



BOTANICAL EXPEDITION IN INDIAN WESTERN HIMALAYA: A CASE STUDY FROM THE VALLEY OF FLOWERS NATIONAL PARK

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ABSTRACT

Continued floristic surveys and plant inventories are essential for understanding plant diversity, ecosystem dynamics, and promoting both conservation efforts and sustainable development for the well-being of human societies. The current botanical expedition to the Valley of Flowers National Park (VoFNP) has documented a total of 317 (4 gymnosperms and 313 angiosperms) higher plant species. This diverse collection includes *Alliaria petiolata* (CAL 87711), *Anemone polyanthes* (85281), *Deutzia staminea* (87753), *Eleutherococcus cissifolius* (94196), *Epilobium angustifolium* (85249), *Liparis rostrata* (94177), *Eremogone kumaonensis* (85227), *Euphorbia maddenii* (87713), *Gentiana crassuloides* (85223), *Gentiana elwesii* (73323), *Gentiana infelix* (85241), *Pedicularis heteroglossa* (85233), *Phryma leptostachya* (85205), *Polygonatum graminifolium* (94180), *Rhododendron arboreum* var. *roseum* (87723), *Silene baccifera* (85209), *Trifolium repens* (87703), *Trifolium resupinatum* (87737), *Veronica ciliata* (85297), representing 16 genera and 15 families as lesser-known plant species in the region (i.e. Bhyundar Valley), with new distributional records enhancing our understanding of the local flora. The present expedition further substantiates the presence of several IUCN-threatened categories, namely 'Critically Endangered (CR)' species such as *Dolomiaea costus* and *Nardostachys jatamansi*; 'Endangered (EN)' species like *Aconitum heterophyllum*, *Cypripedium elegans*, and *Cypripedium himalaicum*, along with 'Vulnerable (VU)' species including *Aconitum violaceum*, *Cypripedium cordigerum*, and *Malaxis muscifera* in the study area.

Keywords: Botanical Survey, Indian Himalayan Region, Uttarakhand, Alpine Flora, Central National Herbarium (CAL).

INTRODUCTION

Perceived as conventional, floristic studies play a vital role in contemporary botany by offering crucial insights into a territory's flora, facilitating effective biodiversity conservation, molecular research on pivotal genera, and guiding management strategies to alleviate anthropic pressure (Wagensommer, 2023). The regular updating of regional floristic inventories, incorporating new

discoveries and distribution records, is imperative for assessing the conservation status of plant species, requiring thorough collection, identification, and documentation within smaller ecoregions to evaluate the overall biodiversity wealth of districts, states, and countries (Rawat *et al.*, 2016). To enhance biodiversity conservation at the regional scale, creating a dynamically updated species list and integrating data from diverse sources to construct a comprehensive plant

distribution database is crucial (Xiao *et al.*, 2023). Botanical baseline records play a critical role in evaluating threats, prioritizing species conservation efforts, and implementing sustainable resource management strategies (Bargali *et al.*, 2022). Also, the lack of scientific data urgently calls for further research utilizing appropriate taxa, reliable techniques, and on-the-spot field studies throughout the entire Himalayan range to comprehend the impact of climate change, its cascading effects, and explore possible mitigation strategies (Rawat, 2010). Aligned with this perspective, the present botanical expedition has been undertaken in the renowned Valley of Flowers National Park (VoFNP) located in the Western Himalayas of India.

The main aim of this study is to catalog higher plant species by gathering and identifying reference specimens to serve as a foundation for future research. While previous studies by other researchers have explored similar aspects in the region (Smythe, 1938; Ghildiyal, 1957; Wadhwa *et al.*, 1987; Hajra & Balodi, 1995; Murthy, 2011; Rana & Rawat, 2012; Bisht *et al.*, 2018; Das *et al.*, 2019), our current findings serve as a valuable cross-check for previously reported species and contribute new additions to the earlier checklist, particularly highlighting new and lesser-known plant species.

MATERIALS AND METHODS

Study area

The Valley of Flowers National Park (VoFNP), a botanical paradise, UNESCO World Heritage Site, is located in the district Chamoli of Uttarakhand state, Northern India (UNESCO, 2023). The Valley of Flowers constitutes an integral core zone within the Nanda Devi Biosphere Reserve (Kuniyal, 1998). The VoFNP spans a total area of 87.5 square kilometers, situated between latitude 30°41'–30°48' N and longitude 79°33'–79°46' E, with an altitude ranging from 3200 to 6700 meters above sea level. The VoFNP possesses lush meadows, cascading waterfalls, and snow-clad peaks, forming a mesmerizing landscape. Winter blankets the region in snow, while summer transforms it into a riot of colors with a diverse array of wildflowers (Fonia, 2009). The Valley of Flowers is also home to diverse fauna and flora including several threatened taxa.

