FLORAL DIVERSITY ALONG SUB – ALPINE AND ALPINE ECOSYSTEM IN CHENAP VALLEY OF NANDA DEVI BIOSPHERE RESERVE, UTTARAKHAND

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By

Manoj Singh / Harish Negi

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Prepared by:
Manoj Singh JRF
Gopeshwar Range,
Forest Research Wing,
Government of Uttarakhand

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Introduction

High altitude landscape in Western Himalaya are of particular importance as they play a vital role in the ecological balance and provide several ecosystem services. Due to enchanting , picturesque landscape they attract ecologists, naturalists and pilgrims from time immemorial. The Indian Himalayan Region (IHR) has about 18440 species of plants (Singh and Hajra1996); including 1748 species of medicinal plants (Samant et al. 1998) and 575 species of wild edibles (Samant and Dhar 1997). The representative biodiversity –rich areas of the IHR have been protected through a Protected Area Network, including 5 Boisphere Reserves, 28 National Parks and 98 wildlife Sanctuaries covering an area of 51899km^2 (Mathur et al.2000; Joshi 2002). These Protected Areas (PAs) include tropical , subtropical, temperate , subalpine and alpine regions, with the respective ecosystems of these zones. The history of conservation of the NDNP began in 1939 after the declaration of the Rishi Ganga Gorge as a Wildlife Sanctuary. The conservation status of the area was increased through designation as a National Park (NP) in 1983. It forms the core zone of the Nanda Devi Biosphere Reserve (NDBR). The Nanda Devi Biosphere Reserve (NDBR) is the second biosphere reserve designated by the Government of India and represent a distinctive combination of mountain ecosystems with unique floral and faunal diversity. Recognition of its uniqueness and rich biodiversity, the reserve has been included in the World Network of Biosphere Reserves. The altitude ranges from 2000 – 7817m. Climatically, the area is dry with low annual precipitation and remains snow – covered except between mid- May to October.

Chenap valley : Located in the Chamoli district of Uttarakhand , Chenap valley is one of the hidden treasure of Uttarakhand about which a few people especially trekkers know about, situated at a height of 3700 m at the base of Sonashikhar peak. Conspicuous view of Himalaya . from Chenap valley thrills the trekkers. Snow clad peaks of Nandadevi, Nandakot, Dronagiri, Hathighoda mesmerizes the tourist. Chenap valley and meadows resembles the valley of Flowers, but still unexplored by botanists.

Chenap valley is located about 28 km from Joshimath. From NH 58 at Marwadi Alaknanda Bridge there is newly construted road to Thaing village. From Thaing village there is 8 km trek to Chenap valley. Although the trek is small but it is one of the tough trek.

No studies are available on the floristic diversities of Chenap valley. This is the first floral diversity exploration carried by research wing of Forest Department in the month of june 2021.

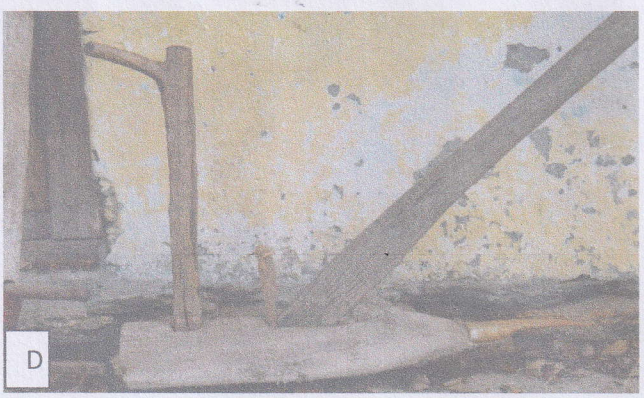


Fig . 1: A, Study area map. , B &C – View Thaing villegae , D & F– Traditional Plough and Sickle , E – Local Red coloured Potato .

Fig 3 : Different habitat types in the study area.

