

Floristic diversity in high-altitude wetlands of Ladakh Union Territory, Trans Himalaya, India

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Abstract. This study records a total of 212 taxa (201 species and 11 varieties) in 131 genera and 37 families of flowering plants. The family Asteraceae dominated with 32 species and 17 genera, followed by Poaceae with 31 species and 21 genera. Twenty-five species are recorded under different threat categories and 22 are native to the Himalayan region. *Lancea tibetica* Hook. f. & Thomson and *Waldheimia stoliczkae* (C.B. Clarke) Ostenf. are endemic to the cold desert areas of the Indian Himalayan Region. This study provides baseline data on floristic diversity for effective implementation of conservation approaches in selected high-altitude wetlands of the Ladakh region.

Key words. Chushul Marshes, cold desert, flora, Pangong Tso, Tso Kar, Tso Moriri, wetlands

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INTRODUCTION

The Himalayas are home to a diversity of wetlands, which includes lakes and marshes with several characteristics that make it a unique ecosystem. Wetlands located above 2,500 m a.s.l. are considered high-altitude wetlands (HAWs) (Anonymous 2010; Khan and Baig 2017). HAWs are often generated and recharged by glaciers, snow-melt from the surrounding mountains, and precipitation. These wetlands are considered an important ecological system because they provide diverse ecosystem services such as habitat for threatened and endemic flora and fauna, a breeding ground for migratory birds, pastureland, and spiritual and religious value in the region, as well as supporting to local economies. HAWs are one of the most unique ecosystems and are very sensitive to global climate change and anthropogenic activities (Schmidt and Psenner 1992). Although remote HAWs are protected from direct human impact, in the last few decades, they have been affected progressively by climate change (Rogora et al. 2006).

The region of Ladakh Union Territory exhibits extreme environmental conditions, temperature fluctuations, strong radiation, mostly low buffering capacity, and low nutrient levels; this has led to them being termed “cold deserts”. The targeted wetlands, namely, Pangong Tso, Tso Moriri, Tso Kar, and the Chushul marshes, are located in Ladakh and described as HAWs. Due to extreme harsh climate conditions, the biodiversity of the HAWs is more sensitive to environmental changes (Psenner 2002). These wetlands not only provide employment to local people but are also home to unique biodiversity. Ladakh wetlands are the only summer breeding grounds for globally Threatened Black-necked Cranes (*Grus nigricollis* Przhevalsky, 1876) and other migratory birds (Pfister 2004). The flora and fauna of this region are adapted to the harsh climate conditions; vegetation is reduced, productivity is generally low, and most species occur in sparse populations. During recent years, these wetlands have faced many challenges, including agricultural intensification and unregulated tourism activities, accumulation of solid waste and garbage, increased grazing, and unchecked development. All these threats are impacting the fragile HAW ecosystems. Ecological knowledge is needed for a better understanding of the relationships of environmental variables to the wetlands. Floristic diversity in an area is an important component for the study of biodiversity and ecological patterns (Farina 1998).

Several previous explorers have conducted extensive floristic surveys in the Ladakh region (Kachroo et al. 1977; Chaurasia and Singh 1997; Murti 2001; Rawat et al. 2001; Rawat and Adhikari 2002; Kala and



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Mathur 2002; Klimes 2003; Srivastava and Shukla 2015). Despite ecological and conservation importance, limited information on floristic diversity and distribution patterns is available specifically for the HAWs (Bhat et al. 2011; Rawat and Adhikari 2005; Dey et al. 2021). To fill this knowledge gap, we document the floristic diversity and threatened species of selected high-altitude wetlands.

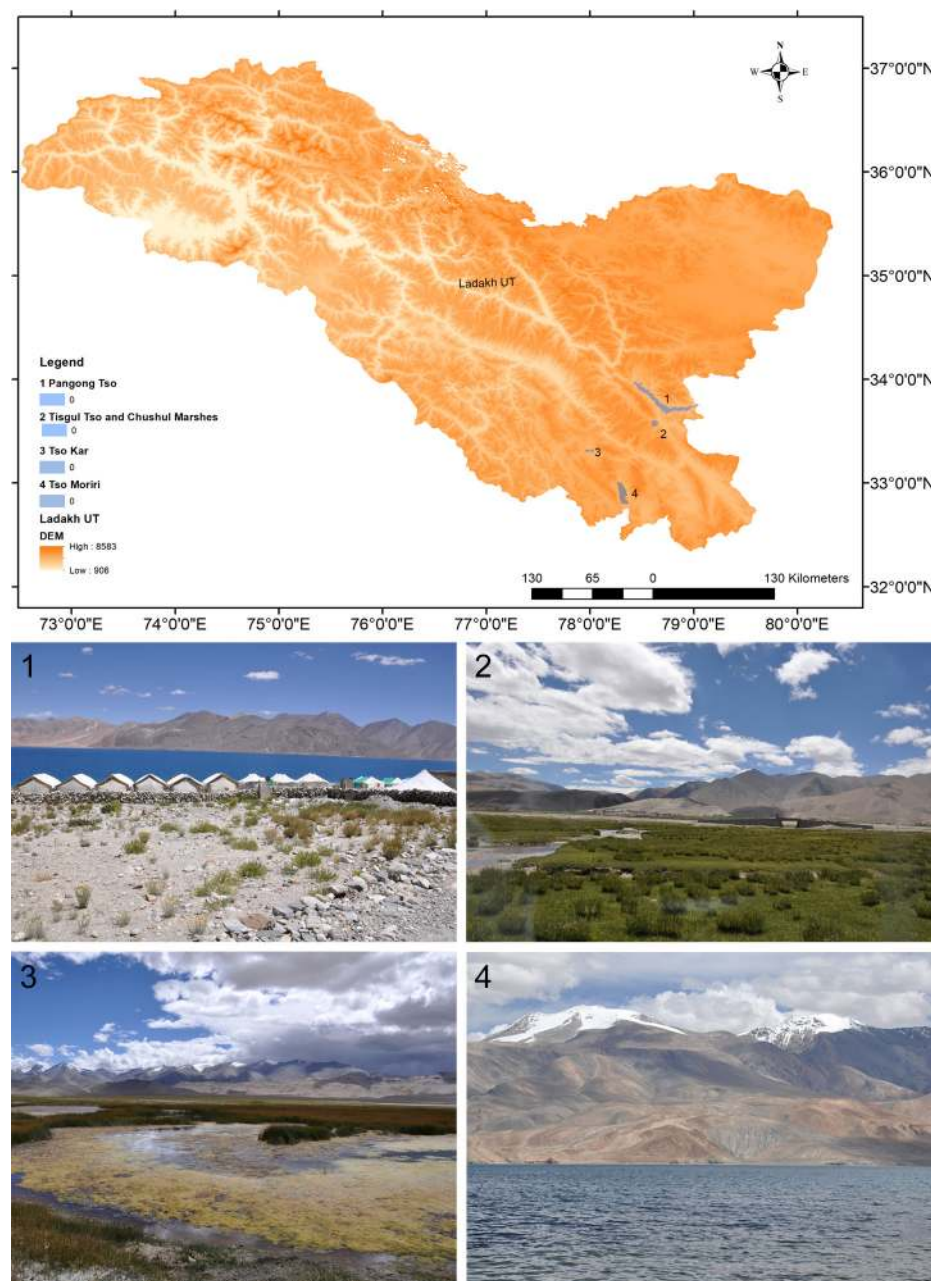
STUDY AREA

Pangong Tso. Pangong Tso is one of the trans-boundary lakes bisected by the international border between India and Tibet, China. About two-thirds of it lies in Tibet, while one-third is in eastern Ladakh (Figure 1). The lake is 4,281m a.s.l. and has a catchment area of about 2,000 km². It is approximately 134 km long. During winter the lake freezes completely, despite being saline water.

Tso Moriri. Tso Moriri, in eastern Ladakh, has an area of c. 120 km² in the Rupshu Desert (Figure 1). This high-altitude lake is situated at ca. 4,553 m a.s.l. and freezes in winter. Tso Moriri Lake has been designated as a wetland of international importance under the Ramsar Convention in 2002.

Tso Kar. The high-altitude wetlands of Tsokar on the Changthang Plateau of eastern Ladakh are one of the most unique ecosystems of the world. They are traditionally used by the nomadic Changpas for their livelihoods (Figure 1). It is a dumbbell-shaped, brackish-water lake rich in deposits of borax and salt. The

Figure 1. Study area map of major high-altitude wetlands (HAWs) of Chanthang area, Ladakh Union Territory.



Changthang Plateau, which has an area of 6,179 ha and an altitude of 4,400–5,800 m a.s.l.) represents an important biogeographic province within the Trans-Himalayas.

Chushul and Tisgul Tso marshes. These are a complex of shallow ponds, marshes, and wet meadows in a broad, sandy valley to the east (10,000 ha) and west (1,000 ha) of Chushul, ca. 15 km south of Pangong Tso (Figure 1). This wetland complex is fed by springs and streams flowing down into the valley from the Ladakh Range to the southwest. Some streams terminate on the sandy plains as stagnant pools, which become saline as they evaporate; others carry sufficient water to flow into Pangong Tso and, ultimately, the Indus River. Small freshwater marshes have formed where these streams coalesce or where they reach a body of standing water. Most of the ponds and marshes are frozen from November to March. They reach their maximum extent during June and July through increased melt water run-off from the high peaks and shrink again thereafter. The ponds average only 1–2 m in depth. The Chushul wetland is situated in the Changthang region of Ladakh in India at an altitude of 4,352 m a.s.l.

METHODS

Field survey, data collection, and vegetation sampling. We undertook extensive and intensive field surveys from mid-June to the first week of September (10–15 days each month) in 2016 and 2019 in and around the study area. Plant specimens were collected from all habitats, including marsh and moist meadows, sandy plains, grassy slopes, higher slopes, scrub steppe, fell-fields, and livestock camps. Specimens were preserved following the methods of Jain and Rao (1977). We housed the specimens in the herbarium of the G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora (**GBP**). We used the standard literature floras of Ladakh (Murti 2001; Srivastava and Shukla 2015) for plant identification and confirmed our identifications with authentic specimens from the Botanical Survey of India, Dehradun (**BSD**) and Forest Research Institute, Dehradun (**DD**). The species were categorized according to their International Union for Conservation of Nature (**IUCN**) Red List category (Ved et al. 2003; Mehta et al. 2020, 2023). For endemic and native species, specimens and publications on the cold-desert floras were consulted (Dhar and Samant 1993; Murti 2001; Srivastava and Shukla 2015). The habit and habitat were recorded in the field and noted from earlier herbarium/literature records. Scientific names and taxonomic authorities were based on the Angiosperm Working Group (2016). Families were arranged alphabetically. For nomenclature, the online sources of Tropicos (<https://www.tropicos.org>) and The Plant List (<http://www.theplantlist.org>) were also followed. Additionally, documentation of the local names of plant species was based on the field-survey data through interviews with local inhabitants. Species native to the Himalayan region are provided with brief descriptions and other details provided in a tabular form. The photographs captured in the wetland areas provided in the figure section are representative of the floral diversity, but they are not categorized according to endemic status or risk factors.

RESULTS

Documentation of floristic diversity and threatened species. Our surveys recorded 212 taxa (201 species and 11 varieties) belonging to 131 genera and 37 families from the selected HAWs (Figures 2–7). Among them, only one species, *Ephedra gerardiana* Wall. ex C.A. Mey., is a gymnosperm (Table 1). Floristic diversity was highest in the Tso Moriri Wetland, with 146 species and nine varieties belonging to 106 genera and 33 families, followed by Pangong wetland with 146 species and six varieties belonging to 33 families and 102 genera. Tso Kar had 100 species and five varieties belonging to 73 genera and 26 families, and the Chushul Marshes had 82 species and four varieties belonging to 61 genera and 25 families. Finally, Tisgul Tso had 78 species and four varieties belonging to 61 genera and 27 families. Of the taxa recorded, 200 (146 in Pangong, 147 in Tso Moriri, 80 in Tisgul, 84 in Chushul, and 98 in Tso Kar) plant specimens were collected by us and 12 other species were compiled from the literature and herbaria. The studied wetlands have 49 taxa in common, while 23 taxa were exclusive to Pangong, 20 to Tso Moriri, six to Tisgul, four to Chushul, and seven to Tso Kar. Of the 37 families, over 85% of the total flora were represented by 16 dominant families, with Asteraceae the most dominant (17 genera, 32 species, and one variety) in all selected wetlands, followed by Poaceae (21 genera, 31 species, and one variety), Amaranthaceae (11 genera and 14 species), Brassicaceae (11 genera and 12 species), Fabaceae (six genera and 12 species), Cyperaceae (three genera and 11 species), Polygonaceae (five genera and nine species), Caryophyllaceae (six genera and eight species), Lamiaceae (five genera and seven species), Ranunculaceae (five genera and seven species), Gentianaceae (four genera and six species), Rosaceae (three genera and six species), Apiaceae (four genera and five species), Boraginaceae (three genera and four species), Papaveraceae (two genera and four species), Orobanchaceae (two genera and three species) (Figure 8). Fourteen families are represented by a single species, namely Amaryllidaceae, Celastraceae, Ephedraceae, Euphorbiaceae, Geraniaceae, Lentibulariaceae, Onagraceae, Phrymaceae, Salicaceae, Saxifragaceae, Scrophulariaceae, Solanaceae, Tamaricaceae, and Urticaceae. No orchids (Orchidaceae) were present within the study area. We found that herbaceous habits were dominant (201, 94%). Tso Moriri harbored the highest number of herbs (146) followed by Pangong (142), Tso kar (100),