Research Design

The VoFNP remains inaccessible to visitors and botanists during the winter season due to heavy snowfall and frozen glaciers. Therefore, field surveys were conducted between April and September of the years 2017 and 2018. Plant specimens were collected in triplicate, each tagged with a unique field/voucher number using a herbarium field book (CAL). Notable field characteristics and local information were recorded, and the specimens were pressed, dried, poisoned, and processed for herbarium mounting following the method outlined by Jain & Rao (1977). The collected samples were identified with the help of relevant literature, and matching with authentic herbarium specimens at various national herbaria (GUH, BSD, DD, CAL), and international digital herbaria (BM, K, P, etc.). Finally, the processed specimens were deposited at the Central National Herbarium (CAL), Howrah, for future reference. For the updated accepted name and family of each species, the current online databases like 'Plants of the World Online' (<http://www.plantsoftheworldonline.org/>) and 'World Flora Online' (<http://www.worldfloraonline.org/>) were consulted and followed.

RESULTS AND DISCUSSION

The present study documented a total of 317 species of higher plants in the study area, consisting of 313 Angiosperms and 4 Gymnosperms. The species are categorized by groups, and the families are organized alphabetically within each group. The detailed list is provided below:

Group I - Gymnosperms

Cupressaceae: *Juniperus indica* Bertol. [CAL 87788] (Fig. 1.A), **Pinaceae:** *Abies pindrow* Royle [87722], *Pinus wallichiana* A.B.Jacks. [85228], **Taxaceae:** *Taxus wallichiana* Zucc. [87719].

Group II(A) - Dicotyledons

Acanthaceae: *Strobilanthes atropurpureus* Nees [87896], **Aceraceae:** *Acer acuminatum* Wall. ex D.Don [87718]; *A. sterculiaceum* Wall. [87724], **Apiaceae:** *Bupleurum longicaule* Wall. ex DC. [87795]; *B. rupestre* Edgew. [87796]; *Chaerophyllum villosum* Wall. ex DC. [87768]; *Cortia depressa* (D.Don) C.Norman [73317]; *Pleurospermum angelicoides* (Wall. ex DC.) Benth. ex C.B. Clarke [87802]; *P.*



brunonis Benth. ex C.B.Clarke [85278]; *Selinum vaginatum* C.B. Clarke [87899]; *S. wallichianum* (DC.) Raizada & H.O. Saxena [85277]; *Tordyliopsis brunonis* DC. [73301]; *T. japonica* (Houtt.) DC. [85207], **Aquifoliaceae:** *Ilex dipyrrena* Wall. [87759], **Araliaceae:** *Eleutherococcus cissifolius* (Griff. ex C.B.Clarke) Nakai [94196] (Fig. 1.B); *Hedera nepalensis* K.Koch [87763], **Asclepiadaceae:** *Cynanchum auriculatum* Royle ex Wight [85203], **Asteraceae:** *Ainsliaea aptera* DC. [87729]; *Anaphalis nepalensis* (Spreng.) Hand.-Mazz. [87817]; *A. royleana* DC. [87865]; *Aster albescens* (DC.) Wall. ex Hand.-Mazz. [87847]; *A. diplostehioides* (DC.) C.B.Clarke [87792]; *Carpesium nepalense* Less. [87844]; *Cirsium wallichii* DC. [73447]; *Cremanthodium arnicoides* (DC. ex Royle) R.D.Good [87845]; *Dolomiaea costus* (Falc.) Kasana & A.K.Pandey [87857] (Fig. 1.C); *D. macrocephala* DC. ex Royle [73304]; *Dubyaea hispida* (D.Don) DC. [85246]; *Erigeron multiradiatus* (Lindl. ex DC.) Benth. & Hook.f. [87827]; *Helichrysum luteoalbum* (L.) Rchb. [87739]; *Himalaiella auriculata* (DC.) Raab-Straube [87814]; *Inula orientalis* Lam. [87850]; *Lactuca lessertiana* (Wall. ex DC.) Wall. ex C.B.Clarke [85283]; *Leontopodium himalayanum* DC. [85236]; *Ligularia amplexicaulis* DC. [87846] (Fig. 1.D); *Melanoseris brunoniana* (Wall. ex DC.) N.Kilian & Ze H.Wang [87777]; *M. cyanea* Edgew. [73398]; *M. violifolia* (Decne.) N.Kilian [87778]; *Myriactis nepalensis* Less. [87851]; *Parasenecio quinquelobus* (Wall. ex DC.) Y.L.Chen [87884]; *Saussurea fastuosa* (Decne.) Sch.Bip. [87780]; *S. ovata* Benth. [87894] (Fig. 1.E); *S. piptathera* Edgew. [87826]; *S. taraxacifolia* (Lindl.) Wall. ex DC. [73364]; *Senecio analogus* DC. [87783]; *S. graciliflorus* (Wall.) DC. [87823]; *Solidago virga-aurea* L. [87800]; *Synotis alata* (Wall. ex DC.) C.Jeffrey & Y.L.Chen [87883]; *S. kunthiana* (Wall. ex DC.) C.Jeffrey & Y.L.Chen [87897]; *Taraxacum officinale* Webb [87736], **Balanophoraceae:** *Balanophora papuana* Schltr. [73414], **Balsaminaceae:** *Impatiens sulcata* Wall. [85248], **Berberidaceae:** *Berberis jaeschkeana* C.K.Schneid. [85258]; *B. umbellata* Wall. ex G. Don [87761]; *Sinopodophyllum hexandrum* (Royle) T.S. Ying [87708], **Betulaceae:** *Betula utilis* D.Don [73361], **Boraginaceae:** *Arnebia benthamii* (Wall. ex

