



## 11.0 The Alpine Landscape in Western Sikkim: Special Habitats and Threatened Plants

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### Introduction

The alpine landscape in the Himalaya is lined up as an archipelago on high mountains at the southern periphery of the high central Asia, separated from each other by deeply incised transverse valleys (Miehe 1997). Spread on either side of the Greater Himalaya or *Himadri*, this zone exhibits exceptional ecological, geohydrological, aesthetic and biological values. This zone is demarcated by a distinct treeline towards lower elevation that lies around 3300+200 m above msl in the western and 3800+200 m in the eastern Himalaya. The area immediately above natural treeline is usually occupied by a range of vegetation formations such as *Krummholz* (= stunted forest or crooked wood, German), matted strands of shrubs, herbaceous meadows, bogs, and fell-fields paved with mosses and lichens.

The alpine region in Sikkim and other parts of eastern Himalaya differs considerably from that of western Himalaya in terms of extent, terrain, climate, plant community composition, primary productivity, faunal assemblages and history of human use. This zone becomes rather limited in extent and fragmented from west to east. The eastern Himalaya has a prolonged monsoon season from June to September and little precipitation is received from western disturbances in winter. The western Himalaya, on the other hand, has a short monsoon from July to August and a fairly long wet season from November to April. The eastern Himalaya is more tropical in latitude and is geographically closer to the Bay of Bengal and heavily influenced by the monsoon winds. Consequently, it has an oceanic climate with higher humidity and exhibits higher seasonal primary productivity. The tree line is higher at 4000 m and the permanent snow line at 5500 m. The *krummholz* and alpine scrub zone is also more extensive. It has a relatively recent history of extensive grazing and pristine areas with an insignificant history of grazing still exist. The recent geological origin, limited extent and fragmentation, steeper terrain and higher rainfall make them more fragile as compared to the western Himalaya.

The Khangchendzonga NP is located on the western flank of Sikkim (India) between 27° 30' to 27° 55' N latitude and 88° 02' and 88° 37' E longitude and spreads over 1784 km<sup>2</sup> adjacent to Nepal. The park is named after Mt. Khangchendzonga (8586 m), the third highest peak in the world. The park covers nearly 25% of the geographical area of the state (Sikkim). The climate of KNP is characterized by a long monsoon followed by a long winter. The annual rainfall varies from more than 300 cm in the southern part to less than 150 cm in the north and altitude ranges from ca. 1220 m to 8586 m. As per the classification by Champion & Seth (1968), as many as 18 distinct types and sub-types are discernible within KNP. Floristic study by Maity and Maiti (2007) indicates that the KNP and surrounding buffer forests harbour about 1580 species of vascular plants which include 106 species of Pteridophytes, 11 Gymnosperms and 1463 Angiosperms. The alpine zone as used in this article includes the areas between 4000 and 5000 m elevation. Physiognomically it starts from where the *Krummholz* thickets end and the alpine scrub begins and extends up to the subnival vegetation. About 22% of the park with an extent of 390 km<sup>2</sup> falls within this zone.



## Vegetation Structure and Composition

The alpine meadows of KNP are dominated by sedges namely *Kobresia nepalensis* (on smooth slopes), *Kobresia duthiei* (on broken slopes) and *Kobresia pygmaea* and *Kobresia schoenoides* (in dry meadows). Grassy meadows of *Danthonia cachemyriana* and tall forb communities in deep soil are more characteristic of the western Himalaya and were virtually absent in KNP (Rawat 2005). The major grass-dominated vegetation in the KNP is the *Deschampsia caespitosa* marsh meadow found only in the fringes of glacial lakes and streams. The subalpine thickets of *Rhododendron* and alpine scrub vegetation of *Rhododendron*, *Cassiope* and *Juniperus* is much more extensive in the Sikkim Himalaya. Based on numerical classification the vegetation of the alpine zone was segregated into 11 types namely, krummholz thicket, Juniper scrub, *Rhododendron* scrub, morainic scrub, *Salix sikkimensis* riverine thicket, *Myricaria rosea* riverine scrub, *Kobresia nepalensis* moist meadow, *Kobresia duthiei* moist meadow, *Kobresia pygmaea* moist meadow, *Deschampsia caespitosa* marsh meadow and *Anaphalis xylorhiza* dry meadow (Plates 11 A & 11B). Brief description of the special habitats is as follows:

**(i) Krummholz thickets** : Extensive *Krummholz* thickets are found between 3600 to 4200 m. This category extends upwards from the tree line and gradually becomes stunted with elevation before giving way to the alpine scrub communities. They favour shady and moist localities and are most luxuriant in the north and northwest aspects especially on rocky slopes. The vegetation formation is dense, thicket forming and impenetrable with the canopy height generally varying between one to four meters mostly dominated by various species of *Rhododendron*. The following associations are easily identifiable viz., *Rhododendron campanulatum*, *R. lanatum*, *R. thomsonii* and *R. wightii* – *R. fulgens*. The floor is thickly carpeted with mosses and fallen leaves and the ground flora is generally sparse (Plate 11A).