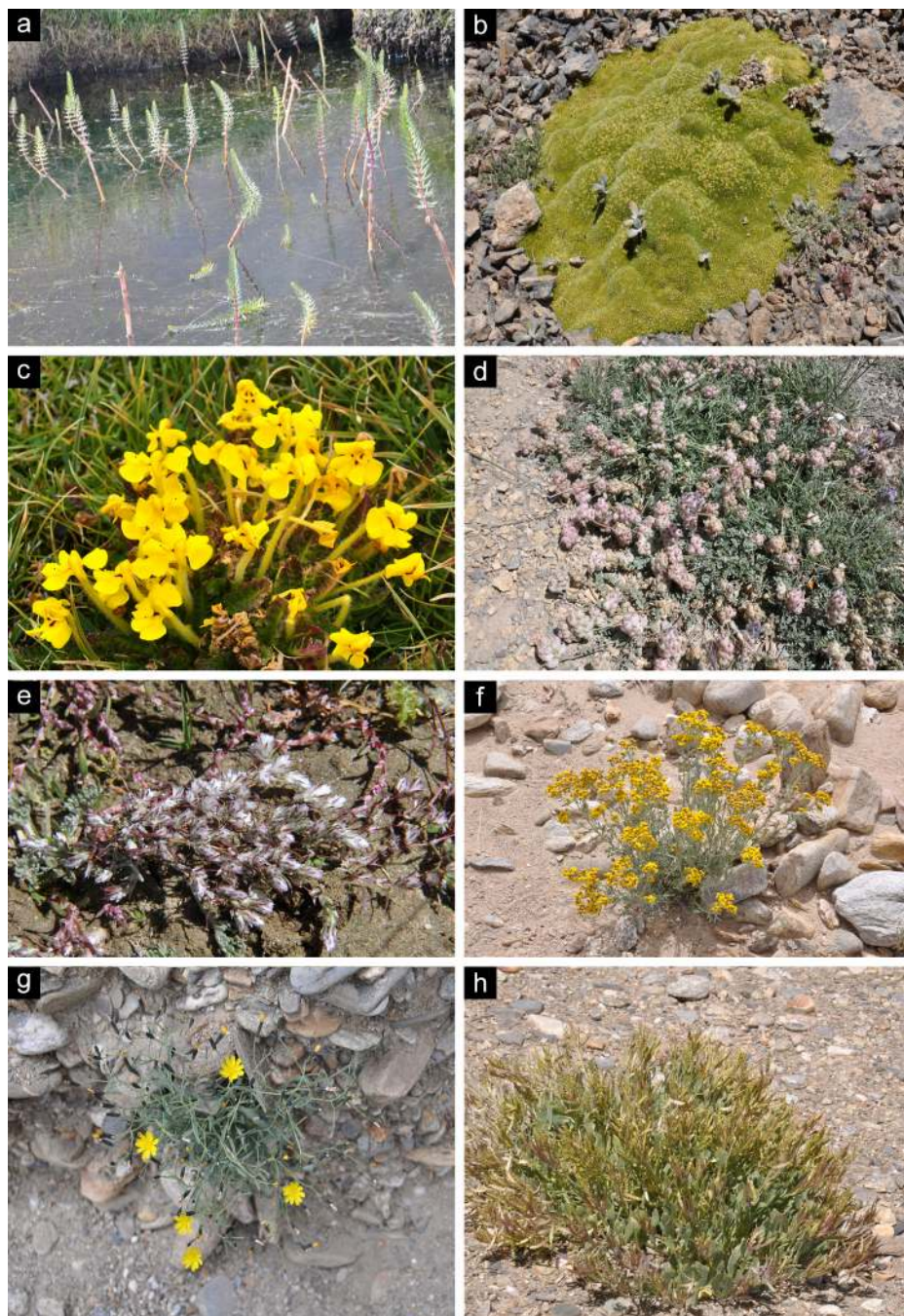


Figure 2. Vascular plants recorded in and around of the study area. **a.** *Hippuris vulgaris* **b.** *Thylacospermum caespitosum* **c.** *Pedicularis longiflora* var. *tubiformis* **d.** *Oxytropis tatarica* **e.** *Polygonum paronychioides* **f.** *Ajania tibetica* **g.** *Askellia flexuosa* **h.** *Christolea crassifolia*.

and the Chushul and Tisgul marshes (83, 79). We observed a few individuals of ferns and bryophytes, and *Funaria hygrometrica* Hedwig (Funariaceae) was identified for the first time from Pangong, Tso Moriri, and the Chushul marshes. *Alyssum canescens* DC., *Draba oreades* Schrenk ex Fisch. & C.A. Mey., *Gentianodes algida* var. *nubigena* (Edgew.) Omer, Ali & Qaiser, *Hypocoum leptocarpum* Hook. f. & Thomson, *Halerpestes sarmentosa* (Adams) Kom. var. *sarmentosa*, *Hippuris vulgaris* L., *Microula tibetica* Benth, *Polygonum sibiricum* Laxm., *Suaeda microsperma* Bunge, *Suaeda olufsenii* Paulsen, *Saussurea taraxacifolia* (Lindl. ex Royle) Wall. ex DC., *Triglochin maritima* L., *Triglochin palustris* L. and *Utricularia aurea* Lour. are restricted or only distributed in specific habitats in these cold desert regions.

Analysis of altitudinal distribution of the species found revealed 201 taxa, or 97% of the total flora, occurs at 4,200–4,400 m a.s.l. This is followed by 157 species (74%) at 4,401–4,600 m, 13 species (6%) at 4,601–4,800 m, and 11 species (9%) at 4,801–5,000 m. *Artemisia* L., with eight species, was the dominant genus, followed by *Carex* L. (seven species), *Potentilla* L. and *Saussurea* DC. (six species each), *Oxytropis* DC., *Poa* L., and *Polygonum* L. (five species each), and *Ranunculus* L., *Pedicularis* L., *Nepeta* L., *Juncus* L., *Potamogeton* L., *Kobresia* Willd., *Campeiosachys* Drobow, *Silene* L., and *Stipa* L. (three species each). We recorded the highest number of species (53) on moist slopes, followed by sandy slopes (48), moraines/



Figure 3. Vascular plants recorded in and around of the study area. **a.** *Chesneya nubigena* **b.** *Koenigia islandica* **c.** *Caragana versicolor* **d.** *Saussurea gnaphalodes* **e.** *Saussurea taraxacifolia* **f.** *Rheum spiciforme* **g.** *Ephedra gerardiana* **h.** *Astragalus confertus*.

streams (30), rocky slopes (30), grassy slopes (28), salt marshes (25), marshy places (23), meadows (17), and stony slopes (16) (Figure 9).

The growing season in Ladakh is very short and vegetation comes into full bloom from June to September. Maximal flowering times were observed from June–September (57 taxa), followed by July–September (47 taxa), July–August (45 taxa), June–August (35 taxa), July–October (six taxa), and May–October (five taxa).

Of the 212 taxa, 23 are classed as Least Concern. *Arnebia euchroma* (Royle ex Benth.) I.M. Johnst. and *Ephedra gerardiana* are Endangered, and *Physochlaina praealta* (Decne.) Miers is reported as Vulnerable (Table 2). Eight species have a stable population while the remaining 18 are unknown (IUCN Red List 2021; Ved et al. 2003). Of the total species, 21 are native to the Himalayan region, and *Lancea tibetica* Hook. f. & Thomson and *Waldheimia stoliczkae* (C.B. Clarke) Ostenf. are endemic to the cold desert region of Indian Himalayan region (Figure 10).

An overview of the native plant taxa recorded is presented here.

Table 1. Floristic diversity in and around of HAWs of Ladakh Union Territory. **Abbreviations:** occurrence: “+” = present in the wetlands site; **Wetlands:** Pan = Pangong, TN = Tsomoriri, Tis = Tisgul, Chu = Chushul, Tsk = Tsokar. **Habit:** H = herb, S = shrub, C = climber, T = tree. **Nativity:** ** = Native to Himalayan region; **Habitat:** Roc = rocky, Slp = slopes, Sto = stony, Mar = marshy, Pla = places, Wet = wet, Mea = meadows, Alg = along, San = sandy, Loa = loamy, Cre = crevices, Moi = moist, Pln = plains, Ste = steppes, Gra = gravel, Scr = screes, Alp = alpine, Rod = roadside, Gla = glacial, Mor = moraines, Sal = saline, Grs = grassy, Riv = river, Str = stream, Bor = borders, Rivbed = riverbeds, Sha = shady, Dr = dry, Gras = grasslands, Ban = banks, Wd = weed field, Semi = semideserts, Watlg = waterlogged, Watcrs = water course, Semiaq = semi-aquatic, Bou = boulder, Aqu = aquatic, Wst = waist. **Herbarium:** GBP = G.B. Pant National Institute of Himalayan Environment, Almora, BSD = Herbarium of Botanical Survey of India, Northern Regional Centre, Dehradun, DD = Forest Research Institute, Dehradun, WI = Wildlife Institute of India, Dehradun, CAL = Central National Herbarium, Botanical Survey of India, Kolkata. **Specimens / literature details:** PB = Puja Bhojak, DD = Dipti Dey, SKS = S.K. Srivastava, M = Murti. **State or union territory:** LA = Ladakh, JK = Jammu and Kashmir, HP = Himachal Pradesh, SK = Sikkim, UK = Uttarakhand, AS = Assam, AR = Arunachal Pradesh, MN = Manipur, ML = Meghalaya, MZ = Mizoram. **Red List category:** 1 = Endangered, 2 = Vulnerable, 3 = Least Concern.

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
Amaranthaceae												
<i>Atriplex erosa</i> Brueckner & Verdoorn	+	+			+	4200–4600	San, Gra Slp	Greenish	Jul–Oct	H	PB & DD 6344, 5596 (GBP)	India (JK, LA), Pakistan, Russia, Europe
<i>Axyris prostrata</i> L.	+	+		+		4200–4300	San Pla	Greenish	Jul–Oct	H	PB & DD 6714 (GBP)	India (JK, LA, SK), Russia, Tajikistan, Nepal, China, Mongolia
<i>Chenopodium prostratum</i> Bunge ex Herder	+	+			+	4200–4500	San Pla, Wd	Yellowish-green	Jul–Sep	H	PB & DD 4408, 5619 (GBP)	India (JK, LA), Russia, C. Asia, Pakistan, China, Mongolia
<i>Chenopodium pamicum</i> Iljin	+	+			+	4200–4500	Wd	Yellowish-green	Jul–Aug	H	PB & DD 5886 (GBP)	India (HP, JK, LA, UK), Afghanistan, Pakistan, China, Mongolia
<i>Corispermum tibeticum</i> Iljin	+	+	+	+	+	4300–4500	San Sal Slp	Yellowish-green	Jul–Sep	H	PB & DD 5855, 5854, 5605 (GBP)	India (JK, LA), Pakistan, China
<i>Dysphania botrys</i> (L.) Mosyakin & Clemants	+	+	+	+	+	4200–4500	San, Rivbed	Yellowish-green	Jul–Sep	H	PB & DD 5877, 5620 (GBP)	India (HP, JK, LA, UK, SK), Europe, Pakistan, Nepal, Bhutan, Iran, Russia, China, N. Africa
<i>Grubovia dasyphylla</i> (Fisch. & C.A. Mey.) Freitag & Kadereit	+					4200–4300	Moi, Sha Pla	Greenish	Jul–Sep	H	PB & DD 5518 (GBP)	India (JK, LA), China, Pakistan, Russia, Mongolia
<i>Oxybasis glauca</i> (L.) S. Fuentes-B., Uotila & Borsch	+	+			+	4200–4500	San Slp	Yellowish-green	Jul–Sep	H	PB & DD 5894 (GBP)	India (HP, JK, LA), China, Pakistan, Iran, Russia, Europe, Africa, Australia, N. America
<i>Halogeton glomeratus</i> (M. Bieb.) C.A. Mey.	+		+	+	+	4200–4500	Sal	Yellow	Jul–Sep	H	PB & DD 5551 (GBP)	India (JK, LA), Pakistan, China, Mongolia, Russia, Afghanistan
<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	+	+	+	+	+	4200–5000	Semi, Roc Slp, Ste	white	Jul–Sep	S	PB & DD 4461, 6723, 5465 (GBP); SKS 115296 (BSD)	India (HP, JK, LA, UK) Europe, Russia, Pakistan, Afghanistan, Nepal, China, Mongolia, N. Africa, N.W. America
<i>Krascheninnikovia pungens</i> (Popov) Czerep.		+			+	4200–4500	Dr Sto Ste, San Pla	White	Jul–Sep	S	PB & DD 6719 (GBP)	NW India, Tajikistan, Afghanistan, N Pakistan, Nepal, China
<i>Salsola collina</i> Pall.	+	+			+	4200–4600	San, Alg Rod	Reddish brown or pinkish	Jul–Sep	H	PB & DD 5893, 5517 (GBP); SKS 115306 (BSD)	India (HP, JK, LA), Pakistan, China, Siberia, U.S.S.R.
<i>Suaeda microsperma</i> Bunge					+	4200–4600	Sal, San Slp	Greenish	Jul–Sep	H	PB & DD 5891 (GBP)	India (HP, JK, LA)
<i>Suaeda olufsenii</i> Paulsen	+	+	+	+	+	4200–4600	Sal, San Slp	Purple green	Jul–Sep	H	PB & DD 5892, 6718, 5464 (GBP)	India (JK, LA)
Amaryllidaceae												
<i>Allium stracheyi</i> Baker**	+			+		4200–4300	Moi Slp	Pink	Jul–Aug	H	PB & DD 5709, 5708 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Nepal, Pakistan
Apiaceae												
<i>Carum carvi</i> L.	+	+			+	4200–4300	Moi Slp	White or pinkish	Jun–Sep	H	PB & DD 5950, 5508 (GBP)	India (HP, JK, LA, UK), Afghanistan, Bhutan, China, Nepal, Pakistan, Europe
<i>Heracleum pinnatum</i> C.B. Clarke	+	+				4200–4300	Sto Slp	White	Jun–Sep	H	PB & DD 5552, 5940 (GBP)	India (HP, JK, LA), China, Pakistan
<i>Pleurospermum stellatum</i> (D. Don) Benth. ex C.B. Clarke	+	+				4200–4500	Roc Slp	White	Jun–Aug	H	PB & DD 6352, 5949, 5970 (GBP)	India (HP, JK, LA, UK), China, Nepal, Pakistan
<i>Selinum elatum</i> M. Hiroe		+				4200–4600	Roc Slp	White	Jun–Sep	H	PB & DD 5946 (GBP)	India (HP, JK, LA)
<i>Selinum wallichianum</i> (DC.) Raizada & H.O. Saxena	+					4200–4500	Roc Slp	White	Jun–Sep	H	PB & DD 5947 (GBP)	India (HP, JK, LA, SK, UK), China, Bhutan, Nepal, Pakistan
Asteraceae												
<i>Ajania fruticulosa</i> (Ledeb.) Poljakov	+	+	+	+	+	4200–4600	Roc Slp	Yellow	Jun–Aug	H	PB & DD 5761, 5590, 5749 (GBP)	India (HP, JK, LA) China, Russia, Mongolia, Kazakhstan
<i>Ajania tibetica</i> (Hook. f. & Thomson ex C.B. Clarke) Tzevelev	+	+			+	4200–4600	Dr Slp	Yellow	Jul–Sep	H	PB & DD 4448, 5580, 5757 (GBP); SKS 115242 (BSD)	India (HP, JK, LA, SK) China, Pakistan, Kazakhstan
<i>Allardia nivea</i> Hook. f. & Thomson ex C.B. Clarke	+					4300–4500	Gra Scr Slp	Pink	Aug–Sep	H	PB & DD 6741 (GBP)	India (JK, LA), Pakistan, Afghanistan, China, Nepal
<i>Anaphalis contorta</i> (D. Don) Hook. f.					+	4200–4300	Moi Slp	White	Jul–Aug	H	SKS 115475 (BSD)	India (HP, JK, LA, UK, SK, ML), China, Afghanistan, Bhutan, Pakistan, Nepal
<i>Anaphalis nepalensis</i> var. <i>monocephala</i> (DC.) Hand.–Mazz.		+		+		4200–4300	Gla Mor	White	Jul–Oct	H	PB & DD 5767, 5766 (GBP)	India (HP, JK, LA), Bhutan, China, Nepal, Pakistan
<i>Artemisia biennis</i> Willd.	+	+	+	+		4200–4500	Moi, Riv Ban	Yellow and purplish green	Jun–Aug	H	PB & DD 6796, 5591 (GBP)	India (HP, JK, LA, UK, SK), Pakistan, Afghanistan, Turkey, USSR, China, N. America
<i>Artemisia demissa</i> Krasch.				+		4200–4300	San Ste, Gra Slp	Yellowish	Jul–Aug	H	PB & DD (GBP)	India (JK, LA), China, Tajikistan, Afghanistan