G.Don) I.M.Johnst [94195]; *Cynoglossum lanceolatum* Forssk. [87867]; *Hackelia uncinata* (Benth.) C.E.C. Fisch. [87869]; *Myosotis sylvatica* Hoffm. [85298], **Brassicaceae:** *Alliaria petiolata* (M.Bieb.) Cavara & Grande [87711]; *Arabis pterosperma* Edgew. [85210]; *Arcyosperma primulifolium* (Thomson) O.E.Schulz [87856]; *Capsella bursa-pastoris* (L.) Medik. [87712]; *Cardamine impatiens* L. [87701]; *Crucihimalaya himalaica* (Edgew.) Al-Shehbaz, O'Kane & R.A.Price [85299]; *Draba lasiophylla* Royle [94178]; *Erysimum odoratum* Ehrh. [85204]; *Megacarpaea polyandra* Benth. ex Madden [85264] (Fig. 1.F), **Campanulaceae:** *Campanula aristata* Wall. [85267]; *C. latifolia* L. [87822]; *C. pallida* Wall. [87862]; *Codonopsis rotundifolia* Karst. & Schenck [87819]; *Cyananthus integer* Wall. ex Benth. [85300]; *C. lobatus* Wall. ex Benth. [87803]; *C. microphyllus* Edgew. [87835], **Caprifoliaceae:** *Lonicera myrtillus* Hook.f. & Thomson [87828]; *L. obovata* Royle ex Hook.f. & Thomson [87785]; *Viburnum cotinifolium* D.Don [87760], **Caryophyllaceae:** *Eremogone kumaonensis* (Maxim.) Pusalkar & D.K.Singh [85227] (Fig. 1.G); *Gypsophila cerastioides* D.Don [87892]; *Silene baccifera* (L.) Roth [85209]; *S. edgeworthii* Bocquet [87831]; *S. himalayensis* (Rohrb.) Majumdar [85220]; *S. indica* (Roxb.) Roxb. ex Otth [87877]; *S. vulgaris* (Moench) Garcke [87830]; *Stellaria decumbens* Edgew. [87890]; *S. monosperma* Buch.-Ham. ex D.Don [87870]; *S. patens* D.Don [85295], **Corylaceae:** *Corylus jacquemontii* Decne. [87752], **Crassulaceae:** *Rhodiola heterodonta* (Hook. f. & Thomson) Boriss. [87812]; *R. sinuata* (Royle ex Edgew.) S.H.Fu [87878]; *R. wallichiana* (Hook.) S.H. Fu [87821]; *Rosularia rosulata* (Edgew.) H. Ohba [87732], **Cuscutaceae:** *Cuscuta europaea* L. [87787], **Elaeagnaceae:** *Elaeagnus parvifolia* Wall. ex Royle [87765]; *Hippophae salicifolia* D.Don [87766], **Ericaceae:** *Cassiope fastigiata* (Wall.) D.Don [73316] (Fig. 1.H); *Gaultheria trichophylla* Royle [87838]; *Rhododendron arboreum* Sm. [87726]; *R. arboreum* Sm. var. *roseum* Lindl. [87723]; *R. anthopogon* D.Don [87806]; *R. campanulatum* D.Don [87790]; *R. lepidotum* Wall. ex G.Don [87720] (Fig. 1.I), **Euphorbiaceae:** *Euphorbia maddenii* Boiss. [87713]; *Euphorbia pilosa* L. [73426]; *E. sharmae* U.C.Bhattach. [85292]; **Fabaceae:**

