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Nature's Remedies and Conservation: Ethnomedicinal Plants in the Tungnath Region, West Himalaya

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Abstract. Among the 150 species of medicinal plants found in the Tungnath region of the Western Himalaya, herbs make up the majority (76.8%), followed by shrubs, trees, climbers, and pteridophytes. Of these species, 20.2% are native to other parts of the world, while 67.5% are native to the Himalayan region. From sub-tropical to alpine climates, these plants are found in a range of elevation gradients, with plant species suited to each zone. Most medicinal plants are members of the Rosaceae, Polygonaceae and Ranunculaceae families. The most often utilized plant parts are complete plants (22.5%), leaves (24.4%), and roots (28.7%). Although these plants treat a variety of illnesses, the most prevalent ones are gastrointestinal disorders (23.8%), dermatological concerns (30.5%), and general health difficulties like fever (34.6%). Additionally, the study sheds light on the location and density of these plants throughout the May-September growing season. The cool, temperate, and subalpine regions have the highest degree of plant species similarity (82.7%) among climatic zones, followed by other nearby zones. The research highlights the significance of protecting these plants for both their therapeutic benefits and the region's ecological equilibrium.

Key words: alpine, medicinal plants, nativity, timberline, traditional knowledge

Introduction

Ethnobotany involves the interaction of humans with nature to extract and utilize plant species for their properties, including in food, medicine, and other uses. Over time, indigenous people and their cultures have continued to use plant species for their benefits. Traditional knowledge is a part of a wider belief system and is considered integral to everyday life and wellbeing. According to the WHO (2002), 65-80% of the world's healthcare practice involves the use of traditional medicine (TM), commonly referred to as Complementary and Alternative Medicine (CAM). About 70% population of India use traditional medicine in their primary health care needs (WHO 2002). The Himalaya occupies only 15% of the country's geographical area but accounts for about 30% of the endemic species found in the Indian sub-continent (Nautiyal *et al.* 1998). The Himalayan region is endowed with a rich variety of floral and faunal species. The region shows great diversity in vegetation with more than 18,440 species of plants. Among these, 1,748 species are medicinal plants, including 118 species of essential oil-yielding medicinal plants (Samant *et al.* 2000). The medicinal plant species also comprise economical, nutritional, aesthetic, cultural, and sacred values, and are an important part of the life and livelihood of the indigenous Himalayan communities (Samant *et al.* 1998, Makhuri *et al.* 1998). The Himalayan region is a reservoir of medicinal and aromatic plants, and the diverse ecological and climatic conditions of the region support the growth of varieties of medicinal and aromatic plants (Adhikari *et al.* 2003, 2007; Maikhuri *et al.* 1998). Uttarakhand state in the Indian Region supports the highest number of plant species known for medicinal properties due to its unique geography, varied topography, and diverse climatic conditions (Kala *et al.* 2004).

The income generated from the medicinal and aromatic plants (MAPs) accounts for more than half of the total earnings from the livestock, agriculture, and cultivation of spices in the Himalayan region. The high demand for MAPs in pharmacology industries leads to increased pressure on the alpine region. Over exploitation of MAPs is primarily resulting in the unsustainable extraction of resources. The collection of MAPs has a negative impact on the subalpine and alpine regions, which are also affected by the collection of fuel wood because local inhabitants run shops in religious or tourist areas for their livelihood. Trampling by sheep and goats, as well as camping by residents and tourists/naturalists, disturb the topsoil in these habitats where endangered and rare medicinal plant species occur.

In the Indian Himalayan region, MAPs are known to have restricted habitats and limited distribution limits. Therefore, the conservation initiatives of threatened plant species are necessary to reduce the pressure on natural resources (Nautiyal *et al.* 2001). The regulated extraction of MAPs leads to an equitable sharing of resources among various stakeholders and thereby would help in conserving and managing these natural resources. In

the Himalayan region, medicinal plants are vital to local communities' livelihoods since they offer both economic opportunities as well as necessary healthcare resources. In places with little access to contemporary medical services, these plants frequently serve as the main source of traditional medicine, assisting families in managing health concerns (Angmo *et al.* 2022). In addition to safeguarding these plants' availability for future generations, sustainable harvesting boosts the regional economy by facilitating trade in herbal products (Mbelebele *et al.* 2024). Communities may protect biodiversity and strengthen their resistance to economic shifts by using sustainable practices like managed harvesting and agriculture (Tiwari and Tiwari 2014). Furthermore, raising knowledge of the ecological and cultural importance of medicinal plants supports conservation initiatives, supporting the preservation of the ecosystem and local means of subsistence (Chandra and Sharma 2018). Therefore, maintaining the Himalayas' unique biodiversity and promoting the socioeconomic well-being of its inhabitants depends heavily on sustainable utilization of plants for medicinal purposes.

Material and Methods

Study area

The study was conducted at and around the Tungnath region (Appendix 1) in the upper catchment of the Alaknanda and Mandakini rivers of Uttarakhand, West Himalaya (Fig. 1). Four distinct seasons were discernible in the study area viz., summer (May - June), monsoon (July to mid-September), autumn (mid-September to October) and winter (November - April). The period with total snow cover is usually between 4-5 months, and melts during April - May, marking the arrival of favorable conditions for plant growth (Adhikari *et al.* 2018). The study area can be broadly divided into four major zones based on vegetation type.

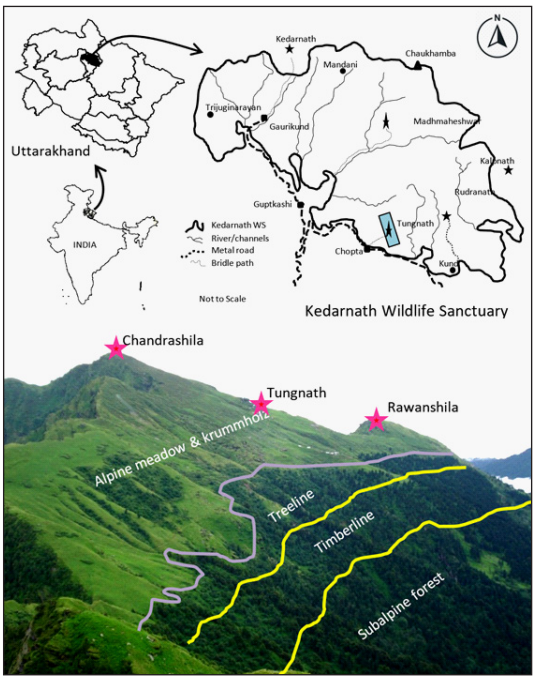

Fig. 1. Location of study area in Kedarnath Wildlife Sanctuary in Uttarakhand.

Sub-alpine forest: The subalpine forests in the study area start at an elevation of 2800m, and end at 3200m. The sub-alpine forest is dominated by *Abies pindrow*, *A. spectabilis* and *Quercus semecarpifolia*, while the understory canopy is dominated by *Rhododendron arboreum* and *Rhododendron campanulatum*, followed by *Viburnum erubescens* and *Sorbus* sp. The shrub layer is represented by *R. barbatum*, *Rosa sericea*, *Rubus niveus*, *Salix* spp., *Cotoneaster* spp. and *Thamnocalamus spathiflorus*.

Timberline: Timberline in the study area ranges between 3200-3300m, and is populated by *Betula utilis* and *Abies spectabilis* on north to north-west facing slopes, while south to south-west facing slopes are dominated by *Q. semecarpifolia* and *R. arboreum* (Rai *et al.* 2012). However, the '*krummholz*' layer under the tree canopy is formed by *Rhododendron campanulatum*. On steep rocky slopes, climatically modified dwarf and stunted individuals of *R. arboreum* form the timberline. Other major shrub species in the zone include *Rubus niveus*, *Salix denticulata*, *Rosa sericea*, *Viburnum grandiflorum*, *Cotoneaster microphylla*, *Lonicera* spp., and *Berberis* spp. *Cypripedium elegans*, *C. cordigerum*, *Neottia pinetorum*, and *Platanthera leptocaulon* are some varieties of rare orchid taxa in the area (Rai *et al.* 2012).

Treeline: The treeline in the study area is dominated by *Rhododendron campanulatum*, a dominant shrub species interspersed with a few individuals of *Sorbus*, *Abies*, *Acer* and *Betula* species that form the '*krummholz*' between 3300 and 3400m, along with the dwarf shrubs viz., *R. anthopogon* and *R. lepidotum*, and provides micro-habitat to several important MAPs.

Alpine meadow and scrubs: The alpine meadow above 3400m supports various plant communities, including cushionoid herb, grasses, and sedges. Herbaceous flora is represented by *Anaphalis* spp., *Anemone* spp., *Corydalis cornuta*, *Swertia ciliata*, *Hypericum* sp., *Origanum vulgare*, *Thymus linearis*, *Fritillaria roylei*, *Cypripedium himalaicum*, *Dactylorhiza hatagirea*, *Goodyera repens*, *Paeonia emodi*, *Meconopsis aculeata*, *Sinopodophyllum hexdrum*, *Rheum australe*, *Aconitum heterophyllum*, *Caltha palustris*, *Potentilla argyrophylla*, *Bergenia stracheyi* and *Pedicularis hoffmeisteri*, *Bistorta* spp., *Gaultheria strichophylla*, *Trachydium roylei*, *Sibbaldia cuneata*, *Tanacetum longifolium*, and many other species (Appendix 2).