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
<i>Artemisia macrocephala</i> Jacquem. ex Besser	+	+	+	+	+	4200–4500	Gra Rivbed	Yellow	Jun–Sep	H	PB & DD 5607, 5512, 5817, 6781 (GBP)	India (HP, JK, LA, UK), Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, China, Mongolia, Pakistan, Russia
<i>Artemisia minor</i> Jacquem. ex Besser	+	+			+	4300–4500	Sto Ste	yellow	Jul–Sep	H	PB & DD 5484 (GBP)	India (HP, JK, LA, UK, SK), Pakistan, Bhutan, W. Nepal, China
<i>Artemisia salsoloides</i> Willd.	+	+	+	+	+	4200–4500	Sto Ste, Sto Rivbed	White or brown	Jun–Sep	H	PB & DD 5960, 5419 (GBP)	India (HP, JK, LA, UK), China, Russia, Pakistan
<i>Artemisia santolinifolia</i> Turcz. ex Krasch.	+	+	+	+	+	4200–4500	Sto Ste	Yellow	Jul–Sep	H	PB & DD 5832 (GBP)	India (HP, JK, LA, UK), Afghanistan, Pakistan, China, Russia, C. Asia
<i>Artemisia stracheyi</i> Hook. f. & Thomson	+	+				4200–4500	Sto, San Ste	Gray yellow	Jul–Sep	H	PB & DD 5833 (GBP)	India (JK, LA), China, Pakistan
<i>Artemisia stricta</i> Edgew.		+	+	+		4200–4300	Sto, San Slp	Greenish white	Jul–Aug	H	PB & DD 5556, 5959, 5831 (GBP)	India (HP, JK, LA, UK), China, Bhutan, Nepal
<i>Askellia flexuosa</i> (Ledeb.) W.A. Weber **	+	+	+	+	+	4200–4600	Sto, Gra Str	Yellow	Jun–Sep	H	PB & DD 5424, 5765, 5507 (GBP)	India (JK, LA), Nepal, China, Mongolia, Asia, Russia, Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan, Pakistan
<i>Aster flaccidus</i> Bunge	+	+	+	+	+	4200–4600	Wet Alp Gras	Blue	Jul–Sep	H	PB & DD 5627, 4497, 6777 (GBP)	India (HP, JK, LA, UK, SK), Afghanistan, China, Central Asia, Bhutan, Kazakhstan, Mongolia, Nepal, Pakistan, Russia, Uzbekistan
<i>Aster semiprostratus</i> (Grierson)	+				+	4200–4300	Sto, Gra, San Slp	Blue or purple	Jul–Aug	H	PB & DD 5769, 6783 (GBP)	India (JK, LA), Nepal, China
<i>Cirsium arvense</i> (L.) Scop.	+	+	+	+		4200–4300	Moi Pla	Purple	Jul–Sep	H	PB & DD 5546, 5773, 5753 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Kazakhstan, Nepal, Europe
<i>Cremanthodium ellisii</i> (Hook. f.) Kitam. **	+				+	4200–4600	Alp Mea, Gra Slp	Yellow	Jun–Sep	H	PB & DD 5758 (GBP)	India (HP, JK, LA, UK), China, Nepal, Pakistan
<i>Crepis flexuosa</i> (Ledeb.) C.B. Clarke	+		+	+		4200–4600	Roc Slp	yellow	Jul–Aug	H	PB & DD 5598 (GBP); SKS 115318 (BSD)	India (HP, JK, LA, UK), Pakistan
<i>Echinops cornigerus</i> DC.					+	4200–4500	Dr Slp	Whitish blue	Jun–Sep	H	PB & DD 5781 (GBP)	India (HP, JK, LA, UK), China, Nepal, Pakistan, Afghanistan
<i>Lactuca tatarica</i> (L.) C.A. Mey.	+	+				4200–4300	Moi Slp, San Slp, Alp Rod	Purple blue	Jun–Sep	H	PB & DD 5770, 5738 (GBP)	India (HP, JK, LA), Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Mongolia, Pakistan, Russia, Uzbekistan, Europe, N. America
<i>Leontopodium leontopodium</i> Hand.–Mazz.	+	+	+	+	+	4200–4600	Grs Slp, Alp Mea	White with yellowish	Jul–Oct	H	PB & DD 5736, 5768 (GBP)	India (HP, JK, LA, UK, SK), Nepal, Pakistan, China
<i>Pyrethrum pyrethroides</i> (Kar. & Kir.) B. Fedtsch. ex Krasch.	+					4200–4300	Sto Slp	White	Jul–Sep	H	PB & DD 4499 (GBP)	India (HP, JK, LA)
<i>Saussurea bracteata</i> Decne.**	+					4200–4300	Sto Slp	purplish	Jul–Sep	H	PB & DD 5506 (GBP)	India (HP, JK, LA, UK), China, Pakistan
<i>Saussurea glacialis</i> Herder	+	+			+	4500–5000	Scr Slp	Purple	Jul–Sep	H	PB & DD 5733 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Pakistan, Russia, Nepal
<i>Saussurea gnaphalodes</i> (Royle ex DC.) Sch. Bip.	+	+			+	4300–4600	Scr Slp, Loa, Gra Slp	Purple	Jul–Sep	H	PB & DD 5739, 5741 (GBP)	India (HP, JK, LA, UK), Afghanistan, E. Kazakhstan, Kyrgyzstan, Tajikistan, Nepal, Pakistan
<i>Saussurea graminifolia</i> Wall. ex DC.			+			4500–4700	Moi Slp	Purple	Jul–Sep	H	PB & DD 5780, 5752 (GBP)	India (HP, JK, LA, UK, AR, SK), Bhutan, China, Nepal
<i>Saussurea schlagintweitii</i> Klatt	+	+				4500–4800	Roc Cre	Purplish red	Aug–Sep	H	PB & DD 5562, 6797 (GBP)	India (HP, JK, LA) China
<i>Saussurea taraxacifolia</i> (Lindl. ex Royle) Wall. ex DC.		+				4300–4600	Moi Pla	Purple	Jul–Aug	H	PB & DD 5764, 5764 (GBP)	India (HP, JK, LA, UK, SK, AR), China, Nepal, Bhutan, Pakistan
<i>Senecio dubitabilis</i> C. Jeffrey & Y.L. Chen	+	+				4200–4300	San Pla, Sto Rivbed	Yellow	Jul–Aug	H	PB & DD 5735 (GBP)	India (HP, JK, LA, UK) China, Pakistan, Russia, Mongolia
<i>Taraxacum virgineum</i> Kirschner, Stepanek & Klimes	+	+	+	+	+	4200–4600	Mar Pla	White	Jun–Aug	H	PB & DD 5751, 4433, 5524 (GBP)	India (HP, JK, LA, UK) China, Pakistan, Afghanistan, Russia, Mongolia
<i>Taraxacum officinale</i> F.H. Wigg	+	+	+	+	+	4200–4600	Mar Pla	Yellow	Jun–Aug	H	PB & DD 5744, 5745, 5469 (GBP); SKS 115300 (BSD)	India (HP, JK, LA, UK, PB, Meghalaya, SK) Afghanistan, China, Nepal, Pakistan, Europe
<i>Waldheimia stoliczkae</i> (C.B. Clarke) Ostenf.	+					4200–4300	Moi Roc Slp	White	Jul–Aug	H	PB & DD 5539 (GBP)	India (HP, JK, LA), Pakistan, Afghanistan, China, Russia
Boraginaceae												
<i>Arnebia euchroma</i> (Royle ex Benth.) I.M. Johnston** ¹	+	+				4300–4500	Dr Slp	Purple - white	Jul–Sep	H	PB & DD 5992, 5569 (GBP)	India (HP, JK, LA, UK), China, Afghanistan, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Russia, Tajikistan, Turkmenistan, Uzbekistan
<i>Arnebia guttata</i> Bunge	+	+				4200–4500	San, Gra Slp	Yellow	Jul–Sep	H	PB & DD 4472, 4473 (GBP); SKS 115294 BSD	India (HP, JK, LA, UK), China, Afghanistan, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Russia, Tajikistan, Turkmenistan, Uzbekistan
<i>Eritrichium canum</i> (Benth.) Kitam**	+					4200–4300	San Slp	Blue to white	Jun–Sep	H	PB & DD 5987, 5988 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Pakistan, Nepal
<i>Eritrichium canum</i> var. <i>fruticosum</i> (Klotzsch) Y.J. Nasir		+				4200–4300	San Slp	Blue to white	Jun–Sep	H	PB & DD 4427 (GBP)	India (HP, JK, LA, UK), China, Pakistan
<i>Microula tibetica</i> Benth**	+	+				4200–4500	Mol Pla	White or blue	Jul–Aug	H	PB & DD 6795 (GBP); SKS 115313 (BSD)	India (HP, JK, LA), China, Nepal

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
Brassicaceae												
<i>Alyssum canescens</i> DC.	+	+	+	+	+	4300–5000	San Pln, Sto Ste	White or pinkish	May–Jun	H	PB & DD 5921, 4446, 4405, 6326 (GBP)	India (JK, LA), Russia, Kazakhstan, Pakistan, China, Mongolia.
<i>Arabidopsis thaliana</i> (L.) Heynh.	+			+		4200–4600	Moi Roc Slp	White	Jun–Sep	H	PB & DD 5967, 5965 (GBP)	India (HP, JK, LA, UK, SK), Bhutan, China, Nepal, Africa, America, Pakistan, Temperate Asia
<i>Arabis tibetica</i> Hook. f. & Thomson		+				4200–4500	San, Gra Slp	White	Jun–Sep	H	PB & DD 6717, 5621 (GBP); SKS 115319 (BSD)	India (HP, JK, LA, UK), China, Pakistan, Nepal, Afghanistan, Central Asia
<i>Capsella bursa-pastoris</i> (L.) Medik.		+	+			4200–4300	Alp Mea, Moi Slp, Alg Rod	White	Jun–Oct	H	PB & DD 5964 (GBP)	India (HP, UK), throughout the temperate region of the Himalayas
<i>Christolea crassifolia</i> Cambess.	+	+	+	+	+	4200–4600	San Slp, Gra Scr	White with purplish base	Jun–Aug	H	PB & DD 5528, 6351, 5966, 5497 (GBP)	India (HP, JK, LA, UK), China, Pakistan, Central Asia
<i>Dilophia salsa</i> Thomson	+					4200–4300	Gla Str, Sal Mar	White	Jun–Sep	H	PB & DD 6304 (GBP)	India (HP, JK, LA, SK), Bhutan, China, Pakistan, Nepal
<i>Dontostemon glandulosus</i> (Kar. & Kir.) O.E. Schulz		+				4200–4500	Gra Pln, Riv Ban	White pinkish	Jul–Aug	H	PB & DD 5589 (GBP)	India (HP, JK, LA, SK), China, Bhutan, Pakistan
<i>Draba altaica</i> (C.A. Mey.) Bunge	+					4300–4600	Roc Cre, Gra Slp, Gla, Mor	White	Jun–Aug	H	PB & DD 5926 (GBP)	India (HP, JK, LA, UK, SK), Bhutan, China, Pakistan, Nepal, Afghanistan, Central Asia, W. Siberia
<i>Draba oreades</i> Schrenk ex Fisch. & C.A. Mey.	+				+	4300–5000	Sto Slp, Roc Cre	Yellow	Jun–Aug	H	SKS 115320 (BSD)	India (HP, JK, LA, UK, SK), Bhutan, China, Pakistan, Nepal, Central, Western Asia
<i>Lepidium apetalum</i> Willd.	+	+	+	+	+	4200–4600	San Slp	Greenish	Jun–Aug	H	PB & DD 5953, 5488, 5482, 5924 (GBP); SKS 115332 (BSD)	India (HP, JK, LA, UK), Central & S.W. Asia, Nepal
<i>Parrya nudicaulis</i> (L.) Regel	+	+			+	4200–4600	Alg Str, Moi Pla	Whiteish purple	May–Jul	H	PB & DD 5496 (GBP)	India (JK, LA), Pakistan, Afghanistan, Central & N. Asia, Arctic Europe
<i>Sisymbrium orientale</i> L.		+				4200–4300	Moi Roc Slp	Pale yellow	Apr–Aug	H	SKS 115304 (BSD)	India (HP, JK, LA, UK)
Caprifoliaceae												
<i>Lonicera microphylla</i> Willd. ex Schult.	+					4200–4300	Roc Slp	White to yellow	Jun–Oct	S	PB & DD 6735 (GBP)	India (JK, LA), Afghanistan, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Russia, China
<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	+	+			+	4300–4500	Dr Slp	White or purplish	Jun–Sep	S	PB & DD 5527, 5721, 5720 (GBP)	India (HP, JK, LA, UK, AR, SK), Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, China
Caryophyllaceae												
<i>Arenaria bryophylla</i> Fernald	+	+		+	+	4300–4600	Sto Slp, Roc Mor	White	Aug–Sep	H	PB & DD PB & DD 5874, 5875, 5408 (GBP)	India (Alpine Himalayas, JK, LA, SK, UK), Bhutan, China, Pakistan, Nepal
<i>Gastrollychnis apetal</i> (L.) Tolm. & Kozhanch.	+	+			+	4200–4600	Moi Slp	Violet	Jul–Sep	H	PB & DD 5579, 5616, 5711 (GBP)	India (HP, JK, LA, UK, SK), China, Pakistan, Nepal, Afghanistan, Russia
<i>Oberna behen</i> (L.) Ikonn. ³		+				4200–4300	Grs Slp, Alp Mea	White	Jun–Sep	H	SKS 115312 (BSD)	India (HP, JK, LA, UK), China, Nepal, Europe, Temperate Asia, N. Africa, America, Japan
<i>Silene caespitella</i> F. N. Williams	+	+			+	4200–4600	Roc, Grs Slp	Whitish purple	Jun–Sep	H	PB & DD 5714, 5618, 5713, 5712 (GBP)	India (HP, JK, LA), China, Nepal, Bhutan
<i>Silene graminifolia</i> Otth	+					4200–4300	Alp Mea	White	Jun–Sep	H	PB & DD 5550 (GBP)	India (JK, LA, HP, UK), Pakistan, China
<i>Silene moorcroftiana</i> Wall. ex Benth.	+					4300–4500	Roc Cre	White	Jul–Sep	H	PB & DD 6767 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Nepal, Pakistan
<i>Stellaria depressa</i> Em. Schmid		+				4300–4500	Moi Pla	White	Jul–Oct	H	PB & DD 6330 (GBP)	India (HP, JK, LA), Afghanistan, China, Nepal, Europe, Pakistan, Russia, W. Asia
<i>Thylacospermum caespitosum</i> (Cambess.) Schischk.		+			+	4500–5000	Sto Slp, Roc Cre	Green to yellowish	Jun–Sep	H	PB & DD 5636, 5560, 5847, 6793 (GBP)	India (HP, JK, LA, UK, SK), China, Nepal, Russia, Pakistan, Central Asia
Celastraceae												
<i>Parnassia laxmannii</i> Pall. ex Schult.**			+			4200–4300	Moi Pla	White	Jun–Aug	H	PB 5727 (GBP)	India (HP, JK, LA, UK, SK), Afghanistan, China, Mongolia, Russia, Pakistan, Nepal
Crassulaceae												
<i>Rhodiola imbricata</i> Edgew.	+					4200–4500	Roc slp	Yellow	Jun–Aug	H	PB & DD 5577 (GBP)	India (HP, JK, LA, UK, SK), Afghanistan, Iran, Pakistan, Nepal, Russia
<i>Rhodiola tibetica</i> (Hook. f. & Thomson) S.H. Fu	+	+			+	4200–4500	Sto Alp Slp	Pink Red	Jun–Aug	H	PB & DD 5696, 6729 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Pakistan
Cyperaceae												
<i>Blysmus compressus</i> (L.) Panz. ex Link. ³			+			4200–4300	Sal	Yellow to reddish-brown	Jun–Aug	H	PB & DD 5457, 6753, 6511 (GBP)	India (JK, LA, SK), Europe, N. Iran, C. Asia, Afghanistan
<i>Carex haematostoma</i> Nees				+	+	4300–4600	Alp Mea	Brownish	Jul–Aug	H	PB & DD 6773 (GBP)	India (HP, JK, LA, UK, AR, SK), China, Nepal, Pakistan
<i>Carex melanantha</i> C.A. Mey.		+	+	+	+	4200–4600	Moi San Slp	Brownish	Jul–Aug	H	PB & DD 6508, 5445 (GBP)	India (HP, JK, LA, UK, SK, AR), Afghanistan, China, Nepal, Pakistan, Siberia, Turkey
<i>Carex microglochin</i> Wahlenb. ³	+		+	+	+	4200–4600	Moi, Wet Sal Pla	Brownish	Jul–Aug	H	PB & DD 6750, 6765 (GBP)	India (HP, JK, LA, UK, SK, AR), Afghanistan, China, Italy, Nepal, Canada, N. America, Pakistan

