A floristic survey across three coniferous forests of Kashmir Himalaya, India – a checklist

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Abstract: This study presents a checklist of the flora of three coniferous forests of the Himalayan biodiversity hotspot in Kashmir: low-level blue pine (BP), mixed coniferous (MC) and subalpine (SA) forests. The list includes altitudinal distribution and conservation status of 272 vascular plant species representing 196 genera and 64 families. Excluding neophytes (70 taxa, 62 genera, and 27 families), Magnoliophyta comprised 190 taxa, 139 genera, and 50 families; Pinophyta seven taxa, six genera, and three families; and Pteridophyta three taxa, three genera, and two families. Most speciose families from Magnoliophyta include Compositae, Apiaceae, and Rosaceae. Genera such as Artemisia, Potentilla, Viola, and Saussurea contributed the maximum number of species. In case of Pinophyta, the principal families are Piceaee with four taxa followed by Cupressaceae (2 taxa), whereas genus Juniperus comprised two species. In Pteridophyta, Pteridaceae (2 taxa) formed the most speciose family. The herbs contributed 177 taxa, followed by tress (15 taxa), shrubs (8) and subshrubs (2). The maximum number of taxa belongs to SA (136 taxa) followed by MC (134 taxa) and BP (83 taxa) forests. The species distribution reveals 20, 30, and 46 taxa are exclusive to BP, MC, and SA forests. More than 16% of taxa are categorized in the International Union for Conservation of Nature (IUCN) Red List, and 24 taxa are endemic to the Himalayan landscape. The checklist provides a roadmap for research, protection and conservation of plant diversity, especially the threatened taxa.

Keywords: Compositae, coniferous forest, conservation, elevation, floristic survey, hotspot, Kashmir Himalaya, mountains, threatened taxa.

Abbreviations: Afg.—Afghanistan | Ah—Annual herb | APG—Angiosperm Phylogeny Group | Bh—Biennial herb | BP—Low-level blue pine forest | C—Central | CBD—Convention on Biological Diversity | CR—Critically Endangered | DO—Data Deficient | DS—Deciduous shrub | DT—Deciduous tree | E—Eastern | EC—Eastern-central | EN—Endangered | ES—Evergreen shrub | ET—Evergreen tree | IHR—Indian Himalayan Region | IUCN—International Union for Conservation of Nature | LC—Least Concern | MC—Mixed coniferous forest | Medit.—Mediterranean | Mya.—Myanmar | N—Northern | NA—Not assessed | NC—North-central | NE—North-eastern | NW—North-western | OER—Observed elevation range | Pak.—Pakistan | Ph—Perennial herb | Phip.—Philippines | S = Southern | S—Shrub | SA—Subalpine forest | SC—South-central | SE—South-eastern | SS—Subshrub | SW—South-western | Temp.—Temperate | Thail.—Thailand | TPL—The Plant List | VU—Vulnerable | W—Western.
INTRODUCTION

Research on biodiversity became an essential aspect of biological research immediately after the Convention on Biological Diversity (CBD), with the goal of determining the implications of rapid depletion, management and climate change on species composition and diversity. Biodiversity-related data provide a foundation for species conservation and habitat protection (Cadotte 2006). With only 2.2% of global land area, India houses over 18,000 plant species, including 5,000 endemic flora, and is recognized among the 17 global mega-biodiverse countries (Nayar 1996; Singh et al. 2015). About half of the biodiversity hotspots representing 25% of the known biota are reported from mountain ecosystems (Wester et al. 2019). However, until recently, mountains acquired the attention of researchers, policy-makers, and conservationists.

Currently, diverse habitats supporting distinct flora are experiencing the threat of destruction due to fragmentation, rapid human population growth and climate change (Janssen et al. 2016; IUCN 2017). Consistent reductions in plant diversity call for continuous exploration of the population status of flora using systematic (IUCN) criteria, as this is acknowledged as the most rigorous strategy/technique for evaluating the global status of biodiversity and categorizing plants based on their projected risk of extinction (Maes et al. 2015; Orsenigo et al. 2018; Nowak et al. 2020).

The Himalaya, extending from Afghanistan to Myanmar, is one of 36 biodiversity hotspots harbouring a diverse range of flora and fauna, resulting from the phytogeographical complexity of the region (Zachos & Habel 2011). About half of the known biodiversity in India, particularly endemics, is contributed by the 13% land area of the Indian Himalayan Region (IHR). The phytogeographical complexity in the present Jammu & Kashmir, located on the northwestern side of the Himalaya, contributes significantly to various life forms. On account of its floristic status, the Kashmir Himalaya is a part of Himalayan biodiversity hotspot, and it is also considered to be vulnerable to climate change and thus species extinction (Rashid et al. 2015). Several scholars over the course of time have made significant contributions to floristic knowledge of the Himalayan region: Hooker (1872–1897); Lambert (1933); Javeid (1966, 1978, 1979); Hajra (1983); Polunin & Stainton (1984); Kachroo (1993); Singh & Kachroo (1994); and Malik et al. (2010). However, critical taxonomic knowledge about the Kashmir Himalaya is still poor. In addition, a detailed study on the altitudinal distribution of taxa across the forest types is lacking. Consequently, the present study was undertaken to document the floristic diversity of the area, and to highlight its conservation significance.

MATERIALS AND METHODS

Study area

The study area spans over five districts of the Kashmir valley (33.513–34.659 °N & 74.497–75.019 °E) in the present Jammu & Kashmir, India (Figure 1; Image1). Kashmir valley exhibits a warm summer and humid continental climate (Dfa; Peel et al. 2007) with four distinctive seasons, i.e., spring, summer, autumn, and winter. Climate data from the last 38 years revealed that Kashmir valley experiences an annual mean minimum and maximum temperature of 5.4 ± 0.4 °C and 17.6 ± 0.8 °C (Dad et al. 2021). Furthermore, the mean annual rainfall is 1005.5 ± 197.6 mm (Dad et al. 2021). About 46% of precipitation occurs during pre-monsoon, followed by south-west monsoon (27%), winter monsoon (25%), and post-monsoon (8%). Disturbances posed by the Mediterranean Sea during winter lead to frequent rain and snowfall in the valley. The period of snowfall extends from October–March. Geologically, the study area consists of rocks chiefly composed of slates, phyllites and quartzites (Krishnan 1982). The predominant soil orders are entisols, inceptisols, alfisols, and mollisols (Mahapatra et al. 2000; Sidhu & Surya 2014).

Low-level blue pine (BP) forest ranges from 1,500–2,400 m on gentle to moderate slopes. Even-aged stands of the blue-pine, *Pinus wallichiana* A.B.Jacks intermixed with deodar, *Cedrus deodara* (Roxb. ex D.Don) G.Don and the spruce, *Picea smithiana* (Wall.) Boiss., occur depending upon the aspect. Since the ground surface is covered with litter, understorey herb vegetation is less comprising of *Poa alpina* L., *Fragaria nubicola* (Lindl. ex Hook. f.) Lacaita, *Viola coniceps* Wall. in summer season (Shaheen et al. 2012). Dominant shrub species include *Viburnum grandiflorum* Wall. ex DC., *Berberis lycium* Royle, *Indigofera heterantha* Brandis depending upon aspect and canopy cover. Anthropogenic disturbances include land encroachment (for cultivating *Zea mays* L. and *Solanum tuberosum* L.), non-timber forest product extraction (fruits of *Viburnum grandiflorum* Wall. ex DC., medicinally important herbs, honey, nutritious and medicinally important fungus – *Morchella esculenta* (L.) Pers. etc.), lopping, firewood collection, grazing, and fire.

Mixed coniferous (MC) forest, commonly referred to...
as fir forest, occupies the central and western Himalaya from an elevation of about 2,400–3,000 m. Tree species such as evergreen coniferous (*Abies pindrow* (Royle ex D.Don) Royle, *Picea smithiana* and *Pinus wallichiana*) and deciduous broad-leaved tree species (*Acer caesium* Wall. ex Brandis, and *Prunus cornuta* (Wall. ex Royle) Steud.,) predominate. The regeneration of tree species is low or absent, as indicated by the presence of few saplings and seedlings. Understorey vegetation blossoms after the snowmelt during the spring season and is quite dense and diverse. The dominant shrub and herb species include *Viburnum grandiflorum* and *Stipa sibirica* (L.) Lam., (Dar & Sundarapandian 2016). Epiphytic moss and lichen cover the trunk and lower branches of emergent tree species. Activities such as grazing, extraction of plants and plant materials of economic and medicinal value, firewood collection, illegal logging, etc., contribute to forest degradation.