Astragalus chlorostachys Lindl. [87882]; *A. himalayensis* Bunge [87858]; *Parochetus communis* Buch.-Ham. ex D.Don [73424]; *Piptanthus nepalensis* (Hook.) D.Don [87717]; *Thermopsis barbata* Benth. [87786] (Fig. 1.J); *Trifolium repens* L. [87703]; *T. resupinatum* L. [87737]; *Trigonella emodi* Benth. [87841], **Gentianaceae**: *Gentiana argentea* (Royle ex D.Don) Royle ex D.Don [87742]; *G. capitata* Buch.-Ham. ex D.Don [87741]; *G. crassuloides* Bureau & Franch. [85223]; *G. elwesii* C.B.Clarke [73323] (Fig. 1.K); *G. infelix* C.B.Clarke [85241]; *G. pedicellata* (D.Don) Wall. [85263]; *G. tubiflora* (G.Don) Griseb. [85239]; *G. venusta* (G.Don) Wall. ex Griseb. [85240]; *Halenia elliptica* D.Don [87829]; *Lomatogonium carinthiacum* (Wulfen) A.Braun [85296]; *Swertia cuneata* D.Don [73303]; *S. purpurascens* (D.Don) C.B. Clarke [87798], **Geraniaceae**: *Geranium collinum* Stephan ex Willd. [73376]; *G. lambertii* Sweet [85245]; *G. nepalense* Sweet [73423]; *G. pratense* L. [85244]; *G. robertianum* L. [85206]; *G. wallichianum* D.Don ex Sweet [87789], **Grossulariaceae**: *Ribes glaciale* Wall. [87716], **Hippocastanaceae**: *Aesculus indica* (Wall. ex Cambess.) Hook. [87764], **Hydrangeaceae**: *Deutzia staminea* R.Br. ex Wall. [87753], **Hypericaceae**: *Hypericum lysimachioides* Boiss. & Noë [85202], **Lamiaceae**: *Ajuga brachystemon* Maxim. [87704]; *Clinopodium umbrosum* (M. Bieb.) Kuntze [73337]; *C. vulgare* L. [87791]; *Elsholtzia eriostachya* (Benth.) Benth. [87898]; *Lamium album* L. [87757]; *Leonurus cardiaca* L. [85208]; *Nepeta laevigata* (D.Don) Hand.-Mazz. [87840]; *Origanum vulgare* L. [73336]; *Phlomis bracteosa* (Royle ex Benth.) Kamelin & Makhm. [87815]; *Prunella vulgaris* L. [87888]; *Salvia nubicola* Wall. ex Sweet [87824] (Fig. 1.L); *Stachys melissaefolia* Benth. [73338]; *Thymus linearis* Benth. [87839], **Malvaceae**: *Malva verticillata* L. [73435], **Morinaceae**: *Morina longifolia* Wall. ex DC. [87859] (Fig. 2.A), **Oleaceae**: *Syringa emodi* Wall. ex Royle [73463], **Onagraceae**: *Circaea alpina* L. [87774]; *Epilobium angustifolium* L. [85249] (Fig. 2.B); *E. latifolium* L. [73307]; *E. laxum* Royle [87849]; *E. leiophyllum* Hausskn. [85282]; *E. royleanum* Hausskn. [85229], **Orobanchaceae**: *Orobancha alba* Stephan ex Willd. [85265] (Fig. 2.C), **Papaveraceae**: *Corydalis cashmeriana* Royle [85235]; *C. cornuta* Royle [87848]; *C. govaniana* Wall. [73313]; *C. meifolia* Wall. [73310]; *Meconopsis aculeata* Royle [87770] (Fig. 2.D), **Parnassiaceae**: *Parnassia nubicola* Wall. ex Royle [73439], **Phrymaceae**: *Phryma leptostachya* L. [85205], **Plantaginaceae**: *Veronica ciliata* Fisch. [85297] (Fig. 2.E); *V. himalensis* D.Don [85259]; *V. serpyllifolia* subsp. *humifusa* (Dicks.) Syme [87734], **Polemoniaceae**: *Polemonium caeruleum* L. [73343], **Polygonaceae**: *Aconogonon rumicifolium* (Royle ex Bab.) H.Hara [73384]; *Bistorta emodi* (Meisn.) H.Hara [87748]; *B. vacciniifolia* (Wall. ex Meisn.) Greene [87772]; *B. vivipara* (L.) Gray [73339]; *Koenigia polystachya* (Wall. ex Meisn.) T.M.Schust. & Reveal [87784]; *Oxyria digyna* (L.) Hill [87866]; *Persicaria nepalensis* (Meisn.) Miyabe [73340]; *Polygonum delicatulum* Meisn. [73318]; *P. filicaule* Wall. ex Meisn. [73320]; *Rheum australe* D.Don [73383]; *R. moorcroftianum* Royle [73415] (Fig. 2.F); *R. spiciforme* Royle [73302]; *Rumex acetosa* L. [87807]; *R. nepalensis* Spreng. [87714], **Primulaceae**: *Androsace globifera* Duby [85225]; *A. poissonii* R.Knuth [85242]; *A. primuloides* D.Don [87842]; *Primula denticulata* Sm. [87715]; *P. involucrata* Link & Otto ex Sweet [94187]; *P. macrophylla* D.Don [85232]; *P. minutissima* Jacquem. ex Duby [94183] (Fig. 2.G); *P. reidii* Duthie [87833], **Ranunculaceae**: *Aconitum balfourii* Stapf [73452]; *A. lethale* Griff. [73416] (Fig. 2.H); *A. violaceum* Jacquem. ex Stapf [73399]; *Actaea spicata* L. [87725]; *A. spicata* var. *acuminata* (Wall. ex Royle) H.Hara [73330]; *Anemone polyanthes* D.Don [85281]; *A. vitifolia* Buch.-Ham. ex DC. [73474]; *Aquilegia pubiflora* Wall. ex Royle [85201]; *Caltha palustris* L. [87706]; *Clematis barbellata* Edgew. [94197]; *C. connata* DC. [73438]; *C. montana* Buch.-Ham. ex DC. [87755]; *Thalictrum alpinum* L. [94193]; *T. cultratum* Wall. [73403]; *T. elegans* Wall. ex Royle [73402]; *T. reniforme* Wall. [73333]; *T. secundum* Edgew. [87794]; *Trollius acaulis* Lindl. [94185], **Rosaceae**: *Cotoneaster acuminatus* Lindl. [87881]; *C. duthieanus* (C.K.Schneid.) G. Klotz [73451]; *C. microphyllus* Wall. ex Lindl. [87782]; *C. simonsii* Hort. ex Baker [85260]; *C. affinis* Lindl. [87767]; *Filipendula vestita* (Wall. ex G.Don) Maxim. [87771]; *Fragaria nubicola* (Hook.f.) Lindl. ex Lacaita [87733]; *Geum roylei* Wall. ex F.Bolle [73427]; *Potentilla astragalifolia* Bunge [85279]; *P. fruticosa* L. [73450]; *P. microphylla* D.Don [73321]; *P. nepalensis* Hook. [73422] (Fig. 2.I); *P. polyphylla* Wall. ex Lehm. [73449]; *P. indica* (Jacks.) Th.Wolf [73345]; *Prunus cornuta* (Wall. ex Royle) Steud. [87756]; *Rosa macrophylla* Lindl. [87853]; *Rubus pedunculosus* D.Don [87854]; *R. macilentus* Cambess. [87751]; *Sibbaldia cuneifolia* (Bertol.) Paule & Soják [87891];

