

Distribution of vegetation types in northwest Himalaya with brief remarks on phytogeography and floral resource conservation

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Abstract. The vegetational wealth of northwest Himalaya is discussed in this paper. Unlike the vegetation of eastern Himalaya, the forests are not diverse and rich. The forests here are mainly classified under (i) tropical forests, (ii) subtropical forests, (iii) temperate forests, (iv) subalpine forests and (v) alpine vegetation, primarily based on the altitude. The plant resources of the region are briefly outlined with reference to (i) wild edible plants, (ii) medicinal and aromatic plants, (iii) ornamental plants, (iv) orchids, (v) fodder resources, (vi) bamboos and (vii) other biologically interesting species. The brief phytogeographical affinities of the northwest Himalayan flora, the major threats to the flora and some conservation programmes are also discussed.

Keywords. Northwest Himalaya; plant resources; affinities; threats and conservation.

1. Introduction

Although the Himalaya form a continuous chain of mountain system the distribution pattern of vegetation varies significantly from west to east. The eastern Himalaya are more green and diverse compared to the dry arid regions in the western Himalaya. The northwest Himalaya for this study comprises the areas of Jammu and Kashmir, Himachal Pradesh and western Uttar Pradesh.

2. Vegetation

The vegetation type met with in any particular area depends on the climate, the soil, topographical situation and geographical location. The topography of northwest Himalayan region is irregular and disturbed by valleys and plateau of various extent and as such the stratification is not clear. There is also a great diversity in the floristic pattern due to great altitudinal variation, coupled with rainfall factor which becomes lesser and lesser as one travels from east to west. However, on the basis of altitude and climate the vegetation types of this region may be divided as follows:

1. Tropical forests:

- (i) Scrub forests
- (ii) Deciduous forests
- (iii) Tree savannah forests
- (iv) Swamp forests

2. Subtropical forests:

- (i) Broad leaved forests
- (ii) Pine forests
- (iii) Subtropical evergreen sclerophyllous forests

3. Temperate forests:
 - (i) Broad leaved forests
 - (ii) Coniferous forests
4. Sub alpine forests
5. Alpine vegetation.

The details of the floristic composition and distribution of these forests are avoided as the same are discussed in detail by Schweinfurth (1957), Gupta (1964), Champion and Seth (1968), Rau (1974), Dhar and Kachroo, (1983) and Singh and Singh (1987).

3. Affinities

The study on the phytogeographical affinities of the flora of the northwest Himalaya with the surrounding regions is indeed very fascinating. The close affinity between the flora of the northwest Himalaya with those of Europe, the near east and middle east is well established (Legris 1963; Gupta 1962, 1964, 1982; Meher-Homji 1973; Rau, 1974, 1975, 1981; Dhar 1978; Sahni 1982).

The European and central Asian elements are frequent in areas west of the river Sutlej, while the Chinese elements extend from Yunnan in the east right through the east Himalayan ranges.

From the dry mountains of western and middle Asia many elements have spread to the western ranges of the Himalaya. This influx is greatly due to the arid and dry conditions prevailing here particularly in the interior ranges of Ladakh, Lahul and Spiti valley. Several such species of middle Asia like *Rosularia alpestris*, *Salix karelinii*, *Sorbaria tomentosa*, *Lathyrus humilis*, *Acantholimon lycopodioides*, *Myricaria squamosa*, *Oxytropis microphylla*, *Halogeton glomeratus*, *Biebersteinia odora* etc. are found in the northwest Himalayan region.

Cedrus deodara common on the west Himalayan slopes is also distributed as far away as in Afghanistan. The eastern limit of the distribution of the species is the western part of Nepal. Based on this as well as on the distribution pattern of several species it has been concluded that the zone of transition between the phytogeographical regions of eastern and western Himalaya is approximately the area between 80°E to 84°E longitude (Stearn 1960; Banerji 1963).

As far as number of gymnosperm species is concerned, although the eastern Himalaya is richer there exist vaster, coniferous forests in the western Himalaya. *Pinus gerardiana*, *Juniperus polycarpus*, *Picea smithiana* are among the gymnosperms distributed in the northwest Himalaya but absent in the eastern Himalaya. Similarly *Ephedra*, an important genus of medicinal value, is well represented in the northwestern Himalaya with 6 species while only one species occurs in the eastern Himalaya.

Several species like *Larix griffithiana*, *Picea spinulosa*, *Cephalotaxus griffithii*, *Gnetum montanum*, *Cycas pectinata* etc. found in east Himalaya are absent beyond east Nepal.

Several temperate species from Europe and other temperate regions have also found their way to this region. Some of these species are *Melilotus officinalis*, *Medicago falcata*, *Aconogonum alpinum*, *Trifolium repens*, *Lotus corniculatus*,

Onopordum acanthium, *Chenopodium foliosum*, *Centaurea iberica*, *Geranium pratense*, *Mentha longifolia*, *Carthamus lanatus*, *Artemisia absinthium*, *Briza media*, *Dactylis glomerata*, *Poa trivialis*, *Draba nemorosa*, *Erophila verna*, *Barbarea vulgaris*, *Cardamine impatiens* etc.