Methods

Based on the secondary literature, including Samant *et al.* (1998, 2000), Makhuri *et al.* (1998), Adhikari *et al.* (2003, 2005, 2007), Kala *et al.* (2004), Nautiyal *et al.* (1998, 2001), Rai *et al.* (2012), Kala *et al.* (2004), Chandra *et al.* (2021), Kala (2005), Semwal *et al.* (2007), Rawat *et al.* (2016), Nautiyal (1981), Purohit *et al.* (1985), Rawat and Pangtey (1987), Uniyal *et al.* (2002), a list of medicinal plants was prepared for the Tungnath region. Interviews were also performed with local inhabitants such as shopkeepers, priests,

graziers/local laborers who frequently use the area, including those who collect medicinal plants for personal or commercial purposes. As mentioned, the elevation range of MAPs was taken from the literature, not from the study area.

Results

The study area, (i.e., Tungnath region) harbours 150 species of medicinal plants, as detailed by Appendix 3. Herbs contributed significantly (76.8%) to the population, followed by shrubs (14.6%), trees (6.0%), climbers (1.3%), and pteridophytes (0.7%). The study area supports 67.5% of native species of the Himalayan region, 5.3% of Himalayan region or Indian origin, and 20.2% from other regions of the world. These medicinal plant species are largely wide-ranging, and their range distribution along the elevation gradient is shown in Fig. 2.

Of the 150 medicinal plants recorded, 56 species are distributed from the sub-tropical to the alpine region (55.4% species in the cool temperate region, 14.3% species up to the subalpine region, and 30.4% species up to the alpine region). 31 species are distributed from the warm temperate region to the alpine region (38.7% species in the cool temperate region, 6.5% species up to the subalpine region, and 54.8% species up to the alpine region). 46 species are distributed from the cool temperate region to the alpine region (8.7% species in the cool temperate region, and 91.3% species in the alpine region). Finally, 6 species are distributed from the subalpine to the alpine region, whereas 12 species (*Aconitum balfourii*, *Potentilla multifida*, *Allium humile*, *Nardostachys jatamansi*, *Gentiana stipitate*, *Rheum webbianum*, *Picrorhiza kurroa*, *Juniperus indica*, *Rheum moorcroftianum*, *Neopicrorhiza scrophulariiflora*, *Nardostachys grandiflora* and *Swertia cuneata*) are distributed only in the alpine region.

Rosaceae was the dominant family among the families, with 15 species, followed by Polygonaceae (13), Ranunculaceae (11 species), Asteraceae (10 species), Apiaceae and Ericaceae (7 species each), Lamiaceae and Scrophulariaceae (6 species each), Orchidaceae (5 species), Alliaceae, Caprifoliaceae, Fumariaceae, Gentianaceae and Saxifragaceae (4 species each), Berberidaceae, Geraniaceae and Valerianaceae (3 species each), Balsaminaceae, Brassicaceae, Campanulaceae, Fabaceae, Liliaceae, Papaveraceae, Parnassiaceae, Pinaceae, Plantaginaceae, Rubiaceae, and Violaceae (2 species each; Appendix 1). However, 19 families (Aceraceae, Betulaceae, Boraginaceae, Caryophyllaceae, Cupressaceae, Grossulariaceae, Hypericaceae, Iridaceae, Lycopodiaceae, Melanthiaceae, Oleaceae, Onagraceae, Oxalidaceae, Paeoniaceae, Podophyllaceae, Primulaceae, Taxaceae, Urticaceae and Zingiberaceae) were represented by only a single species.

The plant parts used were in following order of prevalence: roots (28.7%) > Leaves (24.4%) > whole plant (22.5%) > fruit ≈ seed (5.7%) > Flower (4.3%) > Rhizome (3.3%) > Tuber (2.3%) > Bulb (1.4%) > Twig (1.0%) > Resin (0.5% each), while the use of various plant parts is shown in Fig. 3.

Medicinal plants used in different ailments have been classified under 10 major categories shown in Fig. 4. The use of medicinal plants under different categories of ailment (based on percentage) are in the following order: Gastro-intestinal category with 11 ailments [diarrhea (23.8%), dysentery (22.2%), gastric (15.9%), ulcer (11.1%), vomiting, anthelmintic and colic (4.7% each), digestive disorder, piles and acidity (3.1% each), gall stone and vermicidal (1.6% each)]; Dermatological category with 7 ailments [cut (30.5%), skin (23.7%), burn (13.6%), boils (11.9%), antiseptic and sores (8.5% each), insecticide (3.4%)], General category with 6 ailments percentage of species use [fever (34.6%), cough (19.2%), headache (16.3%), cold (10.6%), tonic (12.5%), astringent (6.7%)]; Circulatory category with 6 ailments [anti-inflammatory and aphrodisiac (23.8% each), snakebite (19.0%), bleeding (14.3%), diabetic and diuretic (9.5% each)]; Skeleton and muscles category with 6 ailments [wounds (59.7%), body ache (12.9%), swelling (9.7%), rheumatism (8.1%), bone fracture and joint pain (4.8% each)]; Respiratory category with 4 ailments [bronchitis (33.3%), lung disease and asthma (25.9% each, throat (14.8%)], Vital organs category with 4 ailments [liver (40.0%), kidney (30.0%), jaundice (20.0%), tuberculosis (10.0%)] and Genital category with 3 ailments [urinary trouble (63.6%), abortifacient (36.4%)]. However, the use of medicinal plant species for the ailments like Ophthalmic (eye disease, 9), Dental (toothache, 5), Hair (dandruff, 1) and Vector-borne (malaria, 3).

The average density of different medicinal species over several months is shown in Fig. 5. In the initiation phase of the growth period in May,

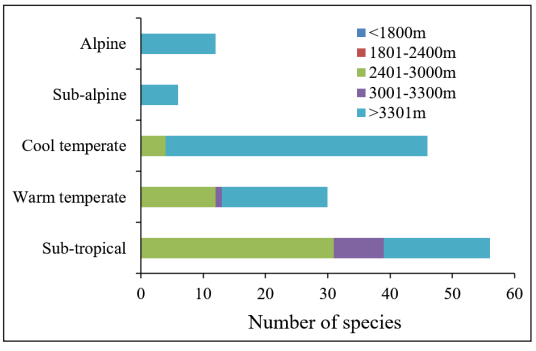

Fig. 2. Distribution of medicinal plants across various climatic zones.

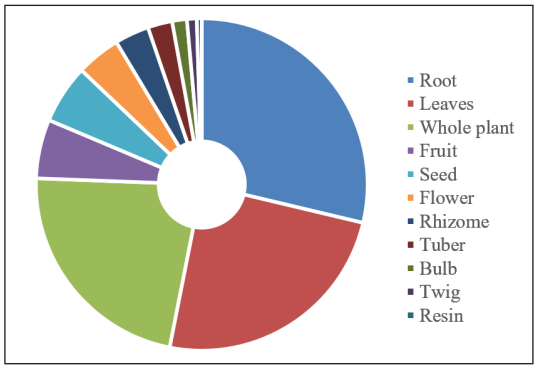

Fig. 3. Use of various plant parts for different ailments.