Sorbaria tomentosa (Lindl.) Rehder [87750]; *Sorbus aucuparia* L. [87776]; *Spiraea bella* Sims [87804], **Rubiaceae:** *Galium aparine* L. [87889], **Rutaceae:** *Skimmia laureola* (DC.) Siebold & Zucc. ex Walp [94198], **Salicaceae:** *Salix denticulata* Andersson [73356]; *S. disperma* Roxb. ex D.Don. [87721]; *S. flabellaris* Andersson [85221]; *S. lindleyana* Wall. ex Andersson [85222], **Saxifragaceae:** *Bergenia ciliata* (Haw.) Sternb. [87730]; *Saxifraga brachypoda* D.Don [87836]; *S. brunonis* Wall. ex Ser [73390]; *S. cernua* L. [85214]; *S. diversifolia* Wall. ex Ser. [87834, 85266]; *S. filicaulis* Wall. ex Ser. [87876]; *S. jacquemontiana* Decne. [73327] (Fig. 2.J); *S. pallida* Wall. ex Ser. [73354]; *S. stenophylla* Royle [85293], **Scrophulariaceae:** *Euphrasia himalayica* Wettst. [85231]; *Hemiphragma heterophyllum* Wall. [87740]; *Pedicularis bicornuta* Klotzsch [87855]; *P. gracilis* Wall. ex Benth. [87808]; *P. heteroglossa* (Prain) Pusalkar & D.K.Singh [85233]; *P. porrecta* Wall. [73404]; *P. punctata* Decne. [73341]; *Picrorhiza kurrooa* Royle [73366]; *Scrophularia edgeworthii* Benth. [73400], **Staphyleaceae:** *Staphylea emodi* Wall. [87762] (Fig. 2.K), **Tamaricaceae:** *Myricaria germanica* (L.) Desv. [73360] (Fig. 2.L), **Urticaceae:** *Urtica dioica* L. [73448], **Valerianaceae:** *Nardostachys jatamansi* (D.Don) DC. [87860]; *Valeriana hardwickii* Wall. [85285]; *V. himalayana* Grubov [73335]; *V. stracheyi* C.B.Clarke [85211]; *V. jatamansi* Jones [87745], **Violaceae:** *Viola biflora* L. [73353]; *V. canescens* Wall. [87735];