There are also other introductions like *Datura suaveolens*, *D. stramonium* from tropical America, *Nicandra physaloides* from Peru, *Ipomoea purpurea* from central America, *Ipomoea carnea* from south America, *Martynia annua* from America etc. which have now become naturalized.

Viola biflora a common species in the northwestern Himalaya is also known from Europe, Siberia, central Asia, north Korea, Japan, north America as well as in the central and eastern Himalayan regions. Similarly *Capparis spinosa* is known from Afghanistan to Nepal, West Asia, Europe. *Poa alpina* is another species which is widely distributed in Pakistan, India, Europe, Mediterranean region, middle east to central Asia and north America.

However, some species like *Cotoneaster frigidus*, *Rubus calycinus*, *Rubus acuminatus*, *Androsace delavayi*, *Osmanthus suavis*, *Boschniakia himalaica* etc. originating in southwest China reach only up to Kumaon in Uttar Pradesh. Similarly there are species like *Cypripedium elegans*, *Cypripedium himalaicum*, *Roscoea purpurea*, *Primula tibetica*, *Primula primulina* etc. which extend from southwest Tibet to Uttar Pradesh.

Circaeaster agrestis another plant of north-western China extends across Tibet to the Himalaya as far west as Garhwal. Similarly there are several species distributed not only in the northwestern Himalaya but all along the Himalayan range up to southeast Asia, Burma, etc. (table 1).

The extraneous elements of the flora from southwest China, central Asia, west Asia, Europe have mixed-up with the local species now forming a permanent

Table 1. Some species of Chinese origin widely distributed in the Himalaya.

Name	Family	Distribution
<i>Valeriana jatamansii</i> Jones	Valerianaceae	Afghanistan to southwest China, Burma
<i>Valeriana hardwickii</i> Wall.	Valerianaceae	Pakistan to southwest China, Burma, southeast Asia
<i>Cardiocrinum giganteum</i> (Wall.) Makino	Liliaceae	Kashmir to southwest China, Burma
<i>Dactylorhiza hatagirea</i> (D Don) Soo	Orchidaceae	Pakistan to southeast Tibet, Europe, north Africa, central west and southeast Asia
<i>Primula denticulata</i> Smith	Primulaceae	Afghanistan to southeast Tibet, Burma
<i>Taxus baccata</i> L. ssp.	Taxaceae	Afghanistan to southwest
<i>Wallichiana</i> (Zucc.) Pilger		China, Burma, southeast Asia
<i>Symplocos paniculata</i> (Thunb.) Miq.	Symplocaceae	Pakistan to southwest China, Burma, Japan, southeast Asia
<i>Jasminum dispernum</i> Wall.	Oleaceae	Kashmir to southwest China, southeast Asia
<i>Buddleja asiatica</i> Lour.	Loganiaceae	Pakistan to Bhutan, central and south China, Burma, southeast Asia
<i>Acer oblongum</i> Wall. ex DC.	Aceraceae	Pakistan to southwest China, Burma, southeast Asia
<i>Hedera nepalensis</i> K Koch	Araliaceae	Afghanistan to southwest China, Burma
<i>Svida oblonga</i> Sojak	Cornaceae	Kashmir to southwest China, Burma, southeast Asia
<i>Lycesteria formosa</i> Wall.	Caprifoliaceae	Pakistan to southwest China, Burma
<i>Lonicera webbiana</i> Wall. ex DC.	Caprifoliaceae	Afghanistan to southwest China

denizen of the northwestern Himalayan flora. At the same time, some of these migratory elements have remained unchanged. Example of such species are *Melilotus alba*, *Melica nutans*, *Potentilla fruticosa*, *Aconogonum alpinum*, *Flemingia strobilifera*, *Nasturtium officinale*, etc.

Some species are also treated as related sub-species or close variants of the species found in Eurasian regions. Presumably these taxa migrated to this region during the Pleistocene glaciations and subsequently adopted to the new environs resulting in their present status.

Although the Himalaya form one continuous chain of mountains running from Naga Parbat on the Indus to Namcha Barwa on the bend of the Tsang-Po in south east Tibet (ca 2250 km), the floristic patterns of west Himalaya are so distinct that it is impossible to treat them as one unit, atleast botanically. The eastern Himalayan region is richer and more diverse in plant wealth because of the greater amount of precipitation which the area receives compared to western Himalaya.

The distribution and strength of some taxa in western and eastern Himalaya are shown in table 2.

Although the northwest himalayan flora is an admixture of floras from Mediterranean region, central Asia, Europe, southwest China, etc., a careful analysis reveals that the northwest Himalayan region is also rich in endemic species (table 3).