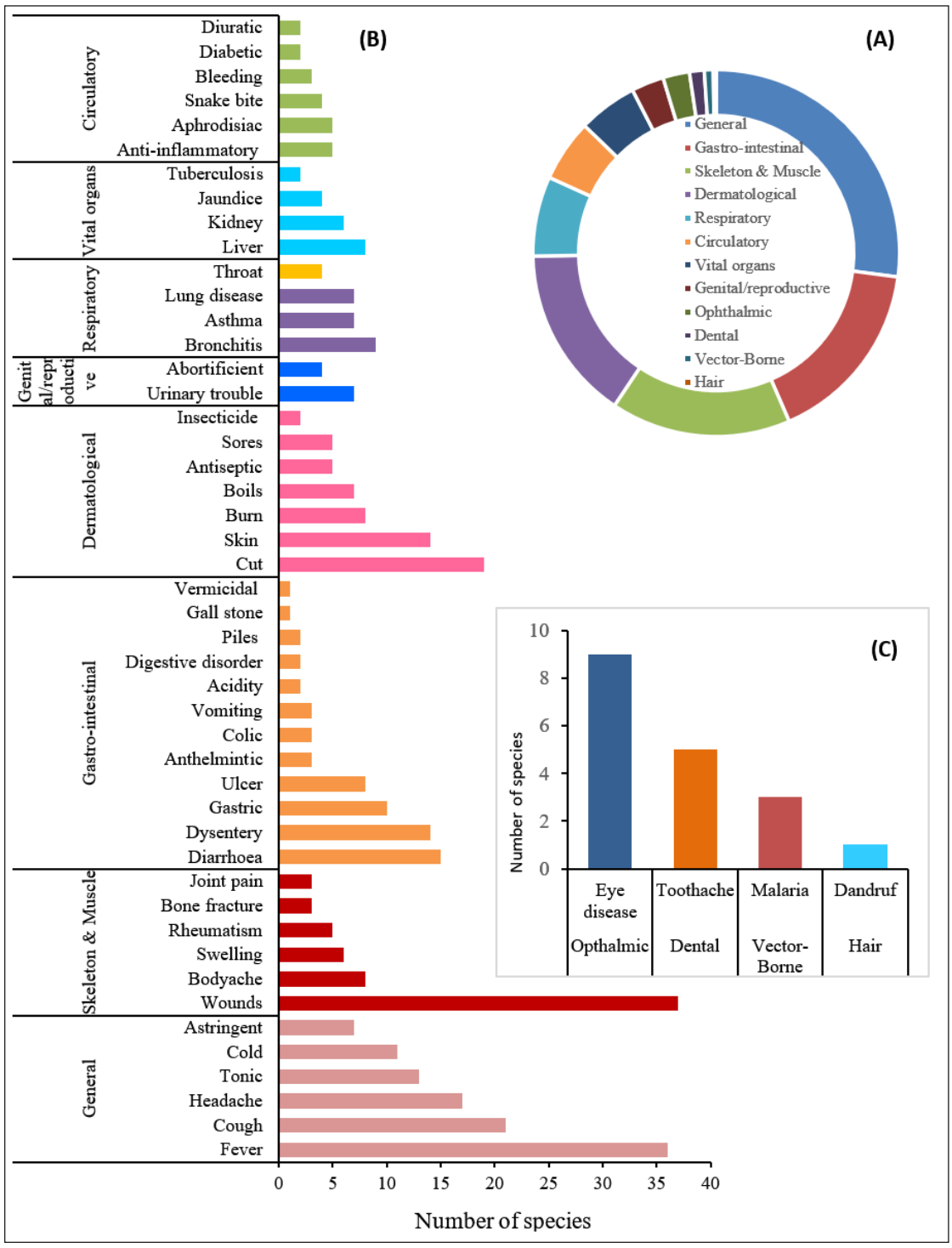

Fig. 4. Proportion of medicinal plants used in major categories (A & B) and number of species used in various ailments (C).

22 MAPs are present, of which 17 MAPs (*Ranunculus hirtellus*, *Plantago major*, *Picrorhiza kurroa*, *Bistorta amplexicaulis*, *Caltha palustris*, *Pedicularis pectinata*, *Anemone rivularis*, *Tanacetum longifolium*, *Prunella vulgaris*, *Primula denticulate*, *Dactylorhiza hatagirea*, *Potentilla fulgens*, *Pimpinella diversifolia*, *Rumex nepalensis*, *Anemone obtusiloba*, *Morina longifolia*, and *Aconitum heterophyllum*) have shown high density across the months (May through September). Only 3 MAPs (*Goodyera repens*, *Parnassia nubicola*, and *Swertia ciliata*) have shown high density during June out of 32 MAPs present, while 9 MAPs (*Geranium wallichianum*, *Potentilla atrosanguinea*, *Viola biflora*, *Selinum wallichianum*, *Bistorta vaccinifolia*, *Senecio laetus*, *Geranium pratense*, *Epilobium royleanum*, and *Elsholtzia stroblifera*) have shown high density values in July, of the total 38 MAPs present, and only 5 MAPs (*Parochetus communis*, *Jurinea dolomiaea*, *Saussurea auriculata*, *Bistorta macrophylla* and *Impatiens scabrida*) have shown high density in August, of the 37 MAPs present. At the end of the growth period, (i.e., September), 8 MAPs (*Taraxacum officinale*, *Plantago himalaica*, *Cynanthus*

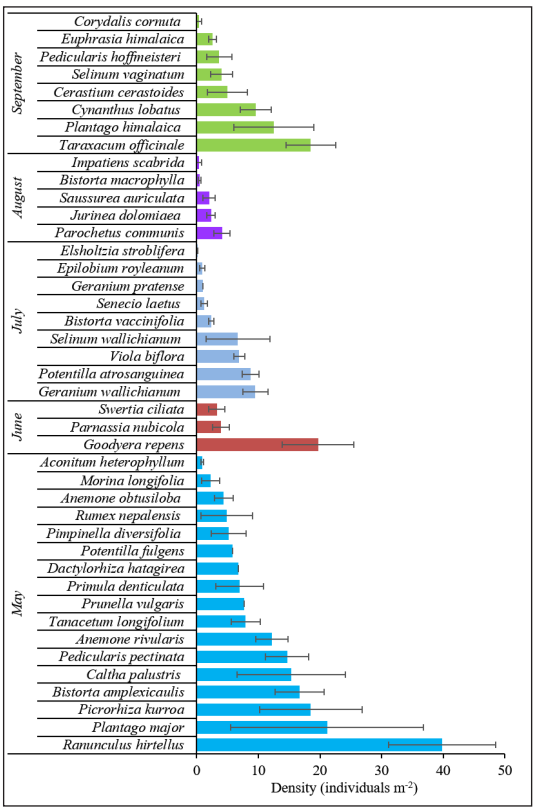

Fig. 5. Medicinal plant density (average) across months.

lobatus, *Cerastium cerastoides*, *Selinum vaginatum*, *Pedicularis hoffmeisteri*, *Euphrasia himalaica*, and *Corydalis cornuta*) have shown high density of the total 36 MAPs across the growing period. The maximum density was shown by *Ranunculus hirtellus* across the months and ranged from 27.43+2.4 to 39.8+8.7 individuals m^{-2}, *Goodyera repens* from 0 to 19.7+5.8 individuals m^{-2}, *Geranium wallichianum* 0 to 9.5+2.1 individuals m^{-2}, *Parochetus communis* 1.5+0.4 to 4.1+1.3 individuals m^{-2} and *Taraxacum officinale* 13.7+2.6 to 18.4+3.0 individuals m^{-2}.

Similarity of MAPs across the climatic zones

The similarity of MAPs across climatic zones is shown in Table 1. The highest similarity was observed between cool temperate and subalpine regions (82.7%) > subalpine and alpine regions (82.2%) > warm temperate and cool temperate regions (80.2%) followed by subtropical and warm temperate regions (79.1%).

Discussion

The average density of medicinal species was calculated across the growing season from May to September for 2 years (2017 and 2018) and is presented in Table 2. However, several other important medicinal plants were present in the study area, which have not been recorded through quadrat sampling.

The density of *Picrorhiza kurroa* was higher (6.9±3.2 individuals m^{-2}) than that found in other studies conducted in various parts of Himalaya, viz. 0.6-1.9 individuals m^{-2} in Kumaon region by Chandra *et al.* (2021), 0.71-3.9 individuals m^{-2} in Gurez valley, Kashmir Himalaya by Dad and Khan (2011), 0.9-1.9 individuals m^{-2} in Kumaon Himalaya by Chandra *et al.* (2020), 3.4-4.5 individuals m^{-2} in Himalayan Protected Areas by Kala (2005), 2.2 individuals m^{-2} in Kedarnath WS by Semwal *et al.* (2007). The density of *Selinum wallichianum* was lower (4.8±0.7 individuals m^{-2}) than that of the values reported for various regions in Garhwal Himalaya (13.9±4.1 individuals m^{-2} in Bhilangna range and 9.2±6.3 individuals m^{-2} in Gangotri range) and similar values 4.5±2.0 individuals m^{-2} for North Jakholi range by Rawat *et al.* (2016) and higher than that of the values reported for Valley of Flowers NP (2.5±1.7 individuals m^{-2}) by Kala (2005). The density of *Dactylorhiza hatagirea* was within the range (6.7 individuals m^{-2}) reported for Gurez valley, Kashmir Himalaya (0.12-16.3 individuals m^{-2}) by Dad and Khan (2011) and Protected areas in Himalayan region (0.37-18.0 individuals m^{-2}) by Kala (2005), while higher than that of the values reported for Kumaon region (0.6-1.1 individuals m^{-2}) by Chandra *et al.* (2020), for Langtang NP (0.2 individuals m^{-2}) by Shrestha and Shrestha (2012) and for Kedarnath WS (3.5 individuals m^{-2}) by Semwal *et al.* (2007). Similarly, the density value of *Aconitum heterophyllum* is within the range reported for Gurez valley, Kashmir Himalaya (0.28-1.48 individuals m^{-2}) by Dad and Khan (2011, protected areas in Himalayan region by Kala (2005; 0.23-0.43 individuals m^{-2}) and north-central Nepal by Chapagain *et al.* (2019; 0.5-2.7 individuals m^{-2}), but is on the lower side of the range reported for Kumaon region by Chandra *et al.* (2020; 0.9-1.5 individuals m^{-2}) and lower than the values reported for Garhwal Himalaya by Nautiyal *et al.* (2002; 2.57 individuals m^{-2}), in Kedarnath WS by Semwal *et al.* (2007; 1.4-3.6 individuals m^{-2}) and in Mandakini valley, Garhwal Himalaya by Nautiyal *et al.* (2002; 1.0-2.5 individuals m^{-2}). However, the density of *Jurinea dolomiaea* (1.6±0.2 individuals m^{-2}) was higher than that of Langtang NP (1.2 individuals m^{-2}) reported

Zone	Sub-tropical	Warm Temperate	Cool Temperate	Sub-alpine	Alpine
Sub-tropical	100				
Warm Temperate	79.1	100			
Cool Temperate	59.1	80.2	100		
Sub-alpine	46.3	59.7	82.7	100	
Alpine	21.5	36.7	66.4	82.2	100

Table 1. Medicinal plants' similarity (%) between various climatic zones.

