oct
<i>Scutellaria stocksii</i> Boiss.	Herb	The	Lep	May-Aug
<i>Teucrium stocksianum</i> Boiss.	Herb	The	Nan	May-Sep
<i>Teucrium stocksianum</i> subsp. <i>incanum</i> (Aitch. and Hemsl.) Rech. f.	Herb	The	Lep	May-Sep
<i>Vitex negundo</i> L.	Shrub	NanP	Mes	Year Round
Liliaceae				
<i>Lilium polyphyllum</i> D. Don	Herb	Geo	Mic	Jun-Jul
<i>Tulipa clusiana</i> Redouté	Herb	Geo	Nan	Mar-Jul
<i>Fritillaria cirrhosa</i> D. Don	Herb	Geo	Nan	Apr-Jul
<i>Fritillaria cirrhosa</i> subsp. <i>roylei</i> Ali	Herb	Geo	Nan	Apr-Jul
<i>Gagea pakistanica</i> Levichev and Ali	Herb	Geo	Nan	Mar-Apr
Linaceae				
<i>Linum corymbulosum</i> Rchb.	Herb	The	Lep	Mar-Jun
Lythraceae				
<i>Punica granatum</i> L.	Shrub	NanP	Nan	Apr-Jul
Malvaceae				
<i>Malva neglecta</i> Wallr.	Herb	The	Mes	Apr-Jun
Meliaceae				
<i>Azadirachta indica</i> A. Juss.	Tree	MesP	Nan	Apr-May
<i>Melia azedarach</i> L.	Tree	MegP	Nan	Mar-Apr

Table 2. (Cont'd.).

