1.0 Special Habitats and Threatened Plants of Ladakh

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Introduction

Located in the rain shadow of the Great Himalayan massif, Ladakh forms a major portion of the Indian Trans-Himalaya. Also known as 'Little Tibet', this region is spread over some 96,700 km^2 area in the state of Jammu & Kashmir. The region exhibits typical biophysical features of cold deserts having low precipitation and mean annual temperature, short growing season, low primary productivity and sparse vegetation cover. Biogeographically, it is divisible into two provinces *viz*., Ladakh Mountains and Eastern Plateau (Rodgers & Panwar 1988). The former includes rugged mountain ranges and valleys while the latter is gently undulating elevated landscape that forms the western extension of Tibetan Plateau (Plate 1). Floristically, Ladakh is not as rich as comparable altitudes of Greater Himalaya, but it supports a unique assemblage of flora having close affinity with Central Asia and Tibetan plateau. The region has an enormous variation in altitude (2600 to >6500 m asl). Snowline in the Trans-Himalaya is located at much higher altitude (5800 – 6000 m) as compared to Greater Himalaya where it is usually around 5500 m. This provides adequate area for the plants of high alpine and sub-nival zone. The interface between the moist alpine zone of Greater Himalaya and the cold arid region is generally sharp. Mean annual precipitation varies from 50 to 150mm and it increases at higher altitudes, while deep river valleys such as lower Nubra and Zanskar are particularly dry. The arid landscape is interspersed with glacial streams, rivers and lake basins which form crucial Life -Support System for all living forms and provide ecosystem services. Geologically, Ladakh is quite diverse and divisible into several zones, each comprising a series of formations and sedimentary sequences ranging in age from recent to Cretaceous period which have undergone complex tectonic evolution (Frank *et al.* 1977, Thakur & Rawat 1992). In the extreme west there are basaltic formations (Dras volcanics), while in the north-eastern parts one comes across the remnant Tethyan sea beds.

Based on extensive floristic surveys, Kachroo *et al.* (1977) have reported 611 species of flowering plants from Ladakh. However, recent estimates suggest that the number may be much higher. Dickore & Miehe (2002) estimate that for most of the ladakh the richness of vascular plants may be about 500-1000 species per 10,000 km^2, while in Karakoram and north-eastern Ladakh the plant species richness is much lower *i.e.*, <300 species per 10,000 km^2. In recent surveys of south-eastern Ladakh, Klimes (2003) recorded 404 species of vascular plants in about 10,207 km^2 area. The life-forms of the plants exhibit high adaptability to extreme climatic conditions and biotic pressures (Klimes 2003, Rawat & Adhikari 2005). The dominant families of angiosperms are Asteraceae, Poaceae, Rosaceae and Brassicaceae having about 135, 130, 60 and 57 species respectively. The prominent genera are *Saussurea*, *Astragalus*, *Oxytropis*, *Potentilla*, *Carex* and *Polygonum*, each having more than 20 species. The area is diverse in wild legumes (11 genera and 45 species) which enrich the alpine steppe habitat. Despite numerous floristic surveys by various organizations, a comprehensive flora giving updated nomenclature, site specific distribution of species, patterns of rarity and endemism is still lacking for the region.

Special Habitats

Extreme fluctuation of daily temperature, strong winds, sandy soil, solifluction at the higher altitudes and high salinity in the pan shaped lake basins have given rise to a number of unique landforms, micro-habitats and plant communities. In the absence of detailed geo-botanical surveys, it is difficult to paint a complete picture of plant communities and their

distribution across all the habitats. Here, only a few examples of special landforms and corresponding vegetation types have been described. These 'Special Habitats' reflect peculiar ecological settings and harbour unique plant assemblages including some of the rare and threatened species (Plate 1).

i. *Moist meadows Zanskar Ranges*

The areas immediately north of Greater Himalaya, especially in the moist pockets of Zanskar range and northern slopes of Nun Kun, Kolahoi and Zoji La are characterized by the presence of moist meadows rich in herbaceous flora. The basins of larger mountains *e.g.*, Surru, Kargil and Dras, especially towards higher slopes receive higher snow during winter which support extensive grassy slopes dominated by *Festuca kashmeriana*, *Oryzopsis munroi* and *Melica persica*. Moist slopes harbour a rich array of medicinal and aromatic plants including *Ephedra gerardiana*, *Podophyllum hexandrum*, *Inula rhizocephala*, *Iris ensata*, *Swertia speciosa*, *Arnebia euchroma*, *Bistota affinis*, *Cicer microphyllum*, *Geranium grevilleanum*, *Allium carolinianum* and *Rheum australe* to name a few. *Pulsatilla wallichiana*, one of the little known anemones, can be seen occasionally on these slopes. *Colchicum luteum*, a valuable medicinal herb is found in moist meadows around Dras.