Species	Density	Species	Density
Ranunculus hirtellus	31.4±2.0	*Parochetus communis*	3.3±0.5
Taraxacum officinale	16.2±0.9	*Parnassia nubicola*	3.2±0.2
Plantago major	16.2±2.3	*Rumex nepalensis*	3.0±0.6
Goodyera repens	11.2±2.4	*Cerastium cerastoides*	2.8±0.7
Pedicularis pectinata	9.0±1.7	*Primula denticulata*	2.5±1.0
Caltha palustris	8.5±2.1	*Pedicularis hoffmeisteri*	2.3±0.4
Cynanthus lobatus	8.2±0.8	*Euphrasia himalaica*	2.3±0.2
Plantago himalaica	7.3±1.6	*Bistorta vaccinifolia*	2.2±0.1
Geranium wallichianum	7.1±1.1	*Pimpinella diversifolia*	1.8±0.8
Bistorta amplexicaulis	7.1±2.6	*Swertia ciliata*	1.8±0.4
Picrorhiza kurroa	6.9±3.2	*Jurinea dolomiaea*	1.6±0.2
Dactylorhiza hatagirea	6.7	*Saussurea auriculata*	1.3±0.2
Tanacetum longifolium	6.4±0.5	*Morina longifolia*	1.2±0.4
Potentilla atrosanguinea	6.3±1.3	*Geranium pratense*	1.0
Potentilla fulgens	5.8	*Senecio laetus*	1.0±0.1
Anemone rivularis	5.7±1.9	*Aconitum heterophyllum*	0.8±0.1
Viola biflora	5.4±0.6	*Epilobium royleanum*	0.7±0.1
Prunella vulgaris	5.1±0.7	*Bistorta macrophylla*	0.4±0.02
Selinum wallichianum	4.8±0.7	*Corydalis cornuta*	0.4±0.02
Anemone obtusiloba	4.4	*Impatiens scabrida*	0.3±0.02
Selinum vaginatum	3.8±0.1	*Elsholtzia stroblifera*	0.2±0.02

Table 2. Medicinal plant density (individuals m^{-2}) recorded across the months (May-September; average of 2 years).

by Shrestha and Shrestha (2012), lower than that of protected areas of the Himalayan region (0.1-2.3 individuals m^{-2}) reported by Kala (2005), and within the range reported for Kumaon region (2.7 individuals m^{-2}) by Awasthi *et al.* (2003).

The high similarity of medicinal and aromatic plants between the immediate zones and the decreasing similarity with increasing elevation could be due to several factors. Microclimates are more similar in adjacent, lower-elevation zones with consistent environmental factors like temperature, humidity, sunlight and soil, supporting similar plant species. Medicinal and aromatic plants requiring specific conditions, are better suited to lower elevations due to temperature, oxygen and soil changes at higher altitudes. The gene flow between species decreases with altitude, as populations at higher elevations become isolated and evolve differently. The plant similarity declines with increasing altitude, as species at higher elevations are more specialized. The seed dispersal is limited in steep or variable terrains, reducing plant overlap between zones. Habitat fragmentation is more pronounced at higher elevations due to less favourable growth conditions.

Implications of MAPs conservation in Tungnath region

Intensive livestock grazing in subalpine forests has led to overgrazing, preventing the regeneration of medicinal and aromatic plants (MAPs) in Tungnath region. Continuous consumption by livestock, combined with soil trampling, degrades soil structure and impedes plant establishment, resulting in the decline of plant populations. In alpine meadows, increased foot traffic from pilgrims and tourists, particularly from shortcuts, exacerbates the problem by causing vegetation trampling and soil erosion, further hindering the growth and regeneration of both medicinal and other native plant species (Appendix 3).

The spread of *Polygonum polystachyum*, an invasive plant species in the region, intensifies competition for essential resources, further threatening native plant communities and reducing biodiversity. Managing this invasive species is crucial for maintaining the ecological integrity of the region and preserving its native flora. Overharvesting of medicinal plants, combined with these environmental stressors, poses a significant risk to plant populations and disrupts local biodiversity. This not only threatens the viability of traditional medicinal practices but also undermines the overall health of the ecosystem. To ensure sustainability, it is crucial to develop policy and implement guidelines for plant collectors and traditional practitioners, promoting responsible harvesting practices that support the long-term regeneration of medicinal plant populations while maintaining the ecological balance of the region.

Indiscriminate fuelwood harvesting by local shop owners and migratory herders poses a significant threat to the region's vegetation, including vital medicinal plants. This practice, coupled with the area's sensitivity to climate change, exacerbates the depletion of local plant resources, disrupting the delicate ecological balance, especially in the transitional zones between subalpine forests

and alpine meadows. Unsustainable fuelwood collection not only endangers the survival of medicinal plants but also compromises the overall health of these ecosystems. To mitigate these impacts, it is essential to promote alternative fuel sources, such as supply of gas cylinders at a subsidized rate, for local shopkeepers and to encourage sustainable harvesting practices among herders. Additionally, implementing sustainable grazing practices, controlling invasive species, and regulating plant collection are key strategies for conserving medicinal plants in the region. A comprehensive policy document, developed through collaboration with local communities, government agencies and conservation organizations, is critical for ensuring the long-term protection of these valuable resources. By fostering cooperative efforts among stakeholders, we can enhance the resilience of the region's ecosystems. Protecting medicinal plants is not only vital for maintaining biodiversity but also for safeguarding the region's cultural heritage and healthcare practices, both traditional and modern.

The conservation of MAPs in the Tungnath region is threatened by overgrazing, habitat fragmentation, invasive species, overharvesting, and unsustainable fuelwood collection (Appendix 4). To ensure their sustainability, it is essential to promote responsible harvesting, sustainable grazing practices, control invasive species, and collaborate on policy development with local communities and authorities. Protecting MAPs is crucial for biodiversity, ecosystem health, and preserving traditional medicinal practices.