Family/Plant species	Habit	Life form	Leaf class	Phenology
Moraceae				
<i>Ficus carica</i> L.	Tree	NanP	Mes	May-Jul.
<i>Ficus religiosa</i> L.	Tree	MesP	Mes	Mar-Oct
<i>Morus alba</i> L.	Tree	MegP	Mic	Apr-Sep
<i>Morus nigra</i> L.	Tree	MegP	Mic	Mar-Jul
Myrtaceae				
<i>Eucalyptus amplifolia</i> Naudin	Tree	MegP	Mes	Aug-Sep.
<i>Eucalyptus globulus</i> Labill.	Tree	MegP	Mes	Jul-Sep
<i>Callistemon citrinus</i> (Curtis) Skeels	Tree	MicP	Nan	Dec - Mar
Nitrariaceae				
<i>Peganum harmala</i> L.	Herb	HemC	Lep	Apr-Oct
Oleaceae				
<i>Syringa emodi</i> Wall. ex Royle	Shrub	NanP	Mic	May-Jul
<i>Jasminum humile</i> L.	Shrub	MicP	Nan	Apr-May
<i>Jasminum officinale</i> L.	Shrub	MicP	Nan	May-Jul
<i>Olea europaea</i> L.	Tree	MesP	Mic	Apr-May
<i>Olea ferruginea</i> Wall. ex Aitch.	Tree	MesP	Mic	Apr-Jun
Onagraceae				
<i>Epilobium aitchisonii</i> P.H. Raven	Herb	HemC	Nan	May-Aug
<i>Epilobium royleanum</i> Hausskn.	Herb	The	Nan	Jul-Oct
<i>Epilobium tetragonum</i> L.	Herb	The	Nan	Jul-Oct
<i>Oenothera rosea</i> L'Hér. ex Aiton	Herb	HemC	Nan	Aug-Oct
Orchidaceae				
<i>Habenaria aitchisonii</i> Rechb. f. ex Aitch. and Hemsl.	Herb	Geo	Mic	Jul-Aug
Orobanchaceae				
<i>Orobanche caryophyllacea</i> Sm.	Herb	The	aphylla	Jun-Jul
<i>Leptorhabdos parviflora</i> (Benth.) Benth.	Herb	The	Lep	Apr-Jul
<i>Pedicularis pyramidata</i> Royle	Herb	The	Nan	Sep-Nov
Oxalidaceae				
<i>Oxalis corniculata</i> L.	Herb	The	Nan	Mar-Dec
Papaveraceae				
<i>Corydalis falconeri</i> Hook. f. and Thomson	Herb	HemC	Nan	June-Aug
<i>Corydalis meifolia</i> wall	Herb	HemC	Lep	Jul-Sept
<i>Corydalis pakistanica</i> Jafri	Herb	HemC	Lep	Jun-Jul
<i>Corydalis pulchella</i> Aitch. and Hemsl.	Herb	The	Nan	May- Jul
<i>papaver dubium</i> L.	Herb	The	Nan	Mar- Jun
<i>Papaver somniferum</i> L.	Herb	The	Mes	Apr-Jun
Pinaceae				
<i>Abies pindrow</i> (Royle ex D.Don) Royle	Tree	MegP	Lep	Apr-Jun
<i>Cedrus deodara</i> (Roxb. ex D. Don) G. Don	Tree	MegP	Lep	Mar-Oct
<i>Picea smithiana</i> (Wall.) Boiss.	Tree	MegP	Lep	Apr-Oct
<i>Pinus roxburghii</i> Sarg.	Tree	MegP	Lep	Mar-Apr
<i>Pinus wallichiana</i> A.B. Jacks.	Tree	MegP	Nan	May-Nov
Plantaginaceae				
<i>Plantago lanceolata</i> L.	Herb	The	Mes	Aug-Sep
<i>Plantago major</i> L.	Herb	The	Mes	Aug-Sep
<i>Wulfeniopsis amherstiana</i> (Benth.) D.Y. Hong	Herb	The	Mic	May-Jul
Platanaceae				
<i>Platanus orientalis</i> L.	Tree	MegP	Mes	Apr-May
Plumbaginaceae				
<i>Acantholimon subulatum</i> Boiss.	Shrub	Che	Lep	Apr-Jul
Poaceae				
<i>Echinochloa colona</i> (L.) Link	Herb	The	Nan	May -Sep
<i>Echinochloa frumentacea</i> Link	Herb	The	Nan	Sep-Oct
<i>Echinochloa oryzoides</i> (Ard.) Fritsch	Herb	The	Nan	Aug-Oct
<i>Eragrostis curvula</i> (Schrad.) Nees	Herb	HemC	Nan	Apr-Sep
<i>Melica persica</i> Kunth	Herb	Geo	Nan	Jul-Aug
<i>Themeda anathera</i> (Nees) Hack.	Herb	Geo	Nan	Jun-Oct
<i>Aristida cyanantha</i> Nees	Herb	HemC	Mic	May-Sep
<i>Arthraxon lancifolius</i> (Trin.) Hochst.	Herb	HemC	Nan	Jul-Oct
<i>Arundo donax</i> L.	Herb	HemC	Nan	Jul-Oct
<i>Avena barbata</i> Pott ex Link	Herb	The	Nan	Feb-May
<i>Bromus pectinatus</i> Thunb.	Herb	The	Nan	Apr-Aug
<i>Cenchrus ciliaris</i> L.	Herb	HemC	Lep	Feb-Mar
<i>Chloris cruciata</i> (L.) Sw.	Herb	HemC	Lep	Jul-Oct

Table 2. (Cont'd.).