**(ii) Alpine scrub** : Dwarf *Rhododendron* scrub is widespread in the higher reaches above the *Krummholz* zone. This category (less than 1 meter tall) represents alpine moist scrub and favours the north - northeastern aspects between 3900 to 4600 m. This vegetation is very dense and the *Ericaceous* cover is more than 50% with very few gaps or openings. The shrub layer is co-dominated by three species of *Rhododendron*, viz., *R. anthopogon* (sun-pate), *R. setosum* and *R. lepidotum*. Juniper scrub is found generally between 3700 to 4400 m on warmer slopes i.e, south and southwest aspect. The characteristic species are *Juniperus recurva* and *J. indica*. The former is prostrate in habit and found more commonly between 3700 - 4100 m, while the latter usually occurs in the form of erect shrub between 4000 to 4400 m. In the inner dry valleys this Juniper ascends up to 4800 m.

**(iii) *Kobresia nepalensis* moist meadow** is the most widespread and dominant vegetation in altitudes ranging from 4000 to 5100 m in the alpine zone. It occurs most luxuriantly on the smooth slopes and ridge tops in the upper reaches of moist, exposed, glaciated valleys. This dense soft mat like formation has an average height of 0.1 m. The cover of *Kobresia nepalensis* (sun buki) varies a lot with micro-topography and co-dominates with *Bistorta milletii*, *Potentilla peduncularis*, *Rhododendron lepidotum*, *Primula capitata* and species of *Arenaria*, *Juncus* and *Carex*. Openings in rich soils are colonized by *Potentilla peduncularis*, around cattle camps by *Ranunculus hirtellus* (khorsane) and compacted soils by *Bistorta* sp., *Picrorhiza scrophulariiflora* (kurki), *Lomatogonium* spp. (Vern. Sharmaguru and Mahaguru) are the valuable ethno-medicinal plants found in this vegetation. This is the most extensive and nutrient rich vegetation that sustains livestock and wild ungulate populations in the KNP.

**(iv) *Kobresia duthiei* moist meadow** found in pockets prefers moist valleys on slopes that are bouldery and steep in the 4000 to 4600 m elevation zone. The vegetation is tussock forming dominated by *Kobresia duthiei* (cover greater



than 40%) with an average height of 0.30 m. In openings *K. nepalensis*, *Kobresia capillifolia*, *Rheum acuminatum*, *Rhododendron anthopogon*, *Geranium donianum* and species of *Heracleum*, *Swertia* sp. and *Pleurospermum* and *Juncus* are usually found. Good population of valuable medicinal plants like *Aconitum ferox*, *Nardostachys grandiflora*, *Bergenia purpurascens* can be seen at such sites.

(v) *Kobresia pygmaea* moist meadow is found in the upper reaches of the glaciated and relatively dry Zemu and Lhonak valleys in the elevation range of 4400 to 5100 m. As the name suggests in the upper reaches this vegetation is stunted having average height of 0.05 m. In the lower reaches, especially along streams *Kobresia schoenoides* and *Bistorta vivipera* and in the upper reaches *Kobresia* spp., *Bistorta milletii*, *Potentilla fruticosa* and *Aster falconeri* co-dominate.

(vi). *Anaphalis xylorhiza* dry meadows are found in the trans-Himalayan glaciated valley flats usually between 4500 to 5100 m. This Tibetan steppe like vegetation grows in dry, arid conditions and is characterized by dwarf herbaceous formations (average height is 0.1 m). The total vegetation cover is not more than 40%. *Anaphalis xylorhiza* is the dominant species (cover greater than 20%) with other associates such as *Bistorta vivipera*, *Kobresia schoenoides*, *Kobresia nepalensis*, *Lancea tibetica* and various species of *Arenaria* and *Pedicularis*. Other species include *Aster diplostephiodes*, *Delphinium caeruleum*, *Cyananthus incanuns*, *Cortiella* sp., *Scabiosa* sp., *Gentiana stipitata*, *Lonicera rupicola*, *Elymus nutans* and species of *Rhodiola* and *Oxytropis*.