ii. *Marsh meadows of Changthang*

Several lake basins and seasonally inundated banks of Indus in Changthang have given rise to lush green marsh meadows which are patchy but rich in plant life. Pools of shallow water support a number of aquatic species such as *Potamogeton pectinatus*, *Myriophyllum verticillatum*, *Hippuris vulgaris*, *Ranunculus natans* and *R. trichophyllus.* The marsh meadows are dominated by sedges (species of *Carex*, *Blysmus*, *Kobresia* and *Eleocharis*) and a few grasses *e.g.*, *Calamogrostis holciformis*, *Poa* spp., *Puccinellia* spp. Typical herbaceous elements in marsh meadows include species of *Ranunculus*, *Pedicularis*, *Gentiana*, *Gentianella* and *Primula*. Some of the species, typical of saline marshes (halophytes) are *Atriplex tatarica*, *Pucinellia himalaica*, *Suaeda olufsenii*, *Triglochin maritimum* and *Glaux maritima.* Rawat & Adhikari (2005) have identified several communities along moisture gradients in Tso Kar basin, Changthang.

iii. *Craggy Rock Surfaces in Zanskar*

A few pockets in the Zanskar range exhibit special lithological features making them unique. For example, higher slopes of Naki La, adjacent to Lachung La that rise abruptly above Yunam River consist of monotonous, phyllitic, olive coloured shales with fine graded sandstones intermingled with 'exotic' limestone. Geologically such areas correspond with Namik La Flysch. Floristically such areas are quite diverse and interesting. Among the rocky crags of Naki La (eastern Zanskar) the plant communities comprise dwarf *Isopyrum anemonoides*, *Silene viscosa*, *Minuarta biflora*, *Valeriana himalayana*, *Rhodiola fastigiata*, *Saxifraga* spp., *Biebersteinia odora* and *Festuca kashmiriana* to name a few.

iv. *Scree bases*

Scree bases (colluvial deposits) and tallus along valley bottoms in Zanskar and other parts of Western Ladakh represent yet another special habitat. Such areas, usually parallel to stream or river courses, harbour several characteristic species *e.g.*, *Lamium rhomboideum*, *Corydalis crassifolia*, *C. moorcroftiana*, *Astragalus nivalis*, *Oxytropis tatarica*, *Rheum tibeticum*, *Elymus nutans*, *Aquilegia fragrans*, *Thermopsis inflata* and *Silene hispida*. It appears that most of these species are dispersed mechanically along with loose cobbles and are well adapted to grow in such habitats. Some of the species *viz.*, *C. crassifolia*, *T. inflata* and *A. nivalis* have typically swollen or inflated fruits to aid wind dispersal along valley bottoms.

v. *Riverine Scrub*

Two species of *Hippophae*, *viz.*, *H. rhamnoides* ssp. *turkistanica* and *H. tibetana* form major constituents of riverine scrub in Ladakh. While the former is much taller (>1 m) and forms dense thickets along the banks of Indus, Shyok and Nubra rivers, the latter, a dwarf (<50 cm) shrub, forms extensive patches in flat terminal moraines and alluvial areas in Zanskar and Surru valleys. Common associates of *H. rhamnoides* are *Myricaria germanica* and *Phragmites australis.* Along the hill streams *M. elegans* forms gregarious and pure stands of riverine scrub. In Nubra valley, in addition to these species *Tamarix gallica* and *Rosa webbiana* are common elements of riverine scrub. *Salix flabellaris* and *S. pycnostachya* are the common willows which can be seen along riverine areas in the Zanskar and much of the lower Ladakh (<4000 m). The riverine scrub in Nubra and other parts of Ladakh serve as most important habitats for critically endangered species of mammals such as lynx (*Felis lynx*) and Nubra pika (*Ochotona nubrica*) which are confined to only a few localities in Ladakh and Nubra respectively (Chundawat & Rawat 1994).

vi. *Scrub Steppe*

Well drained, relatively moist slopes in Changthang support typical scrub steppe dominated by *Cargagana versicolor*, a key-stone species in the region. The mosaics of *Caragana* sp. scrub on gelifluction lobes give a peculiar appearance to the landscape which can be seen on eastern slopes of Taklang La and other parts of Rupshu. Depending upon the micro-topography and soil depth several scrub communities have been identified in Changthang area *e.g.*, *Caragana – Artemisia*, *Artemisia – Eurotia* and *Artemisia – Tanacetum* (Rawat & Adhikari 2005). Towards inner dry ranges especially wind blown slopes of Khardung La and Chang La, patches of *Acantholomon lycopodioides* form pure stands, while dry alluvial fans, flat terraces and valley bottoms (*ca*. 4000 m) in Nubra valley are frequented by *Ephedra gerardiana.* The latter is also found in association with other shrubs in Nubra valley *e.g.*, *Lycium ruthinicum* and *Tamarix gallica*.