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
<i>Carex nivalis</i> Boott		+				4200–4500	Riv Ban, Gla Mor	Purplish black	Jul–Aug	H	PB & DD 6798 (GBP)	India (HP, JK, LA, UK, SK, AR), Afghanistan, China, Nepal, Pakistan
<i>Carex orbicularis</i> Boott ³	+	+	+	+	+	4200–4600	Sal, Riv Ban, Moi San Slp	Blackish -brown	Jun–Sep	H	PB & DD 5475, 5448 (GBP)	India (HP, JK, LA, UK, SK, AR), Asia
<i>Carex pamirensis</i> C.B. Clarke	+	+	+			4200–4500	Moi, Alp Mea	Brownish	Jun–Jul	H	PB & DD 5455 (GBP)	India (JK, LA, UK), Afghanistan, Pakistan, Tibet
<i>Carex sagaensis</i> Y.C. Yang	+	+			+	4200–4600	Moi San Slp	Brownish	Jun–Sep	H	PB & DD 5473 (GBP)	India (JK, LA), China
<i>Kobresia nitens</i> C.B. Clarke	+	+			+	4200–4600	San Gla Mor	Brown	Jul–Sep	H	PB & DD 5437 (GBP)	India (HP, JK, LA, UK), China, Nepal, Pakistan
<i>Kobresia royleana</i> (Nees) Boeckeler	+	+	+	+	+	4200–4600	Dr Gras Alg Str	Brown	Jul–Sep	H	PB & DD 6749 (GBP)	India (HP, JK, LA, UK, AR, SK), Bhutan, China, Nepal, Pakistan
<i>Kobresia schoenoides</i> (C.A. Mey.) Steud.		+		+		4200–4300	Sto, Sal, Gla Mor	Brown	Jul–Aug	H	PB & DD 6775 (GBP)	India (HP, JK, LA, UK, SK, AR), Bhutan, China, Nepal, Pakistan, Siberia, USSR
Ephedraceae												
<i>Ephedra gerardiana</i> Wall. ex C.A. Mey. ¹	+	+			+	4200–4600	Sto Slp	Yellow	Jul–Oct	S	PB & DD 5943, 5944 (GBP); SKS 115454 (BSD)	India (HP, JK, LA, UK, SK) Afghanistan, Bhutan, China, Nepal, Pakistan, Tajikistan
Euphorbiaceae												
<i>Euphorbia tibetica</i> Boiss.		+	+		+	4200–4600	San Slp	Purple	Jul–Aug	H	PB & DD 5514, 5695 (GBP)	India (HP, JK, LA, UK), China, Pakistan
Fabaceae												
<i>Astragalus confertus</i> Benth. ex Bunge	+	+	+	+	+	4200–4600	Moi Slp	violet	May–Aug	H	PB & DD 5801, 5808 (GBP)	India (HP, JK, LA, UK, SK), Nepal, Tibet, Turkestan
<i>Astragalus melanostachys</i> Bunge	+	+				4200–4500	San Rivbed	Pale pink	Jun–Sep	H	PB & DD 4420 (GBP); SKS 115328 (BSD)	India (HP, JK, LA, UK), Afghanistan, Nepal, Pakistan, China, Eurasia
<i>Astragalus strictus</i> Graham ex Benth.	+	+	+	+		4200–4400	Moi Sha Slp	Pale pinkish to purple	Jul–Sep	H	PB & DD 5584, 5553 (GBP)	India (HP, JK, LA, UK, SK), Bhutan, Nepal, China
<i>Caragana versicolor</i> Benth.	+	+	+	+	+	4200–4600	San Slp	Yellow	Jun–Aug	s	PB & DD 5779, 5775, 5794 (GBP)	India (HP, JK, LA, UK), Afghanistan, Nepal, Pakistan, China
<i>Chesneya nubigena</i> (D. Don) Ali		+		+	+	4200–4500	Moi Slp	Purple	Jun–Aug	H	PB & DD 5801 (GBP)	India (HP, JK, LA, UK), Pakistan, China, Turkestan
<i>Cicer microphyllum</i> Royle ex Benth.	+	+				4200–4500	Gra, Sto Scr	Blueish purple	Jul–Aug	H	PB & DD 5791, 5792 (GBP)	India (HP, JK, LA, UK), Pakistan, China, Nepal, Afghanistan
<i>Hedysarum tibeticum</i> (Benth.) B.H. Choi & H. Ohashi	+		+	+		4200–4500	Dr Slp	Pink with yellow base	Jun–Sep	H	PB 5795, 5788, 5776 (GBP)	India (JK, LA, SK, UK), Pakistan, China, Nepal
<i>Oxytropis hypoglottoides</i> (Baker) Ali	+	+	+			4200–4500	Sal Gra, Roc Slp	Blue to violet	Aug–Sep	H	PB & DD 5586, 6782 (GBP)	India (HP, JK, LA), Pakistan, China, Russia
<i>Oxytropis lapponica</i> (Wahlenb.) Gay		+			+	4200–4600	Dr Slp	Purple	Jun–Aug	H	PB & DD 4431 (GBP); SKS 115325 (BSD)	India (HP, JK, LA, UK, SK), Pakistan, China, Nepal, Afghanistan, Australia, Bhutan, Italy, Hungary, Norway, Spain, Sweden
<i>Oxytropis microphylla</i> (Pall.) DC.	+	+		+	+	4200–4500	Gla Slp	Blueish purple or pink	Jun–Aug	H	PB & DD 5805, 5585, 5786, 5787 (GBP)	India (HP, JK, LA, UK, SK), Pakistan, China, Nepal, Northern Eurasia
<i>Oxytropis pusilla</i> Bunge	+					4200–4500	Sal Gra	Purple	Jun–Sep	H	PB & DD 5799 (GBP)	NW India, NE Afghanistan, N Pakistan, China
<i>Oxytropis tatarica</i> Cambess. ex Bunge **	+	+			+	4200–4500	San Pln, Ste	Blue or purple	Jun–Aug	H	PB & DD 5789, 5790, 5797 (GBP)	India (HP, JK, LA, UK), Pakistan, China, Nepal, Afghanistan
Gentianaceae												
<i>Aloitis moorcroftiana</i> (Wall. ex G. Don) Omer, Qaiser & Ali **					+	4200–4600	Moi Pla	Blue with pale yellow base	Jul–Aug	H	PB & DD 6000 (GBP)	India (HP, JK, LA, UK), China, Nepal, Pakistan, Afghanistan
<i>Comastoma tenellum</i> (Rottb.) Toyok. **	+	+	+	+	+	4200–4500	Mar Pla	Blue	Jul–Aug	H	PB & DD 5537, 5601, 5976, 5995 (GBP); SKS 115323 (BSD)	India (HP, JK, LA, UK), Nepal, Europe, America
<i>Gentiana leucomelaena</i> Maxim.	+	+	+	+	+	4200–4600	Mar Pla	Pale blue or white	Jun–Aug	H	PB & DD 5972, 5999, 5997 (GBP) SKS 115329 (BSD)	India (HP, JK, LA, UK), China, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan
<i>Gentiana tubiflora</i> (G. Don) Wall. ex Griseb.				+		4200–4300	Moi Pla	Blue	Jun–Aug	H	PB & DD 5993 (GBP)	India (HP, JK, LA, UK, SK), China, Nepal
<i>Gentianodes algida</i> var. <i>nubigena</i> (Edgew.) Omer, Ali & Qaiser					+	4300–5000	San Pla, Watcrs	Blue	Aug–Oct	H	PB & DD 5862, 5378 (GBP)	India (HP, JK, LA, UK, AR, SK), Pakistan, China, Nepal
<i>Gentianopsis paludosa</i> (Munro ex Hook. f.) Ma		+				4200–4300	Moi Pla	Blue or yellowish white	Jul–Sep	H	PB & DD 5568 (GBP); SKS 115462 (BSD)	India (HP, JK, LA, UK, SK), Nepal, Pakistan, Bhutan, China
<i>Lomatogonium brachyantherum</i> (C.B. Clarke) Fernald	+	+	+	+	+	4200–4600	Mar Pla	Blue to violet	Aug–Oct	H	PB & DD 5875, 5874 (GBP)	India (HP, JK, LA), Afghanistan, China, Bhutan, Pakistan, Nepal
Geraniaceae												
<i>Geranium himalayense</i> Klotzsch **	+	+				4200–4500	Moi Pla	Blue	Jun–Aug	H	PB & DD 5588, 5703 (GBP)	India (HP, JK, LA, UK), Afghanistan, Bhutan, China, Pakistan, Nepal
Juncaceae												
<i>Juncus bufonius</i> L. ³	+					4200–4300	Moi, Mar Pla	Pale green	Jul–Sep	H	PB & DD 6387 (GBP)	India (Throughout), Cosmopolitan
<i>Juncus membranaceus</i> Royle ex D. Don	+		+	+	+	4200–4600	Wet, Moi Pla	Whitish	May–oct	H	PB & DD 5843 (GBP)	India (HP, JK, LA, UK, SK, AR) Afghanistan, China, Nepal, Pakistan
<i>Juncus thomsonii</i> Buchenau	+	+	+	+	+	4200–4600	Wet, Sal, Alp Mea	Browinsh	Jul–Sep	H	PB & DD 5845, 5844, 5623 (GBP)	India (HP, JK, LA) C. Asia, Tibet