### Floristic Structure and Threatened Plants

Based on extensive floristic surveys conducted during 2004 - 2007, we have recorded a total of 585 species of angiosperms within the alpine zone of KNP. These belong to 67 families and 243 genera. The dominant families are Asteraceae (69 species), Ranunculaceae (35 species), Poaceae (32 species), Scrophulariaceae (30 species), Cyperaceae (28 species) and Rosaceae (28 species). The prominent genera are *Pedicularis* (21 species), *Carex* (18 species), *Saxifraga* (18 species) and *Rhododendron* (17 species). The gymnosperms in the subalpine and alpine zones include *Taxus baccata* subspecies *wallichiana*, *Tsuga dumosa*, *Abies densa*, *Juniperus indica*, *Juniperus recurva* and *Ephedra gerardiana*. The KNP along with the adjacent reserve forests is home to as many as 22 endemic and 22 rare and threatened plants. Species of high conservation value and botanical interest in sub-alpine and alpine areas include *Schizandra grandiflora* (a primitive climber with flowers like miniature *Magnolia*), *Helwingia himalaica* (bearing flowers at the center of the leaf and endemic to the Eastern Himalaya), *Circaea agrestis* (*Chloranthaceae* of uncertain affinity), *Pinguicula alpina* (an insectivorous plant), *Triosteum himalayanum* (endemic to Himalaya), *Brachycaulos simplicifolius* (an unusual herb of *Rosaceae*) among others. Few more alpine plants needing special mention for their high conservation significance are the wild poppies (*Meconopsis* sp.) which bear spectacular flowers and have several medicinal properties, species of *Corydalis*, *Rhodiola*, *Pleurospermum*, *Saussurea*, *Primula*, *Gentiana*, *Swertia*, *Pedicularis*, *Polygonatum* and several ground orchids. Among the rhubarb species *Rheum nobile* is particularly vulnerable owing to its striking inflorescence which is often plucked by the herders and local communities to make pickle.

Key floral species for conservation are *Rheum nobile* (Kenjo), *Gymnadenia orchidis* (panch amle), *Nardostachys grandiflora* (jatamansi), *Ephedra gerardiana*, *Picrorhiza scrophulariiflora* (kurki), *Aconitum ferox* (Bikh), *Saussurea obvallata*, wild Alliums, Giant Lily (*Cardiocrinum giganteum*), Pseudo-ginseng (*Panax pseudo-ginseng*), *Pleurospermum* sp. and Caterpillar-mushroom (*Cordyceps sinensis*). Status of a few species is given below :



***Saussurea obvallata* (DC.) Sch.-Bip. (Asteraceae)**

Local Name : *Brahma-Kamal*

**Distribution** : Relatively drier valleys of Lachen and Lachung in North Sikkim

**Habitat** : Along streams in sub-alpine fir and alpine scrub habitats between 3,500 to 4,000 meters elevation

**Threat** : Grazing and inflorescence valued as an offering to Hindu deities

***Gymnadenia orchidis* Lindl. (Orchidaceae)**

Local Name : *Panch-Amle*

**Distribution** : Relatively moist valleys in West and North Sikkim

**Habitat** : Sub-alpine fir and alpine scrub habitats between 3,000 to 4,000 meters elevation

**Threat** : Digitate tuber collected for medicinal purposes

***Rheum nobile* Hook. f. & Thorns. (Polygonaceae)**

Local Name : *Kenjo*

**Distribution** : Endemic to Eastern Himalaya, it is distributed in the moist valleys of Sikkim

**Habitat** : Scree slopes in the high alpine areas between 4,700 to 5,500 meters elevation in skeletal soils

**Threat** : Grazing and collection by herders for making pickle

***Aconitum ferox* Seringe (Asteraceae)**

Local Name : *Bikh*

**Distribution** : Moist valleys of Sikkim

**Habitat** : Sub-alpine fir and alpine scrub habitats between 3,000 to 4,000 meters elevation

**Threat** : Tuber collected for medicinal purposes

## Impacts of Anthropogenic Activities

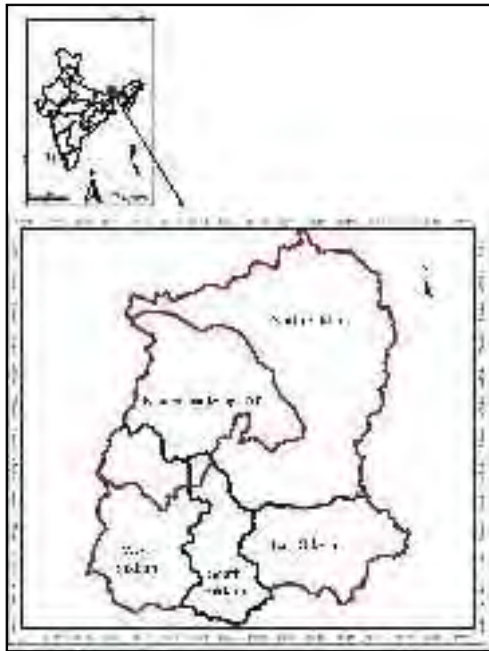
Pastoralism, collection of medicinal and aromatic plants and subsistence hunting were the main livelihoods prevalent in the KNP traditionally, while trekking tourism has expanded rapidly since early 1990s. Major impacts of anthropogenic activities on alpine vegetation are discussed below:

**i. Impacts of Pastoral Practices** : In the KNP the livestock biomass increased from 608 metric tonnes in 1950 to 763 metric tonnes in 2004 owing to a substantial rise in the populations of yak and cow-yak crossbreeds. The livestock impact units in the winter pastures increased more than 8 times from 2 to 17 Livestock Unit days ha<sup>-1</sup> during this period. The main impacts of pastoralism on the natural environment are clearing and burning of forests, localized extraction of slow growing Juniper and Rhododendron firewood and a decline in the population of grazing sensitive plants. The herders carried out habitat manipulation by converting vegetation types like Juniper scrub in the alpine zone and the oak, hemlock and fir forests in the temperate and sub alpine zones into artificial pastures. Plants sensitive to yak grazing found in pastures not grazed by them are *Heracleum* sp. (ganer), *Allium pratti* (dandu), *Kobresia duthiei* (bhalu buki), *Pleurospermum* spp. (seto cheeru and shyamphul), *Saussurea obvallata* (brahma kamal) and *Saussurea uniflora* (thulo dudhe jhaar). These plants are annual or biannual, tall and regarded as nutrient rich by the herders.

**ii. Impacts of Medicinal and Aromatic Plant Collection** : Alpine medicinal plants mostly *Aconitum ferox* (bikh) and *Picrorhiza scrophulariiflora* (kurki) were in high demand and were collected from 1970s to 1990s in truckloads with dried tubers of *Bikh* fetching USD 0.33 kg<sup>-1</sup> and dried stems of *Kurki* fetching USD 0.44 kg<sup>-1</sup>. The state government banned the commercial collection of medicinal plants for ten years from 2001 onwards. Aromatic plants *Juniperus recurva* (sikpa) and *Juniperus indica* (bhairung) were in high demand for incense making and large scale commercial collection was done by the yak and dzo herders between 1970s and 1990s. Dried *Juniperus recurva* used to fetch USD



**Plate 11A**  
**Alpine Habitats of Khangchendzonga NP, Sikkim**



*Krummholtz* thicket (3800 – 4400m)



Juniper scrub (4000 – 4400m)



Rhododendron scrub (4000 – 4500 m)



*Kobresia* meadow



*Kobresia pygmaea* moist meadow



*Anaphalis xylorhiza* dry meadow



**Plate 11B**  
**Some Threatened Plants of Alpine Zone of Sikkim**



*Saussurea obvallata*  
(BRAHMA-KAMAL)



*Gymnadenia orchidis*  
(PANCH-AMLE)



*Rheum nobile*  
(KENJO)



*Aconitum ferox*  
(BIKH)



0.033 kg<sup>-1</sup> while dried *Juniperus indica* USD 0.056 kg<sup>-1</sup> in the local market and were collected in truckloads. At present no apparent impact of past collection was noticeable except very low populations of the high value species in south-western parts of KNP. The abundance of these plants is relatively better in Zemu valley, which has remained relatively untouched in terms of commercial exploitation of plants.

**Conservation Action :** In Sikkim a determined political leadership along with strong support from the local people is initiating conservation action to reduce the yak (and their hybrid) numbers in the greater Himalayan part of KNP while also providing alternative livelihood support to the herders from ecotourism enterprise. Consequently over the last few years the livestock population in the KNP has reduced significantly. Commercial harvest and transit of medicinal and aromatic plants has been banned from the forest areas of the State since 1990 owing to degradation of habitat and rapid depletion of this valuable resource.

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### References

- Champion, H. G. & S.K. Seth. 1968. *A revised survey of forest types of India*. Manager of Publications, Government of India, New Delhi.
- Maity, D. & G.G. Maiti. 2007. *The wild flowers of Kanchenjunga Biosphere Reserve, Sikkim*. Naya Udyog, Kolkata.
- Miehe, G. 1997. Alpine vegetation types of the Central Himalaya. pp. 161-184. *In*: Wielgolaski F.E. (ed.) *Polar and alpine tundra Ecosystems of the world*. Volume 3. Elsevier, Amsterdam and New York.
- Rawat, G. S. 2005. *Alpine Meadows of Uttaranchal: Ecology, Landuse and Status of Medicinal and Aromatic Plants*. Bishen Singh Mahendra Pal Singh, Dehra Dun.