Group II(B) - Monocotyledons

Amaryllidaceae: *Allium humile* Kunth [85247]; *A. stracheyi* Baker [87861]; *A. wallichii* Kunth [87895], **Araceae:** *Arisaema jacquemontii* Blume [73329]; *A. propinquum* Schott [73328], **Convallariaceae:** *Clintonia udensis* Trautv. & C.A. Mey. [73408]; *Maianthemum purpureum* (Wall.) La Frankie [73453]; *Ophiopogon intermedius* D.Don [87744]; *Polygonatum cirrhifolium* (Wall.) Royle [94181]; *P. graminifolium* Hook [94180] (Fig. 3.A); *P. multiflorum* (L.) All. [73331], **Iridaceae:** *Iris kumasensis* Wall. [94184] (Fig. 3.B), **Juncaceae:** *Juncus concinnus* D.Don [87887]; *J. himalensis* Klotzsch [87886]; *J. membranaceus* Royle [85238], **Liliaceae:** *Fritillaria cirrhosa* D.Don [94188] (Fig. 3.C); *Gagea lutea* (L.)

Ker Gawl. [87702]; *Lilium nanum* Klotzsch [94179]; *L. oxypetalum* (D.Don) Baker [87820]; *Lloydia longiscapa* Hook. [94186]; *Nomocharis oxypetala* (D.Don) E.H Wilson [94189], **Melanthiaceae:** *Aletris pauciflora* (Klotzsch) Hand.-Mazz. [87793], *Trillium govanianum* Wall. ex D.Don [87864], **Orchidaceae:** *Androcorys josephi* (Rchb.f.) Agrawala & H.J.Chowdhery [87811]; *Calanthe tricarinata* Lindl. [87747] (Fig. 3.D); *Cephalanthera longifolia* (L.) Fritsch [94194]; *Cypripedium cordigerum* D.Don [94199] (Fig. 3.E); *C. elegans* Rchb.f. [85244] (Fig. 3.F); *C. himalaicum* Rolfe [85243] (Fig. 3.G); *Dactylorhiza hatagirea* (D.Don) Soó [94190] (Fig. 3.H); *Epipactis helleborine* (L.) Crantz. [87880]; *Gymnadenia orchidis* Lindl. [94191]; *Habenaria edgeworthii* Hook.f. ex Collett [73430]; *H. intermedia* D.Don [73475]; *H. latilabris* (Lindl.) Hook.f [94200]; *Herminium macrophyllum* (D.Don) Dandy [73429]; *Liparis rostrata* Rchb.f [94177] (Fig. 3.I); *Malaxis muscifera* (Lindl.) Kuntze [87769] (Fig. 3.J); *Neottia chandrae* Raskoti et. al. [85212] (Fig. 3.K); *N. listeroides* Lindl. [87879]; *Oreorchis foliosa* var. *indica* (Lindl.) N.Pearce & P.J.Cribb [85213]; *O. micrantha* Lindl. [94176]; *Ponerorchis chusua* (D.Don) Soó [85230], **Poaceae:** *Briza media* L. [87801]; *Calamagrostis emodensis* Griseb [73456]; *Dactylis glomerata* L. [87818]; *Phleum alpinum* L. [73375]; *Poa annua* L. [87705]; *P. pagophila* Bor [87813]; **Zingiberaceae:** *Roscoeia alpina* Royle [73415] (Fig. 3.L).