The subalpine forest (SA) forms a transition between MC forest and alpine scrub or grassland from 2,900–3,500 m. *Abies pindrow* is a characteristic and dominant species intermixed with *Betula utilis* D.Don. *Rhododendron* spp. occur as undergrowth or form individual stands. The species of Primulaceae, Ranunculaceae, and Compositae constitute the main understory herbaceous vegetation. The subalpine forest is equally subjected to anthropogenic disturbances like the other forest types besides heavy winter snowfall as a natural disturbance (Gairola et al. 2009).

**Sampling, herbarium preparation, and data analysis**

A reconnaissance floristic survey was undertaken in the landscape between the elevation gradient of 1,500 m and 3,800 m to understand the forest types and composition. Three coniferous forests of Kashmir Himalaya: BP, MC, and SA (Champion & Seth 1968) were identified in the region. Botanical explorations were undertaken during 2019 (March–July) and 2020 (May–August) by employing a random sampling approach considering the accessibility and forest types. During the survey, plants such as trees, shrubs and herbs were documented and voucher specimens were collected. Specimens were processed (pressing, drying, chemical treatment, and mounting) following recommended standard techniques (Rao & Sharma 1990), and examined and identified at the Centre for Biodiversity...
and Taxonomy, University of Kashmir. The voucher specimens were deposited at the Department of Ecology and Environmental Sciences Herbarium, Pondicherry University. The Plant List (TPL; http://www.theplantlist.org/) was referred for updated binomial nomenclature and the author names. Angiosperm Phylogeny Group III (APG III) Classification (2009) and Chase & Reveal (2009) for angiosperms and Gymnosperms were followed for categorizing families. Khuroo et al. (2007) was referred for the origin and alien status of flora. Various information sources were explored to acquire Himalayan and global records of inventoried taxa, including Himalayan flora literature (Hooker 1872–1897; Polunin & Stainton 1984), Tropicos (http://www.tropicos.org/), India Biodiversity Portal (https://indiabiodiversity.org/), Flowers of India (http://www.flowersofindia.net/) and Plants of the World online (http://www.plantsoftheworldonline.org/).

RESULTS

Species composition and distribution

A total of 272 taxa belonging to 196 genera and 64 families are present across the three Kashmir Himalayan coniferous forests (Table 1). Of the total vascular plants, neophytes (aliens) represent 70 (25.73%) taxa within 27 and 62 families and genera (Table 2). This includes invasive aliens (IA; 51.42%), naturalised aliens (NZ; 38.57%), casual/naturalised aliens (C/NA; 8.57%) and cultivated unescaped aliens (CU; 1.43%). Among the aliens, woody flora accounted five (7.14%) species (Robinia pseudoacacia L., Syringa emodi Wall. ex Royle, Crataegus songarica K. Koch, Rosa brunonii Lindl., Aesculus indica (Wall. ex Cambess.) Hook.). All the neophytes are excluded hereafter from further analysis.

Most of the native taxa belong to Magnoliophyta (192 taxa, 139 genera, and 50 families), whereas Pinophyta (seven taxa, six genera, and three families) and Pteridophyta (three taxa, three genera, and two families) are less represented (Table 2). Within Magnoliophyta, 177 taxa (92%) belong to Magnoliopsida and 15 (7.8%) to Liliopsida. Among these, there are 177 herb taxa (174 Magnoliophyta and three Pteridophyta), eight shrub taxa (Magnoliophyta only), 15 tree taxa (eight Magnoliophyta and seven Pinophyta) and two subshrubs (Magnoliophyta only). Herbs are dominated by perennials (150 taxa, 85%), followed by annuals (17 taxa, 9.6%), biennials (two taxa, 1.1%) and evergreen (one taxon, 0.56%). Moreover, seven (3.9%) herbaceous taxa are either perennials, annuals or biennials (Table 2). Of the 15 reported tree taxa, most of them are deciduous (8, 59%), followed by evergreen conifers (seven, 41%). Similarly, among the shrubs, seven (88%) are deciduous (including one climber), and one (12.5%) is evergreen.

The images of selected plant taxa are provided (Images 2–7).

Three families in Magnoliophyta with greater contribution to species richness include Compositae (28 taxa, 13.86%) and Apiaceae and Rosaceae (13, 6.44% each). Families with ten or more species (besides above three) include Lamiales, Leguminosae, Poaceae (11, 5.45% each), and Ranunculaceae (10, 4.95%) (Figure 2). Species-rich genera, i.e., Artemisia, Potentilla, Viola, and Saussurea contributed 16 (7.92%) taxa. Majority of families (26, 47.27%) and genera (108, 72.97%) are monotypic with a single taxon. Among Pinophyta, Pinaceae (four taxa) and Cupressaceae (two taxa) are predominant families, whereas Juniperus is the principal genus contributing two taxa. Pteridophyta is represented by Pteridaceae (two taxa) and Equisetaceae (one taxon), and all the three genera (Adiantum, Equisetum, and Pteris) contributed equally, i.e., one species. In contrast to tree and understorey herb vegetation, all shrub families and genera contributed one species each.

The number of taxon varied among the forest types and corresponding elevation due to the uneven distribution of taxa (Table 1). The SA and MC forests represent greater number of taxa, i.e., 136 and 134, followed by BP forest (83 taxa). The species distribution revealed that 20 taxa are exclusive to BP forest, whereas 30 and 46 taxa are limited to MC and SA forests. However, 22.77% of taxa with a wide distributional range are shared among forest types. Furthermore, BP & MC, BP & SA, and MC

| Phylum      | Taxon | Genera | Family | Trees | Shrubs | Subshrub | Herbs |
|-------------|-------|--------|--------|-------|--------|----------|-------|
| Magnoliophyta | 262   | 187    | 59     | 10    | 10     | 3        | 239   |
| Pinophyta    | 7     | 6      | 3      | 7     | –      | –        | –     |
| Pteridophyta | 3     | 3      | 2      | –     | –      | –        | 3     |
| **Total**    | 272   | 196    | 64     | 17    | 10     | 3        | 242   |

Table 1. Distribution of taxa among various taxonomic groups in three coniferous forests viz., low-level blue pine forest (BP), mixed coniferous forest (MC), subalpine forest (SA) of Kashmir Himalaya, India.
& SA forests shared 16, two, and 43 taxa, respectively. The SA forest harbours greater number of species of Compositae (16.18%) and Caryophyllaceae (5.15%) than to landscape-scale flora (13.86% and 4.46%) in top 10 families. Similarly, Poaceae, and Rosaceae in BP (10.84% & 7.23%) and MC forests (8.21% & 7.46%) contributed greater number of taxa than to the overall landscape (5.45% & 6.44%).

Determination of phytogeographic distribution and taxa status

The distribution of most of the recorded taxa is confined to the northern temperate regions. However, 24 taxa restricted their distribution to the Himalayan landscape (Table 2). Despite the considerable research on plant conservation in Kashmir Himalaya, the analysis of the conservation status of the flora revealed that 169 taxa are not assessed (NA), and the remaining 33 (16.37%) taxa are included under IUCN Red List category (Table 2). Among them, two species Saussurea costus (Falc.) Lipsch. and Aconitum chasmanthum Stapf ex Holmes are Critically Endangered (CR); four species Trillium govanianum Wall. ex D.Don, Aconitum heterophyllum Wall. ex Royle, Taxus wallichiana Zucc. and Atropa acuminata Royle ex Lindl. are Endangered (EN); one species Cypripedium cordigerum D.Don is Vulnerable (VU), two species Asparagus filicinus Buch.-Ham. ex D.Don and Corylus jacquemontii Decne. fall under Data Deficient (DD) category and 24 species are Least Concern (LC). With regard to the forest type and vertical distribution, the maximum number of threatened taxa (VU+EN+CR) occur in SA forest at high altitudinal zones.