Material and method

Study site

The survey was carried out in Chinap valley ($30^0$35'07.10" N, $079^0$29'23.47"E at elevation 3700m) within Nanda Devi Biosphere Reserve (NDBR) It is in the Chamoli district and covers a large area of the catchments of river Alaknanda, a major tributary of the river Ganga. Four prominent season were observed at the high altitude region (>3000m), viz., short summer (May – June), Monsoon (July mid – September) and autumn (mid- September – October) and long winter (November – April). The summer is generally dried and monsoon season is characterized by incessant rains, while heavy snowfall during winter , followed by frequent hail storms during April – May is the characteristic feature of the study area. The snow cover lasted for about 3 months and melts during April – May, resulting high soil moisture that favours initiation of plant growth.

Forest type and vegetation

Sub alpine Forest: The sub alpine forest is formed by Quercus semicarpifolia, Betula utilis, Abies pindrow, with other tree species viz., *Acer caesium,Taxus wallichiana, Rhododendron arboreum, Quercus floribunda, Alnus nepalensis, Symplocos chinensis* and *Sorbus foliolosa* . The shrub layer is dominated by *R. campaulatum, Vibernum cotonifolium, Vibernum grandiflorum* and *Himalrandia tetrasperma* with *Rosa, Rubus* and *Skimmia.* The herb layer is dominated by *Trachydium roylei* and *Danthonia* spp. Few patches of Podophyllum hexandrum and Nardostachys jatamansi found in bouldary grassy slopes.

Alpine meadows and Scrubs : The ground layer vegetation consists of cushinoid herb, grasses and sedges. The herbecious flora represented by some unique species such as *Cypripedium himalaicum, Cypripedium elegance*, Impatiens spp, *Caltha palustris, Geranium wallichianum, Potentilla atrosanguinea*, few scattered patches of *Meconopsis aculeata, Picrorrhiza kurrooa, Megacarpaea polyandra, Oxygraphis polypetella, Ranunculus hirtellus, Gentiana capitata, Galearis spathulata* etc. Valley is predominated by *Rhododendron anthopogon, Rhododendron campanulatum, Rumax nepalensis* and *Polygonum polysticum.*