vii. *Fell-fields and sub-nival zones*

The sub-nival zone that lies usually above 5000 m asl, is characterized by very short (1-2 months) growing season and extremely harsh climatic conditions. Such areas are usually unstable due to snow and avalanche action and hence support very low vegetation cover. The stable and sheltered areas with higher moisture support mosses and lichens. Some of the typical angiosperms in these areas are *Carex nivalis*, *Saussurea gnaphaloides*, *S. medusa*, *S. glacialis*, *S. werneroides*, *S. nana*, *Draba altaica*, *Saxifraga hirculoides*, *Androsace tapete*, *Rhodiola tibetica* and *Leontopodium alpinum*. At such heights, especially on gentle slopes one can often see the fell-field and cushion forming communities of *Thylacospermum – Arenaria* and *Androsace* species.

viii. *Remnant woodlands*

Palaeobotanical evidences suggest that several parts of Zanskar and Lower Ladakh had much more extensive patches of natural woodlands in the past which have declined rapidly due to combined action of anthropogenic pressures and increasing aridity. Some of the remnant patches of natural woodland, especially of birch (*Betula utilis*), juniper (*Juniperus semiglobosa*), elm (*Ulmus wallichiana*) and some poplars (*Populus euphratica*, *P. ciliata*, *P. alba*) can be seen in Western Ladakh and Nubra Valley. No efforts have been made to delineate or notify such patches for further conservation. In some of the valleys natural woodlands have been replaced by plantations of willow and exotic poplars (*Salix* spp, *Populus nigra*, *P. balsamifera*). Junipers as well as birch are mainly harvested for religious ceremonies and fuel. As a result, they have disappeared from much of their range in Nubra, Khaltse and Chilling-Zanskar road area.

Threatened Plants

Ladakh lies at the cross roads of floral migration between Central Asia and Greater Himalaya. Therefore, the level of endemism in the flora of Ladakh is relatively low (<6%). Several species which exhibit range extension into Ladakh from adjoining floristic regions such as Tibetan plateau, Greater Himalaya or Mediterranean region may have small and fragmented populations within this area. Other species are sparsely distributed owing to limited habitats available to them. The high value medicinal and aromatic plants having narrow distribution range and low populations are particularly threatened in the region. Some of the threatened plants of Ladakh, their brief description, distribution and causes of threat are given below:

1. *Colchicum luteum* Baker (Liliaceae)
English Name : Golden Collyrium

An annual herb. Stem-base below the ground, thickened into a solid, thick, fleshy, gibbously-ovoid corm with dark-brown scales and a longitudinal groove on one side, having 2 daughter-corms, one at the base and other at the top, 15-30 x 8-15 mm. Leaves few, all radical, 3-5, dark green, linear-oblong or oblanceolate obtuse, appearing with or after flowering. Flowers golden yellow, 1-2, on a very short stalk or scape among leaf-sheaths. Fruits 2.5-3.8cm long capsules with long recurved beake, having numerous seeds. Seeds are brownish-white, globose or irregularly globular, 2-3mm in diameter.

Found on moist slopes – sparsely distributed in parts of Dras. Also found at higher alpine meadows of Kashmir Valley. Corms are used widely as medicine in the treatment of gout (seed and corm) and also as alterative, aphrodisiac, carminative and laxative. Seeds contain 'colchicine', a valuable alkaloid used widely in cytological studies and it is known to induce polyploidy. Major threats include over exploitation and habitat degradation.

2. *Inula rhizocephala* Schrenk. (Asteraceae)
Local Name : *Turzit*

Dwarf, stemless herbs. Leaves in rosettes, ad-pressed to the ground, 3-5 cm long, bristly hairy. Heads yellow, 1.6-2.5 cm across, collected at the centre of the rosette. Involucral bracts narrow, outer green, inner purplish. Whole plant (including roots) is used in the treatment of chest pains and common cold. This plant is locally used in the treatment of constipation, intestinal infections and ulcers.