Family/Plant species	Habit	Life form	Leaf class	Phenology
<i>Cynodon dactylon</i> (L.) Pers.	Herb	HemC	Lep	Year Round
<i>Dactylis glomerata</i> L.	Herb	The	Nan	Jul-Aug
<i>Heteropogon contortus</i> (L.) P. Beauv. ex Roem. and Schult.	Herb	The	Nan	Jun-Oct
<i>Imperata cylindrica</i> (L.) Raeusch.	herb	Geo	Lep	Apr-Jun
<i>Koeleria macrantha</i> (Ledeb.) Schult.	Herb	HemC	Lep	Apr-Sep
<i>Miscanthus sinensis</i> Andersson	Herb	HemC	Mes	Jun-Sep
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	Herb	Che	Mic	Jun-Oct
<i>Poa aitchisonii</i> Boiss.	Herb	The	Nan	Apr-Jul
<i>Poa annua</i> L.	Herb	The	Lep	Mar-Sep
<i>Poa infirma</i> Kunth.	Herb	The	Lep	Mar-Apr
<i>Puccinellia tenuiflora</i> (Griseb.) Scribn. and Merr.	Herb	The	Lep	May-Aug
<i>Saccharum spontaneum</i> L.	Herb	Che	Mac	Jul-Sep
<i>Setaria intermedia</i> Roem. and Schult.	Herb	The	Mes	Sep-Nov
Polygalaceae				
<i>Polygala abyssinica</i> R. Br. ex Fresen.	Herb	HemC	Lep	Mar-Sep
<i>Rumex chalapensis</i> Mill.	Herb	Che	Mic	May-Aug
<i>Rumex dentatus</i> L.	Herb	Che	Mes	May-Jun
<i>Oxyria digyna</i> (L.) Hill	Herb	The	Nan	May-Aug
<i>Persicaria amplexicaulis</i> (D. Don) Ronse Decr.	Herb	The	Mic	Apr-Nov
Primulaceae				
<i>Androsace robusta</i> (R. Knuth) Hand.-Mazz.	Herb	The	Lep	Jun-Aug
<i>Androsace rotundifolia</i> Hardw.	Herb	The	Lep	May-Jul
<i>Androsace studiosorum</i> Kress	Herb	HemC	Nan	May-Jul
<i>Androsace tibetica</i> (Maxim.) R.Knuth	Herb	Che	Nan	Jul-Aug
<i>Androsace tibetica</i> var. <i>kurramensis</i> (Y.J.Nasir) Govaerts	Herb	The	Mic	Jun-Aug
<i>Cortusa brotheri</i> Pax ex Lipsky	Herb	The	Nan	May-Aug
<i>Primula denticulata</i> Sm.	Herb	Geo	Mes	Apr-Jun
<i>Primula denticuloides</i> Y.J. Nasir	Herb	The	Mic	May-Jul
<i>Primula macrophylla</i> D. Don	Herb	The	Mic	May-Aug
<i>Primula macrophylla</i> var. <i>moorcroftiana</i> (Wall. ex Klatt) W.W. Sm. and H.R. Fletcher	Herb	The	Mic	Jun-Jul
<i>Myrsine africana</i> L.	Shrub	NanP	Lep	Mar-May
Pteridaceae				
<i>Platytaenia kuramensis</i> Nasir	Herb	HemC	Nan	Jun-Sep
<i>Adiantum venustum</i> D. Don	Herb	The	Nan	Spores in July
Ranunculaceae				
<i>Delphinium vestitum</i> Wall. ex Royle	Herb	The	Mes	Aug-Sep
<i>Anemone obtusiloba</i> D. Don	Herb	HemC	Nan	May-Jul
<i>Aquilegia moorcroftiana</i> var. <i>afghanica</i> (Brühl) Riedl	Herb	Geo	Mic	Apr-May
<i>Aquilegia moorcroftiana</i> Wall. ex Royle	Herb	Geo	Nan	Apr-May
<i>Paraquilegia anemonoides</i> (Willd.) Ulbr.	Herb	Che	Nan	Jun-Jul
<i>Ranunculus arvensis</i> L.	Herb	The	Nan	Mar-Apr
<i>Ranunculus repens</i> L.	Herb	The	Nan	Jun-Jul
<i>Ranunculus sceleratus</i> L.	Herb	The	Nan	Mar-Apr
Rhamnaceae				
<i>Berchemia pakistanica</i> Browicz	Shrub	NanP	Nan	May-Jul
<i>Sageretia thea</i> (Osbeck) M.C. Johnst.	Shrub	NanP	Lep	Jul-Sep
<i>Sageretia thea</i> var. <i>brandrethiana</i> (Aitch.) Qaiser and Nazim.	Shrub	NanP	Lep	Jul-Sep
Rosaceae				
<i>Cotoneaster affinis</i> Lindl.	Shrub	NanP	Nan	Apr-Jul
<i>Fragaria nubicola</i> (Hook. f.) Lindl. ex Lacaita	Herb	The	Nan	May-Aug
<i>Potentilla gerardiana</i> Lindl. ex Lehm.	Herb	HemC	Lep	Jun-Aug
<i>Potentilla turczaninowiana</i> Stschegl.	Herb	HemC	Nan	Jun-Aug
<i>Sorbus aucuparia</i> L.	Shrub	NanP	Nan	May-Aug
<i>Spiraea boissieri</i> C.K.Schneid.	Shrub	NanP	Nan	Jun-Sep
<i>Spiraea pilosa</i> Franch.	Shrub	NanP	Nan	Jun-Sep
<i>Cotoneaster microphyllus</i> Wall. ex Lindl	Shrub	NanP	Nan	Mar-May
<i>Cotoneaster nummularius</i> Fisch. and C.A. Mey.	Shrub	NanP	Nan	Mar-May
<i>Prunus amygdalus</i> Batsch	Tree	MesP	Nan	Apr-Aug
<i>Prunus armeniaca</i> L.	Tree	MicP	Mes	Mar-Jul
<i>Prunus dulcis</i> (Mill.) D.A. Webb	Tree	MicP	Mes	Apr-Aug
<i>Rosa canina</i> L.	Shrub	MicP	Nan	May-Jul
<i>Rosa ecae</i> Aitch.	Shrub	MicP	Lep	May-Jun
<i>Rosa sericea</i> Lindl.	Shrub	MicP	Nan	May-Jul
<i>Rosa webbiana</i> Wall. ex Royle	Shrub	MicP	Nan	June-Aug