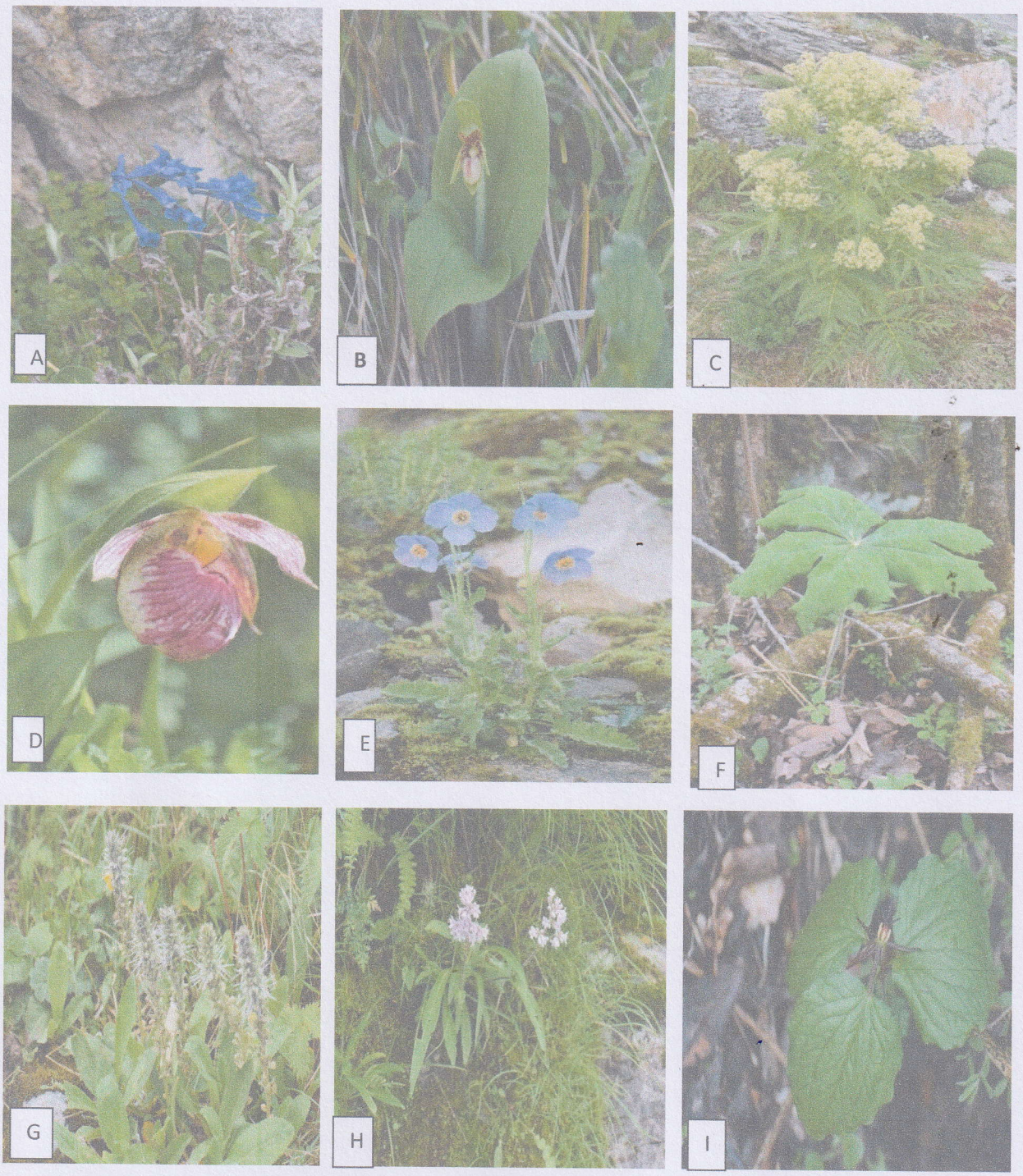


Fig 4 : Some important plant species of the study area ; a : *Corydalis cashmeriana, b: Cypripedium elegans, c: Megacarpaea polyandra, d: Cypripedium himalaicum, e: Meconopsis aculeata, f: Podophyllum hexandrum, g: Picrorhiza kurrooa, h: Nardostachys jatamansi, and i: Trillium govanianum.*

Important plants and their GPS reading.

S. No.	Plants Name	GPS reading
1	Cypripedium elegans Rchb.f.	N – 30° 35" 7.10' E – 079° 29" 23.47 Altitude – 3697m
2	*Cypripedium himalaicum* Rolfe	N – 30° 35" 7.10' E – 079° 29" 23.47 Altitude – 3696m
3	*Meconopsis aculeata*	N – 30° 35" 17.12' E – 079° 29" 22.00 Altitude – 3650m
4	*Megacarpaea polyandra* Benth.	N – 30° 35" 12.00' E – 079° 29" 20.4 Altitude – 3700m
5	*Picrorhiza kurrooa* Royle ex Benth.	N – 30° 35" 17.12' E – 079° 29" 22.00 Altitude – 3650m
6	*Nardostachys jatamansi* (D.Don) DC.	N – 30° 35" 17.12' E – 079° 29" 22.00 Altitude – 3650m
7	*Trillium govanianum* Kunth.	N – 30° 35" 27.12' E – 079° 29" 15.14 Altitude – 3647m
8	*Betula utalis* D.Don	N – 30° 35" 14.12' E – 079° 29" 28.00 Altitude – 3580m
9	*Aconitum balfourii* Stapf.	N – 30° 35" 27.12' E – 079° 29" 15.14 Altitude – 3647m
10	*Malaxis muscifera* (Lindl.) Kuntze	N – 30° 35" 17.12' E – 079° 29" 22.00 Altitude – 3650m