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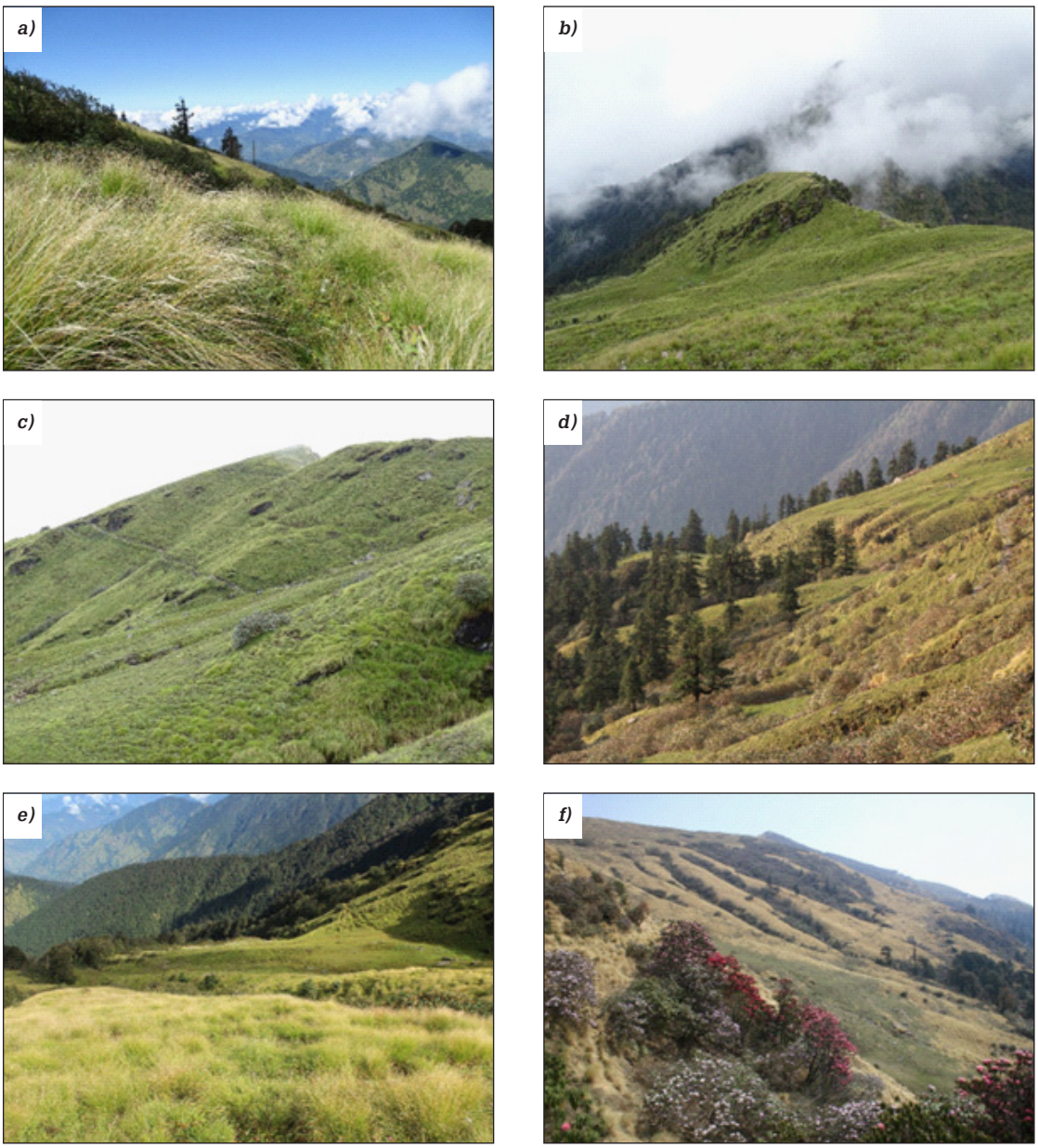
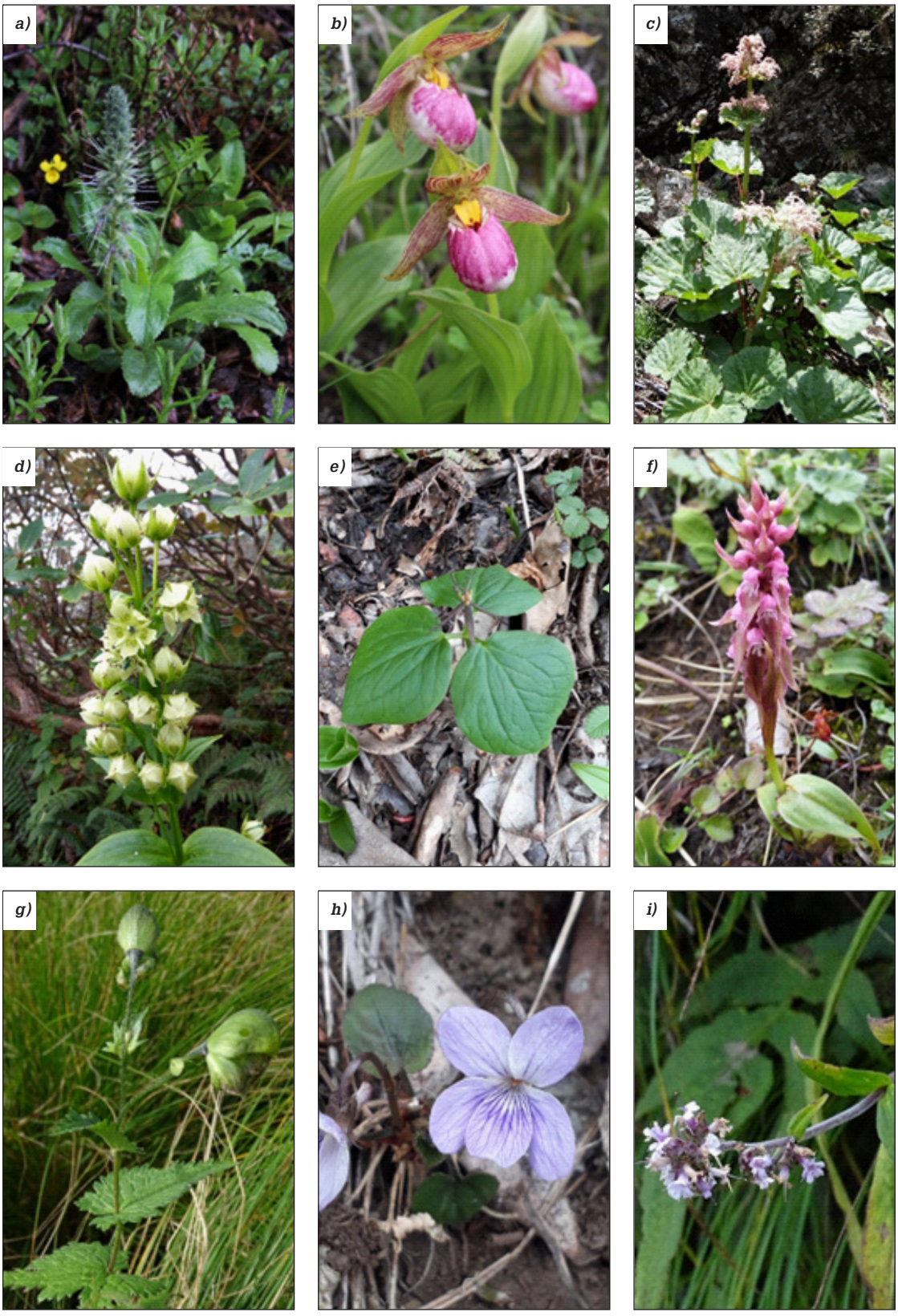
Appendix 1



Appendix 1. a) *Danthonia* dominated community with Krummholz, b) Alpine meadow dominated by Mixed herbaceous and *Danthonia* communities, c) *Danthonia* community on higher slopes, d) Interspersed subalpine forest with krummholz, e) Upper slopes dominated by *Danthonia* community, while flat meadow in centre dominated by *Polygonum polystachyum* and subalpine forest in the background and f) ridges (exposed sites) dominated by *Danthonia* community and furrows (depressed sites) dominated by krummholz and fore ground is dominated by *Polygonum polystachyum*.

Appendix 2



Appendix 2. Important medicinal plants of the study area: a) *Picrorhiza kurroa*, b) *Cypripedium himalaicum*, c) *Rheum emodi*, d) *Swertia speciosa*, e) *Trillium govanianum*, f) *Satyrium nepalense*, g) *Aconitum heterophyllum*, h) *Viola canescens*, i) *Nardostachys jatamansi*.

Appendix 3

Botanical name	Local name	Family	Nativity	Lower	Higher	Part used	Uses
Trees							
Abies pindrow (Royle ex D. Don.) Royle	Himalayan fir, ragha, pindrau, badar	Pinaceae	Reg Himal	2400	2900	Fl, Lv, Bk	Foliar extract as anti-inflammatories, leaves for bronchitis and asthma, inner bark for constipation, cones as diuretic and purgative
Abies spectabilis (D. Don) Mirb.	Morinda	Pinaceae	Reg Himal	2800	3000	Lv, Bk	Fever, asthma, bronchitis, wounds, sores
Acer acuminatum Wall. ex D. Don	Rath-kanchula, Kanjla	Aceraceae	Reg Himal	2400	3000	Sd	Abortifacient
Betula utilis Don	Bhoj-patra	Betulaceae	Reg Himal, Japon	2700	4000	Bk, Resin	Spermicidal, wounds, gastric troubles
Rhododendron arboreum Sm.	Burans	Ericaceae	Reg Himal	1500	3300	Lv, Bk, Fr	Respiratory disorders, digestive disorders, dysentery, fever, headache, rheumatism, wounds
Prunus cornuta (Royle) Steud.	Jamna, Jamoni	Rosaceae	Europe, As Bor	1700	2900	Sd	Kernels applied on neuralgic pain
Sorbus cuspidata Hedlund	Mouli	Rosaceae	Reg Himal	2500	2800	Bk	Fever
Taxus contorta Griff.	Thuner, Rakhal	Taxaceae	Reg Bor Temp	2400	3800	Lv, Bk	Tumors, cancer, bark is used for preparation of tea of medicinal value
Herbs							
Aconitum balfourii Stapf	Mitha	Ranunculaceae	Reg Himal	3400	3900	Rt	Sciatica, throat and internal inflammation, fever
Aconitum heterophyllum Wall.	Patis	Ranunculaceae	Reg Himal	3300	4500	Rt	Aphrodisiac, tonic, diarrhea, fever, rheumatism, gastric trouble, headache, intestinal pain, stomachache
Ajuga parviflora Benth.	Small-Flowered Bugleweed	Lamiaceae	Reg Himal	1500	3300	Lv	Anthelmintic, astringent
Allium carolianum DC.	Ladam	Alliaceae	Carolina, central and southern Asia	3000	4000	Bb	Diuretic, stimulant, tonic, toothache, earache, headache, joint pain
Allium humile Kunth.	Laichu	Alliaceae	Reg Himal	3500	4000	Lv	Indigestion, external injuries, spices and flavoring food
Allium stracheyi Baker	Jwari Dhun, Dhungar, Faran	Alliaceae	Reg Himal	3000	4500	Wp	Joint pain, swelling
Allium wallichii Kunth.	Doona, Gobra, Laddu	Alliaceae	Praec	2000	3500	Bb	Pectoral diseases, bile complaints, flatulence, body massage
Anaphalis contorta (D. Don.) Hook.f.	Buglya	Asteraceae	Reg Himal	1000	3200	Wp	Insect repellent, cuts, wounds, boils
Anaphalis triplinervis (Sims) Clarke	Bugla, Buglya	Asteraceae	Reg Himal	1000	3500	Lv, Wp	Laceration of toes, insect repellent, stop bleeding, wounds, cuts
Anemone obtusiloba Don	Kanchphool	Ranunculaceae	Reg Himal	2000	3000	Rt	Diarrhea
Anemone rivularis Ham.	Daipha	Ranunculaceae	Ind or	2100	3600	Rt	Headache, fever, eye diseases, cuts, wounds, burns, antidote to snake bite, laxative