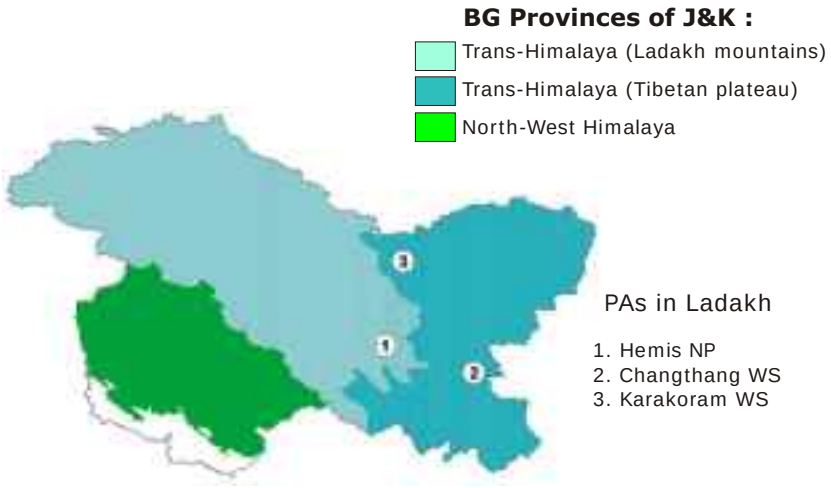
Occasional in moist meadows between 3500-4000 m asl in Western Ladakh especially Nun-kun basin, Kargil and Surru valleys. Over exploitation and habitat degradation are the major causes of population decline.

3. *Saussurea medusa* Maxim (Asteraceae)
English Name : Snow Lotus

Woolly herbs. Stem short, elongates up to 10 cm with age. Basal leaves rosette shaped, obovate or rhomboid, apex of upper leaves dentate. Flower heads embedded in woolly hairs, rarely exposed outside the hairs. Composite heads 5-8 cm in diameter.

Restricted to morainic and stable scree slopes in Karakoram range especially Marsmik La (5400 m). So far known from Karakoram range (India), Tibet and Nepal. Past and present populations have not been assessed. The species is naturally sparse in the region. No immediate threat is perceived except over collection for botanical curiosity.

Plate 1
Landforms and Little Known Taxa from Ladakh



PAs in Ladakh

1. Hemis NP
2. Changthang WS
3. Karakoram WS

Ladakh & Zanskar Ranges

Changthang Plateau

Marsh meadow, Ladakh

Rajender Sharma

A. *Caloplaca flavorubescens*: An orange lichen with Buddhist inscriptions
1. *Colchicum luteum*
2. *Inula rhizocephala*
3. *Saussurea medusa*
4. *Allium przewalskianum*
5. *Arnebia euchroma*

4. *Allium przewalskianum* Regel (Alliaceae)
Local Name : *Skotze*

A perennial bulbous herb. Leaves shorter than scape, cylindrical hollow. Scape 10-40 cm, cylindrical, covered with leaf sheaths only at base. Umbels globose, densely many flowered. Perianth pink to red or dark purple. Filaments equal, 1.5 -2 times as long as perianth segments, connate at base and adnate to perianth segments. Ovary globose, without concave nectaries at base. Style much longer than ovary, exserted. Fls. and Frs. June – September.

Dry, open scrub and rock crevices between 4000 - 4800 m. Leaves collected locally to prepare condiments and also used medicinally. Distributed in Pakistan, India (Karakoram and Ladakh ranges), Nepal and China (Tibet). The species is locally collected but also protected in agricultural fields in Durbuk and Nubra Valleys.

5. *Arnebia euchroma* (Royle) Johnston (Boraginaceae)
Local Name : *Dimmok*, *Aambokh*

Perennial herbs with dense stiff hairs and thick root stock. Basal leaves long, linear. Upper leaves shorter and broader. Flowers pink or purplish white in terminal dense (globular) racemes. Occasional on dry sandy / stony slopes 3500 – 4500 m asl. Roots yield purple dye which is mixed with oil and used as hair tonic. The roots are also used as ingredient of *Amchi* medicine for the treatment of cough, backache and several other ailments.

Rocky and gravelly slopes. Distributed in Afghanistan, NW India, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Russia, Tajikistan, Turkmenistan and Uzbekistan. Over extraction for local as well as commercial use is the major cause of its decline.

Conservation Measures

Most of the high value and threatened species of Ladakh including those listed above, can best be conserved with the help of local institutions such as Amchi Association of Ladakh, Women's Alliance of Ladakh and other Self Help Groups. The Department of Forest and Wildlife needs to initiate dialogues with such organizations to identify and set aside a few localities in different watersheds where natural habitats can be protected and restored in order to promote natural regeneration of high value medicinal plants. Amchis and their collectors would be the best judges to set the limits of harvest for various species on a sustainable basis. A network of medicinal plant conservation areas (MPCAs) needs to be established across Ladakh so as to ensure the in-situ conservation of medicinal and associated threatened plants.

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