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
Juncaginaceae												
<i>Triglochin maritima</i> L. ³	+	+	+	+	+	4200–4600	Sal Mar	Greenish	May–oct	H	PB & DD 6324, 5908, 5466 (GBP)	India (HP, JK, LA, UK, SK, AR) Asia, Europe, N. Africa, N. America
<i>Triglochin palustris</i> L. ³	+	+	+	+	+	4200–4600	Sal Mar	Greenish	May–oct	H	PB & DD 5915, 5930, 6371 (GBP); SKS 115476 (BSD)	India (HP, JK, LA, UK, SK, AR), Asia, Europe, N. Africa, America
Lamiaceae												
<i>Dracocephalum heterophyllum</i> Benth. ^{**}	+	+	+	+	+	4200–5000	San Slp, Gla Str, Gra Scr	White	Jul–Aug	H	PB & DD 6726, 5643, 5516 (GBP)	India (HP, JK, LA, SK, UK), China, Nepal, Pakistan, Russia, Turkestan
<i>Elsholtzia eriostachya</i> (Benth.) Benth. ^{**}	+	+	+	+	+	4200–4600	Mar Pla, Gra San Ban	Yellow	Jul–Sep	H	PB & DD 5637, 5570, 6770 (GBP)	India (HP, JK, LA, SK, UK), Bhutan, China, Nepal, Pakistan
<i>Mentha royleana</i> Benth.		+				4200–4300	Alg Str	Light pink	Jun–Aug	H	PB & DD 5425 (GBP)	India (HP, JK, LA, UK), China, Nepal, America, Asia, Pakistan, Russia, Europe
<i>Nepeta discolor</i> Royle ex Benth.	+	+				4200–4300	San Slp	Whitish blue	Jun–Sep	H	PB & DD 5595, 5638 (GBP); SKS 115456 (BSD)	India (HP, JK, LA, UK), Afghanistan, Pakistan
<i>Nepeta floccosa</i> Benth.	+	+		+		4200–4500	Roc, Loa Slp	Blue to pale violet	Jul–Aug	H	PB & DD 5515, 5641 (GBP) SKS 115473 (BSD)	India (HP, JK, LA), China, Afghanistan, Pakistan, E. Turkestan
<i>Nepeta laevigata</i> (D. Don) Hand.–Mazz.	+	+				4200–4300	Moi Pla	Blueish purple	Jun–Aug	H	PB & DD 5431, 5640 (GBP)	India (HP, JK, LA, UK), Afghanistan, Pakistan, Nepal, China
<i>Stachys tibetica</i> Vatke	+					4200–4500	Roc Slp	Pale pink	Jun–Sep	H	PB & DD 6728 (GBP)	India (JK, LA), Pakistan, Tibet
Lentibulariaceae												
<i>Utricularia aurea</i> Lour. ³				+		4200–4300	Mar Pla	Yellow	Apr–Aug	H	PB & DD 5707 (GBP)	India (JK, LA) Cambodia, China, Indonesia, Japan, Korea, Laos, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam, Australia
Onagraceae												
<i>Epilobium chitralense</i> P.H. Raven	+	+	+	+		4200–4500	Moi Sto Rivbed	Pink ot purple	Jun–Aug	H	PB & DD 5715, 5501, 4495 (GBP)	India (HP, JK, LA, UK), Iran, Pakistan
Orobanchaceae												
<i>Euphrasia himalayica</i> Wettst. ^{**}	+	+	+	+		4200–4300	Mar Pla	White	Jul–Aug	H	PB & DD 5558, 4493 (GBP)	India (HP, JK, LA, UK), China, Pakistan, Nepal
<i>Pedicularis cheilanthesifolia</i> Schrenk	+					4200–4300	Moi Pla	White or purplish	Jul–Aug	H	PB & DD 5850 (GBP)	India (HP, JK, LA), Afghanistan, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, China, Nepal, Tajikistan
<i>Pedicularis pectinata</i> Wall. ex Benth ^{**}	+	+	+	+	+	4200–4300	Moi Pla	Purple	Jun–Aug	H	PB & DD 5593, 5869, 5848 (GBP)	India (HP, JK, LA, UK), China, Pakistan, Nepal, Afghanistan
<i>Pedicularis longiflora</i> var. <i>tubiformis</i> (Klotzsch) P.C. Tsoong		+	+	+	+	4200–4600	Mar Pla	Yellow	Jul–Sep	H	PB & DD 6343, 5520, 5470 (GBP) SKS 115322 (BSD)	India (HP, JK, LA, UK, SK), China, Pakistan, Nepal, Bhutan
Papaveraceae												
<i>Corydalis cornuta</i> Royle		+				4200–4300	Roc Cre	Yellow with blackish purple	Jun–Sep	H	PB & DD 5700 (GBP)	India (HP, JK, LA, UK), Pakistan, Nepal, Afghanistan
<i>Corydalis meifolia</i> Wall ^{**}		+				4300–4500	Moi Roc Slp	Yellow	Jul–Sep	H	PB & DD 6740 (GBP)	India (HP, JK, LA, UK, SK), China, Bhutan
<i>Corydalis stricta</i> Stephan ex Fisch.		+				4200–5000	Roc, Sto Slp	Yellow	May–Aug	H	PB & DD 5688 (GBP)	India (HP, JK, LA), Pakistan, Nepal, China, Central Asia
<i>Hypecoum leptocarpum</i> Hook. f. & Thomson	+	+				4300–4500	San, Loa Slp	White or purplish pink	Jul–Sep	H	PB & DD 5981, 5518, 5485 (GBP)	India (HP, JK, LA, UK, SK), Bhutan, China, Nepal, Japan, Afghanistan,
Phrymaceae												
<i>Lancea tibetica</i> Hook. f. & Thomson	+	+	+	+		4200–4500	Mar Slp	Violet-blue	Jun–Aug	H	PB & DD 5547, 5702 (GBP); SKS 114930 (BSD)	India (HP, JK, LA, UK, SK) Bhutan, China, Pakistan Mongolia, Nepal
Plantaginaceae												
<i>Hippuris vulgaris</i> L. ³	+	+	+	+		4200–4500	Mar Pla	Green to purplish	Jun–Jul	H	PB & DD 5692, 5693, 5504 (GBP)	India (HP, JK, LA, UK), China, Pakistan, N. Africa, N. America, Europe
<i>Plantago depressa</i> Willd.	+	+	+	+	+	4200–4600	Moi Pla	White	Jun–Sep	H	PB & DD 5423, 5719, 4491 (GBP)	India (HP, JK, LA, UK, AR, SK), China, Afghanistan, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Russia, Bhutan, Nepal, Korea
<i>Plantago himalaica</i> Pilg.	+					4200–4300	Moi Pla	White	Jun–Sep	H	PB & DD 5526 (GBP)	India (HP, JK, LA, UK), Bhutan, China, Myanmar, Nepal, Pakistan
Poaceae												
<i>Agropyron thomsonii</i> Hook. f.		+			+	4200–4600	Moi Slp	Greenish	Jun–Aug	H	SKS 115311 (BSD)	India, Western Himalaya
<i>Agrostis filipes</i> Hook. f.	+	+	+	+	+	4200–4600	Roc Slp	Brownish with purple	Jun–Aug	H	PB & DD 6390 (GBP)	India (JK, LA, HP, AS)
<i>Agrostis munroana</i> Aitch. & Hemsl.		+			+	4200–4600	Grs Slp	Purple	Jun–Sep	H	PB & DD 6516 (GBP)	India (HP, JK, LA, UK), W. Asia
<i>Avena fatua</i> L. ³		+				4200–4500	Moi Pla	Greenish	Jun–Aug	H	SKS 114919 (BSD)	India (HP, JK, LA, SK), Europe, Asia, Pakistan, India
<i>Bromus arvensis</i> L.	+	+				4200–4300	Grs Slp	Pale green	Jul–Aug	H	PB & DD 6388 (GBP)	India (HP, JK, LA, UK), Asia, Europe, N. America

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
<i>Calamagrostis pseudophragmites</i> (Haller f.) Koeler ³	+	+	+	+	+	4200–4600	Roc Slp	Purple or yellow	Jun–Aug	H	SKS 115465 (BSD)	India (HP, JK, LA, UK, SK), Europe, Asia, Mongolia
<i>Campeioestachys dahurica</i> (Turcz. ex Griseb.) B.R. Baum, J.L. Yang & C. Yen var. <i>dahurica</i>		+			+	4200–4600	Grs Slp	Green or bluish-purple	Jul–Aug	H	PB & DD 6389 (GBP)	India (HP, JK, LA, UK), Bhutan, China, Myanmar, Nepal, Pakistan
<i>Campeioestachys himalayana</i> (Nevski) B.R. Baum, J.L. Yang & C. Yen	+				+	4200–4600	Grs Slp	Green or bluish-purple	Jun–Sep	H	M, 2011	India (HP, JK, LA, UK), Nepal, Pakistan, C. Asia
<i>Campeioestachys nutans</i> (Griseb.) B.R. Baum, J.L. Yang & C. Yen	+	+		+	+	4200–4600	Grs Slp	Green or bluish-purple	Jul–Aug	H	PB & DD 6510 (GBP)	India (HP, JK, LA, UK), China, C. Asia, Pakistan, Nepal
<i>Catabrosa aquatica</i> (L.) P. Beauv. ³	+				+	4200–4600	Mar Pla	Pale green or yellowish	May–Aug	H	M, 2011	Throughout the Himalaya, N. America, Europe
<i>Cymbopogon iwarancusa</i> (Roxb.) Schult.				+		4200–4500	Moi Pla	Whitish green	Apr–Sep	H	PB & DD 5450 (GBP)	India (HP, JK, LA, UK) Iraq, Nepal, Pakistan
<i>Dactylis glomerata</i> L.	+	+	+	+	+	4200–4600	Alp Mea	Green to purplish	Jul–Aug	H	PB & DD 5434, 6760 (GBP)	India (HP, JK, LA, UK), Asia, Australia, Europe
<i>Deschampsia cespitosa</i> (L.) P. Beauv.		+	+			4200–4500	Moi Slp	White or silvery or falcous purplish	Jul–Aug	H	PB & DD 6507 (GBP)	India (HP, JK, LA, SK, UK), Asia
<i>Elymus longiaristatus</i> (Boiss.) Tzvelev	+	+	+	+		4200–4500	Grs Slp	Green or bluish-purple	Jul–Aug	H	PB & DD 6735, 6758 (GBP)	India (HP, JK, LA, UK), Nepal, Pakistan, China
<i>Festuca tibetica</i> (Stapf) E.B. Alexeev	+	+				4300–4500	Roc Slp	purplish	Jul–Aug	H	SKS 115309 (BSD)	India (HP, JK, LA, UK, SK), Tibet, Nepal
<i>Hordeum vulgare</i> L.	+	+				4200–4300	Grs Slp	Greenish	Jul–Sep	H	PB & DD 5545 (GBP)	Throughout the temperate regions
<i>Koeleria pyramidata</i> (Lam.) P. Beauv.		+			+	4200–4500	Alp Mea	Green, purplish or silvery	Jun–Sep	H	PB & DD 6388 (GBP)	Throughout temperate regions of the northern hemisphere
<i>Koeleria spicata</i> (L.) Barberá, Quintanar, Soreng & P.M. Peterson		+			+	4200–5000	Alp Mea	Green to purple or brownish	Jul–Aug	H	PB & DD 6518, 6538 (GBP)	India (HP, JK, LA, UK), Nepal, Europe, Pakistan, Bhutan, Korea
<i>Leymus secalinus</i> (Georgii) Tzvelev	+	+	+	+	+	4200–4600	Grs Slp	Greyish green	Jun–Aug	H	PB & DD 5442, 545 ³ (GBP)	India (HP, JK, LA, UK), C. Asia, China, Pakistan, Siberia
<i>Melica persica</i> Kunth	+	+				4300–4600	Roc Slp	Pale brown	Jul–Aug	H	PB & DD 6762 (GBP)	India (HP, JK, LA, UK), Afghanistan, Pakistan, Turkey, U.S.S.R.
<i>Ochlopoa supina</i> (Schrad.) H. Scholz & Valdés		+				4300–4500	Grs Slp	Purple	Jun–Jul	H	PB & DD 6540 (GBP)	India (HP, JK, LA, UK), Pakistan, Russia, Europe
<i>Poa aitchisonii</i> Boiss.	+		+	+		4200–4500	Alp Mea	Purple	Jun–Sep	H	PB & DD 6763, 6534, 6532 (GBP)	India (HP, JK, LA, UK, SK), Asia, Europe, N. America
<i>Poa attenuata</i> Trin.		+				4300–4600	Gra Slp	Purple	Jul–Aug	H	PB & DD 5575 (GBP)	India (HP, JK, LA, UK), Asia, Mongolia, Siberia
<i>Poa calliopsis</i> Litv. ex Ovcz.		+	+			4300–4500	Grs Slp	Yellow and puple	Jul–Aug	H	PB & DD 6530, 6734 (GBP)	India (HP, JK, LA, UK), C. Asia, Tibet
<i>Poa lahulensis</i> Bor		+			+	4200–5000	Alp Mea	Purple	Jun–Sep	H	PB & DD 6537 (GBP)	India (HP, JK, LA, UK), China, Pakistan
<i>Poa tibetica</i> Munro ex Stapf	+	+				4200–4500	Gra Slp	Pale green and pinkish	Jul–Aug	H	PB & DD 5435 (GBP)	India (HP, JK, LA, UK), Russia, Tibet
<i>Puccinellia distans</i> (Jacq.) Parl.	+	+	+	+	+	4200–4600	Gra Slp	White or yellow	Jul–Aug	H	PB & DD 6509 (GBP)	India (HP, JK, LA, UK), N. America, N. Africa, Europe, Asia, Pakistan
<i>Puccinellia himalaica</i> Tzvelev	+	+				4200–4500	Moi Pla	Green to purplish	Jul–Aug	H	PB & DD 5433 (GBP)	India (JK, LA, HP)
<i>Stipa caucasica</i> Schmalh.			+	+		4200–4500	Moi Pla	White	Jul–Aug	H	PB & DD 5456 (GBP)	India (HP, JK, LA), C. Asia
<i>Stipa orientalis</i> Trin.					+	4400–4600	Roc Slp	Yellow-green	Jul–Aug	H	PB & DD 6385 (GBP)	India (HP, JK, LA, UK), S. Russia, Mongolia, China, Pakistan
<i>Stipa subsessiliflora</i> (Rupr.) Roshev.			+	+		4200–4500	Roc Cre	Purple	Jul–Aug	H	PB & DD 6800 (GBP)	India (HP, JK, LA, UK), Tibet, S. Russia, China
<i>Tenaxia cachemyriana</i> (Jaub. & Spach) N.P. Barker & H.P. Linder	+	+			+	4300–4600	Mea, Dr Slp	Green or brownish	Jul–Sep	H	PB & DD 6517, 6369, 6519 (GBP)	India (HP, JK, LA, UK), Pakistan
Polygonaceae												
<i>Bistorta vivipara</i> (L.) Delarbre	+	+			+	4200–4600	Moi Slp, Gla Mor	Whitish or pink	Jun–Sep	H	PB & DD 5417, 6788, 5571 (GBP)	India (HP, JK, LA, UK, AR, SK), America, China, Pakistan, Japan, Europe, Bhutan, Korea, Kazakhstan, Kyrgyzstan, Mongolia, Myanmar, Nepal, Russia, Thailand
<i>Koenigia islandica</i> L. ³	+	+	+	+	+	4200–4600	Watlg, Loa Slp	White	Jul–Sep	H	PB & DD 5426, 5655, 5467 (GBP)	India (HP, JK, LA, UK), America, China, Pakistan, Europe, Bhutan, Kazakhstan, Kyrgyzstan, Mongolia, Myanmar, Nepal, Russia, Central Asia
<i>Koenigia tortuosa</i> (D. Don) T.M. Schust. & Reveal	+	+	+			4200–4500	San, Sto Slp	White or pinkish	Jul–Aug	H	PB & DD 5656, 6731 (GBP)	India (HP, JK, LA, SK, UK), Bhutan, China, Nepal, Pakistan
<i>Oxyria digyna</i> (L.) Hill					+	4300–4600	Watcrs	Pinkish white	Jun–Oct	H	PB & DD 5654 (GBP)	India (HP, JK, LA, UK, AR, SK), Afghanistan, N. America, Bhutan, China, Japan, Korea, Pakistan, Kyrgyzstan, Mongolia, Nepal, Russia, Tajikistan
<i>Polygonum cognatum</i> Meisn.		+				4200–4300	Wet, San, Alg Rod	Pinkish or White	Jul–Sep	H	PB & DD 5660 (GBP)	India (HP, JK, LA, UK), China, Kazakhstan, Kyrgyzstan, Mongolia, Russia, Tajikistan, Pakistan, Afghanistan, Iran
<i>Polygonum glaciale</i> (Meisn.) Hook. f. var. <i>glaciale</i>	+					4200–4300	Moi, San Slp	White or pinkish	Jun–Aug	H	PB & DD 5597 (GBP)	India (HP, JK, LA, UK, AR, SK), Afghanistan, Nepal, Pakistan
<i>Polygonum paronychioides</i> C.A. Mey.		+				4200–4300	Roc Slp	Pinkish	Jun–Sep	H	SKS 115287 (BSD)	India (JK, LA), Kazakhstan, Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan, Afghanistan, Pakistan, China