Anemone tetrasepala Royle	Kawal	Ranunculaceae	Reg Himal	2100	3600	Lv, Rt	Sedative, bronchitis
Angelica glauca Edgew.	Choru	Apiaceae	Ind or	3000	3800	Rt, Wp	Purgative, dysentery, menorrhea, stomach complaint, vomiting, gastric complaints, bronchitis, constipation, whooping cough
Aquilegia pubiflora Wall. ex-Royle	Baz Jari, Himalayan columbine	Ranunculaceae	Ind or	1500	3000	Wp	Febrifuge, poisonous
Bergenia ciliata (HK.f. & Th.) Engler	Silpara	Saxifragaceae	Reg Himal	1000	3000	Rt	Internal wounds, cutaneous disorders, febrifuge, digestive, tonic
Bergenia stracheyi Hk.f. & Th.) Engler	Ghee-pati, Silphari	Saxifragaceae	Reg Himal	3000	5200	Rt	Diuretic, ophthalmia, tonic, cuts, antiscorbutic, wounds, kidney stone, gallstone
Bistorta amplexicaulis (D. Don) Greene	Kutrya	Polygonaceae	Reg Himal	1500	2700	Wp	Wounds, dysentery and abortion
Bistorta macrophylla (D. Don) Sojak	Kukhri, Chhotaninayin, Kande-e-ninai	Polygonaceae	Reg Himal	2700	4500	Rt & Fr	Lung and intestinal disorders, diarrhea, dysentery, increase blood
Bistorta vaccinifolia (Wall. ex Meissn.) Greene	Inuri	Polygonaceae	Reg Himal	2000	3000	Rt	Tuberculosis
Bistorta vivipara (L.) S.F. Fray	Ban mundu	Polygonaceae	Reg Bor et arct	3300	4800	Rt, Sd	Masticatory, amoebic dysentery
Caltha palustris L.	Marsh marigold, Kingcup	Ranunculaceae	Reg Bor, Temp et Arct	2500	4000	Rt	Warts, anemia
Capsella bursa-pastoris (L.) Medik.	Tuntkya, Botlya	Brassicaceae	Reg Temp	400	4500	Lv, Rt, Wp	Gonorrhea, diarrhea, dropsy, blood pressure, cuts, wounds, urinary troubles
Cerastium cerastoides (L.) Britt.	Starwort mouse ear	Caryophyllaceae	Reg Himal	2800	3900	Wp	Fever
Cicerbita macrorhiza (Royle) Beauv.	Karatu	Asteraceae	Reg Himal	2000	3400	Wp, Lf	Juice taken orally and leaf roll used externally to relive fever, headache
Cirsium wallichii DC.	Kandeiya, Kandra	Asteraceae	Reg Himal	300	3000	Lv, Rt	Hepatic trouble, skin diseases, scorpion stings, chest pain, dysentery, thirst
Codonopsis rotundifloia Benth.	Bibdi	Campanulaceae	Reg Himal	1800	3600	Rt	Aphrodisiac
Corydalis cashmeriana Royle	Kashmir Corydalis	Fumariaceae	Reg Himal	2800	5500	Wp	Chronic fever, bile, burns
Corydalis cornuta Royle	Balsam Jar, Indra-jatta	Fumariaceae	Reg Himal	1500	2800	Rt	Body swelling, inflammations, fever
Corydalis govaniana Wall.	Bhootjata	Fumariaceae	Reg Himal	2400	4600	Rt	Tonic, stomachache, high fever, toothache
Corydalis vaginans Royle		Fumariaceae	Reg Himal	2800	3800	Sap	Eye diseases
Cynanthus lobatus Wall.	Trailing bellflower	Campanulaceae	Reg Himal	3000	3700	Fl, Rt	Stimulant, lymph disorders
Cynoglossum zeylanicum Thumb. Ex Lehm.	Andhahuli	Boraginaceae	Ind or, Malaya	1000	3000	Lv, Rt	Asthma, bronchitis, vomiting, cough, diarrhea
Cypripedium himalaicum Rolfe	Himalayan slipper orchid	Orchidaceae	China occ., Sikkim, Nepal	300	4800	Wp	Urine retention, blocked channels, stone diseases, heart disease, chest disorder, cough

Dactylorhiza hatagirea (Don) Soo	Hatajari, Paanch-anguli	Orchidaceae	Reg Himal	2800	4500	Tu	Wounds, bone fracture, expectorant, astringent, tonic, general debility
Delphinium brunonianum Royle	Kasturi Phool, Kasturi chey	Ranunculaceae	Reg Himal	3000	5500	Rt, St	Renal pain, body swelling, antiseptic to wash wounds
Delphinum vestitum Wall ex Royle	Nirbishi	Ranunculaceae	Reg Himal	2700	4700	Wp	Diarrhea, fever, cuts, wounds, antidote to snakebite
Elsholtzia stroblifera Benth.	Pothi, Puthoj	Lamiaceae	Reg Himal	1300	3800	Wp	Bruises, wounds
Epilobium royleanum Haussk.	Meelu, Bakury	Onagraceae	Reg Himal	1800	2700	Lv, Rt	Stringent, ringworm infection, remove warts
Euphrasia himalaica Wettst.		Scrophulariaceae	Reg Himal	3000	4500	Lv	Eye infection, cardiac ailments
Fritillaria roylei Hook. H (EN) A	Kakoli, Ksirakakol,	Liliaceae	Reg Himal	2700	4000	Rt (Bulb)	Injuries, general tonic, ingredient of Astavarga, rheumatism, asthma, tuberculosis
Galium aparine L.	Khuskusa, Kuri	Rubiaceae	Reg Bor temp. et Magell.	1000	2800	Lv	Astringent and skin diseases, cuts, burns
Gaultheria nummularioides Don	Bhwinla	Ericaceae	Reg Himal, Java	2100	4200	Lv	Antiseptic, neural-stimulus, carmine
Gentiana stipitata Edgew.	Neelkanthi	Gentianaceae	Reg Himal	3500	4500	Wp	Appetizer, stimulant
Geranium nepalense Sw.	Phori, Syunli	Geraniaceae	Ind or, China	1400	4000	Wp, Rt	Fever, renal disorders, itching, eczema
Geranium pratense L.	Meadow geranium	Geraniaceae	Europ., As. bo	3000	4500	Wp	Cough, cold, lung disease, eye disease, fever, lymph fluid disorder backache, joint pain, swelling of limbs, bile disease, stomach disease
Geranium wallichianum D. Don ex Sweet H SF, A	Lal Jari, Ratanjot, Raklamool, Chowhri	Geraniaceae	Reg Himal	2400	3600	Rt, Wp	Peptic ulcer, Toothache, external eye application, fresh juice used to stem bleeding
Goodyera repens R.Br.	Girwara	Orchidaceae	Reg Bor temp.	2200	3300	Wp	Blood purifier, syphilis
Impatiens racemosa Hk.f.	Chunchuni	Balsaminaceae	Reg Himal	1200	2700	Sd	Cough, cold
Impatiens scabrida DC.	Ban-til, Tillua	Balsaminaceae	Reg Himal	1500	2700	Sd, St	Abortifacient, edible
Iris kumaonensis Wall. Ex Don	Chyakri, Chyngru Kator	Iridaceae	Reg Himal	600	4200	Rt, Sd	Fever, epilepsy, urinary complaints, kidney troubles, cause dysentery
Jurinea dolomiaea Boiss.	Dhoop, Dhoop Lakkad	Asteraceae	Reg Himal	3000	4500	Rt	Roots used for incense, antiseptic, fever
Iris kumaonensis Wall. Ex Don	Chyakri, Chyngru Kator	Iridaceae	Reg Himal	600	4200	Rt, Sd	Fever, epilepsy, urinary complaints, kidney troubles, cause dysentery
Jurinea dolomiaea Boiss.	Dhoop, Dhoop Lakkad	Asteraceae	Reg Himal	3000	4500	Rt	Roots used for incense, antiseptic, fever
Lamium album L.	Tilka	Lamiaceae	Europe, Oriens	1500	3700	Wp,	Contraceptive
Malaxis muscifera (Lindl.) Kuntz.	Jeevak-bhed, Rishibhak	Orchidaceae	Reg Himal	1600	3600	Tu	Tonic
Meconopsis aculeata Royle	Himalayan Blue Poppy	Papaveraceae	Reg Himal	3000	4800	Rt, Lv	Narcotic, backache, renal pain, headache