DISCUSSION

The floristic survey revealed 272 taxa from 196 genera and 64 families categorized in three life-forms, i.e., trees and understorey shrubs and herbs (Table 1 & 2). The number of taxa reported in the present study was greater than most of the floristic studies in temperate Kashmir Himalaya (Shaheen et al. 2012; Mir et al. 2019; Malik et al. 2021) and other Himalayan studies (Ahmad et al. 2020; Asif et al. 2020; Tiwari et al. 2020) and also elsewhere (Bai et al. 2011). Compositae and Apiaceae constituted species-rich families in this survey. These families were also well represented in other studies of the Kashmir Himalaya: Asif et al. (2020) Betula forests in northwestern Kashmir Himalaya; Dar & Sundarapandian (2016) forests of western Himalaya, and elsewhere Devi et al. (2014) northwestern Himalaya. Variation in species distribution among the forest types/altitudinal zones could be due to micro-climatic heterogeneity resulting from a change in elevation, slope, and other ecological gradients (Körner 2007), besides evolutionary
### Table 2. List of plant species in three temperate coniferous forests, viz., low-level blue pine forest (BP), mixed coniferous forest (MC), subalpine forest (SA) of Kashmir Himalaya, India.

| Family/Taxon                | Life-form                  | Forest type | OER   | Voucher no.                           | Phytogeographic distribution                  |
|-----------------------------|----------------------------|-------------|-------|---------------------------------------|-----------------------------------------------|
| Acanthaceae                 |                            |             |       |                                       |                                               |
| Pteracanthus alatus (Nees) Bremek. | Erect S                  | BP          | 2200–2300 | PU/EES/KH-1210                   | E. Afg. to S. China, N. Indo-China & Taiwan |
| Adoxaceae                   |                            |             |       |                                       |                                               |
| Sambucus wightiana Wall. ex Wight & Am. | Erect Ph               | BP/MC/SA    | 2200–3310 | PU/EES/KH-15201                   | India, Pak., W. Himalayas                     |
| Viburnum grandiflorum Wall. ex DC. | DS                    | BP/MC/SA    | 1890–3000 | PU/EES/KH-1206                   | Himalayas from Kashmir to SE Tibet            |
| Amaranthaceae               |                            |             |       |                                       |                                               |
| Achyranthes aspera L.     | Ph                        | MC/SA       | 2600–3000 | PU/EES/KH-15001                   | Tropical & Subtropical Old World; throughout India |
| Chenopodium album L.      | Ah                        | MC/SA       | 2650–2990 | PU/EES/KH-15065                   | C. & S. Europe to Nepal; W. Himalayas in India |
| Chenopodium folliculosum Asch. | Ah or Ph                | SA          | 2910–3160 | PU/EES/KH-15066                   |                                               |
| Amaryllidaceae             |                            |             |       |                                       |                                               |
| Allium humile Kunth.       | Bulbous Ph                | MC/SA       | 2700–3015 | PU/EES/KH-15013                   | N. Pak. to C. Himalayas & China               |
| Apiaceae                   |                            |             |       |                                       |                                               |
| Aegopodium alpestre Ledeb. | Ph                        | MC          | 2500–2600 | PU/EES/KH-15008                   | Temp. Asia; W. Himalayas in India             |
| Bunium cylindricum (Boiss. & Hohen.) Drude | Ph                | SA          | 3100–3150 | PU/EES/KH-15045                   | Turkey to C. Asia & Pak. to W. Himalayas      |
| Bupleurum falcatum L.     | Ph                        | BP          | 2120–2130 | PU/EES/KH-15103                   | Himalayas from Pak. to Bhutan                 |
| Bupleurum longicaule Wall. ex DC. | Ph                   | SA          | 3750–3800 | PU/EES/KH-15047                   |                                               |
| Carum carvi L.             | Ph                        | BP          | 2350–2400 | PU/EES/KH-15054                   | Paleartic region; throughout India             |
| Chaerophyllum reflexum Aitch. | Ph                     | BP/MC       | 1927–2450 | PU/EES/KH-15063                   | Himalayas from Pak. to SW China               |
| Chaerophyllum villosum Wall. ex DC. | Ph                 | BP/MC/SA    | 2050–2920 | PU/EES/KH-15064                   | N. Pak. to China; Himalayas in India           |
| Eryngium billardieri Delile | Ph                        | BP          | 2120–2130 | PU/EES/KH-15103                   | EC Turkey to Lebanon & W. Pak.; W. Himalayas in India |
| Heracleum candidans Wall. ex DC. | Climbing Ph            | MC/SA       | 2400–3810 | PU/EES/KH-15119                   | Himalayas from Pak. to SW China               |
| Pimpinella acuminata (Edgew.) C.B. Clarke | Ph                  | BP/MC/SA    | 2200–3120 | PU/EES/KH-15170                   | N. Pak. to China; Himalayas in India           |
| Pimpinella diversifolia DC. | Ph                        | MC          | 2460–2770 | PU/EES/KH-15171                   | E. Afg. to China & Indo-China; Himalayas in India |
| Prangos pabularia Lindl.   | Ph                        | MC/SA       | 2720–3140 | PU/EES/KH-15189                   | Turkey to C. Asia & W. Himalayas              |
| Sanicula elata Buch.-Ham. ex D.Don | Ph                  | SA          | 2910–2930 | PU/EES/KH-15202                   | SE Asia from Pak. to W. China & S. Japan to SE Africa |
| Scandix pecten-veneris L. | Tall robust Ph            | SA          | 3300–3310 | PU/EES/KH-15207                   | Europe to NW India                            |
| Selinium vaginatum C.B. Clarke | Ph                     | SA          | 3790–3800 | PU/EES/KH-15211                   | NE Pak. to W. Himalayas                        |
| Seseli libanotic (L.) W.D.J.Koch | Ph                 | MC/SA       | 2740–2920 | PU/EES/KH-15214                   | Europe, Turkey, Iran, W. Pak. & India           |
| Apocynaceae                 |                            |             |       |                                       |                                               |
| Vincetoxicum cirrhinodoria Medik. | Prostrate erect or climbing Ah | BP/MC | 1980–2760 | PU/EES/KH-15244                   | Europe to W. Siberia & N. Turkey, NW Africa, Himalayas |
| Araceae                     |                            |             |       |                                       |                                               |
| Arisaema jacquemontii Blume | Rhizomatous Ph            | BP/MC/SA    | 2250–2950 | PU/EES/KH-15028                   | Afg. to Mya.                                  |
| Arisaema propinatum Schott | Ph                        | MC/SA       | 2450–2950 | PU/EES/KH-15029                   | Pak. to Himalayas & Tibet                      |
| Araliaceae                  |                            |             |       |                                       |                                               |
| Hedera nepalensis K.Koch | Ph                        | BP/MC       | 1980–2610 | PU/EES/KH-15118                   | Afg. to Thall.; Himalayas in India            |
| Family/Taxon        | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution                                      |
|---------------------|-----------|-------------|-----|-------------|-------------------------------------------------------------------|
| Asparagaceae        |           |             |     |             |                                                                   |
| Asparagus filicinus | Erect or twining | BP | 1800–1900 | PU/EES/KH-15036 | Himalayas to C. China                                             |
| Polygonatum multiflorum (L.) All. | Tufted Ah | BP/MC | 2270–2440 | PU/EES/KH-15181 | Eurasia; W. Himalayas in India                                   |
| Polygonatum verticillatum (L.) All. | Rhizomatous Ph | BP/MC/SA | 1980–3120 | PU/EES/KH-15183 | Europe to China; Himalayas in India                               |
| Balsaminaceae       |           |             |     |             |                                                                   |
| Impatiens brochycenta Kar. & Kir. | Ph | BP/MC/SA | 2120–3310 | PU/EES/KH-15122 | Afg. to C. Asia & W. Himalayas                                   |
| Berberidaceae       |           |             |     |             |                                                                   |
| Berberis lycium Royle | Semi-DS | BP | 2100–2150 | PU/EES/KH-1203 | W. Himalayas from Pak. to Nepal                                   |
| Epimedium elatum C. Morren & Decne. | Rhizomatous Ph | MC/SA | 2520–3120 | PU/EES/KH-15095 | N. Pak. to W. Himalayas                                          |
| Podophyllum hexandrum Royle | Rhizomatous Ph | BP/MC/SA | 2370–3310 | PU/EES/KH-15176 | NE Afg. to C. China; Himalayas in India                            |
| Betulaceae          |           |             |     |             |                                                                   |