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
<i>Polygonum plebeium</i> R. Br. ³	+	+	+	+	+	4200–4500	Moi Slp	Pinkish	Jul–Aug	H	PB & DD 5652 (GBP)	India (Throughout Country), Pakistan, Nepal, Bangladesh, Bhutan, Afghanistan, China, Australia, Malaysia, Indonesia, Japan, Philippines, Russia, Thailand, N. Africa, Kazakhstan
<i>Polygonum sibiricum</i> Laxm.	+	+	+	+	+	4200–4500	Semiaq, Sal	White	Jun–Aug	H	PB & DD 5657, 5604, 5657 (GBP); SKS 115459 (BSD)	India (HP, JK, LA, SK), Afghanistan, China, Kazakhstan, Mongolia, Nepal, Pakistan, Russia, Tibet
<i>Rumex nepalensis</i> Spreng.	+					4200–4300	Moi Wst Pla	Pinkish	Jun–Sep	H	PB & DD 5645 (GBP)	India (AR, AS, HP, JK, LA, SK, UK), Afghanistan, Bhutan, China, Pakistan, Indonesia, Japan, Myanmar, Nepal, Tajikistan
Potamogetonaceae												
<i>Potamogeton filiformis</i> Pers. ³	+	+	+	+	+	4200–4600	Mar Pla	Greenish	May–oct	H	PB & DD 5705, 5564, 5729 (GBP)	India, Europe, Asia, N. America
<i>Potamogeton nodosus</i> Poir. ³				+		4200–4300	Mar Pla	Greenish	Apr–Oct	H	PB & DD 5608, 6731 (GBP)	India, Indonesia, Japan, Kazakhstan, Myanmar, Nepal, Pakistan, Russia, Tajikistan, Thailand, Turkmenistan, Uzbekistan, Vietnam; Africa, SW Asia, Europe, North and South America
<i>Potamogeton pectinatus</i> L. ³		+			+	4300–4600	Mar Pla	Greenish	May–oct	H	PB & DD 5489 (GBP); SKS 115481 (BSD)	Cosmopolitan
Primulaceae												
<i>Glaux maritima</i> L.	+	+	+	+	+	4200–4600	Mar Pla	White or pink	Jun–Sep	H	PB & DD 6747 (GBP)	India (JK, LA), China, Afghanistan, Bhutan, Japan, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Russia, Tajikistan, Turkmenistan, Uzbekistan, N.W. Africa, Australia, Europe, N. & S. America
<i>Primula pamirica</i> Fed.			+			4200–4300	Mar Pla	Pale violet	Jul–Aug	H	PB & DD 5582 (GBP)	N.W. Himalaya, C. Asia
Ranunculaceae												
<i>Clematis ladakhiana</i> Grey–Wilson	+	+				4200–4300	Roc Slp	Yellow	Jul–Sep	C	PB & DD 5554, 5686, 5679 (GBP)	India (HP, JK, LA), China, Pakistan
<i>Delphinium brunonianum</i> Royle **	+	+			+	4300–5000	Sto, Roc Slp	Blue	Jul–Sep	H	PB & DD 4470, 6779 (GBP)	India (HP, JK, LA, UK), China, Pakistan, Nepal, Afghanistan
<i>Halerpestes sarmentosa</i> (Adams) Kom. var. <i>sarmentosa</i>	+	+	+	+	+	4200–4600	Mar Pla	Yellow	Jul–Sep	H	PB & DD 5682, 6374, 6375 (GBP); SKS 115461 (BSD)	India (HP, JK, LA, UK, SK), Pakistan, Nepal, Afghanistan, Russia
<i>Halerpestes tricuspis</i> (Maxim.) Hand.–Mazz.	+					4200–4500	Mar Pla	Yellow	Jun–Aug	H	PB & DD 5483 (GBP)	India (HP, JK, LA, UK, SK), Bhutan, China, Pakistan, Nepal, Russia, Magnolia
<i>Ranunculus aquatilis</i> var. <i>diffusus</i> With. ³	+	+	+	+	+	4200–4300	Aqu	Yellow	Jun–Sep	H	SKS 120301 (BSD)	India (HP, JK, LA, SK, UK), Africa, China, Eurasia, Nepal, N. America, Pakistan
<i>Ranunculus natans</i> C.A. Mey.	+	+	+	+	+	4200–4300	Mar Pla	Yellow	Jun–Jul	H	PB & DD 5599 (GBP)	India (HP, JK, LA, UK), China, Pakistan, Nepal, Afghanistan, Mongolia, Russia
<i>Ranunculus pulchellus</i> C.A. Mey.	+	+	+	+	+	4200–4500	Wet Mea, Alg Str	Yellow	Jun–Oct	H	PB & DD 5678, 5519, 5680, 5683, 5684 (GBP); SKS 115455 (BSD)	India (HP, JK, LA, UK, SK, MN), China, Bhutan, Iran, Pakistan, Nepal, Afghanistan, Russia
<i>Thalictrum alpinum</i> L.	+	+				4300–4500	Mar, Wet Pla	Purplish	Mar– Apr	H	PB & DD 5681 (GBP)	India (HP, JK, LA, UK, SK), Kazakhstan, Myanmar, Mongolia, Vietnam, Europe, N. America, China, Bhutan, Pakistan, Nepal, Afghanistan, Russia
<i>Thalictrum foetidum</i> L. **	+					4200–4500	Mar Pla	Yellow	Mar–Jul	H	PB & DD 5536 (GBP)	India (HP, JK, LA, UK, SK), Europe, China, Pakistan, Nepal, Afghanistan, Japan
Rosaceae												
<i>Chamaerhodos sabulosa</i> Bunge		+				4200–4300	San Pln, Ste, Rivbed	White or pink	Jun–Sep	H	PB & DD (GBP)	India (JK, LA), China
<i>Potentilla anserina</i> L. ³	+	+	+	+	+	4200–4500	Rivbed	Yellow	Jun–Sep	H	PB 5662, 5525, 4476 (GBP)	India (HP, JK, LA), America, Australia, China, Europe, USSR
<i>Potentilla bifurca</i> L.	+	+	+	+	+	4200–4500	San Slp	Yellow	Jul–Sep	H	PB 5532, 5666, 5481 (GBP)	India (HP, JK, LA, SK, UK), Afghanistan, Bhutan, China, Europe, Iran, Pakistan, Russia
<i>Potentilla cinerascens</i> Bertol.	+			+		4200–4500	Sto Pla, Dr Scr	Yellow	Jun–Sep	H	PB 4458 (GBP)	India (JK, LA), Russia, Iran, Afghanistan, Pakistan
<i>Potentilla fruticosa</i> var. <i>arbuscula</i> (D. Don) Maxim.	+	+				4200–4500	Roc slp	Yellow	Jun–Sep	S	PB 5561, 5664 (GBP)	India (HP, JK, LA, UK, SK), Bhutan, China, Nepal
<i>Potentilla multifida</i> L.	+	+	+	+	+	4200–4500	San Riv Ban	Yellow	Jun–Sep	H	PB 5671, 5978 (GBP); SKS 115468 (BSD)	India (HP, JK, LA, UK), Afghanistan, America, China, Europe, Iran, Japan, Mongolia, Pakistan, Russia
<i>Potentilla pamirica</i> var. <i>pamiroalca</i> (Juz.) M. Shah & Wilcock	+	+				4200–4600	Sto Slp	Yellow	Jun–Sep	H	PB 5669, 4416 (GBP)	India (JK, LA), Iran, Tajikistan, Afghanistan, N Pakistan, China, SW Mongolia
<i>Rosa webbiana</i> Wall. ex Royle **	+					4200–4300	Dr San Slp	Pink or Red	Jun–Sep	S	PB 5529 (GBP)	India (HP, JK, LA, UK), Afghanistan, China, Nepal, Pakistan, Russia, Turkey, N. America
Saxifragaceae												
<i>Saxifraga hirculus</i> L. ³			+	+		4200–4300	Moi Sto Slp	Yellow	Jun–Sep	H	PB 5728 (GBP)	India (HP, JK, LA, SK), China, Nepal, Pakistan, Kazakhstan, Mongolia, Russia, Europe, North America

Species name	Pan	Tm	Tis	Chu	Tsk	Altitude (m)	Habitat	Flower color	Flowering & fruiting	Habit	Collection details	Distribution
Salicaceae												
<i>Salix tetrasperma</i> Roxb. ³	+	+		+		4200–4600	San Slp	Pinkish -white	May–Jul	T	PB & DD 5513, 5934 (GBP)	India (HP, JK, LA), Indonesia, Malaysia, Myanmar, Pakistan, Philippines, Thailand, Vietnam
Scrophulariaceae												
<i>Scrophularia dentata</i> Royle ex Benth.	+	+	+	+	+	4200–4600	Roc Slp	Purple-red	Jul–Sep	H	PB & DD 5541, 5603, 5909 (GBP)	India (HP, JK, LA, UK), China, Pakistan, Nepal
Solanaceae												
<i>Physochlaina praealta</i> (Decne.) Miers ²	+	+	+	+	+	4200–4600	Dr Roc Slp	Yellow	Jul–Sep	H	PB & DD 5549, 5939, 6787 (GBP)	India (HP, JK, LA, UK, AR, SK), China, Pakistan
Tamaricaceae												
<i>Myricaria elegans</i> Royle var. <i>elegans</i> ^{**3}	+	+	+			4200–4600	Riv, Str Bor	White or pink	Jul–Sep	S	PB & DD 5717, 6737 (GBP)	India (HP, JK, LA, UK), Russia, China, Pakistan, Nepal
Urticaceae												
<i>Urtica hyperborea</i> Jacq. ex Wedd ^{**}	+	+			+	4200–4600	Roc, Bou Slp	Greenish-purple	Jun–Sep	H	PB & DD 5690 (GBP)	India (HP, JK, LA, UK), China, Pakistan

Table 2. List of species in each threat category in & around of HAWs. **Abbreviations:** Abb–Abbreviations, D– Density, EN– Endangered, VU–Vulnerable, LC– Least–Concern; *=Waterbodies habitat, **=Marshy habitat, other species occurred in Moist and Dry habitats.

Species Name	Abb	Density (ind/m ²) mean ± SE	Red List category	Global population trend	Reference
<i>Arnebia euchroma</i> (Royle ex Benth.) I.M. Johnst.	Aeu	0.2±0.03	EN	Unknown	Ved et al. 2003
<i>Blysmus compressus</i> (L.) Panz. ex Link	Bco	0.8±0.02	LC	Unknown	Akhani and Zehzad 2014
<i>Calamagrostis pseudophragmites</i> (Haller f.) Koeler	Cps	1.4±0.06	LC	Unknown	Akhani 2014
<i>Carex microglochin</i> Wahlenb. ^{**}	Cmi	1.4±0.41	LC	Stable	Lansdown 2014
<i>Carex orbicularis</i> Boott	Cor	3.2±0.11	LC	Unknown	Kavak 2014
<i>Catabrosa aquatica</i> (L.) P. Beauv.	Caq	1.0±0.08	LC	Unknown	Akhani 2014
<i>Ephedra Gerardiana</i> Wall. ex C.A. Mey.	Ege	0.4±0.08	LC, EN	Unknown	Roland 2020; Ved et al. 2003
<i>Hippuris vulgaris</i> L.*	Hvu	2.2±0.10	LC	Stable	Lansdown 2014
<i>Juncus bufonius</i> L.**	Jbu	0.5±0.04	LC	Unknown	Beentje and Gupta 2017
<i>Koenigia islandica</i> L.**	Kis	2.9±0.22	LC	Unknown	Maiz–Tome 2016
<i>Myricaria elegans</i> Royle var. <i>elegans</i>	Mel	0.9±0.04	LC	Unknown	Crowley 2021
<i>Physochlaina praealta</i> (Decne.) Miers	Ppr	2.9±0.41	VU	Unknown	Ved et al. 2003
<i>Polygonum plebeium</i> R. Br.	Ppl	0.6±0.2	LC	Unknown	Watve 2011
<i>Potamogeton filiformis</i> Pers.*	Pfi	2.6±0.18	LC	Unknown	Maiz–Tome 2016
<i>Potamogeton nodosus</i> Poir.*	Pno	0.5±0.02	LC	Unknown	Lansdown 2019
<i>Potamogeton pectinatus</i> L.*	Ppe	0.6±0.03	LC	Stable	Gupta and Lansdown 2013
<i>Potentilla anserina</i> L.	Pan	1.4±0.05	LC	Unknown	Maiz–Tome 2016
<i>Ranunculus aquatilis</i> L. var. <i>diffusus</i> With.*	Raq	1.9±0.07	LC	Stable	Lansdown 2014
<i>Saxifraga hirculus</i> L.	Shi	0.2±0.02	LC	Unknown	Maiz–Tome 2016
<i>Oberna behen</i> (L.) Ikonn.	Obe	0.3±0.02	LC	Stable	Rankou et al. 2015
<i>Triglochin maritima</i> L.**	Tma	1.2±0.10	LC	Unknown	Maiz–Tome 2016
<i>Triglochin palustris</i> L.**	Tpa	2.3±0.18	LC	Stable	Akhani and Zehzad 2014
<i>Utricularia aurea</i> Lour.*	Uau	0.2±0.01	LC	Unknown	Zhuang 2011

Amaryllidaceae

Allium stracheyi Baker

Figure 5c

Jamboo

Materials examined. INDIA – Ladakh · Pangong Tso; 33°54.599'N, 078°27.409'E; alt. 4,250 m; 23.VIII.2016; PB & DD 5709, 5708 (GBP).

Identification. Herb, perennial. Leaves 3–4 slender, narrowly linear, blunt-tipped, a foot long. Flowering stem slender, compressed above. Flower head at top is spherical or hemi-spherical, densely flowered, 2.5 cm in diameter.

Flowing and fruiting. July–August.



Figure 4. Vascular plants recorded in and around of the study area. **a.** *Saussurea bracteata* **b.** *Artemisia minor* **c.** *Geranium himalayense* **d.** *Pleurospermum stellatum* **e.** *Polygonum sibiricum* **f.** *Primula pamirica* **g.** *Halerpestes tricuspidis* **h.** *Suaeda olufsenii*.