Meconopsis paniculata Prain	Poppy	Papaveraceae	Reg Himal	3000	4400	Fl, Lv	Lung, liver fever, bile disease, swelling of limbs, sores
Megacarpaea polyandra Benth.	Barmoul, Rooki	Brassicaceae	Reg Himal	3300	4000	Rt, Lv	Intestinal injury, fever, dyspepsia
Morina longifolia Wall. ex DC.	Somrus, Bish kandara	Caprifoliaceae	Reg Himal	3000	3800	Rt, Lv	Vitality, strength, boils, Wounds, burns, unconsciousness
Nardostachys grandiflora DC.	Nahni, Masi, Jatamansi	Valerianaceae	Reg Himal	3600	4800	Rt	Ulcer, stimulant, stomachache, dysentery
Nardostachys jatamansi DC.	Mansi	Valerianaceae	Reg Himal	3500	4000	Rh	Epilepsy, hysteria
Neopicrorhiza scrophulariiflora (Pennell) Hong	Scrophulaariaceae	Scrophulaaria-ceae	Reg Himal, China	3500	4800	Rh, Rt	Cough, cold
Origanum vulgare L.	Ban tulsi, Jonkjari	Lamiaceae	Europe, As et Afr Trop	1000	4000	Lv, Wp	Diarrhea, bronchitis, colic, hysteria, menstrual complaints, influenza, tonic, stimulant, used to get rid of bad spirits
Oxalis corniculata L. H SF	Amrul, Bhilmora, Khattibuti	Oxalidaceae	Ce. Am	500	1500	Lf, Wp	Corn, cough, cuts, dysentery, insect bite, fever, Jaundice, wart, rickets, scurvy, stomachache, swell, open sores
Oxyria digyna (L.) Hill.	Anlu	Polygonaceae	Reg Bor alp. et arct.	3200	4500	Wp	Cooling, fever, indigestion, appetizer
Paeonia emodi Wall.	Chandrya, Udsalep	Paeoniaceae	Sibir	1500	3300	Rt, Fl, Rh.	Whooping cough, diarrhea, dysentery, intestinal spasm, appetite, urinary diseases, cuts, ulcers, controls maggots on animals
Parnassia laxmannii Pall. Ex Schult.		Parnassiaceae	Reg Himal	3000	4000	Wp	Cough, dyspepsia, fever, cold, stomachache
Parnassia nubicola Hk.f.	Phutkya, Nirbishi	Parnassiaceae	Reg Himal	1800	4200	Wp, Tu	Boils, burns, skin diseases, stimulate vomiting in case of food poison, antidote to snakebite
Parochetus communis Buch. -Ham. ex D. Don	Chemgeephul, Triptri	Fabaceae	Reg Himal, Ind or	1800	3000	Wp	Acidity and gastric problems, cuts, wounds
Pedicularis hoffmeisteri Klotzsch		Scrophulariaceae	Reg Himal	2300	4500	Lv, Fl	Circulatory system disorders, liver fever, bile disorders, wounds
Pedicularis pectinata Wall. Ex Benth.	Lousewort	Scrophularia-ceae	Reg Himal	3200	3800	St, Lv, Rt	Body ache, sedative
Picrorhiza kurroa Benth.	Kutki, Karoo	Scrophularia-ceae	Reg Himal	3500	4500	Rt, Rh	Fever, headache, indigestion, abdominal pain, blood purifier, used to extract picrorhizin
Pimpinella diversifolia DC.	Teroi, Phoree	Apiaceae	Reg Himal, China	1000	3200	Wp	Digestive complaints, cold, cough
Plantago himalaica Pilg.	Luhurya, Lahyrya	Plantaginaceae	Reg Himal	1500	3000	Wp	Dysentery, diarrhea
Plantago major L.	Kaneli	Plantaginaceae	Europe, As et Amer Bor	600	3200	Lv	Gastric troubles, intestinal injury
Pleurospermum angelicoides (DC.) Cl.	Chhipi, Gandrayan	Apiaceae	Reg Himal	2500	4000	Rt	Anthelmintic, gastric complaints
Pleurospermum brunonis Cl.	Lossar, Laser, Gokul Dhup	Apiaceae	Reg Himal	3000	5200	Wp	Massage with ghee on various body joints to relieve pain
Sinopodophyllum hexandrum Royle	Bankakri, Purhalo	Podophyllaceae	Reg Himal	2500	4000	Rt, Fr	Cough, wounds, fever, skin disease, breathing problems, cancer, purgative

Polygonatum verticillatum (L.) All.	Kantula, Khaul, Maha Maida	Liliaceae	Europe, As Bor	1200	3500	Rt, Tu	Gastric troubles, wounds, nervine tonic, aphrodisiac, appetite, fever, tonic, an ingredient of Ashtavarga
Polygonum amplexicaule Don	Dora, Ban Mandu	Polygonaceae	Reg Himal	3000	3500	Rt	Cut, wounds, stomach disorders
Polygonum recumbens Royle ex Bab.	Knotweed	Polygonaceae	Geront Trop et Temp	1800	2700	Wp	Blood purifier, skin disease, boils
Polygonum vaccinifolium Wall.	Knotweed	Polygonaceae	Reg Himal	3000	3800	Wp	Headache, diarrhea, giddiness, antidote to aconite poison
Polygonum viviparum L.	Amjabat	Polygonaceae	Reg Bor et Arct.	3000	5000	Wp	Intestinal bleeding, dysentery, diarrhea, sore throat, leucorrhea, lungs diseases, ulcer
Potentilla argyrophylla Wall.	Bajradanti	Rosaceae	Reg Himal	3000	4200	Lv, St	Toothache
Potentilla atrosanguinea Lodd.	Role	Rosaceae	Reg Himal	3000	4600	Lv	Wounds, analgesic
Potentilla fruticosa L. var. rigida (Lehm.) Wolf	Shrubby Cinquefoil	Rosaceae	Reg Bor Temp	2700	4300	Lv, Rt	Astringent, indigestion
Potentilla fulgens Wall. Ex Hk.f.	Akarada, vajradanti	Rosaceae	Reg Himal	2000	3200	Wp, Rt, Lv, Tw	Wounds, leopard bite, Stomatitis, aphthae, toothache
Potentilla multifida L.		Rosaceae	Europe, As Bor	3500	3900	Sd	Sleeplessness, induce sleep
Potentilla nepalensis Hk.		Rosaceae	Reg Himal	2000	2700	Rt	Fever, digestion, stomachache, burns
Primula denticulata Sm.	Jalkutra, Kanphool, Jayan	Primulaceae	Reg Himal	1800	4500	Fl, St	Diabetes, cold, headache, gastric complaints, urinary ailments, kill lice
Prunella vulgaris L.	Kalveoth	Lamiaceae	Reg Temp	1500	2800	Wp, Lv, Fl	Fever, gastric complaints, breath problems, cerebral complaints, lung diseases, liver complaints, headache
Ranunculus hirtellus Royle	Simariya, Piryal	Ranunculaceae	Reg Himal	1800	2800	Wp	Deteriorated wounds
Rheum australe Don	Dholu, Chhircha	Polygonaceae	Reg Himal	2700	4000	Rt, Lv	Roots and rhizome purgative, toothpowder, dysentery, fever, internal injury, bone fracture, indigestion, general debility, purgative, astringent
Rheum moorcroftianum Royle	Lajua, Tanturi	Polygonaceae	Reg Himal	3500	4800	Rt	Giddiness, cuts, wounds, dysentery, diarrhea, dyspepsia, purgative, internal injury in livestock
Rheum webbianum Royle	Archa, Tul Tanturi	Polygonaceae	Reg Himal	3500	4500	Rt	Appetizer, wounds, internal injury, headache, purgative, astringent
Roscoea alpina Royle	Jilsua, Kakoli	Zingiberaceae	Reg Himal	1000	3800	Lv, Wp	Cuts, wounds, tonic
Rumex nepalensis Spr.	Khatura, Amlya	Polygonaceae	As Occ, Ind or, Malaya, Afr, Austr	500	3000	Lv	Dysmenorrhea, stomachache, colic, boils, cooling diuretic, purgative, swelling of muscles, scurvy
Satyrium nepalense D. Don	Salam-mishri	Orchidaceae	Ind or	2000	3400	Rh	Diarrhea, aphrodisiac
Saussurea auriculata (DC.) Sch.	Thimra, Nurya	Asteraceae	Reg Himal	2000	3000	Lv	Venereal diseases