| Betula utilis D.Don | DT | SA | 2910–3300 | PU/EES/KH-1004 | Afg. to N. & C. China; Himalayas in India                         |
| Corylus jacquemontii Decne. | DT | MC | 2560–2790 | PU/EES/KH-1006 | Europe, Himalayas from Afg. to W. Nepal                           |
| Boraginaceae        |           |             |     |             |                                                                   |
| Arnobia benthami (Wall. ex G. Don) I.M. Johnst. | Rhizomatous Ph | SA | 3800–3900 | PU/EES/KH-15024 | NE Pakistan to W. & C. Himalaya                                  |
| Cynoglossum glabrumatatum Wall. ex Benth. | Bh | BP/MC/SA | 2120–3000 | PU/EES/KH-15084 | Afg. through Kashmir to Sikkim & W. China                       |
| Cynoglossum lanceolatum Forssk. | Bh or Ph | BP/SA | 2230–3800 | PU/EES/KH-15085 | Tropical & S. Africa to Tropical & Subtropical Asia; throughout India |
| Hackelia uncinata (Benth.) C.E.C. Fisch | Ph | SA | 2910–3120 | PU/EES/KH-15117 | Himalayas from Pak. to SW China                                   |
| Myosotis alpestris F.W. Schmidt | Ph | SA | 3150–3310 | PU/EES/KH-15148 | Europe, Himalayas from Pak. to Bhutan                             |
| Myosotis sylvatica Ehrh. ex Hoffm. | Ph | BP/MC/SA | 2260–3150 | PU/EES/KH-15149 | Temp. Eurasia; W. Himalayas in India                              |
| Brassicaceae        |           |             |     |             |                                                                   |
| Arabis amplexicaulis Edgew. | Ph | BP/MC | 2200–2410 | PU/EES/KH-15021 | Afg. to Mongolia & Himalayas                                     |
| Arabis petersperma Edgew. | Ph | MC | 2700–2800 | PU/EES/KH-15023 | Kashmir to China                                                  |
| Capsella bursa-pastoris (L.) Medik. | Erect Ah or Bh | MC/SA | 2420–2950 | PU/EES/KH-15053 | Temp. Eurasia, N. Africa; throughout India                        |
| Chorispora tenella (Pall.) DC. | Ah | MC | 2750–2770 | PU/EES/KH-15067 | SE & E. Europe to China; W. Himalayas in India                    |
| Lepidium apetalum Wild. | Rhizomatous Ph | BP | 2120–2130 | PU/EES/KH-15134 | E. Europe to temp. Asia; Himalayas in India                      |
| Turritis glabra L. | Ah or Bh | BP/MC | 2300–2650 | PU/EES/KH-15022 | Temp. N. Hemisphere; W. Himalayas in India                        |
| Campanulaceae       |           |             |     |             |                                                                   |
| Companula cashmeriana Royle | Ph | SA | 3150–3200 | PU/EES/KH-15050 | Afg. to W. Himalayas to Nepal                                     |
| Companula latifolia L. | Ph | MC/SA | 2525–2920 | PU/EES/KH-15051 | SW Siberia, W. Asia to C. Himalayas                              |
| Codonopsis ovata Benth. | Ph | MC/SA | 2720–3800 | PU/EES/KH-15076 | C. Asia, Himalayas from Pak. to Kashmir                          |
| Codonopsis rotundifolia Benth. | Twining Ph | BP | 2200–2340 | PU/EES/KH-15077 | Pak. to Himalayas & S. Tibet                                      |
| Cannabaceae         |           |             |     |             |                                                                   |
| Cannabis sativa L. | Ah | BP/MC | 1920–2650 | PU/EES/KH-15052 | Native to C. Asia now cosmopolitan                              |
| Caprifoliaceae      |           |             |     |             |                                                                   |
| Dipsacus inermis Wall. | Ph | MC/SA | 2700–3810 | PU/EES/KH-15092 | Himalayas from Afg. to SW China & Mya.                           |
| Lonicera quinquelocularis Hard. | ES | MC | 2500–2700 | PU/EES/KH-15120 | E. Afg. to Himalayas                                              |
| Morina longifolia Wall. | Ph | MC/SA | 2700–2920 | PU/EES/KH-15147 | N. Pakistan to Himalaya & S. Tibet                               |
| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|-------------|-----------|-------------|-----|-------------|------------------------------|
| Scabiosa speciosa Royle¹ | Ah | MC | 2720–2730 | PU/EES/KH-15208 | Himalayas from Pak. to Uttarakhand |
| Valeriana hardwickii Wall.¹ | Dioecious Ph | MC/SA | 2570–3140 | PU/EES/KH-15238 | N. Pak. to S. China & W. Malesia, Himalayas in India |
| Valeriana jatamansi Jones¹ | Ph | MC/SA | 2700–3150 | PU/EES/KH-15239 | Himalayas from Afg. to SW China |
| Compositae | | | | | |
| Achillea millefolium L.¹ | Rhizomatous Ph | BP/MC/SA | 2200–3800 | PU/EES/KH-15002 | Subarctic & temp. N. Hemisphere to Guatemala; W. Himalayas in India |
| Anaphalis contorta (D.Don) Hook.f.¹ | Rhizomatous under-S | BP/MC/SA | 1900–3300 | PU/EES/KH-15014 | Himalayas from Afg. to SW China & Mya. |
| Anaphalis staintoni Georgiadou¹ | Ph | MC | 2700–2800 | PU/EES/KH-15015 | N. Pak. to W. Himalayas |
| Anaphalis virgata Thomson¹ | Ph | BP/MC/SA | 2200–3200 | PU/EES/KH-15016 | Afg. to Xinjiang & Himalayas |
| Arctium lappa L.¹ | Bh | BP/SA | 2300–2950 | PU/EES/KH-15025 | Temp. Eurasia; Himalayas in India |
| Artemisia absinthium L.¹ | Ph | MC/SA | 2750–2920 | PU/EES/KH-15030 | Europe to Siberia & W. Himalayas |
| Artemisia brevifolia Wall. ex DC.¹ | SS | MC | 2450–2720 | PU/EES/KH-15031 | Afg. to W. Tibet & W. Himalayas |
| Artemisia dubia Wall.¹ | SS | BP | 2300–2400 | PU/EES/KH-15032 | Himalayas from Pak. to C. Nepal & China |
| Artemisia scoparia Waldst. & Kitam.¹ | Bh or Ph | MC/SA | 2450–3300 | PU/EES/KH-15033 | Palearctic region; throughout India |
| Artemisia vesitata Wall. ex Besser¹ | SS | SA | 3200–3400 | PU/EES/KH-15034 | Pak. to Mongolia & China, W. Himalayas in India |
| Artemisia vulgaris L.¹ | Ph | SA | 2830–2916 | PU/EES/KH-15035 | Temp. Eurasia to Indo-China & N. Africa |
| Carduus edelbergii Rech.f.² | Ph | BP/MC | 2010–2550 | PU/EES/KH-15056 | Afg. to Nepal |
| Caresesomy abrotanoides L.¹ | Ph | BP/MC | 2200–2570 | PU/EES/KH-15057 | S. & C. Europe to Japan & Himalayas |
| Cephalium crenatum L.¹ | Ah | MC/SA | 2750–2930 | PU/EES/KH-15055 | Eurasia; W. Himalayas in India |
| Centaurea ibérica Trevir.² | Ph | BP | 2250–2300 | PU/EES/KH-15059 | SE & E. Europe to Xinjiang & W. Himalayas |
| Cichorium intybus L.¹ | Ph | BP/MC | 2050–2490 | PU/EES/KH-15068 | N. Africa, C & SW Asia & Europe |
| Cirsium arvense (L.) Scop.¹ | Dioecious Ph | BP | 2200–2210 | PU/EES/KH-15070 | Temp. Eurasia, NW Africa; Himalayas in India |
| Cirsium falconeri (Hook.f.) Petr.¹ | Ph | SA | 2840–2990 | PU/EES/KH-15071 | N. Pak. to S. Tibet & N. Mya. |
| Family/Taxon                                      | Life-form | Forest type | OER          | Voucher no.       | Phytogeographic distribution                                                                 |
|-------------------------------------------------|-----------|-------------|--------------|------------------|-----------------------------------------------------------------------------------------------|
| Cirsium vulgare (Savi) Ten.¹                    | Bh        | SA          | 2940–2950    | PU/EES/KH-15072  | Europe to Siberia & Arabian Peninsula; W. Himalayas in India                                   |
| Cirsium wallichii DC. ²                         | Ph        | BP/MC/SA    | 1920–3210    | PU/EES/KH-15073  | Afg. to Indian Subcontinent                                                                   |
| Cynara canadensis (L.) Cronquist¹               | Ah        | BP          | 2010–2210    | PU/EES/KH-15079  | Native to Neotropic & Neartic regions                                                          |
| Crepis sancto (L.) Bomm.²                       | Ah        | SA          | 2910–2920    | PU/EES/KH-15081  | E. Europe, W. Asia eastwards in Himalayas up to Nepal                                         |
| Doronicum roylei DC. ¹                         | Ph        | SA          | 3800–3810    | PU/EES/KH-15093  | NE Pak. to Himalayas & S. Tibet                                                                |
| Erigeron multifloccatus (Lindl. ex DC.) Benth. ex C. B. Clarke¹ |            |             |              |                  |                                                                                               |
| Lactuca macrorhiza (Royle) Hook. ¹             | Ph        | MC/SA       | 2530–3800    | PU/EES/KH-15101  | Afg. to China                                                                                 |
| Lactuca dolicophylla Kitam.¹                    | Ph        | MC          | 2530–2540    | PU/EES/KH-15126  | Himalayas from Afg. to SW China                                                               |
| Lapsana communis L.¹                            | Ah        | BP/MC/SA    | 2315–2710    | PU/EES/KH-15129  | Europe to Siberia & Iran; W. Himalayas in India                                                |
| Ligularia amplexicaulis DC. ¹                   | Ph        | MC/SA       | 2790–2930    | PU/EES/KH-15137  | Himalayas to S. Tibet                                                                          |
| Ligularia fischeri (Ledeb.) Turcz.¹             | Ph        | MC/SA       | 2570–3540    | PU/EES/KH-15138  | NE Pak. to S. Siberia & Japan; Himalayas in India                                               |
| Myriactis nepalensis Less.¹                     | Ph        | BP/MC/SA    | 1980–3000    | PU/EES/KH-15150  | Himalayas from Afg. to SW China, & SE Asia                                                    |