4. Plant resources

The rich plant wealth of northwest Himalaya have sustained numerous tribal populations for centuries. These tribals (Ladakhis, Mirbahrirs and Gujars of Jammu and Kashmir, Gaddis, Lahulias of Himachal Pradesh, Jaunsari of Jaunsar Bawar, Bhottyas of the border districts of Uttar Pradesh) have their own way of association with the flora and fauna of the region. It is however not possible to highlight all groups of economic plants in this paper but only some important groups which can form a stable source of revenue to the states if properly utilised.

4.1 Wild edible plants

The tribals and other villagers in the Himalaya, consume certain plants or plant parts as vegetables or otherwise. However they have not attempted to undertake large scale cultivation of these edible plants and they rely on the forests around them for their supply of these plants.

These non traditional food plants are, however, not known in other parts of the

Table 2.

Taxa	Western Himalaya (No. of species)	Eastern Himalaya (No. of species)	India (No. of species)
Orchids	ca 250	ca 640	ca 1100
Rhododendrons	ca 5	ca 82	ca 82
Bamboos	ca 19	ca 58	ca 100
Hedychiums	ca 7	ca 34	ca 35

Table 3. Some endemic species in northwest Himalaya.

Species	Altitude (m)	Distribution
<i>Androsace primuloides</i> Duby	3000–4000	Jammu and Kashmir
<i>Hedysarum cachemirianum</i> Benth. ex Baker	2500–4000	Jammu and Kashmir
<i>H. microcalyx</i> Baker	2500–400	Jammu and Kashmir to Uttar Pradesh
<i>Saussurea atkinsonii</i> Clarke	3000–4500	Jammu and Kashmir to Uttar Pradesh
<i>Saussurea clarkei</i> Hook.f.	ca 4400	Jammu and Kashmir
<i>Poa falconeri</i> Hook.f.	ca 4000	Jammu and Kashmir
<i>Poa koelzii</i> Bor	ca 5000	Jammu and Kashmir
<i>Puccinellia stapfiana</i> R R Stewart	ca 5000	Jammu and Kashmir
<i>Puccinellia thomsonii</i> (Stapf) R R Stewart	ca 5000	Jammu and Kashmir
<i>Catabrosella himalaica</i> (Hook.f.) Tzvelev	ca 4500	Jammu and Kashmir
<i>Arabis tenuirostris</i> D E Schulz	ca 3000	Jammu and Kashmir
<i>Hyalopoa nutans</i> (Stapf) Alexeev	ca 3500–4500	Jammu and Kashmir
<i>Delphinium roylei</i> Munz	ca 1600–2500	Jammu and Kashmir
<i>Carex munroi</i> Boot ex Clarke	ca 3800	Himachal Pradesh
<i>Microschoenus duthie</i> Clarke	ca 5300	Uttar Pradesh
<i>Dicranostigma lactucoides</i> Hook.f. and Thoms.	ca 2700–4000	Jammu and Kashmir Himachal Pradesh
<i>Erophila tenerrima</i> (E Schulz) Jafri	ca 4200	Jammu and Kashmir
<i>Christolea scaposa</i> Jafri	ca 4950	Jammu and Kashmir

country. It is also true that the known traditional food plants may not be sufficient to feed the growing population in the years to come. Therefore study on the food value of wild species is highly essential. A few important wild food plants locally available are listed. It is essential to commercialise a few of the species at least on a regional basis (table 4).

4.2 Medicinal and aromatic plants

Medicinal virtues of western Himalayan plants are well known from the early times of the great epics of Ramayana and Mahabhartha. The high hills are the storehouse of numerous bearing herbs which are exploited not only for the pharmaceutical industries in India but outside as well. Due to the unscrupulous traders several of these medicinal species have already become rare in their natural habitats. *Colchicum luteum* of Jammu and Kashmir and Himachal Pradesh, the Brahma Kamal (*Saussurea obvallata*)¹ in the Garhwal Himalaya, the Indian Belladonna (*Atropa acuminata*) of Jammu and Kashmir and Himachal Pradesh are only some cases which can be mentioned. Some of the medicinal plants are highly priced for example Angelica (*Angelica glauca*) costs Rs 2/- per 10 g in the local market, similarly 40 kg of Kuth (*Saussurea costus*) costs Rs 1,200. Naturally, there is temptation both among the locals as well as outsiders for collection of these plants. Although some species are brought under cultivation, several other species are being exploited from their natural habitats.

Same is the case with regard to certain aromatic plants which are extensively used in perfume industry, etc. Large scale cultivation of these plants in this region can be highly regarding. Some of the important medicinal and aromatic species which can be profitably exploited under large scale cultivation are listed in table 5.

Table 4. Some wild edible plants.