Table 2. (Cont'd.).

Family/Plant species	Habit	Life form	Leaf class	Phenology
Rubiaceae				
<i>Himalrandia tetrasperma</i> (Wall. ex Roxb.) T. Yamaz.	Shrub	NanP	Lep	May-Jun
Salicaceae				
<i>Salix capusii</i> Franch.	Shrub	MicP	Nan	Feb-Apr
<i>Salix disperma</i> Roxb. ex D. Don	Tree	NanP	Mic	Mar-Jun
<i>Salix excelsa</i> S.G. Gmel.	Tree	MesP	Mic	Mar-May
<i>Salix pycnostachya</i> Andersson in J.	Tree	MicP	Nan	May-Jul
<i>Salix wallichiana</i> Andersson	Tree	MicP	Nan	Feb-Mar
<i>Populus afghanica</i> (Aitch. and Hemsl.) C.K. Schneid.	Tree	MesP	Mic	Apr-May
<i>Populus alba</i> L.	Tree	MesP	Mes	May-Jul
<i>Populus ontariensis</i> Lodd. ex Loudon	Tree	MesP	Mes	Feb-May
Santalaceae				
<i>Viscum album</i> L.	Parasite	Che	Nan	Apr-May
<i>Viscum cruciatum</i> Sieber ex Boiss.	Herb	The	Lep	Jul- Aug
Sapindaceae				
<i>Dodonaea viscosa</i> Jacq.	Shrub	NanP	Mic	Jan-Mar
Sapotaceae				
<i>Sideroxylon mascatense</i> (A. DC.) T.D. Penn.	Tree	MesP	Nan	Apr-Jul
Saxifragaceae				
<i>Bergenia ciliata</i> Sternb.	Herb	Geo	Mes	Apr-Jun
<i>Bergenia stracheyi</i> (Hook. f. and Thomson) Engl.	Herb	Geo	Mes	Jun-Aug
<i>Saxifraga afghanica</i> Aitch. and Hemsl.	Herb	HemC	Lep	May-Jul
<i>Saxifraga jacquemontiana</i> Decne.	Herb	HemC	Lep	Jul-Sep
Scrophulariaceae				
<i>Scrophularia scabiosifolia</i> Benth.	Herb	The	Mic	Jun-Sep
<i>Verbascum thapsus</i> L.	Herb	The	Mic	Jun-Aug
<i>Buddleja crispa</i> Benth.	Shrub	NanP	Mic	Apr-May
Simaroubaceae				
<i>Ailanthus altissima</i> (Mill.) Swingle	Tree	MicP	Mic	Jul-Aug
Solanaceae				
<i>Atropa acuminata</i> Royle ex lindle.	Herb	The	Mic	Jun-Jul
<i>Datura stramonium</i> L.	Herb	The	Mes	Jun-Jul
<i>Solanum nigrum</i> L.	Herb	The	Mes	Jul-Nov
<i>Solanum nigrum</i> var. <i>villosum</i> L.	Herb	The	Mes	Year Round
<i>Solanum surattense</i> Burm. f.	Herb	HemC	Mes	Year Round
<i>Withania coagulans</i> (Stocks) Dunal	Shrub	Che	Mic	Jan-Apr
<i>Withania somnifera</i> (L.) Dunal	Shrub	Che	Mic	Year Round
Tamaricaceae				
<i>Tamarix indica</i> Willd.	Shrub	NanP	Lep	Jan-Oct
Thymelaeaceae				
<i>Daphne mucronata</i> Royle	Shrub	NanP	Nan	Apr-Sep
Typhaceae				
<i>Typha angustifolia</i> L.	Herb	Geo	Mes	Jun-Aug
<i>Typha domingensis</i> Pers.	Herb	Geo	Mes	Year Round
<i>Typha latifolia</i> L.	Herb	Geo	Mes	Mar-Aug
<i>Typha laxmannii</i> Lep. in Nova.	Herb	Geo	Mes	Jul-Sep
Urticaceae				
<i>Urtica dioica</i> L.	Herb	The	Mic	May-Sep
Verbenaceae				
<i>Lantana camara</i> L.	Shrub	NanP	Mes	Year Round
Viburnaceae				
<i>Viburnum cylindricum</i> Buch.-Ham. ex D. Don	Shrub	NanP	Mac	Jul- Sep
<i>Viburnum cotinifolium</i> D. Don	Shrub	NanP	Mes	Mar-May
<i>Viburnum grandiflorum</i> Wall. ex DC.	Shrub	NanP	Mes	Nov-Jun
Violaceae				
<i>Viola biflora</i> L.	Herb	Geo	Nan	Mar-Jun
<i>Viola canescens</i> Wall.	Herb	Geo	Nan	Mar-Jul
<i>Viola odorata</i> L.	Parasite	Che	Nan	Mar-May
Vitaceae				
<i>Vitis vinifera</i> L.	Shrub	NanP	Mes	May -Jul
Zygophyllaceae				
<i>Fagonia cretica</i> L.	Shrub	The	Lep	Jun-Aug