Asteraceae

***Askellia flexuosa* (Ledeb.) W. A. Weber**

Figure 2g

Tangled Hawkbeard

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.599'N, 078°27.409'E; alt. 4,281 m; 23.VIII.2016; PB & DD 5424, 5765, 5507 (GBP).

Identification. Herb, perennial, glaucescent, glabrous. Inflorescence of each branch corymbiform, sometimes very densely so, with few to several capitula. Capitula with 9–13 florets; involucre narrowly cylindric, florets yellow. Achene pale yellow, fusiform, Pappus 4–6 mm.

Flowering and fruiting. June–October.

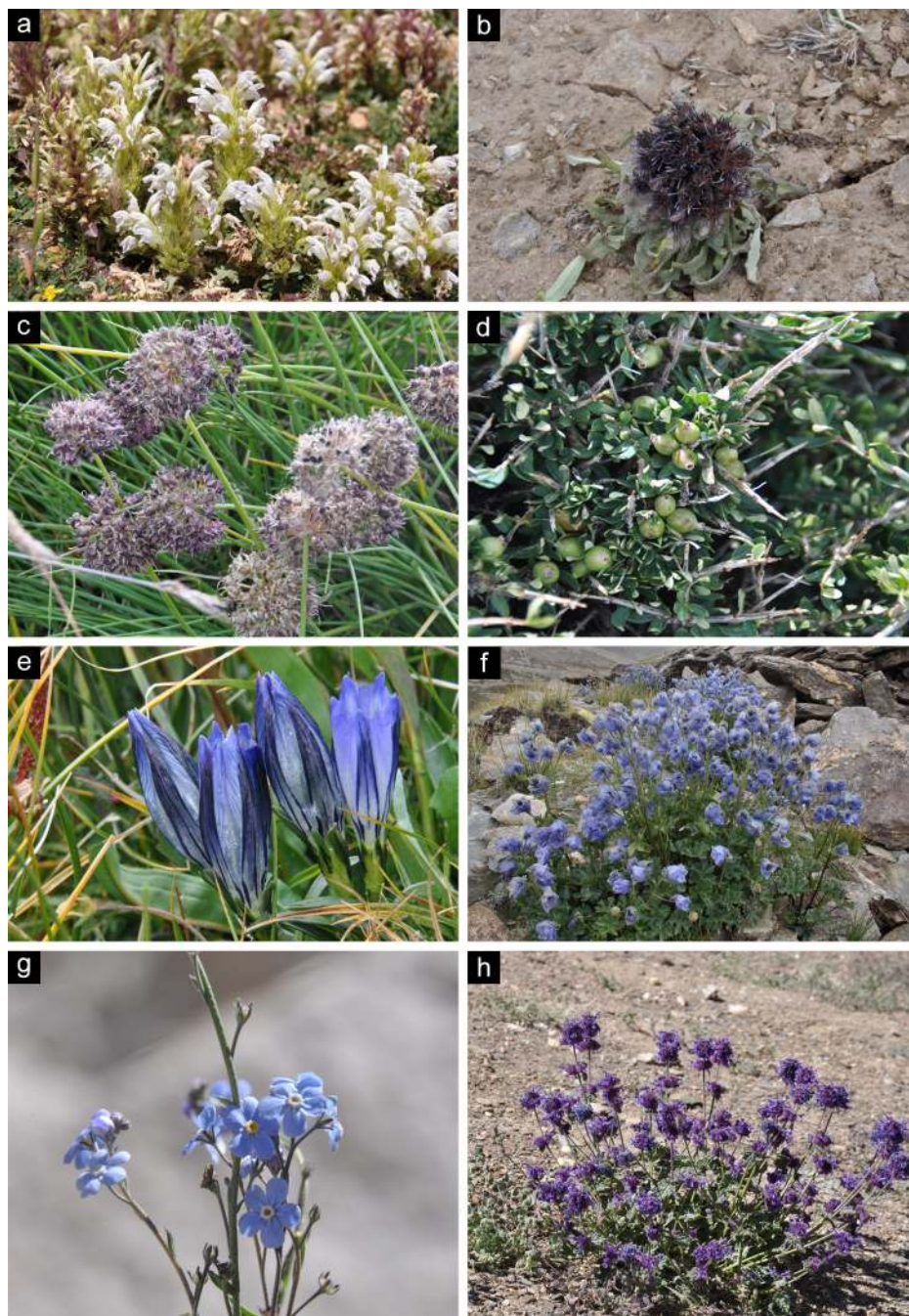


Figure 5. Vascular plants recorded in and around of the study area. **a.** *Dracocephalum heterophyllum* **b.** *Saussurea glacialis* **c.** *Allium stracheyi* **d.** *Lonicera spinosa* **e.** *Gentiana tubiflora* **f.** *Delphinium brunonianum* **g.** *Eritrichium canum* **h.** *Nepeta floccosa*.

***Cremanthodium ellisii* (Hook. f.) Kitam.**

Himalayan Mini Sunflower

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.616'N, 078°27.627'E; alt. 4260 m; 23.VIII.2016; PB & DD 5758 (GBP).

Identification. Stem solitary, at base, branched only in inflorescence, proximally glabrous, distally densely blackish-gray pilose, purplish red. Basal leaves petiolate; petiole often purplish red, winged, tubular-sheathed; stem leaves sessile, ovate or ovate-oblong to linear, margin entire or denticulate, base with or without sheaths. Capitula 1–5, usually solitary or in corymb-raceme, blackish-gray pilose. Involucre hemispheric, outside densely blackish gray pilose; phyllaries 8–14, in 2 rows, 2–9 mm, apex acute and white ciliate. Ray florets sometimes absent, or yellow or purplish red; tubular florets numerous, dark yellow. Achenes brown, cylindric, 4–5 mm. Pappus white, as long as tubular corolla.

Flowering and fruiting. July–October.



Figure 6. Vascular plants recorded in and around of the study area. **a.** *Taraxacum officinale* **b.** *Taraxacum virginicum* **c.** *Rosa webbiana* **d.** *Arnebia guttata* **e.** *Physochlaina praealta* **f.** *Capsella bursa-pastoris* **g.** *Nepeta discolor* **h.** *Oxyria digyna* **i.** *Rumex nepalensis*.

***Saussurea bracteata* Decne.**

Figure 4a

Narrow-leaved Saw-wort

Materials examined. INDIA – LADAKH • Pangong Tso; 33°54.603'N, 078°27.654'E; alt. 4,259 m; 23.VIII.2016; PB & DD 5506 (GBP).

Identification. Herbs perennial, sometimes stemless. Caudex simple or few branched. Stems usually solitary, 2–3 mm in diameter, erect, simple. Rosette and lower stem leaves shortly petiolate; capitulum solitary. Involucre narrowly campanulate to obconic. Phyllaries in ca. 4 rows, densely villous to sparsely pilose, apex acute; Receptacle bristles 1.5–2.5 mm. Corolla purplish red. Achene straw-colored, cylindrical to obovoid. Pappus dirty white.

Flowering and fruiting. July–October.



Figure 7. Vascular plants recorded in and around of the study area. **a.** *Potentilla bifurca* **b.** *Ranunculus pulchellus* **c.** *Lancea tibetica* **d.** *Microaula tibetica* **e.** *Clematis ladakhiana* **f.** *Pedicularis pectinata* **g.** *Comastoma tenellum* **h.** *Elsholtzia eriostachya*.

Boraginaceae

Arnebia euchroma (Royle ex Benth.) I.M. Johnst

Pink Arnebia

Materials examined. INDIA – LADAKH · Tso Moriri; 32°57.881'N, 078°15.828'E; alt. 4,547 m; 27.VIII.2016; PB & DD 5992, 5569 (GBP).

Identification. Herbs perennial. Roots stout, to 2 cm in diameter, containing copious purple dye. Stems usually 1 or 2, erect, spreading, white or pale-yellow hirsute. Leaves sessile, sparsely semi-appressed hirsute. Flowers heterostylous. Corolla dark purple, sometimes pale yellow and purple-red tinged. Nutlets black-brown, broadly ovate.

Flowering and fruiting. June–August.

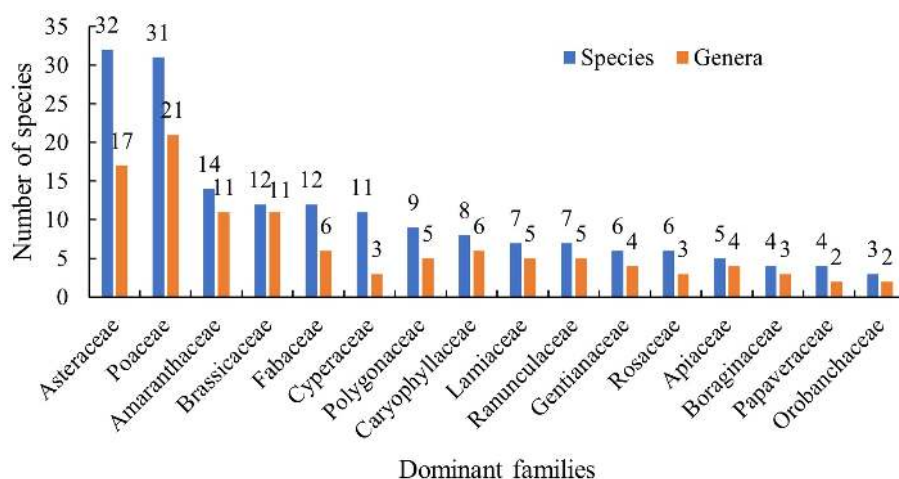
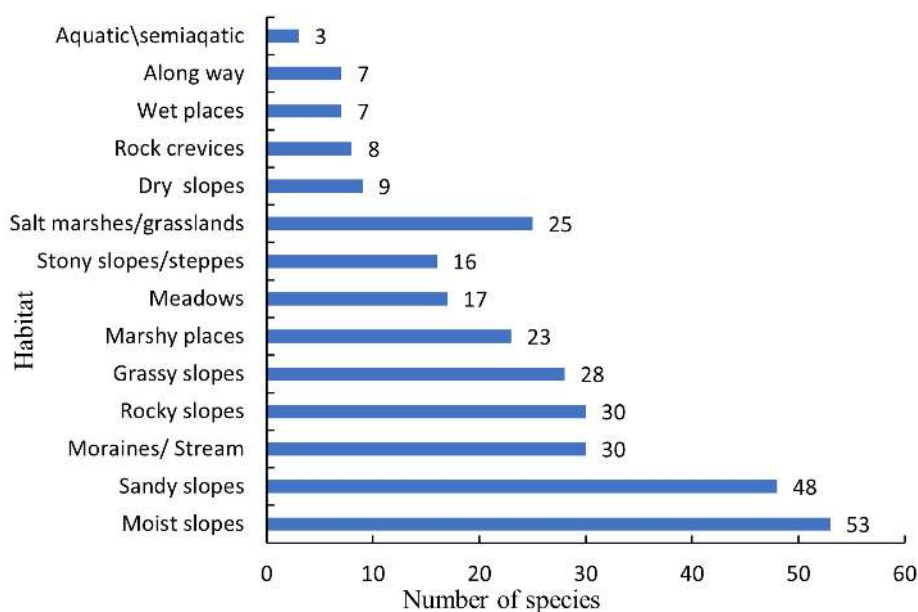


Figure 8. Dominant families with number of species in and around of selected high-altitude wetlands (HAWs).

Figure 9. Distribution of species among different habitats in and around selected high-altitude wetlands (HAWs).



Eritrichium canum (Benth.) Kitam

Figure 5g

Hoary Forget-Me-Not

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.603'N, 078°27.654'E; alt. 4,259 m; 23.VIII.2016; PB & DD 5987, 5988 (GBP).

Identification. Herb, perennial, 15–40 cm tall. Stems erect or decumbent, frequently woody at base, not branched or short-branched above, densely appressed white sericeous. Inflorescences 2 or 3, forked, many flowered; corolla light blue, campanulate-rotate; tube shorter; throat yellow or orange; appendages trapeziform or low trapeziform. Nutlets subtruncate.

Flowering and fruiting. June–July.

Microula tibetica Benth

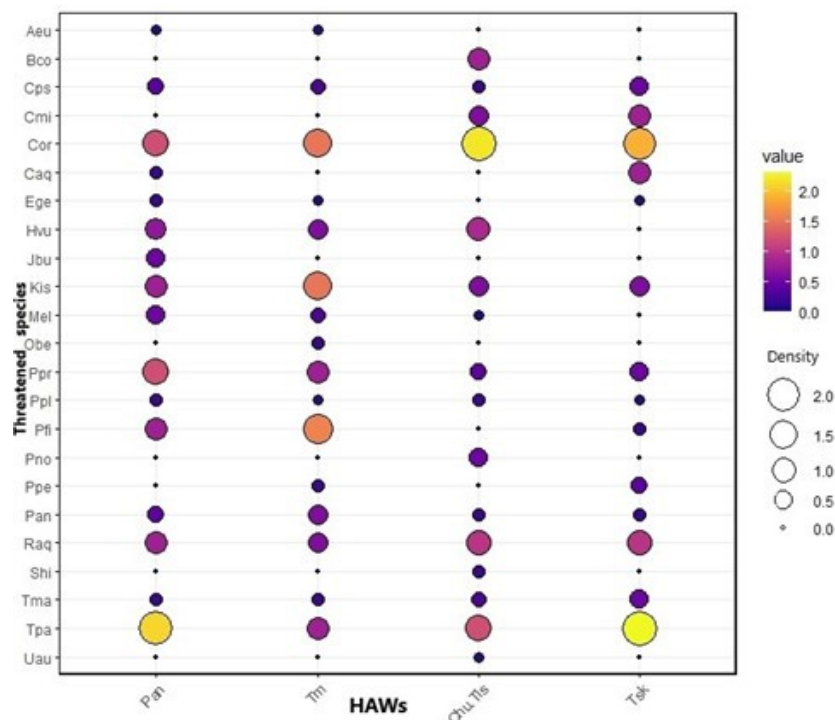
Figure 7d

Materials examined. INDIA – LADAKH · Tso Moriri; 32°57.881'N, 078°15.828'E; alt. 4,547 m; 27.VIII.2016; PB & DD 6795 (GBP); SKS 115313 (BSD).

Identification. Herb, ca. 1 cm tall, sparsely short hispid or subglabrous. Leaves prostrate, spatulate. Inflorescences terminal, very crowded, forming dense, head-like cluster; corolla blue or white, glabrous; appendages low-trapeziform. Nutlets ovate to subrhombic.

Flowering and fruiting. June–August.

Figure 10. Density (size of black circle) of threatened species in different high-altitude wetlands (HAWs).



Saxifragaceae

Parnassia laxmannii Pall. ex Schult.

Bog Star

Materials examined. INDIA – LADAKH • Tisgul Tso; 33°34.606'N, 078°37.212'E; alt. 4,397 m; 24.VIII.2016; PB 5727 (GBP).