In terms of number of species, Asteraceae revealed as the dominant family (with 32 spp.) followed by Rosaceae (22), Orchidaceae (20), Ranunculaceae (17), Lamiaceae (13), Polygonaceae (13), Scrophulariaceae (12), Gentianaceae (11), Apiaceae (10), Caryophyllaceae (10), Brassicaceae (9), Saxifragaceae (9), Fabaceae (8), Primulaceae (8), Campanulaceae (7), and Ericaceae (7). Bisht et al. (2018) observed analogous patterns in the VoFNP, while Kumar et al. (2016) documented similar trends in the neighboring Niti Valley. Additionally, Naithani (1984-85) reported comparable findings for the Chamoli district. In the study area, dominant genera include *Gentiana* and *Saxifraga* with 8 species each followed by *Pedicularis*, *Primula*, *Rhododendron*, *Silene*, *Thalictrum* (5 spp. each), *Saussurea*, *Valeriana*

(4 spp. each), *Stellaria* and *Veronica* (3 spp. each). Out of total documented species, *Alliaria petiolata*, *Anemone polyanthes*, *Deutzia staminea*, *Eleutherococcus cissifolius*, *Epilobium angustifolium*,

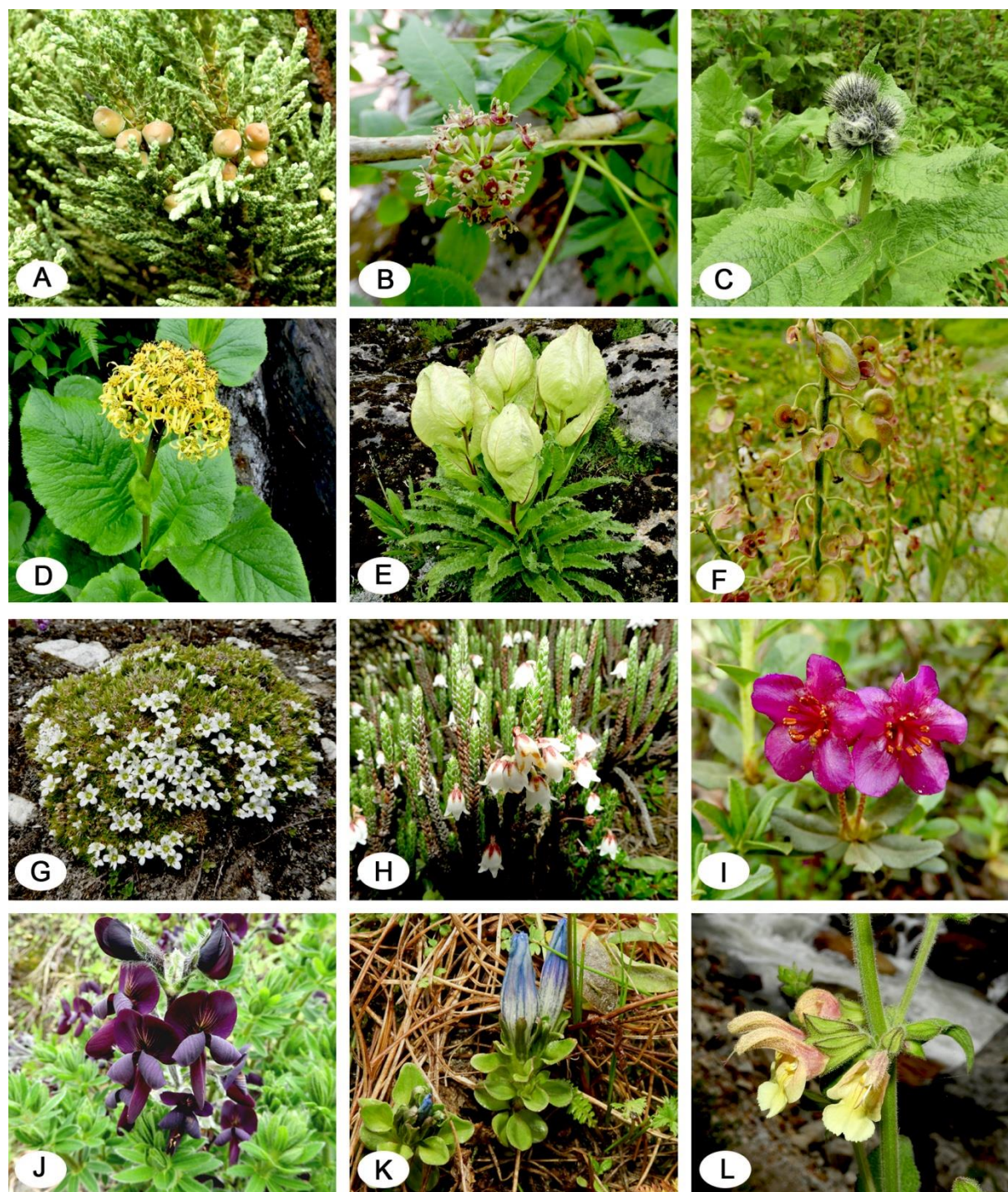


Figure 1: A. *Juniperus indica*, B. *Eleutherococcus cissifolius*, C. *Dolomiaea costus*, D. *Ligularia amplexicaulis*, E. *Saussurea ovata*, F. *Megacarpaea polyandra*, G. *Eremogone kumaonensis*, H. *Cassiope fastigiata*, I. *Rhododendron lepidotum*, J. *Thermopsis barbata*, K. *Gentiana elwesii*, L. *Salvia nubicola*.



Figure 2: A. *Morina longifolia*, B. *Epilobium angustifolium*, C. *Orobanche alba*, D. *Meconopsis aculeata*, E. *Veronica ciliata*, F. *Rheum moorcroftianum*, G. *Primula minutissima*, H. *Aconitum lethale*, I. *Potentilla nepalensis*, J. *Saxifraga jacquemontiana*, K. *Staphylea emodi*, L. *Myricaria germanica*.



Figure 3: A. *Polygonatum graminifolium*, B. *Iris kumasnensis*, C. *Fritillaria cirrhosa*, D. *Calanthe tricarinata*, E. *Cypripedium cordigerum*, F. *Cypripedium elegans*, G. *Cypripedium himalaicum*, H. *Dactylorhiza hatagirea*, I. *Liparis rostrata*, J. *Malaxis muscifera*, K. *Neottia chandrae*, L. *Roscoeia alpina*.

Liparis rostrata, *Eremogone kumaonensis*, *Euphorbia maddenii*, *Gentiana crassuloides*, *Gentiana elwesii*,