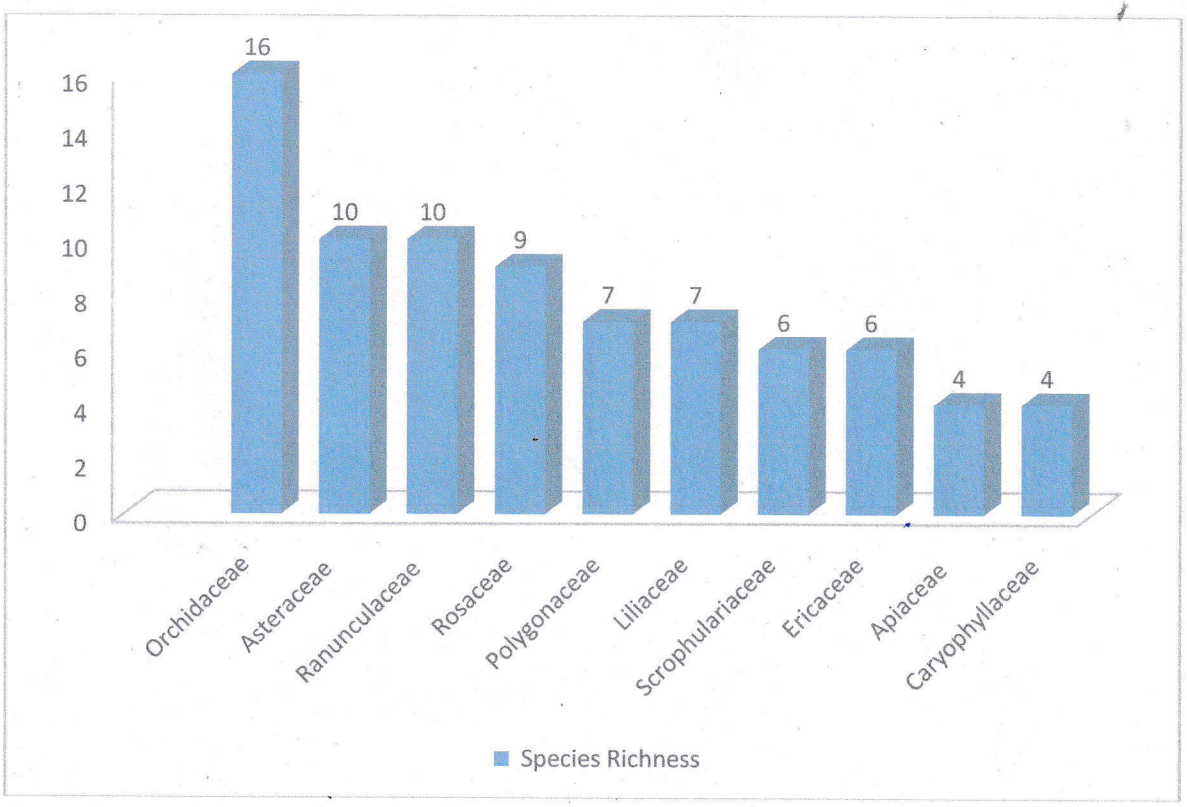
Results

Species diversity

A totoal of 140 species belonging to 110 genera and 47 families of Angiosperms (138 species, 108 genera and 45 families) and Gymnosperms (2 species, 2 genera and 2 families) have been recorded from Chenap Valley , NDBR. Of these , 117 species were herbs, 15 shrubs and 8 trees.

Ten families , Orchidaceae (16 ssp.), Asteraceae (10 ssp.), Ranunculaceae (10 ssp.), Rosaceae (9 ssp.), Polygonaceae (7 ssp.), Liliaceae (7 ssp.), Scrophulariaceae (6 ssp.), Ericaceae (6 ssp.), Apiaceae (4 ssp.) and Caryophyllaceae (4 ssp.) were species – rich. Of these Orchidaceae , Asteraceae , Rosaceae and Ranunculaceae were the dominant families.

Fig . 5 Ten dominant Families in study area.