Name	Family	Vernacular name	Parts used	Distribution
<i>Nymphoides peltata</i> (S Gmelin) Kuntz	Menyanthaceae	Water Chest nut 'Khur'	Nuts	Common in Kashmir valley Temperate Eurasia
<i>Euryale ferox</i> Salisb.	Nymphaeaceae	'Jewar'	Seeds	Kashmir to Assam, China
<i>Nymphaea stellata</i> Willd.	Nymphaeaceae	Bumbosh	Tuber	Throughout India, Africa
<i>Nelumbo nucifera</i> Gaertn.	Nymphaeaceae	Indian lotus	Nuts and petiole	Throughout India, common in Dal Lake, Kashmir, north China
<i>Allium carolinianum</i> DC	Amaryllidaceae	Wild onion	Leaves	Afghanistan to cen- tral Nepal, 3300–4800 m
<i>Allium rubellum</i> M Bieb	Amaryllidaceae	Wild onion	Bulbs	Kashmir
<i>Podophyllum hexandrum</i> Royle	Berberidaceae	May-apple	Ripe fruits	Afghanistan to south- west China
<i>Pinus gerardiana</i> Wall. ex. Lamb.	Pinaceae	Chilgoza	Seeds	Afghanistan to Uttar Pradesh
<i>Dactylorhiza hatagirea</i> (D Don) Soo	Orchidaceae	Sallam Panza	Tubers	Pakistan to south- east Tibet
<i>Cicer microphyllum</i> Benth.	Papilionaceae		Young shoots	Afghanistan to west Nepal, 3300–4500 m
<i>Rheum webbianum</i> Royle	Polygonaceae	Rhubarb	Leaves	Pakistan to west Nepal, 2500–4200 m
<i>Rhodiola imbricata</i> Edgew.	Crassulaceae		Stem and lea- ves	Pakistan to central Nepal ca 4500 m
<i>Rubus ellipticus</i> Smith	Rosaceae	Wild rasp- berry	Fruits	Pakistan to south- west China, south India, Sri Lanka, southeast Asia, 600–2000 m
<i>Fragaria nubicola</i> Lindl. ex Lacaita	Rosaceae	Wild straw- berry	Fruits	Pakistan to south- west China, Burma, 1800–3800 m
<i>Nasturtium officinale</i> B Br.	Brassicaceae	Water-cress	Leaves	Afghanistan to Arunachal Pradesh, Temperate, Asia, Europe, north Africa, 1500–3500 m
<i>Dendrocalamus strictus</i> (Roxb.) Nees	Poaceae	Bamboo	Young shoots	Pakistan to Burma up to 1000 m
<i>Eremurus himalaicus</i> Baker	Liliaceae	Desert candle	Leaves	Afghanistan to Himachal Pradesh, central Asia, 2000–3000 m
<i>Bombax ceiba</i> L.	Bombacaceae	Silk cotton	Flower buds	Jammu and Kashmir to Bhutan, south China, southeast Asia, ca 1000 m

Table 4. (Contd.)

<i>Bauhinia variegata</i> L.	Caesalpinaceae	Kachnar	Flower buds	Arunachal Pradesh, Pakistan to Burma, China, ca 1500 m
<i>Opuntia monacantha</i> (Willd.) Haw.	Cactaceae	Nagphal	Ripe fruits	Native of south America (planted as hedge plant and ripe fruits are sold in the market)
<i>Urtica dioica</i> L.	Urticaceae	Stinging Nettle Bichhu	Young leaves and top of branches	Pakistan to south-west China, up to 2500 m
<i>Myrica esculenta</i> Buch.-Ham. ex D Don	Myricaceae	Kaphal	Fruits	Jammu and Kashmir to Bhutan, Burma, China, southeast Asia, 1000–2000 m
<i>Elaeagnus parviflora</i> Wall. ex Royle	Elaeagnaceae	Girvai Goe-win Gehain	Fruits	Afghanistan to south west China, 1000–2500 m
<i>Hippophae rhamnoides</i> L. sub sp. <i>turkestanica</i> Rousi	Elaeagnaceae	Tarwa Tasru Sirna	Fruits	Pakistan to Himachal Pradesh, central Asia, 2000–3500 m

Table 5. Medicinal and aromatic plants.

Species	Vernacular name	Ecology	Distribution and altitude
<i>Aconitum heterophyllum</i> Wall. ex Royle	Atis	Open grasslands	Pakistan to central Nepal, 2500–4000 m
<i>Arnebia benthamii</i> (Wall. ex G Don) Johnston	Balchari	Open hill slopes amidst	Pakistan to west Nepal, 3000–4000 m
<i>Atropa acuminata</i> Royle	Indian Belladonna	In the forests (cultivated in Jammu and Kashmir)	Pakistan to Himachal Pradesh
<i>Colchicum luteum</i> Baker	Hirantutiya	Open hill slopes	Pakistan to Himachal Pradesh, 1000–2500 m
<i>Dioscorea deltoidea</i> Wall. ex Kunth	Kins	At the edge of the forests in open places	Jammu and Kashmir to Bhutan, Afghanistan, 2000–2500 m
<i>Gentiana kurrooa</i> Royle	Karu	Open grasslands	Pakistan to Uttar Pradesh, 1800–2500 m
<i>Nardostachys grandiflora</i> DC.	Jatamanshi	In rock crevices and in open places	Uttar Pradesh to south-west China, 3500–4500 m
<i>Picrorhiza kurrooa</i> Royle ex Benth.	Katki	In rock crevices and in open places	Pakistan to Uttar Pradesh, 3000–4000 m
<i>Podophyllum hexandrum</i> Royle	Ban Kakri	Amidst boulders	Afghanistan to southwest China, 2500–4000 m

Table 5. (Contd.)