| Picris hieracoides Sibth. & Sm.¹                | Ph        | MC/SA       | 2430–3000    | PU/EES/KH-15169  | Temp. Eurasia; Himalayas in India                                                             |
| Saussurea albenscens Hook. f. & Thomson¹        | Ph        | SA          | 3050–3060    | PU/EES/KH-15204  | NW Himalayas                                                                                  |
| Saussurea taraxacifolia (Lindl.) Wall. ex DC. ¹ | Ph        | SA          | 3800–3810    | PU/EES/KH-15205  | Himalayas from Kashmir to Bhutan, Xizang                                                      |
| Senecio chrysanthemoides DC.¹                   | Ph        | MC/SA       | 2420–3150    | PU/EES/KH-15212  | Afg. to SC China & Indo-China                                                                 |
| Serrata pallida DC. ¹                           | Ph        | MC          | 2430–2440    | PU/EES/KH-15213  | N. Pak. to Nepal                                                                               |
| Sigesbeckia orientalis L.²                      | Tufted Ph | BP          | 2200–2210    | PU/EES/KH-15217  | E. Europe to Asia & Australia                                                                  |
| Solidago virgo-aurea L.¹                        | Ph        | MC/SA       | 2670–3810    | PU/EES/KH-15220  | W. Europe to C. Siberia & Phy.; Himalayas in India                                             |
| Tanacetum micraulce Sch.Bip.¹                   | Ph        | SA          | 3010–3810    | PU/EES/KH-15229  | Kashmir to SW China                                                                           |
| Taraxacum officinale (L.) Weber ex F.H.Wigg.²   | Semi-prostrate Ph | BP/MC/SA | 1920–3410 | PU/EES/KH-15230 | Cosmopolitan                                                                                 |
| Tussilago farfara L.¹                           | Ph        | MC/SA       | 2670–3130    | PU/EES/KH-15236  | Palearctic region; Himalayas in India                                                           |
| Xanthium spinosum L.¹                           | Ph        | MC/SA       | 2230–2240    | PU/EES/KH-15128  | C. & E. Canada to Mexico; Peru to S. South America                                              |
| Convolvolaceae                                   |           |             |              |                  |                                                                                               |
| Convolvolus arvensis L.²                        | Climbing & prostrate Ah or Ph | MC | 2440–2460 | PU/EES/KH-15078 | Eurasia; throughout India                                                                     |
| Crassulaceae                                     |           |             |              |                  |                                                                                               |
| Sedum eversii Ledeb.²                           | Ph        | SA          | 3790–3810    | PU/EES/KH-15210  | Siberia to Afg. & N. China; W. Himalayas in India                                               |
| Cupressaceae                                     |           |             |              |                  |                                                                                               |
| Juniperus semiglabosa Regel²                    | Monoecious ET | MC | 2450–2500 | PU/EES/KH-1008 | SE Iran to C. Asia, Himalayas from Pak. to Uttarakhand                                           |
| Juniperus squamata Buch.-Ham. ex D.Don²         | Monoecious bushy, semi-prostrate S/ET | SA | 3150–3440 | PU/EES/KH-1015 | N. Afg. to China                                                                              |
| Cyperaceae                                      |           |             |              |                  |                                                                                               |
| Carex stenophyllo Wahlenb.¹                     | Rhizomatous creeping Ph | SA | 2800–2920 | PU/EES/KH-15058 | From Caucasus & Iran to Pak., Kashmir & Mongolia                                               |
| Dioscoreaceae                                   |           |             |              |                  |                                                                                               |
| Dioscorea deltoidea Wall. ex Griseb.¹           | Climbing Ph | BR/SA | 1880–2810 | PU/EES/KH-15091 | Himalayas to SC China & Indo-China                                                              |
| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|-------------|-----------|-------------|-----|-------------|-------------------------------|
| Elaeagnaceae |           |             |     |             |                               |
| Hippophae rhamnoides L. | Dioecious DT | MC | 2400–2500 | PU/EES/KH-1204 | Paleartic region; W. Himalayas in India |
| Equisetaceae |           |             |     |             |                               |
| Equisetum arvense L. | Erect or prostrate rhizomatous Ph | BR/SA | 2320–3060 | PU/EES/KH-15100 | Subartic & temp. N. Hemisphere |
| Euphorbiaceae |           |             |     |             |                               |
| Euphorbia esula L. | Erect Ph | MC | 2600–2760 | PU/EES/KH-15104 | Paleartic; W. Himalayas in India |
| Euphorbia pilosa L. | Ph | SA | 2920–2930 | PU/EES/KH-15105 | C. Asia, N. Pak. to Himalayas |
| Euphorbia wallichii Hook. | Ph | SA | 3140–3540 | PU/EES/KH-15106 | Himalayas from Afg. to W. Himalayas to Sikkim |
| Gentianaceae |           |             |     |             |                               |
| Gentiana carinata (D.Don) Griseb. | Ph | MC/SA | 2570–3000 | PU/EES/KH-15111 | Himalayas from Pak. to Uttarakhand |
| Gentiana moorecroftana Wall. ex G.Don | Aromatic, dwarf, creeping mat forming herb | SA | 3790–3800 | PU/EES/KH-15251 | Himalayas from Kashmir to Nepal |
| Gentiana tianschanica Rupr. ex Kusn. | Ah | SA | 3790–3800 | PU/EES/KH-15112 | Himalayas & China |
| Lomatogonium caeruleum (Royle) Harry Sm. ex B.L. Burtt | Tufted Ph | SA | 3790–3810 | PU/EES/KH-15140 | Himalayas from Kashmir to Nepal |
| Swertia petalota D.Don | Rhizomatous Ph | BP/MC/SA | 2310–3210 | PU/EES/KH-15228 | E. Afg. to W. & C. Himalayas |
| Geraniaceae |           |             |     |             |                               |
| Geranium pusillum L. | Ph | BP/MC/SA | 1920–2920 | PU/EES/KH-15113 | Europe to W. Himalayas |
| Geranium wallichianum D.Don ex Sweet | Ah or Bh | BP/MC/SA | 1920–3810 | PU/EES/KH-15114 | E. Afg. to Himalayas & Tibet |
| Hamamelidaceae |           |             |     |             |                               |
| Parrotiopsis jacquemontiana (Decne.) Rehder | DS/small DT | BP | 2100–2300 | PU/EES/KH-1201 | E. Afg. to W. Himalayas |
| Hypericaceae |           |             |     |             |                               |
| Hypericum perforatum L. | Ah or Bh | BP/MC/SA | 1980–3450 | PU/EES/KH-15121 | Europe to China, NW Africa, SW Sudan; W. Himalayas in India |
| Iridaceae |           |             |     |             |                               |
| Iris hooferiana Foster | Ah | MC/SA | 2560–3810 | PU/EES/KH-15123 | Afg. to W. Himalayas |
| Juglandaceae |           |             |     |             |                               |
| Juglans regia L. | DT | BP | 2000–2390 | PU/EES/KH-1007 | West Asia, W. China & Himalayas |
| Lamiaceae |           |             |     |             |                               |
| Clinopodium umbrosum (M.Bieb.) Kuntze | Ph | BP/MC/SA | 2200–3000 | PU/EES/KH-15074 | Caucasus to N. Mya.; W. Himalayas in India |
| Clinopodium vulgare L. | Ph | BP/MC/SA | 1920–3280 | PU/EES/KH-15075 | Medit., Europe to Siberia & W. Himalayas |
| Lamium album L. | Ph | MC/SA | 2560–2930 | PU/EES/KH-15127 | Paleartic region; W. Himalayas in India |
| Nepeta erecta (Royle ex Bentham.) Bentham. | Ph | MC | 2700–2770 | PU/EES/KH-15151 | E. Afg. to W. Himalayas |
| Nepeta laevigata (D.Don) Hand.-Mazz. | Ph | BP/MC | 2200–2410 | PU/EES/KH-15152 | Himalayas from Afg. to SW China |
| Nepeta linearis Royle ex Bentham. | Ph | MC/SA | 2720–3810 | PU/EES/KH-15153 | E. Afg. to W. Himalayas |
| Origanum vulgare L. | Ph | BP/MC/SA | 2310–3210 | PU/EES/KH-15155 | Eurasia; Himalayas in India |
| Phlomis bracteosa Royle ex Bentham. | Rhizomatous Ph | SA | 2920–3800 | PU/EES/KH-15166 | E. Afg. to Himalayas |
| Phlomis cashmeriana Royle ex Bentham. | Ph | BP/MC/SA | 2310–2910 | PU/EES/KH-15167 | Afg. to W. Himalayas |
| Prunella vulgaris L. | Ph | BP/MC/SA | 1920–3150 | PU/EES/KH-15191 | Europe, N. Africa, N. America & Asia |
| Salvia hians Royle ex Bentham. | Erect Ph | MC | 2590–2600 | PU/EES/KH-15198 | Himalayas from Kashmir to Nepal |
| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|--------------|-----------|-------------|-----|-------------|-----------------------------|
| Salvia moorcroftiana Wall. ex Benth. | Aromatic Ph | MC | 2720–2730 | PU/EES/KH-15199 | Himalayas from Pak. to W. Nepal |
| Salvia nubicola Wall. ex Sweet | Ph | MC/SA | 2700–2920 | PU/EES/KH-15200 | E. Afg. to Himalayas |
| Stachys floccosa Benth. | Erect Ph | BP/MC/SA | 2390–2710 | PU/EES/KH-15223 | Himalayas from Afg., Pak. to Kashmir |
| Stachys sericea Wall. ex Benth. | Ph | SA | 2920–2930 | PU/EES/KH-15224 | Kashmir to SE Tibet |
| Thymus linearis Benth. | Ah | MC/SA | 2500–3000 | PU/EES/KH-15250 | N. Iran to Xinjiang & Himalayas |