Saxifraga diversifolia Wall ex Springe	Silyans	Saxifragaceae	Reg Himal	2000	3000	Rt	Vermifuge
Scrophularia himalensis Royle	Sikula, Pani-jhar	Scrophulariaceae	Reg Himal	1500	2800	Lv	Wounds, insecticide
Selinum condollei DC.	Bhutkeshi, Moor	Apiaceae	Reg Himal	1800	2800	Rt	Hysteria, cough, asthma
Selinum vaginatum Cl.	Bhutkeshi	Apiaceae	Reg Himal	2500	3000	Rt	Hysteria, dysmenorrhea
Selinum wallichianum (DC.) Raizada & Saxena	Bhutkeshi, Moor, Murva	Apiaceae	Reg Himal	2700	4800	Rt, Fr	Cuts, wounds, antiseptic, check bleeding, colic, gastritis and intestinal, antioxidant, anti-fungal, anti-diabetic, epilepsy
Senecio laetus Edgew.	Zerjum	Asteraceae	Reg Himal	2000	3000	Wp, Fl	Insect bite, ringworm, puss formation in ear, inflammation of mouth, sore throat
Solidago virgaurea L.	Pinja-phool, Sonali	Asteraceae	Reg Bor temp.	300	3000	Lv, Wp, Rt	Throat irritation, asthma, kidney diseases, rheumatism, wounds, old ulcer, diuretic
Swertia alata Cl.	Chiratta	Gentianaceae	Reg Himal	1800	3300	Wp	Tonic, febrifuge
Swertia ciliata Burtt.	Kala Chiraita	Gentianaceae	Reg Himal	2200	4000	Wp	Malaria, fever
Swertia cuneata D. Don		Gentianaceae	Reg Himal	3600	5000	Wp	Bile disease, liver disease, cough, cold, fever, wind fever, bone fever, headache
Tanacetum longifolium Wall.ex.DC.		Asteraceae	Reg Himal	3300	3500	Lf	Stomachache, indigestion
Taraxacum officinale Weber	Kanphuliya, Karatu, Dudhee	Asteraceae	Reg Temp, Bor Austr	500	4500	Rt, Lv, Wp	Kidney diseases, gastric ulcer, liver complaint, dysentery, bowel complaints, blood purifier, headache, vertigo, dislocation of joints, wounds, mouth blisters, tonic, alcoholism, acidity, intestinal worms
Thymus linearis Benth.	Balmajhar, Mirchi Ghas	Lamiaceae	Europe, As et Afr Bor	2000	4500	Wp	Vermicidal, liver complaints, skin diseases, postnatal treatment, stomachache, heating effect, eye diseases, anthelmintic
Trillidium govanianum Wall. ex D. Don	Satwa, Nagchhtri	Melanthiaceae	Reg Himal	2700	3800	Rh	Analgesic, anti-inflammatory
Urtica dioica L.	Kandali, Kagoos	Urticaceae	Reg Bor Temp	600	3600	Lv, Rt	Injury, contraceptive, ripening of boils, internal injury
Valeriana hardwickii Wall.	Tagar	Caprifoliaceae	Reg Himal	1500	4000	Rh, Rt	As nervine, sleep disorders, reduce blood pressure, roots used as stimulant, carminative, antidote and antiseptic
Valeriana jatamansii Jones	Balchhari, Sumaya, Mushkabala	Valerianaceae	Reg Himal	2000	4000	Rt, Lv, Tu	Mental disorders, hysteria, urinary complaints, epilepsy, aphrodisiac, insecticide, incense
Viola biflora L.	Vanafsa, Dundubirali	Violaceae	Reg Bor Temp	2100	4500	Wp	Bronchitis, fever, cough, leukoderma and other skin diseases, emetic, diaphoretic
Viola pilosa Bl.	Vanfsa, Kauru	Violaceae	Ind or, Malaya, China	500	3000	Wp	Diaphoretic, body ache, emetic, asthma, bronchitis, wound, cuts, lung diseases

Shrub

Berberis aristata (Roxb.) DC.	Kingor	Berberidaceae	Ind or	1800	3000	Fr, Rt	Eye diseases, diarrhea
Berberis kumaonensis Sch.	Kingora	Berberidaceae	Reg Himal	2700	4000	Rt	Skin diseases, menorrhea, blood purifier, malaria, jaundice, eye diseases, astringent
Berberis lycium Royle	Kasmal, Kirmora	Berberidaceae	Reg Himal	1500	3000	Rt	Piles, jaundice
Cassiope fastigiata Don	Thamban	Ericaceae	Reg Himal	2800	5000	Wp	Itching
Cotoneaster acuminata Lindley	Ruins, Rensu.	Rosaceae	Reg Himal	2000	3900	Lv	Arthritis, rheumatic, urine trouble
Cotoneaster microphylla Wall. Ex Lindl.	Bugarchilla, Wanni.	Rosaceae	Reg Himal	2000	3000	Lv, Fr	Diarrhea, astringent
Gaultheria trichophylla Royle	Jheri	Ericaceae	Reg Himal	3000	3600	Lv, Fr	Wound, cough
Hypericum uralum Buch. -Ham ex Don	Bhyoul	Hypericaceae	Reg Himal	600	3000	Sd	Food poisoning, abortifacient
Juniperus indica Bertol	Billa, Sirsing, Bitharu	Cupressaceae	Reg Himal	3700	4500	Lv, Fr, Tw	Anti-inflammatory, antibacterial, diuretic functions, kidney disorders, skin, lymph disease, fever, cough, cold, sores, wounds
Leycesteria formosa Wall.	Bhujnali, Danda, Bheker	Caprifoliaceae	Reg Himal	1000	2800	Lv	Dandruff, lice
Piptanthus nepalensis D. Don	Chembera	Fabaceae	Reg Himal	2000	2700	Sd, Lv	Galactagogue
Rhododendron anthopogon Don	Talsi, Kouti	Ericaceae	Reg Himal, As Bor	3000	4300	Lv	Bronchitis, headache, cold, cough
Rhododendron campanulatum Don	Ratpa, Simru	Ericaceae	Reg Himal	3000	4000	Rt, Lv	Boils, cold, cough, fever, headache, rheumatism, skin diseases, sciatica, syphilis, hemicrania
Rhododenron lepidotum Wall. Ex G. Don	Atarasu, Sumral, Simris	Ericaceae	Reg Hmal, Java	2400	4500	Lv	Arthritis, inflammation
Ribes glaciale Hook.f. & Thomson		Grossulariaceae	Reg Himal	2600	4000	Wp	Antioxidant, anti-inflammatory, analgesic, diuretic
Ribes himalense Royle ex Decne	Kaladani, Kimkolia	Saxifragaceae	Reg Himal, Europ. bor.	3000	4500	Lv	Dysentery, cuts, wounds
Rosa macrophylla Lindl.	Dand-kunja	Rosaceae	Reg Himal, China	1500	3000	Fr	Paste applied on skin ailments
Rosa sericea Lindl.	Dhurkunja, Shedham	Rosaceae	Reg Himal	2200	3800	Rt, Sd	Uterine disease, headache, liver complaints
Rubus nepalensis Kuntze	Gangoor	Rosaceae	Reg Himal, Ind or	2000	3000	Fr	Paste externally used on burns
Rubus niveus Thunb.	Kala Hisalu	Rosaceae	Ind or, Malaya, China	650	3000	Fr, Rt	Antioxidant, anti-Inflammatory, antifungal, antibacterial, inflammation, dental caries, colitis, obesity, edema, diarrhea, fever, fatigue, cough, hypoxia, headache, asthenia, hyperalgesia, diabetic, antidote of snakebite
Spiraea bella Sims.	Kuji	Rosaceae	Reg Himal	2100	3000	Sd	Paste applied to wash sores and wounds

Syringa emodi Wall ex Royle	Ghiya, Shafori	Oleaceae	Reg Himal	2500	2800	Sd, Fl	Fever
Viburnum grandiflorum Wall. ex DC.	Thakla, Teelinh	Caprifoliaceae	Reg Himal	1800	2800	Fr	Hepatic troubles
Climbers							
Clematis barbellata Edgew.	Kanguli	Ranunculaceae	Reg Himal	3000	3400	Rt, Lv	Skin diseases, itching
Rubia cordifolia L.	Kasoos	Rubiaceae	As Trop, Temp Afr Trop	600	2700	Rt, St	Blood clotting agent, menorrhagia
Pteridophyte							
Lycopodium clavatum L.		Lycopodiaceae	China, Japan, Korea	1000	3000	Wp	Skin eruptions, urinary complaints, constipation

Appendix 3. Details of medicinal and aromatic plants at and around Tungnath region, Uttarakhand. Abbreviations used are: Bb = Bulb, Bk = Bark, Fr = Fruit, Fl = Flower, Lv = Leaves, Re = Resin, Rh = Rhizome, Rt = Root, Sd = Seed, Sh = Shoot, Sp = Sap, St = Stem, Tw = Twig, Wp = Whole plant.

Appendix 4

Appendix 4. Tungnath's beauty is fading under the strain of uncontrolled tourism, mule traffic and haphazard developmental activities, like hotel and shop constructions (top left), uncontrolled sheep and goat grazing by herders in subalpine forest gaps (top right), camping in forest gaps (middle left), uncontrolled visitation by tourists and pilgrims in pristine alpine meadows (middle right), wild flower collection by local shopkeepers for sale as well as for show (lower left and right).