Species	Vernacular name	Ecology	Distribution and altitude
<i>Hedychium spicatum</i> Smith	Spiked ginger lilly	Epiphytic or in the forests	Himachal Pradesh to Arunachal Pradesh 1500–2500 m
<i>Fritillaria roylei</i> Hook.		Amidst grasses in alpine meadows	Pakistan to Uttar Pradesh, 2500–4000 m
<i>Corydalis govaniana</i> Wall.	Bhutan-Keshi	Amidst boulders in the sub-alpine and alpine region	Pakistan to east Nepal, 3500–4000 m
<i>Ferula jaeschkeana</i> Vatke		On open hill slopes	Pakistan to Himachal Pradesh, 2500–3500 m
<i>Prangos pabularia</i> Lindl.	Avipriya	On open hill slopes amidst boulders	Afghanistan to Kashmir, 2000–3000 m
<i>Dactylorhiza hatagirea</i> (D Don) Soo	Salam Panja	In alpine and sub-alpine meadows	Pakistan to southeast Tibet, 3000–4000 m
<i>Rubia manjith</i> Roxb. ex Fleming	Majith	In open places amidst shrubs	Pakistan to southeast Tibet, 1500–2500 m
<i>Valeriana jatamansii</i> Jones	Indian vallerin	Amidst boulders and in the forests	Afghanistan to southwest China, Burma, 1500–3500 m
<i>Arctium lappa</i> L.		In waste places and near the cultivated land	Afghanistan to Nepal, west Tibet
<i>Aconitum deinorrhizum</i> Holms ex Stapf	Safed Bikh	Amidst boulders, on open hill slopes	Jammu and Kashmir to Bhuntan, 2500–3500 m
<i>Artemisia brevifolia</i> Wall.	Kirmala worm seed	In open places, amidst stones	Nepal to Tibet, 2000–4000 m
<i>Berberis aristata</i> DC	Rasaut	In open places	Himachal Pradesh to Nepal
<i>Hyoscyamus niger</i> L.	Henbane Khurasani ajvayan	Along the road side in open places	Pakistan to Uttar Pradesh, southwest China, north Africa, north America, Temperate Eurasia
<i>Jurinea dolomiaea</i> Boiss.	Doop	Open hill slopes	Pakistan to east Nepal, 3000–4000 m

4.3 Ornamental plants

This is one group which has not received due attention in India. Although several wild beautiful plants in the Himalaya have been recognised, no efforts have been made to systematically identify, collect, multiply and popularise them in our manmade settings. A few can also be used for improving species already found in our gardens. Only some of the very important ones in this direction are listed in table 6. While these species are suitable for high altitude gardens, their introduction at comparatively lower elevation is possible only after acclimatization trials.

Table 6. Ornamental plants.

Name	Altitude (m)	Flowering time and flower colour	Distribution
<i>Arisema propinaum</i> Schott (Araceae)	2400–3600	May–June, dark purple or green with purple stripes	Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Nepal, southeast Tibet
<i>Aster falconeri</i> (Asteraceae)	3000–4200	July–Aug, purple	Jammu and Kashmir, Himachal Pradesh, Pakistan, Nepal
<i>Begonia picta</i> (Begoniaceae)	600–2800	July–August, pinish-white	Jammu and Kashmir, Uttar Pradesh, Bhutan
<i>Berberis lycium</i> (Berberidaceae)	1500–3000	April–June, yellow	Jammu and Kashmir, Uttar Pradesh, Pakistan, Nepal
<i>Capparis spinosa</i> (Capparidaceae)	2000–3000	May–Sept., white	Jammu and Kashmir, Himachal Pradesh, Nepal, west Asia, Europe
<i>Cardiocrinum giganteum</i> (Liliaceae)	2000–3000	June–July, white	Throughout Himalayas, southwest China, Burma
<i>Carissa opaca</i> (Apocynaceae)	600–1200	March–April, white	Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh
<i>Cyananthus lobatus</i> (Campanulaceae)	3500–4500	July–Sept., bright-blue	Himachal Pradesh, Uttar Pradesh, Nepal southwest China
<i>Eremurus himalaicus</i> (Liliaceae)	2000–3000	May–June, white	Jammu and Kashmir, Himachal Pradesh, Afghanistan, Pakistan, Central Asia
<i>Gentiana stipitata</i> (Gentianaceae)	3500–4000	Aug.–Sept., pale-mauve	Uttar Pradesh, Nepal
<i>Hypericum hookerianum</i> (Hypericaceae)	1500–2500	July–Sept., yellow	Uttar Pradesh, Sikkim, Nepal, Bhutan
<i>Impatiens sulcata</i> (Balsaminaceae)	1500–3500	July–August, purple	Jammu and Kashmir, Uttar Pradesh, Himachal Pradesh, Sikkim, Nepal, Bhutan
<i>Inula grandiflora</i> (Asteraceae)	2000–3500	Aug.–Sept. yellow	Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh

4.4 Orchids

Much has been said about the orchid wealth in the Himalaya and their depletion from the natural habitats. In India there exist *ca* 1100 species of which 250 species are reported from the hill districts of Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir. They are generally found in the humid tropical to almost alpine regions. It may be mentioned here that out of 250 species of orchids found in the northwestern Himalaya almost 50% of the species are threatened due to disturbance of natural habitats. Some important ornamental orchid species which are also rare in the region are listed in table 7.