Species distribution

Alpine meadows were dominated by various plant species depends on the disturbance regimes, such as in undisturbed area *Danthonia* sp. (fig. 2)from community with large number of herbaceous species, whereas in camping areas and grazing sites nitrophilous species were dominant , *Polygonum polystachyyum, Persicaria amplexicaulis, Bistorta vivipara and Rumex nepalensis.* While whereas dry rocky sites Xerophytic species were dominant, *Rheum australe, Ribes glaciale Megacarpaea polyandra and Rhodiola sp.* The extensive *krummholz* of *Rhododendron campanulatum* in subalpine and alpine transition zone and scrub formation by *Rhododendron anthopogon* and *R. lepidotum* in alpine meadows are unique with distribution of many herbaceous species under their canopies.

Rarity

In the present study , 19 species (Critically Endangered ;4 spp., Endangered 9 spp., Vulnerable 1 spp., Near Threatened 3 spp., and Least Concern 2 spp.) have been recorded in the IUCN 2011,2017,2020 and Red Data Book of Indian Plants (Nayar and Sastry 1987,1988, 1990).

Endemism

Endemic species have been identified based on the distribution of species in a geographical area (Dhar and Samant 1993, Samant et al.). The species restricted to Indian Himalayan Region (IHR) have been considered as endemic whereas those with extended distribution to neighbouring countries as wide endemic. More then 13 species found within Chenap valley NDBR wide endemic. These include *Acer caesium, Aconitum heterophyllum, Berberis jaeschkeana, Bergenia stracheyi, Bistorta affinis, Corydalis cashmeriana, Cypripedium elegans, Silene indica, Meconopsis aculeate, Megacarpaea polyandra, Rhododendron anthopogon, Viburnum cotinifolium and Viburnum grandiflorum.* Two species are endemic to Himalaya viz. *Allium stracheyi, Angelica glauca,* . Two species viz. *Ajuga brachystemon* and *Pedicularis pectinata* are endemic to Western Himalaya.

Conclusion

In general , very few protected areas of the IHR have been floristically explored (Samant et al. 1998b), with the exception of the three highland (Nanda Devi , Valley of flowers and Great Himalayan) Samant 1993. The presence of 140 species in small area indicates rich floral diversity in Chenap valley. Our primary study shows that Valley consists of 19 threatened taxa and 17 species endemic to Himalaya. Study also indicate that valley is dominated by Orchidaceae , Astraceae, Ranunculaceae and Rosaceae families. During study it observed that species like *Polygonum polystachyyum, Persicaria amplexicaulis, Bistorta vivipara* and *Rumex nepalensis* are growing vigorously in core region of valley, this may led in to the restricted distribution or elimination of many sensitive taxa *(viz.,* Orchid , *Meconopsis aculeata , Picrorhiza kruooa* etc. Frequent surveys of valley is needed in different flowering time so as to assess biodiversity of valley more exactly .

Appendix I : The checklist of plants along subalpine, and alpine zones in Nanda Devi Biosphere Reserve (NDBR)

Family/ Species	Habit	Status
Ranunculaceae		
Aconitum balfourii Stapf	H	Vulnerable
Aconitum heterophyllum Wall. ex Royle	H	Endangered
Anemone polyanthes D.Don	H	-
Anemone obtusiloba D.Don	H	-
Anemone rivularis Buch.-Ham.	H	-
Caltha palustris L.	H	-
Oxygraphis polypetala (Royle) Hook. f. & Thomson	H	-
Ranunculus diffusus DC.	H	-
Ranunculus hirtellus Royle	H	-
Thalictrum alpinum L.	H	-
Berberidaceae		-
Berberis aristata DC.	S	-
Berberis jaeschkeana C.K.Schneid.	S	-
Podophyllaceae		-
Podophyllum hexandrum Royle	H	Endangered
Papaveraceae		-
Meconopsis aculeata Royle	H	Critically Endangered
Fumariaceae		-
Corydalis cashmeriana Royle	H	Endangered
Corydalis govaniana Wall	H	-
Brassicaceae		-
Arcyosperma primulifolium (Thomson) O.E. Schulz	H	-
Capsella bursa-pastoris (L.) Medik	H	-
Megacarpaea polyandra Benth. ex Madden	H	-
Violaceae		-
Viola biflora L.	H	-
Caryophyllaceae		-
Cerastium cerastoides (L.) Britton	H	-
Gypsophila cerastioides D. Don	H	-
Silene indica (Roxb.) Roxb. ex Otth	H	-
Silene vulgaris (Moench) Garcke	H	-
Rutaceae		-
Skimmia anquitilia N.P. Tayler & Airy Shaw	S	-
Aceraceae		
Acer caesium Wall. & Brandis		
Fabaceae		-
Trifolium repens L.	H	-
Rosaceae		-
Cotoneaster microphyllus Wall. ex Lindl.	S	-
Fragaria nubicola (Hook. f.) Lindl. ex Lacaita	H	-
Geum elatum Wall ex G.Don	H	-
Potentilla argyrophylla Wall. ex Lehm	H	-
Potentilla atrosanguinea Lodd. ex Lehm.	H	-
Potentilla lineata Trevir.	H	-