Key: (Life form class) **Geo**; geophyte, **The**; Therophyte, **HemC**; Hemicryptophyte, **Che**; Chamaephyte, **NanP**; Nanophanerophyte, **MegP** Megaphanerophyte, **MesP**; Mesophanerophyte, **MicP**; Microphanerophyte, **P**; Parasite. (Leaf Spectra) **Lep**; Leptophyll, **Mes**; Mesophyll, **Nan**; Nanophyll, **Mic**; Microphyll, **Aph** = Aphyllous

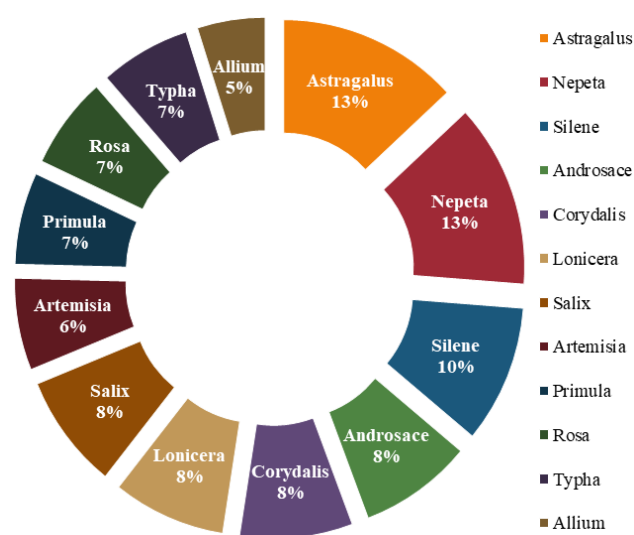


Fig. 3. Depiction of percentage of species in different genera.

Table 3. Life forms diversity of the species..

Life form	Recorded plant species	Percentage %
Therophytes	114	31.23
Hemicryptophytes	67	18.36
Nanophanerophytes	60	16.44
Geophytes	42	11.51
Microphanerophytes	26	7.12
Chamaephytes	23	6.30
Mesophanerophytes	17	4.66
Megaphanerophytes	16	4.38

Table 4. Leaf size classes of collected plant taxa.