Table 7. Ornamental orchids.

Name	Habitat	Distribution
<i>Anoectochilus roxburghii</i> (Wall.) Lindl.	Terrestrial	Uttar Pradesh, northeastern India, Sikkim, Bangladesh, Nepal, Bhutan, Burma, China, Malay, Thailand
<i>Calanthe alpinae</i> Hook.f.	Terrestrial	Uttar Pradesh, Sikkim, Arunachal Pradesh, Nepal, Bhutan
<i>Calanthe pachystalix</i> Rchb.f. ex Hook.f.	Terrestrial	Uttar Pradesh, Nepal, Indo-China
<i>Calanthe plantaginea</i> Lindl.	Terrestrial	Himachal Pradesh, Uttar Pradesh, Arunachal Pradesh, Sikkim, Nagaland, Nepal, Bhutan
<i>Calanthe puberula</i> Lindl.	Terrestrial	Himachal Pradesh, Uttar Pradesh, Arunachal Pradesh, Sikkim, Meghalaya, Nagaland, Nepal, Bhutan, Burma
<i>Cymbidium iridioides</i> D Don	Epiphytic	Uttar Pradesh, Sikkim, Meghalaya, Nepal, Bhutan
<i>Cymbidium lowianum</i> Rchb.f.	Epiphytic	Uttar Pradesh, Arunachal Pradesh, Nagaland, Burma, Thailand
<i>Cypripedium cordigerum</i> D Don	Terrestrial	Uttar Pradesh, Sikkim, Nepal, Bhutan
<i>Cypripedium elegans</i> Rchb.f.	Terrestrial	Uttar Pradesh, Sikkim, Nepal, Bhutan
<i>Cypripedium himalaicum</i> Rolfe	Terrestrial	Uttar Pradesh, Sikkim, Nepal, Bhutan, southeast Tibet, China
<i>Dendrobium heterocarpum</i> Wall. ex. Lindl.	Epiphytic	Uttar Pradesh, northeast India, Sikkim, Nepal, Bhutan, Burma, Java, Srilanka

4.5 Fodder resources

Almost all tribal population in the northwest Himalaya rear animals like sheep, goats or even yaks as in Ladakh. These animals consume besides grasses and sedges several other herbs as well as foliage of trees and shrubs. There are several high altitude pasture lands which are being grazed by these flocks for innumerable generations. However, now with the declaration of some areas as National Parks, sanctuaries they are deprived of some of the best pastures known to them. The needs of the tribals, however, cannot be ignored and alternative measures for providing them with adequate fodder must be considered. Some species of high fodder value must be raised near villages as part of social forestry and agro forestry programmes.

The following are some of the important fodder crops which can be raised at different altitudinal zones of the north-west Himalaya.

Acacia catechu, *Albizia lebbeck*, *Bauhinia variegata*, *Dendrocalamus strictus*, *Ficus religiosa*, *Grewia oppositifolia*, *Morus alba*, *Ougenia oojainensis*, *Quercus leucotrichophora*, *Quercus floribunda*, *Ziziphus nummularia*, *Moringa oleifera*, etc. and grasses like *Themeda anathera*, *Chrysopogon fulvus*, *Bothriocloa pertusa*, *Poa pratensis*, *Dactylis glomerata* etc.

4.6 Ferns and fern-allies

The northwestern Himalaya is poor in number of species of ferns and fern-allies in

comparison to eastern Himalaya. Out of ca 1000 species of ferns occurring in India only 264 species (Dhir 1979) are reported from this region. Except for the recent report of *Cyathea spinulosa* from Garhwal the tree ferns are not available in this region.

Some of the interesting and rare species of this region are *Botrychium lanuginosum*, *B. ternatum*, *B. lunaria*, *B. virginianum*, *Osmunda claytoniana*, *O. regalis*, *Polystichum atkinsonii*, *P. duthei*, *Athyrium duthei*, *Thelypteris gracilescens*, *Cheilanthes dalhousiae*, *C. dubia*, *Dryopteris gamblei*, *Woodsia alpina*, *W. andersonii*, *W. cycloloba*, *Selaginella adunca* etc.