Leguminosae

| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|--------------|-----------|-------------|-----|-------------|-----------------------------|
| Argyrolobium floccidum (Royle) Jaub. & Spach | Prostrate Ph | MC | 2400–2550 | PU/EES/KH-15027 | India, Nepal & Pak. |
| Lathyrus humilis (Ser.) Spreng. | Ah or Ph | SA | 3110–3120 | PU/EES/KH-15130 | E. Europe to temp. Asia & W. Himalayas |
| Lathyrus laevigatus (Waldst. & Kit.) Gren. | Ph | MC/SA | 2670–3060 | PU/EES/KH-15131 | Himalayas, Himalayas from Pak. to W. Nepal |
| Lathyrus pratensis | Ph | SA | 2830–2840 | PU/EES/KH-15132 | Europe to Mongolia & Himalayas, Morocco, Ethiopia & Yemen |
| Leonurus cardiaca | Scrambling Ph | SA | 2920–2930 | PU/EES/KH-15133 | Europe, Himalayas from Pak. to Nepal |
| Lespedeza cuneata (Dum.Cours.) G.Don | Ah | BP | 1980–1990 | PU/EES/KH-15136 | Afg. to Japan & tropical Asia, E. & SE Australia |
| Medicago sativa | Prostrate or decumbent Ph | BP | 1920–1930 | PU/EES/KH-15143 | Europe to Mongolia & Indian Subcontinent |
| Medicago lupulina | Erect or procumbent Ph | BP/MC | 1880–2720 | PU/EES/KH-15144 | Asia, Africa & Europe |
| Medicago minima (L.) L. | Ah or Ph | MC | 2770–2780 | PU/EES/KH-15145 | Temp. Eurasia to India, tropical Africa to SW. Arabian Peninsula |
| Oxytropis cachemiriana Cambess. | Creeping annual or short-lived Ph | SA | 3790–3800 | PU/EES/KH-15160 | N. Pak. to W. Himalayas |
| Oxytropis mollis Benth. | Ph | SA | 3790–3800 | PU/EES/KH-15162 | India, Pakistan & Xizang |
| Robinia pseudoacacia L.* | DT | MC | 2330–2340 | PU/EES/KH-1012 | Native to N. America |
| Trifolium pratense | Erect or decumbent Ph | BP/MC | 1980–2710 | PU/EES/KH-15144 | Asia, Africa & Europe |
| Trifolium repens | Erect to decumbent Ph | BP/MC/SA | 1920–3540 | PU/EES/KH-15235 | Macaronesia, NW Africa, Egypt to Zimbabwe, Europe to Mongolia & Himalayas |
| Trigonella emodi Benth. | Ph | SA | 3800–3810 | PU/EES/KH-15232 | Afg. to Himalayas |
| Vicia sativa L.* | Ah or Ph | MC/SA | 2780–3120 | PU/EES/KH-15243 | Kashmir to Eurasia |

Lilacaeae

| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|--------------|-----------|-------------|-----|-------------|-----------------------------|
| Fritillaria roylei Hook. | Ph | SA | 3800–3900 | PU/EES/KH-15252 | Pak. to C. China |
| Malvaceae | | | | | |
| Malva neglecta Wallr. | Ph | BP/MC/SA | 2310–2940 | PU/EES/KH-15142 | Canary Islands, Morocco, Europe to C. Asia & W. Himalayas |

Meliaceae

| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|--------------|-----------|-------------|-----|-------------|-----------------------------|
| Trillium govanianum Wall. ex D.Don | Erect or spreading Ph | SA | 3050–3310 | PU/EES/KH-15233 | E. Afg. to Himalayas |
| Oleaceae | | | | | |
| Syringa emodi Wall. ex Royle | DT | MC | 2450–2500 | PU/EES/KH-1205 | Pak. to Nepal & Tibet |

Onagraceae

| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|--------------|-----------|-------------|-----|-------------|-----------------------------|
| Circaea alpina | Rhizomatous Ph | BP/MC/SA | 2380–3000 | PU/EES/KH-15069 | Temp. N. Hemisphere |
| Epilobium hirsutum L.* | Ph | BP/MC/SA | 2200–3150 | PU/EES/KH-15097 | Temp. Eurasia to Africa; W. Himalayas in India |
| Epilobium laxum Roye | Ph | SA | 2980–2990 | PU/EES/KH-15098 | C. Asia to W. Himalayas |
| Denothera roose L’Her. ex Aiton | Ph | BP/MC/SA | 2230–2930 | PU/EES/KH-15154 | Native to C. & S. America |
| Orchidaceae | | | | | |
| Cypripedium cordigerum D.Don | Ph | SA | 2950–2960 | PU/EES/KH-15087 | N. Pak. to Himalayas & S. Tibet |
### Floristic survey across three coniferous forests of Kashmir Himalaya