Leaf size spectra	No of species	Percentage %
Nanophyll	158	43.29
Leptophyll	82	22.47
Microphyll	65	17.81
Mesophyll	53	14.52
Aphylla	5	1.37
Macrophyll	2	0.55

Discussions

The Kurram Valley is considered to be diverse and rich similar to that of Chitral and Himalayan belt of Pakistan (Stewart, 1972). The floral diversity may be attributed with varied geophysical setting and climatic conditions of the area. Since, two floristic regions fall in the area i.e. the Irano-Turanian (lower Kurram) and Sino-Japanese (central and upper Kurram). The continuous population growth, human made ecological threats and environmental changes encourage such studies. Nichols (1930) belived the studies on biological diversity are urgent to devise conservation strategies. In our study, Asteraceae was recorded dominant family. It is one of the largest families in flora of Pakistan (Ali & Qaiser, 1995; Stewart, 1972). It comprises of maximum herbaceous habit and occurs from lowlands to the sub-nival zone of the mountains. The vast mountain terrains support

herbaceous life as compared to woody species (Abbas *et al.*, 2019). The dominance of this family may be favored by high seed dispersal and high rates of pollination. Similar results were also reported by Sher *et al.*, (2014) and Ali *et al.*, (2017). In the studies of Badshah *et al.*, (2013), Khan *et al.*, (2018), and Ullah *et al.*, (2016) also reported Asteraceae as leading family. Likewise, the species of Lamiaceae and Fabaceae inhabit mostly in mountain ecosystems and have a great diversity with a cosmopolitan distribution (Lewis *et al.*, 2005). The prevailed herbaceous growth may be correlated with prolong harsh climatic conditions. The short vegetation season of the area permits the maximum growth of therophytes (Billings, 1987; Gomaa, 2012). The climatic conditions become hostile with elevation. Since, shrubs and trees are limited to lower altitudes (Givnish, 1984) agricultural and wastelands. The stunted shrub species at high altitudes such as *Rhododendron collettianum*, *Juniper communis*, *Pertya aitchisonii*, *Rosa canina* survive in harsh climatic conditions (snow fall, circadian environmental fluctuations, ice sliding and avalanches). The number of tree species decreases with elevation. Akhtar & Bermeier (2015) observed drastic decrease in species was seen above 3000 m, possibly due to severe natural conditions, i.e. snow fall and cold temperature, with altitude and environmental gradients as main factors (Colwell & Lees, 2000; Grytnes, 2003). Our results showed similarity with the findings of Hussain *et al.*, (2015) reporting the dominant therophyte in Chitral (Hindu Kush) range in northern Pakistan. Therophytes are good indicators of dry climates with adverse seasons because they are better adapted to these climates (Cain & Castro, 1959; Shah & Rozina, 2013). Whereas hemicryptophytes indicate the cold and harsh climates protecting perennatng buds (Cain & Castro, 1959; Archibold, 2012). The most common leaf spectra of the Kurram Valley were nanophyll, leptophyll, and microphyll. Nanophyll and leptophyll are representative of hot, xeric environments, whereas microphylls are indicative of cold environmental conditions, typical at higher elevations (Cain & Castro, 1956). Species having large leaves are better adapted to moist and warmer climates, while smaller leaves can be indicators for dry conditions, less precipitation and high temperature. Similar trends have been described in the studies of Rashid *et al.* (2011) Ullah (2015), Majid *et al.*, (2018), Shah & Rozina (2013) Durrani & Hussain (2005); Khan *et al.* (2015) Shaheen *et al.* (2016). They reported nanophyllous taxa at lower altitudes with less rain spell and microphylls at high altitude. The phenology is linked to environmental signals, such as temperature, sunlight, rainfall, humidity, soil moisture and drought (Rathcke & Lacey, 1985). Unfolding of leaves and anthesis are earlier at lower altitudes, however the fruiting period starts earlier at higher altitude (Omondi *et al.*, 2016; Asim *et al.*, 2016; Bijalwan *et al.*, 2013). Amjad *et al.*, (2017) recorded similar findings to this study with the majority of plant species from Nikyal Valley, District Kotli, Azad Jammu and Kashmir, Pakistan showing the highest