4.7 Bamboos

The importance of Bamboos is well known. Except the Kashmir valley they are found in almost all states in the tropical to temperate zones up to 3700 m. The western Himalaya is not rich in bamboos. According to Bahadur and Jain (1983) out of ca 100 species known from India only 14 species are recorded from the western Himalaya. These species belong to the genera *Bambusa* (4), *Chimonobambusa* (2), *Dendrocalamus* (4), *Phyllostachys* (2) and *Thamnocalamus* (2), *Chimonobambusa jaunsarensis* and *Dendrocalamus hookeri* are coming rare due to over exploitation by the local people.

4.8 Other interesting plants

The northwest Himalaya have a number of interesting plants of great scientific curiosity. *Arceuthobium minutissimum*—a tiny loranthaceous parasite on *Pinus*, *A. oxycedri*—parasite on *Juniperus polycarpus*, *Lathraea squamaria*, *Boschniakia himalaica*, *Balanophora involucreta*, *Aeginetia indica*, *Orobanche cernua*, *O. alba* etc. are some of the curious parasitic plants which are rare in the region.

Insectivorous plant species like *Pinguicula alpina*, *Drosera peltata*, *Utricularia* spp. etc. are also frequent.

This region also accounts for some primitive plants like *Circaea agrestis*—tiny herb with open dichotomous venation, *Parrotiopsis jacquemontiana*—prosenchyma of the wood marked with discs as in coniferae, *Myrica esculenta*, *Holboellia latifolia* var. *angustifolia*, *Michelia kisopa* etc.

5. Major threats to flora

The accelerating decline of India's natural wealth during the last few decades is a matter of grave national concern. The reasons for the precarious condition of the natural wealth are too many. Foremost among them is the ever increasing population pressure resulting in the acute need for more and more land both for settlement as well as agricultural purposes. This thirst for land is leading to the reckless destruction of our forests. In the last 30 years about 43 million hectares of forested land have been cleared for developing farmlands in our country. The area under forest cover in India is now estimated to be about 10% only of the total area of India. This is against 33% in the National Forest Policy of India. The northwest Himalaya too like the rest of the country, is no better in this respect.

Of the several factors operating in this region towards depletion of the natural resources the following are some important.

1. Deforestation for (i) extension/development of new townships, (ii) extension of agricultural lands, (iii) for timber and fuel and (iv) for raising monoculture etc.
2. Selective removal of certain medicinal plants such as *Colchicum luteum*, *Nardostachys grandiflora*, *Dioscorea deltoidea*, *Aconitum* spp. etc. in bulk quantities for meeting the needs of the pharmaceutical houses.
3. Felling of certain species for making packing cases for apples, plums etc. which are transported in large quantities.
4. Over collection of orchids and habitat disturbances.
5. Over grazing/lopping of trees for fodder.
6. Construction of artificial reservoirs which lead to submergence of forest areas.
7. Impact of constant tourist and pilgrim activity in such places as Dal lake, Badrinath, Valley of Flowers etc.
8. Road building on hill upsetting the delicate high altitude ecosystem etc.
9. Lime quarrying and setting up of stone crushers in remote forest areas.
10. Establishment of large cement factories which cause great pollution in the area.

6. Some conservation programmes

In the last 2–3 decades there has been a greater realisation of the need to conserve the natural heritage, rather throughout the globe. Several international programmes like the Man and the Biosphere Programme, convention on the International Trade in Endangered Species of Flora and Fauna are all aimed to achieve the conservation programmes. In northwestern Himalayan region the following are some of important conservation measures.

(i) Several protected areas in the form of National Park and Wildlife Sanctuaries have been established in several ecoclimatic zones (table 8). Further the Nanda Devi National Park and Valley of Flowers National Park have also been proposed to be converted to a larger biosphere reserve under the MAB programme. All these pockets form repositories of northwest Himalayan flora and fauna in their pristine and verdant form. However, encroachments by men and cattle are not uncommon and protection of the demarcated areas cannot but be inadequate due to the lack of enough personal and equipment as well as commitments. Greater priority needs to be given to this aspect.

(ii) India is a signatory to Convention on International Trade on Endangered Species (CITES) of plants and animals which had its first conference in Washington in 1973. Under the CITES act the export of some endangered species is strictly banned. Several medicinal plants and orchids are saved from total extinction by the strict application of this convention. Of the several species listed from India the following species are from northwest Himalaya. *Aconitum* spp., *Colchicum luteum*, *Cypripedium* spp., *Dioscorea deltoidea*, *Nardostachys grandiflora*, *Suassurea obvallata*, *Dianthus cachemicus*.

(iii) Red Data Book deals with plants which are highly endangered and are on way to extinction as is evident by their markedly thin population structure with a low rate of multiplication. All countries have their own Red Data Books and Botanical Survey of India has also brought out the Red Data Book of India. Many species of

Table 8. National parks and sanctuaries in several ecoclimatic zones of northwest Himalaya.