Potentilla microphylla D.Don	H	-
Rosa macrophylla Lindl.	S	-
Sorbus foliolosa (Wall.) Spach	T	-
Saxifragaceae		-
Bergenia stracheyi (Hook.f. & Thomson) Engl.	H	Near Threatend
Saxifraga brachypoda D.Don var. fimbriata (Wall.) Engl. & Irmsch	H	-
Saxifraga parnassifolia D.Don	H	-
Parnassiaceae		-
Parnassia nubicola Wall. ex Royle	H	-
Grossulariaceae		
Ribes glaciale Wall.	S	
Crassulaceae		-
Rhodiola sinuata (Royle ex Edgew.) S.H. Fu	H	-
Rhodiola trifida (Hook. f. & Thomson) Jacobsen	H	-
Apiaceae		-
Angelica archangelica L.	H	-
Angelica glauca Edgew.	H	Endangered
Bupleurum hamiltonii N.P.Balakr.	H	-
Trachydium roylei Lindl.	H	-
Caprifoliaceae		-
Lonicera myrtillus Hook f. & Thomson	S	-
Viburnum cotinifolium D.Don	S	-
Viburnum grandiflorum Wall. ex DC.	S	-
Rubiaceae		-
Galium acutum Edgew.	H	-
Rubia cordifolia L.	H	-
Valerianaceae		-
Nardostachys jatamansi (D. Don) DC.	H	Critically Endangered
Valeriana hardwickii Wall.	H	-
Morinaceae		-
Morina longifolia Wall. ex DC.	H	-
Asteraceae		-
Ainsliaea latifolia (D.Don) Sch.Bip.	H	-
Cremanthodium arnicoides (DC. ex Royle) R.D. Good	H	Endangered
Erigeron alpinus L.	H	-
Jurinea macrocephala DC.	H	Critically Endangered
Ligularia amplexicaulis DC.	H	-
Ligularia sibirica(L.) Cass.	H	-
Saussurea taraxacifolia Wall.ex DC.	H	-
Senecio graciliflorus (Wall.) DC.	H	-
Tanacetum dolichophyllum (kitam.) Kitam	H	-
Taraxacum officinale Webb	H	-
Ericaceae		-
Cassiope fastigiata (Wall.) D.Don	S	-
Gaultheria trichophylla Royle	H	-