flowering during April and May. Our results were also congruent with Farooq *et al.*, (2018), due to same climatic condition and similar phytogeographical region. In the recent study nine endemic taxa were sampled from the studied region. The prescribed study indicates the importance of the regional flora. Unfortunately, due to prolong law and order situation, gravely devastated the natural habitats of these endemic species. Therefore, concrete plan is need to be proposed in this study for the conservation of these restricted distribution species before vanishing. The environmental situations also urge an extensive survey and collection by national herbaria to monitor and re-inventory of the species after decades' destructive activities in the region. Moreover, due to the rapid migration and expansion of the human population, habitat degradation and unsustainable use of natural resources, natural flora is vanishing quickly, and the conservation and preservation of biodiversity is needed now more than ever (Davis, 1995; Western, 2001; Woodruff, 2001; Muhammad *et al.*, 2017). Owing to the importance of conservation, Pakistan has faced multiple challenges, and in the case of the Kurram Valley, the flora is on the verge of destruction due to both natural, anthropogenic disturbance and war. Currently, forest Department initiated steps to control deforestation.

Kurram natural forests cover now approximately 8% of the area, while the Parachinar Forest Department has planted about 6% of the area (Hussain *et al.*, 2018). Natural disturbances such as soil erosion, avalanches, and heavy rainfall degrade the soil and change the composition of the ecosystem (Majid *et al.*, 2015). The activity of deforestation increases during the winter due to the over exploitation of woody species for heating purpose. The trade of these firwood species like *Quercus baloot*, *Abies pindrow*, *Pinus wallichiana*, *Pinus roxburghii*, *Nannorrhops ritchieana* and *Olea ferruginea* are exploited for trade, firewood and construction. Similarly, deforestation and illegal trade of economically important species were highlighted by Ali *et al.*, (2005) in Basho Valley, Northern Pakistan. The increasing opulation demands more food and housing creating a greater pressure on these natural resources. The use of certain plants for roofing and thatching also deplete forests (Akhter *et al.*, 2016). The agricultural expansion also contributes to the habitat destruction and decreased natural vegetation cover (Akhter *et al.*, 2016). All these scenarios advocate the concrete and wholistic conservation plan to underpin the ecological restoration and biodiversity conservation of this multiply threaten mountain ecosystem.

Table 5. Phenological period, number of plant species, and percentage.

Flowering	Species	%	Fruiting period	Species	%
April	77	21.10	July	74	20.27
May	74	20.27	August	64	17.53
June	66	18.08	September	55	15.07
March	51	13.97	June	45	12.33
July	43	11.78	October	37	10.14
August	12	3.29	May	33	9.04
Round year	12	3.29	April	17	4.66
February	8	2.19	November	15	4.11
September	8	2.19	Round year	12	3.29
January	6	1.64	March	6	1.64
November	3	0.82	December	4	1.10
October	3	0.82	February	1	0.27
December	1	0.27	January	1	0.27

Table 6. Endemic taxa of the Kurram agency.

Species name	Family	Habit	Habitat	Local distribution
<i>Seriphidium kurramense</i> (Qazilb.) Y. R. Ling	Asteraceae	Shrub	Dry mountain slopes	Kurram
<i>Pseudomertensia anjumiae</i> Kazmi	Boraginaceae	Herb	Moist mountain slopes	Kurram
<i>Rhododendron afghanicum</i> Aitch. and Hemsl.	Ericaceae	Shrub	Mountain slopes	Kurram
<i>Nepeta kurramensis</i> Rech. f	Lamiaceae	Herb	Rocky slopes	Mountains of Kurram
<i>Vincetoxicum cardiostephanum</i> (Rech. f.) Rech. f	Asclepiadaceae	Herb	Mountain dry slopes	Sub-endemic to Kurram
<i>Aquilegia moorcroftiana</i> var. <i>afghanica</i> (Bruehl) H.Riedl	Ranunculaceae	Herb	Moist mountain slopes	Sikkaram Mountains Kurram
<i>Clematis robertsiana</i> Aitch. & Hemsl.	Ranunculaceae	Climbing shrub	Aquatic habitat, along streams	Kurram: Shalisan stream
<i>Oxygraphis shaftoanus</i> Aitch & Nemsl.	Ranunculaceae	Herb	Moist mountain slopes	Sikkaram Mountains Kurram
<i>Ranunculus afghanicus</i>	Ranunculaceae	Herb	Rocky steep slopes	Kurram, Ziarat

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