State	Name	District	Area in hectare
Jammu and Kashmir	Dachigam National Park	Srinagar	14,000.00
	Hemis High Altitude National Park	Leh	60,000.00
	Kishtwar National Park	Kishtwar	31,000.00
	Jasrota Wildlife Sanctuary	Kathua	912,800.00
	Lungnag Wildlife Sanctuary	Kargil	40,000.00
	Nandni Wildlife Sanctuary	Jammu	1,349.80
	Overa Wildlife Sanctuary	Anantnag	3,237.00
	Ramnagar Wildlife Sanctuary	Jammu	1,130.00
Himachal Pradesh	Surinsa, Mansar Wildlife Sanctuary	Udhampur	3,912.00
	Great Himalayan National Park	Kullu	173,600.00
	Bandli Wildlife Sanctuary	Mandi	3,130.00
	Chail Wildlife Sanctuary	Solan	10,855.00
	Daranghat Wildlife Sanctuary	Simla	16,740.00
	Dorlaghat Wildlife Sanctuary	Solan	4,432.00
	Gangul Siah Behi Wildlife Sanctuary	Chamba	900.75
	Gobind Sagar Wildlife Sanctuary	Bilaspur	10,034.00
	Kalatop Khajjar Wildlife Sanctuary	Chamba	4,728.00
	Kanawar Wildlife Sanctuary	Kullu	6,070.00
	Khokhan Wildlife Sanctuary	Kullu	1,405.00
	Kias Wildlife Sanctuary	Kullu	—
	Kugti Wildlife Sanctuary	Chamba	11,828.00
	Lippa Asrang Wildlife Sanctuary	Kinaur	10,911.00
	Majathal Wildlife Sanctuary	Simla	9,206.00
	Manali Wildlife Sanctuary	Kullu	3,170.00
	Maina Devi Wildlife Sanctuary	Bilaspur	4,550.00
	Nargu Wildlife Sanctuary	Mandi	27,837.00
	Pong Dam Wildlife Sanctuary	Kangra	30,700.00
	Rakchham Chitkul Wildlife Sanctuary	Kinnaur	13,844.00
	Renuka Wildlife Sanctuary	Sirmour	1,144.00
	Rupi Bhawa Wildlife Sanctuary	Kinnaut	12,486.97
	Suchu Tun Nala Wildlife Sanctuary	Chamba	414.00
	Shikari Devi Wildlife Sanctuary	Mandi	21,350.00
	Simla Water Catchment area Wildlife Sanctuary	Simla	1,025.03
	Shilli Wildlife Sanctuary	Solan	196.70
	Simbal bara Wildlife Sanctuary	Sirmur	1,925.56
Tirghan Wildlife Sanctuary	Kulu	14,000.00	
Tundah Wildlife Sanctuary	Chamba	6,422.08	
Uttar Pradesh	Corbett National Park	Nainital and Pauri Garhwal	52,082.00
	Nanda Devi National Park	Chamoli	63,033.00
	Valley of Flowers National Park	Chamoli	8,750.00
	Govind Wildlife Sanctuary	Uttarkashi	95,312.00
	Kedarnath Wildlife Sanctuary	Chamoli	96,725.51
Motichur Wildlife Sanctuary	Dehra Dun	—	

northwest Himalaya have also been listed under this in order to draw the attention of the public regarding their precarious conditions.

7. Some further suggestions for conservation

Although the general public and Government is aware of the burning problem and

have established a network of protected areas (table 8) some groups such as orchids have not been given due attention. There are some potential areas for orchids development and conservation in north-west region. One such region in temperate belt is the Hindorakhal, a place in Tehri Garhwal district, 8 km beyond Narendranagar on way to Agrakhal. This locality has a *Quercus incana* forest interspersed with *Euphorbia royleana*. There is a profusion of orchid growth in these trees. Though the number of species of orchids is not many the richness in terms of population density of the orchids is very unique. Even the xerophytic plant *E. royleana* supports a host of orchid species indicating the potentiality of the area for orchid growth. The significant species found in this area are *Coelogyne* spp., *Dendrobium bicameratum* Lindl., *D. amoenum* Wall. ex Lindl., *Eria spicata* (D Don) Hand.-Mazz., *Oberonia pachyrachis* Reichb.f. ex Hook.f., *Pholidota articulata* Lindl., *P. griffithii* Hook.f., *Rhynchostylis retusa* Bl., *Thunia alba* (Lindl.) Rechb.f., *Vanda cristata* Lindl. etc. If properly developed this area can form an open orchidarium of northwest Himalaya where all other species could be introduced and multiplied. Similarly the Askot range, Pithoragarh range, Shandev and Didihat, Dafia Dhooora and Kaflani Reserve Forest in Pithoragarh district are also suitable for the establishment of orchid sanctuary. Out of 220 species known so far from hill districts of Uttar Pradesh, 80 species have been recorded from this area. These areas should be declared as Orchid Sanctuaries.

As regards medicinal plants the following one or two suggestions may be considered. Though a ban has been imposed on collection from the wild, a strict enforcement of this law is essential. No doubt the area has a potential for development of medicinal plants. The pharmaceutical industries should be given responsibility of cultivating the medicinal plants for these industries. The biology of several high altitude medicinal plants needs to be properly understood.

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