Rhododendron anthopogon D.Don	S	Near Threatened
Rhododendron arboreum Sm.	T	-
Rhododendron campanulatum D.Don	S	-
Rhododendron lepidotum Wall.ex G.Don	S	Near Threatened
Primulaceae		-
Primula involucrate Wall.ex Duby Sm.	H	-
Primula stuartii Wall.	H	-
Symplocaceae		
Symplocos chinensis (Lour.) Druce	T	
Asclepiadaceae		
Ceropegia wallichii Wight	S	
Gentianaceae		-
Gentiana carinata Griseb.	H	-
Halenia elliptica D.Don	H	-
Lomatogonium carinthiacum (Wulfen) Rchb.	H	-
Swertia ciliata (D. Don ex G. Don) B.L.Burtt	H	-
Swertia speciosa D.Don	H	-
Boraginaceae		-
Cynoglossum glochidiatum Wall.ex Benth	H	-
Cynoglossum zeylanicum (Lehm.) Brand	H	-
Hackelia uncinata (Benth.) C.E.C.Fisch.	H	-
Scrophulariaceae		-
Euphrasia himalayica Wettst.	H	-
Hemiphragma heterophyllum Wall.	H	-
Pedicularis gracilis Wall. ex Benth.	H	-
Pedicularis hoffmeisteri Klotzsch	H	-
Pedicularis pectinata Wall. ex Benth.	H	-
Picrorhiza kurrooa Royle ex Benth.	H	Critically Endangered
Lamiaceae		-
Ajuga brachystemon Maxim.	H	-
Nepeta govaniana (Wall. ex Benth.) Benth.	H	-
Phlomis bracteosa Royle ex Benth.	H	-
Salvia hians Royle ex Benth.	H	-
Polygonaceae		-
Bistorta affinis (D.Don) Greene	H	-
Oxyria digyna (L.) Hill	H	-
Persicaria amplexicaulis (D.Don) Ronse Decr.	H	-
Persicaria vivipara (L.) Ronse Decr.	H	-
Rheum australe D. Don	H	-
Rubrivena polystachya(Wall. ex Mesin) M. Karl	H	-
Rumex nepalensis Spreng.	H	-
Buxaceae		-
Sarcococca saligna (D. Don) Maell.- Arg.	S	-
Betulaceae		-
Betula utilis D. Don	T	Least Concern
Fagaceae		-

Quercus floribunda Lindl.ex A.Camus	T	-
Quercus semecarpifolia Sm.	T	-
Salicaceae		-
Salix lindleyana Wall. ex Andersson	S	-
Pinaceae		-
Abies pindrow (Royle ex D. Don)Royle	T	Least Concern
Taxaceae		-
Taxus wallichiana Zucc.	T	Endangered
Orchidaceae		-
Cypripedium elegans Reichb.f.	H	Endangered
Cypripedium himalaicum Rolfe	H	Endangered
Epipactis helleborine (L.) Crantz	H	-
Habenaria intermedia D.Don	H	-
Habenaria latilabris (Lindl.)Hook	H	-
Galearis spathulata (Lindl.)P.F. Hunt	H	-
Goodyera fusca (Lindl.) Hook.f.	H	-
Goodyera repens (L.) R. Br.	H	-
Gymnadenia orchidis Lindl.	H	-
Liparis glossula Rchb.f.	H	-
Liparis rostrata Rchb.f.	H	-
Malaxis muscifera (Lindl.) Kutze.	H	-
Peristylus duthiei (Hook.f.) Deva & H.B.Naithani	H	-
Peristylus elisabethae (Duthie) R.K.Gupta	H	-
Ponerorchis chusua (D.Don) Soó	H	-
Satyrium nepalense D.Don	H	-
Zingiberaceae		-
Roscoea alpina Royle	H	-
Iridaceae		-
Iris kemaonensis Wall. ex G. Don	H	-
Amaryllidaceae		-
Allium stracheyi Baker	H	-
Allium wallichii Kunth	H	-
Nartheciaceae		-
Aletris pauciflora (Klotzsch) Hand.-Mazz	H	-
Haemodoraceae		-
Ophiopogon intermedius D.Don.	H	-
Liliaceae		-
Clintonia udensis Trautv. & Mey.	H	-
Gagea serotina (L.) Ker Gawl.	H	-
Lloydia longiscapa Hook.	H	-
Lilium oxypetallum (D.Don) Baker	H	-
Polygonatum geminiflorum Decne	H	-
Smilacina purpurea Wall.	H	-
Trillium govanianum Wall. ex D.Don	H	Endangered
Juncaceae		-
Juncus himalensis Klotzsch	H	-

Areceae		-
Arisaema jacquemontii Blume	H	-
Typhonium sagittariifolium Gagnep.	H	-
Poaceae		-
Danthonia cachemyriana Jaub. & Spach	H	-
Poa annua L.	H	-

* Symbol – H; Herb, S; Shrub, T; Tree

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