Gentiana infelix, *Pedicularis heteroglossa*, *Phryma leptostachya*, *Polygonatum graminifolium*, *Rhododendron arboreum* var. *roseum*, *Silene baccifera*, *Trifolium repens*, *Trifolium resupinatum*, *Veronica ciliata* from 16 genera and 15 families as revealed as lesser-known plant species in the region.

CONCLUSION

Conducting floristic surveys and maintaining plant inventories over time is critical for a comprehensive understanding of plant diversity and ecosystem dynamics. The information gathered not only aids in conservation efforts but also contributes to sustainable development and the well-being of human societies. The identification of *Alliaria petiolata*, *Eleutherococcus cissifolius*, *Liparis rostrata*, *Phryma leptostachya*, *Rhododendron arboreum* var. *roseum*, *Veronica ciliata* and others as lesser-known plant species in the region represents a valuable addition to our understanding of local biodiversity.

The valley of flowers has sustained a rich biological diversity of ecological significance. Various institutions, including the state forest department, Universities, and NGOs, are actively engaged in addressing diverse aspects to ensure the sustainability of the ecoregions. Their efforts, such as the removal of the invasion of *Koenigia polystachya* (*Polygonum polystachyum*), clearing solid wastes, controlling the daily tourist influx, preventing illegal exploitation and damage to plants, etc., cannot be ignored. Nevertheless, certain critical issues demand attention to preserve the delicate balance of this unique ecosystem. The occurrence of some invasive weeds in or around the area (uphill migration), the gradual replacement of native angiosperm plant communities by pure fern communities, and the expansion of *Koenigia polystachya*, along with an alarming reduction in the population size of some threatened [*Nardostachys jatamansi* (CR), *Aconitum heterophyllum* (EN), *Cypripedium elegans* (EN), *Aconitum violaceum* (VU), *Cypripedium cordigerum* (VU), and *Malaxis muscifera* (VU)], and rare species, should be considered in future planning and management for the area. It is essential to establish a robust system for continuous monitoring of

biodiversity, with a focus on tracking changes in plant communities and the population sizes of threatened and rare species.

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