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| Family/Taxon                        | Life-form | Forest type | OER          | Voucher no.       | Phytogeographic distribution                                                                 |
|------------------------------------|-----------|-------------|--------------|------------------|-----------------------------------------------------------------------------------------------|
| Epipactis helleborine (L.) Crantz¹  | Rhizomatous Ph | BP/SA      | 2230–2960    | PU/EES/KH-15096  | NW Africa, Europe to China; Himalayas in India                                                   |
| Epipactis royleana Lindl.³         | Rhizomatous Ph | MC/SA      | 2700–2920    | PU/EES/KH-15099  | E. Afg. to C. Asia & Himalayas in India                                                        |
| Orobanchaceae                      |           |             |              |                  |                                                                                               |
| Orobancha alba Stephan¹           | Rhizomatous aromatic Ph | MC/SA | 2770–3160    | PU/EES/KH-15156  | Europe, Afg., Pak., W. Himalayas & Tibet                                                       |
| Pedicularis pectinata Wall. ex Benn.¹ | Ph             | BP/SA      | 2310–3810    | PU/EES/KH-15163  | W. Himalayas from Pak. to W. Nepal                                                            |
| Orobanchaeae                       |           |             |              |                  |                                                                                               |
| Oxalis acerosella L.¹              | Tufted Ph   | BP/SA      | 1880–3120    | PU/EES/KH-15158  | Europe to Japan; W. Himalayas in India                                                        |
| Oxalis corniculata L.¹*            | Rhizomatous Ph | BP/SA | 1880–2950    | PU/EES/KH-15159  | Cosmopolitan                                                                                   |
| Papaveraceae                       |           |             |              |                  |                                                                                               |
| Corydalis stewartii Fedde¹         | Rhizomatous Ah or Bh | BP | 2200–2210    | PU/EES/KH-15080  | Afg. to Nepal                                                                                  |
| Phytolaccaceae                     |           |             |              |                  |                                                                                               |
| Phytolaca acinosa Roxb.²           | Ph         | BP/MC      | 2270–2500    | PU/EES/KH-15168  | Kashmir to SW China                                                                            |
| Pinaceae                           |           |             |              |                  |                                                                                               |
| Abies pindrow (Royle ex D.Don) Royle¹ | Coniferous ET | BP/SA | 2220–3300    | PU/EES/KH-1001    | N. Afghanistan to Nepal                                                                         |
| Cedrus deodara (Roeb. ex D.Don) G.Don¹ | Coniferous ET | BP | 1810–2200    | PU/EES/KH-1005    | NE Afg. to W. Nepal & NW India                                                                 |
| Picea smithiana (Wall.) Boiss.¹     | Coniferous ET | BP/SA | 2000–2960    | PU/EES/KH-1509    | NE Afg. to C. Himalayas                                                                         |
| Pinus wallichiana A.B.Jacks.²      | Coniferous ET | BP/SA | 1800–3140    | PU/EES/KH-1510    | Himalayas from Afg. to Tibet                                                                    |
| Plantaginaceae                     |           |             |              |                  |                                                                                               |
| Plantago lanceolata L.¹*           | Ph         | BP/SA      | 1920–2930    | PU/EES/KH-15172  | Paleartic & Nearctic regions; Himalayas in India                                                |
| Plantago major L.¹*                | Ph         | BP/SA      | 2200–3160    | PU/EES/KH-15173  | European, N. & C. Asia, introduced all over the world                                           |
| Veronica laxa Benth.¹              | Ph         | BP/SA      | 2120–3150    | PU/EES/KH-15240  | N. Pak. to Nepal, C. & S. China & Japan; W. Himalayas in India                                 |
| Veronica persica Poir.¹*           | Ph         | SA         | 2950–2960    | PU/EES/KH-15241  | Native to Iran, now a worldwide weed; Himalayas in India                                        |
| Poaceae                            |           |             |              |                  |                                                                                               |
| Agrostis gigantea Roth¹             | Rhizomatous Ph | BP/SA | 2250–2850    | PU/EES/KH-15010  | Paleartic region, introduced in Nearctic; Himalayas in India                                   |
| Brachypodium sylvaticum (Huds.) P.Beauv.¹ | Tufted Ph | BP/SA | 2250–2510    | PU/EES/KH-15040  | Eurasia; throughout India                                                                      |
| Bromus inermis Leyss.¹*            | Rhizomatous Ph | BP/SA | 2050–2760    | PU/EES/KH-15041  | Paleartic & Nearctic regions; W. Himalayas in India                                             |
| Bromus japonicus Thumb.¹*          | Ah         | BP/SA      | 2250–2950    | PU/EES/KH-15042  | Medit. to temp. Eurasia; W. Himalayas in India                                                  |
| Bromus pectinatus Thumb.¹           | Ah         | BP/SA      | 2250–2300    | PU/EES/KH-15043  | Europe, Iran & Afg. eastwards through India to China, Pak., Sudan through Ethiopia to Egypt, Sinai & Arabia |
| Bromus tomentosus Trin.¹           | Rhizomatous Ph | BP/SA | 2250–2800    | PU/EES/KH-15044  | Medit. to Xinjiang & Pak.; W. Himalayas in India                                               |
| Calamagrostis pseudophragmites (Haller) Koeler¹ | Creeping rhizomatous tufted Ph | MC/SA | 2450–3800    | PU/EES/KH-15049  | Europe to Japan & Himalaya; Himalayas in India                                                  |
| Cynodon dactylon (L.) Pers.¹        | Stoloniferous Ph with rhizomes | BP/SA | 1920–2930    | PU/EES/KH-15083  | Temp. & Subtropical Old World to Australia; throughout India                                   |
| Elymus dahuricus Grieseb.¹          | Tufted Ph   | MC         | 2430–2780    | PU/EES/KH-15094  | Tem. Asia; Himalayas in India                                                                  |
| Koeleria macrantha (Lede.) Schult.¹ | Rhizomatous Ph | MC/SA | 2460–3810    | PU/EES/KH-15124  | Temp. N. Hemisphere to Mexico; Himalayas in India                                               |
| Lolium perenne L.¹                  | Ph         | MC         | 2420–2430    | PU/EES/KH-15139  | N. Africa, Europe to Siberia & Himalayas                                                        |
| Oryzopsis gracilis (Mez) Pilg.¹     | Ah or Ph    | BP/SA      | 1920–2630    | PU/EES/KH-15157  | Iran to China                                                                                  |
| Phleum alpinum L.¹                  | Trailing or creeping Ph | BP/SA | 2250–3140    | PU/EES/KH-15165  | Paleartic & Nearctic regions; Himalayas in India                                               |
| Family/Taxon         | Life-form | Forest type | OER   | Voucher no. | Phytogeographic distribution                                                                 |
|---------------------|-----------|-------------|-------|-------------|---------------------------------------------------------------------------------------------|
| Poa alpina L.       | Ph        | BP/MC/SA    | 1980–3150 | PU/EES/KH-15174 | Temp. N. Hemisphere to Mexico; W. Himalayas in India                                        |
| Poa pratensis L.    | Tufted Ph | BP/MC/SA    | 2070–2990 | PU/EES/KH-15175 | Paleartic & Nearctic regions; Himalayas in India                                               |
| Polygonum fugax Nees ex Steud. | Ph | BP/MC/SA    | 2310–3000 | PU/EES/KH-15180 | Iraq to Mya. mainly in Himalayas & C. Asia                                                   |
| Setaria viridis (L.) P.Beauv. | Bt or Ph | BP | 2360–2370 | PU/EES/KH-15215 | Paleartic; Himalayas in India                                                                   |
| Stipa sibirica (L.) Lam. | Caspitoise or tufted Ah | BP/MC | 1920–2770 | PU/EES/KH-15227 | Temp. Asia to Himalayas                                                                        |
| Vulpia myuros (L.) C.C.Gmel. | Prostrate Ph | BP/MC | 2260–2450 | PU/EES/KH-15249 | Europe to Taiwan & Sri Lanka., Arabian Peninsula & Kenya; throughout India                     |
| Polemoniaceae        |           |             |       |             |                                              |
| Polemonium caeruleum L. | Ah | MC/SA | 2590–2960 | PU/EES/KH-15178 | Europe to C. Siberia & Caucasus, Himalayas from Pak. to W. Nepal                            |
| Polygonaceae         |           |             |       |             |                                              |
| Aconogonon alpinum (All.) Schur | Ph | BP | 2300–2400 | PU/EES/KH-15003 | Paleartic; W. Himalayas in India                                                              |
| Bistorta amplexicaulis (D.Don) Greene | Erect Ph | BP/MC/SA | 2300–3000 | PU/EES/KH-15039 | E. Afg. to C. China; Himalayas in India                                                       |
| Oxystigma (L.) Hill | Ph | SA | 2830–3160 | PU/EES/KH-15161 | Paleartic & Nearctic regions; Himalayas in India                                               |
| Persicaria capitata (Buch.-Ham. ex D.Don) H.Gross | Ph | BP/MC/SA | 2200–3150 | PU/EES/KH-15164 | Indian Subcontinent to S. China & Indo-China                                                   |
| Polygonum aviculare L. | Ph | BP/MC/SA | 2210–2950 | PU/EES/KH-15177 | Paleartic & Nearctic regions; Himalayas in India                                               |
| Polygonum filiforme Thum. | Ph | SA | 3790–3800 | PU/EES/KH-15196 | Himalayas from Pak. to Nepal                                                                 |
| Rheum webbianum Royle | Ph | SA | 1920–1930 | PU/EES/KH-15179 | Himalayas from Pak. to Nepal                                                                 |
| Rumex nepalensis Spreng. | Erect Ph | BP/MC/SA | 1920–3410 | PU/EES/KH-15197 | Afg., India, Pak., Persia, SW China, Turkey, N. Africa & Italy                               |
| Primulaceae          |           |             |       |             |                                              |
| Androsace rotundifolia Sm. | Rhizomatous Ph | MC | 2600–2750 | PU/EES/KH-15017 | Afg., Tibet & W. Himalayas                                                                    |
| Androsace sarmentosa Wall. | Ph | MC | 2700–2800 | PU/EES/KH-15018 | Indian Himalayas, Nepal & Tibet                                                               |
| Primula macrophylla D. Don | Erect Ph | MC/SA | 2720–3150 | PU/EES/KH-15190 | Himalayas from Afg. to SE Tibet                                                               |
| Pteridaceae          |           |             |       |             |                                              |
| Adiantum capillus-veneris L. | Epilithic perennial fern | BP/MC/SA | 1950–3000 | PU/EES/KH-15007 | Neartic, Neotropical, Afrotopical, Australasian, Indomalayan & Paleartic regions; throughout India |
| Pteris cretica L.    | Rhizomatous Ph | BP | 2370–2380 | PU/EES/KH-15192 | S. Africa, Europe to E. Asia; throughout India                                                |
| Ranunculaceae        |           |             |       |             |                                              |
| Aconitum chasmanthum Stapf ex Holmes | Ph | SA | 3200–3800 | PU/EES/KH-15004 | Himalayas from Pak. to Nepal & Mongolia                                                        |
| Aconitum heterophyllum Wall. ex Royle | Rhizomatous Ph | MC/SA | 2700–3810 | PU/EES/KH-15005 | Himalayas from Pak. to C. Nepal                                                                |
| Actaea spicata L.    | Rhizomatous Ph | MC/SA | 2500–2931 | PU/EES/KH-15006 | E. Afg. to Himalaya                                                                            |
| Anemone obtusiloba Lindl. | Ph | SA | 3200–3300 | PU/EES/KH-15019 | Himalayas, Mongolia, NC China & Kazakhstan                                                      |
| Aquilegia pubiflora Wall. ex Royle | Ph | MC/SA | 2500–3200 | PU/EES/KH-15020 | Afg., Pak., & W. Himalayas                                                                    |
| Caltha palustris L.  | Rhizomatous Ph | MC/SA | 2800–2950 | PU/EES/KH-15048 | Paleartic & Nearctic regions; Himalayas in India                                               |
| Delphinium roylei Munz | Ph | BP | 2200–2210 | PU/EES/KH-15088 | Pak. & Kashmir                                                                                |
| Delphinium vestitum Wall. ex Royle | Ph | MC/SA | 2520–3120 | PU/EES/KH-15089 | Himalayas from Pak. to E. Nepal                                                               |
| Ranunculus hirtellus Royle | Rhizomatous Eh | BP/MC | 2250–2780 | PU/EES/KH-15193 | Himalayas from Kashmir to Sikkim, Tibet & W. China                                             |
| Ranunculus luteus Wall. ex Hook. f. & J.W. Thomson | Ph | BP/MC/SA | 2200–2990 | PU/EES/KH-15194 | Himalayas from Afg. to SW China                                                                |
| Family/Taxon | Life-form | Forest type | OER | Voucher no. | Phytogeographic distribution |
|-------------|-----------|-------------|-----|-------------|-----------------------------|
| Ranunculus palmatifidus Riedl. | Erect Ph | BP/MC/SA | 2310–2930 | PU/EES/KH-15195 | W. Himalayas |
| Thalictrum minus L. | Ph | BP | 2310–2340 | PU/EES/KH-15231 | Himalayas from Pak. to Nepal & temp. Eurasia |
| Rosaceae | | | | | |
| Agrimonia pilosa Ledeb. | | | | | |
| Alchemilla trollii Rothm. | | | | | |
| Crataegus songarica K. Koch | | | | | |
| Filipendula vestita (Wall. ex G. Don) Maxim. | | | | | |
| Fragaria nubicola (Hook. f.) Lindl. ex Lacaita | | | | | |
| Geum elatum Wall. ex G. Don | | | | | |
| Geum roylei Wall. ex F.Bolle | | | | | |
| Potentilla indica (Andrews) Th.Wolf | | | | | |
| Potentilla anserina L. | | | | | |
| Potentilla eriocarpa Wall. ex Lehm. | | | | | |
| Potentilla nepalensis Hook. | | | | | |
| Prunus curnuata (Wall. ex Royle) Steud. | | | | | |
| Rosa brunonii Lindl. | | | | | |
| Rosa webbiana Wall. ex Royle | | | | | |
| Sorbus lanata (D.Don) S.Schauer | | | | | |
| Rubiaceae | | | | | |
| Galium aparine L. | | | | | |
| Galium boreale L. | | | | | |
| Salicaceae | | | | | |
| Populus alba L. | | | | | |
| Populus ciliata Wall. ex Royle | | | | | |
| Sapindaceae | | | | | |
| Acer caesium Wall. ex Brandis | | | | | |
| Aesculus indica (Wall. ex Cambess.) Hook | | | | | |
| Saxifragaceae | | | | | |
| Berenjia ligulata Engl. | | | | | |
| Scorpiulariaceae | | | | | |
| Scrophularia decomposita Royle ex Benth. | | | | | |
| Verbascum thapsus L. | | | | | |
| Solanaceae | | | | | |
| Atropa acuminata Royle ex Lindl. | | | | | |
| Hyoscyamus niger L. | | | | | |
| | | | | | |
| | | | | | |