Identification. Stems 2 or 3(–5), 7.5–25 cm, with 1 leaf near base. Basal leaves (2–)4; petiole 0.5–1.8 cm; cauline leaf sessile, semi-amplexicaul, similar to basal ones but slightly smaller, occasionally with a few caducous, rusty brown, hair-like appendages at base. Flower ca. 2 cm in diameter; hypanthium campanulate. Petals white, brown-veined, obovate, rarely spatulate. Capsule brown, punctate. Seeds brown, glossy, oblong.

Flowering and fruiting. July–September.

Oxytropis tatarica Cambess. ex Bunge

Figure 2d

Tartary Locoweed

Materials examined. INDIA – LADAKH • Tso Moriri; 32°57.400'N, 078°16.208'E; alt. 4,559 m; 27.VIII.2016; PB & DD 6795 (GBP); PB & DD 5770, 5738 (GBP).

Identification. Perennial herb. Root thick and woody. Leaves stipulate; stipule lateral, densely pilose, hairs white. Flowers in peduncled heads; calyx densely pilose, hairs black and white. Corolla blue or yellow rarely purple or keel tipped with purple. Fruit inflated, roundish, covered with white, spreading hairs.

Flowering and fruiting. June–September.

Gentianaceae

Aloitis moorcroftiana (Wall. ex G. Don) Omer, Qaiser & Ali

Moorcroft's Gentian

Materials examined. INDIA – LADAKH • Tso Kar; 33°18.569'N, 077°57.191'E; alt. 4,561 m; 29.VIII.2016; PB & DD 6000 (GBP).

Identification. Annual or biennial, diffusely branched herb. Inflorescence terminal cymes. Flowers pentamerous, solitary, peduncles long, filiform. Corolla campanulate, pentamerous, purple-streaked. Nectaries epipetalous and below filaments, each lobe with two nectaries. Ovary stipitate, capsule usually subinclud- ed, stipitate. Seeds brownish, ovoid, reticulate.

Flowering and fruiting. July–September or November.

***Comastoma tenellum* (Rottb.) Toyok.**

Figure 7g

Dane's Dwarf Gentian

Materials examined. INDIA – LADAKH · Tso Moriri; 32°56.720'N, 078°16.252'E; alt. 4,536 m; 27.VIII.2016; PB & DD 5537, 5601, 5976, 5995 (GBP), SKS 115323 (BSD).

Identification. Annual, 5–12 cm tall. Stems ascending to erect, subquadrangular, branched from base. Basal leaves few, short-petiolate; Flowers terminal, solitary, often tetramerous. Calyx lobes slightly unequal, lanceolate to ovate, Corolla pale blue to blue, tubular, Nectaries 8. Stamens inserted just below middle of corolla tube; capsules exserted from persistent corolla. Seeds (immature) ovoid; seed coat smooth.

Flowering and fruiting. June–July.

Geraniaceae

***Geranium himalayense* Klotzsch**

Figure 4c

Himalayan Geranium

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.566'N, 078°27.723'E; alt. 4,262 m; 23.VIII.2016; PB & DD 5588, 5703 (GBP).

Identification. Perennial. Rhizome stout, oblique. Stem(s) ascending, pubescent–retrorsely hairy. Leaves palmatisect, 5–7-angled. Flowers 3.0–3.5 cm broad. Sepals ovate-lanceolate. Petals purple blue. Filaments gradually narrowed upwards, base ciliate. Mericarps 4 mm long, pubescent glandular. Seeds minutely reticulate.

Flowering and fruiting. July–August.

Lamiaceae

***Dracocephalum heterophyllum* Benth.**

Figure 5a

White Dragonhead

Materials examined. INDIA – LADAKH · Tso Moriri; 32°57.881'N, 078°15.828'E; alt. 4,547 m; 27.VIII.2016; PB & DD 6726, 5643, 5516 (GBP).

Identification. Perennial, aromatic. Stems densely retrorse pubescent. Leaves oblong or ovate-oblong, margin shallowly crenate or serrate, ciliate, teeth of upper cauline blades spinescent. Verticillasters 4–8-flowered, in apical, abbreviated internodes; calyx greenish, bilabiate, corolla white, densely white, or yellowish pubescent. Nutlets narrowly obovoid.

Flowering and fruiting. June–August.

***Elsholtzia eriostachya* (Benth.) Benth.**

Figure 7h

Fuzzy Himalayan Mint

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.599'N, 078°27.409'E; alt. 4,281 m; 23.VIII.2016; PB & DD 5637, 5570, 6770 (GBP).

Identification. Herb, annual. Stems purple-red; leaf blade oblong to ovate-oblong, yellowish green; verticillasters many-flowered; calyx campanulate, densely yellowish, moniliform villous; teeth triangular, subequal, ciliate; corolla yellow, puberulent outside, margin ciliate; tube funnelform. Nutlets brown, ellipsoid.

Flowering and fruiting. July–September.

Orobanchaceae

***Euphrasia himalayica* Wettst.**

Himalayan Eye Bright

Materials examined. INDIA – LADAKH · Chushul Marshes; 33°54.533'N, 078°27.741'E; alt. 4,336 m; 24.VIII.2016; PB & DD 5558, 4493 (GBP).

Identification. Annual herb; stems erect, ascending. Leaves ovate, with acute lobules; bracts ovate, glandular-pubescent. Calyx glabrous to glandular-pubescent; corolla white, with yellow throat; capsules truncate, sparsely ciliate.

Flowering and fruiting. July–August.

***Pedicularis pectinata* Wall. ex Benth**

Figure 7f

Comb-leaf Louse-wort

Materials examined. INDIA – LADAKH · Chushul Marshes; 33°37'187"N, 078°38.988'E; alt. 4,268 m; 25.VIII.2016; PB & DD 5593, 5869, 5848 (GBP).

Identification. Perennial herb. Stems simple or branched; basal leaves long, petioled, pinnate; calyx teeth acute; corolla rose red; filaments hairy; capsules ovoid, ridged, deeply pitted, pale.

Flowering and fruiting. June–August.

Papaveraceae

***Corydalis meifolia* Wall**

Threadleaf Corydalis

Materials examined. INDIA – LADAKH · Tso Moriri; 32°56.786'N, 078°16.224'E; alt. 4,566 m; 28.VIII.2016; PB & DD 6740 (GBP).

Identification. Herb, perennial. Radical leaves long petiolate; racemes corymbose, corolla very broad in profile, somewhat spongy, yellow to orange, base of corolla often brownish to purplish brown; apical keels (excluding crests) of outer petals greenish; inner petals darker at tip, but dorsal crests usually pale. Capsule nutant, elliptical, 4–6-seeded.

Flowering and fruiting. July–September.

Ranunculaceae

***Delphinium brunonianum* Royle**

Figure 5f

Musk Larkspur

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.603'N, 078°27.654'E; alt. 4,259 m; 23.VIII.2016; PB & DD 4470, 6779 (GBP).

Identification. Stem puberulent, often mixed with yellow, glandular hairs, simple. Leaf blade 5–9 cm wide, base abruptly cuneate. Corymb 2–4-flowered, puberulent, Sepals persistent, blue-purple, abaxially sericeous; spur saccate or conic; petals 2-lobed, pilose. Staminode limb oblong, cleft, yellow barbate. Filaments glabrous. Carpels 4 or 5; ovaries sparsely puberulent.

Flowering and fruiting. June–August.

***Thalictrum foetidum* L.**

Lesser Meadow Rue

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.603'N, 078°27.654'E; alt. 4,259 m; 23.VIII.2016; PB & DD 5536 (GBP).

Identification. Plants pubescent or glabrous. Stems branched or simple. Leaf blade 3-pinnate, Inflorescence paniculate, several or many flowered. Sepals 5, yellow, tinged greenish, ovate. Filament base filiform, apex narrowly linear; anther apex mucronate. Carpels 4–8; stigma with triangular wings. Achenes sessile.

Flowering and fruiting. May–July.

Rosaceae

***Rosa webbiana* Wall. ex Royle**

Figure 6c

Webb's Rose

Materials examined. INDIA – LADAKH · Pangong Tso; 33°54.603'N, 078°27.654'E; alt. 4,259 m; 23.VIII.2016; PB 5529 (GBP).

Identification. Shrub, 1–2 m tall. Branchlets purple-brown, slender; prickles in pairs below leaves. Leaves, including petiole, 3–4 cm; stipules mostly adnate to petiole; leaflets 5–9, suborbicular, obovate, or broadly elliptic. Flowers solitary, rarely 2 or 3, fasciculate; hypanthium subglobose or ovoid; sepals 5, triangular-lanceolate; petals 5, reddish or rose; styles free, pubescent. Hip nodding, bright red, subglobose or ovoid.

Flowering and fruiting. June–September.

Tamaricaceae

Myricaria elegans* Royle var. *elegans

False Tamarisk

Materials examined. INDIA – LADAKH · Tso Moriri; 32°57.881'N, 078°15.828'E; alt. 4,547 m; 27.VIII.2016; PB & DD 5717, 6737 (GBP).

Identification. Shrub or small tree. Old branches red-brown or dark purple; branches of current year green or red-brown. Leaves usually in green branchlets of current year, sessile, narrowly elliptical. Racemes usually lateral, rarely terminal; sepals ovate-lanceolate, triangular-ovate or ovate; petals white, pink, or purple-red, obovate, obovate-elliptic, or elliptical, or narrowly obovate or obovate-lanceolate. Stamens slightly shorter than petals; anthers oblong. Ovary conic; capsule narrowly conical. Seeds oblong; awns white, villous throughout.

Flowering and fruiting. June–September.

Urticaceae

***Urtica hyperborea* Jacq. ex Wedd**

Himalayan Nettle

Materials examined. INDIA – LADAKH · Tso Kar; 33°17.974'N, 077°57.968'E; alt. 4,563 m; 29.VIII.2016; PB & DD 5690 (GBP).

Identification. Herb, perennial; caespitose, monoecious, or dioecious. Rhizomes woody, thick. Stems pale brownish and purplish, simple or branched; leaf blade green-blue when dry, ovate or cordate. Inflorescences unisexual, male ones in proximal axils, short spicate, or in clusters; male flowers long-pedicellate; perianth lobes connate, 1/2 of length, hirtellous. Female flowers: perianth lobes connate at base, membranous, unequal, with dorsal–ventral lobes much larger, suborbicular. Achene pale grey, oblong-ovoid, compressed.

Flowering and fruiting. June–September.

DISCUSSION

The flora of Ladakh was extensively surveyed by Kachroo et al. (1977), who recorded 611 species belonging to 131 genera and 37 families. Our survey found 201 species and 11 varieties in the HAWs of our study area. Around 32% of the flora of Ladakh are found in these HAWs which have ecological significance and support high biodiversity. The diverse habitats of these wetlands provide habitat for valuable vascular plants of medicinal importance, and they harbor threatened and endemic species. The families Asteraceae and Poaceae families were dominant, and as they are in other parts of Ladakh and at other alpine habitats in the western Himalayas (Aswal and Mehrotra 1999; Rau 2003; Srivastava and Shukla 2015; Chandra Sekar et al. 2021). Herbaceous forms were dominant, and a study by Klimes (2003) in eastern Ladakh recovered similar results. Due to the harsh climate in our study area, 60% of species are adapted to a diminutive or miniature habit, 20% to a bushy habit, 15% to a cushion-forming habit, and 5% species in a woolly and hairy habit. These wetlands provide habitats for 25 threatened plant species, 22 of which are native to the Himalayan region, with two species *Lancea tibetica* and *Waldheimia stoliczkae* being endemic to the region (Dhar and Samant 1993; Singh et al. 2015; Samant et al. 1998; Srivastava and Shukla 2015). As per our field observations, *Alyssum* L., *Artemisia*, *Caragana* Fabr., *Christolea* Cambess., *Crepis* L., *Draba* L., *Dracocephalum* L., *Elymus* L., *Oxytropis*, *Krascheninnikovia* Gueldenst., *Lonicera* L., *Stipa*, *Tanacetum* L. species were found in scrub and desert steppe habitat. *Androsace sarmentosa* Wall., *Arenaria bryophylla* Fernald and *Thylacospermum caespitosum* (Cambess.) Schischk. cushion-like species in alpine scree and boulder fields; species of *Glaux* L., *Halerpestes* Greene, *Polygonum* L., *Puccinellia* Parl. and *Suaeda* Forssk. ex J.F. Gmel. in salt marshes; *Carex*, *Elsholtzia* Willd., *Euphrasia* L., *Gentianella* Moench, *Juncus*, *Kobresia*, *Microula* Benth., *Pedicularis*, *Polygonum*, *Puccinellia*, *Ranunculus*, *Saussurea*, *Taraxacum* F.H. Wigg. and *Triglochin* L. species in stream banks and marsh meadows, whereas the species of *Hippuris* L., *Potamogeton*, *Ranunculus*, *Utricularia* L. species were found in aquatic and water bodies. Traditional 'Amchi' systems of medicine of the cold desert region of Ladakh have large potential to treat various ailments. The continuous over collection of valuable plants in the region has also resulted in the decrease of wild populations of many threatened medicinal and endemic plants (Kala 2000, 2005; Uniyal et al. 2006). Threatened medicinal plants of HAWs, such as *Arnebia euchroma*, *Carum carvi* L., *Ephedra gerardiana*, *Selinum wallichianum* (DC.) Raizada & H.O. Saxena, *Thalictrum foliolosum* DC., and *Thymus linearis* Benth. were observed in trade (Chauhan 1999; Uniyal et al. 2000). The problem in these HAWs is that July to September are the best season for growing, which coincides with the peak period of tourism. During the field survey we observed threats (i) these HAWs are facing growing impact of tourism, (ii) tremendous grazing pressure, (iii) habit degradation, (iv) human–wildlife conflict, (v) unplanned developmental activities, (vi) construction work around the wetlands, (vii)

some species used for fuelwood, (viii) over exploration and unsustainable utilization and climate change. There is now a need to focus on conservation and management of these important HAWs for preserving biodiversity and the livelihoods of local inhabitants. The local community's participation is very important for making conservation plans for these wetlands because they are attached through religious traditions and their economy is highly dependent on these HAWs. The local administration should allow a limited number of tourists to visit during the peak months and tourists must follow the rules and regulations for maintenance. Further, the migratory livestock grazing in this area should be allowed a rotated grazing system and above-ground shrubby species must be used for fuel sources, not herb species during the winter season by local inhabitants.

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ADDITIONAL INFORMATION

Conflict of interest statement

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: PB. Data curation: PB. Formal analysis: PB. DD: Methodology: DD. Validation: DD. Funding acquisition: KCS. Project administration: KCS. Supervision: HD.

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Data availability

All data that support the findings of this study are available in the main text.

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