Family/Taxon: Family name; Life-form: growth form; Forest type: type of forest; OER: origin of the survey; Voucher no.: voucher number; Phytogeographic distribution: distribution area.
effects (Qian et al. 2015). The variation in microclimate would have enabled the taxa to adjust to a wide range of niches along elevation and a variety of pre-adapted lineages to colonize in the mountain ranges. Therefore, it can be considered that climatic factors differentiate taxa as indicated by resilience developed over their evolutionary past, with these phylogenetic variations, in turn, deciding species heterogeneity (Wiens & Donoghue 2004; Rana et al. 2019).

One of the prerequisites for biodiversity conservation is to determine the areas of particular importance in the context of taxa vulnerability and characteristic habitats and critically evaluate the same, thus enabling them to prioritize these areas for further consideration (Spehn 2011). In the present study, the situation for seven (2.57%) taxa categorized under threatened, i.e., *Saussurea costus* & *Aconitum chasmanthum* (CR), *Trillium govanianum*, *Aconitum heterophyllum*, *Taxus wallichiana*, & *Atropa acuminata* (EN), and *Cypripedium cordigerum* (VU) were found occasionally in the present study and requires immediate conservational priorities across the landscape. Besides climate change and over-grazing, the species in high demand for traditional medicinal and pharmaceutics has led to their extensive collection and illegal trading, thus pushing them closer to extinction (Devi et al. 2014; Nowak et al. 2020).

The sustainability of such flora is imperative across the landscape. Ecological rehabilitation, site-specific in particular should be accomplished by re-vegetating degraded sites with natural vegetation. Existing management regulations must be examined in order to adopt strict guidelines to enhance efficiency in decision-making and avoid fraud. Extensive quantitative plant diversity inventories and biogeographical explorations ought to be directed on the threatened flora to identify its abundance and frequency. Additionally, ex situ management methods must be in place in addition to the in situ conservation programmes. Overall, from our study we infer that all three types of coniferous forests are rich in flora, demonstrating their importance for conservation. We hope that our results will serve as a benchmark for potential future studies on plant ecology of the area. With notable plant diversity, Kashmir Himalaya is probably a suitable site for further investigations. Moreover, because Kashmir Himalayan forests face threats due to various anthropogenic activities, qualitative data of documented flora will help local and regional authorities to propose management and conservation priorities.
Image 1. Study area overview: A,B—Low-level blue pine forest | C,D,E—Mixed coniferous forest | F,G,H—Sub-alpine forest. © Ashaq Ahmad Dar
Image 2. Herbs: 
A—Aconitum chasmanthum | B—Morina longifolia | C—Gentiana tianschanica | D—Sambucus wightiana | E—Vincetoxicum hirundinaria | F—Dipsacus inermis. © Ashaq Ahmad Dar
Floristic survey across three coniferous forests of Kashmir Himalaya

Image 3. Herbs: A—Swertia speciose | B—Iris hookeriana | C—Fragaria nubicola | D—Arisaema jacquemontii | E—Gentiana moorcroftiana.
© Ashaq Ahmad Dar
Image 4. Herbs: A—Filipendula vestita | B—Heracleum candicans | C—Cichorium intybus | D—Gentiana carinata | E—Trillium govanianum | E—Geranium wallichianum. © Ashaq Ahmad Dar
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Image 6. Trees: A—Juniperus squamata | B—Abies pindrow | C—Picea smithiana | D—Sorbus lanata. © Ashaq Ahmad Dar

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Image 7. Shrubs: A—Syringa emodi | B—Parrotopsis jacquemontiana | C—Rosa webbiana | D—Hippophae rhamnoides. © Ashaq Ahmad Dar

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