PHYTOGEOGRAPHIC STUDIES ON THE ALPINE FLORA OF KASHMIR HIMALAYAS

INTRODUCTION

Kashmir Himalayas lie between 33° to 36° north latitude and from 72° to 80° east longitude and occupy an area of 222,800 sq. km. The highest peaks reach 5,000 m in altitude and considerable area occurs as meadowlands or glaciers. A few high altitude lakes also occur.

The alpine and subalpine flora of Kashmir has attracted little attention so far, yet it embraces an array of beautiful rocky species and affords considerable scope in understanding dispersal of plants in this area. However, it is difficult in this area to delimit alpine and subalpine range on altitudinal basis since the floristics change with the environment rather than the altitude. Generally 2,900 m altitude is considered the starting point of an alpine range. It is true that a definite transition is evident between vegetation of temperate subalpine and alpine flora but it is often clouded by patches of "stray" elements. Such cases are enumerated.

As elsewhere, the alpines are largely herbaceous perennials and show greater autonomy than those at low altitudes. The best time of flowering is June-August. Dwarfism is remnant as well as brilliance in hues of flowers.

The general pattern of vegetation of various areas is similar to a great extent excepting in a few alpine localities. This is due to the same age of the mountains. The topography is
varied and has caused local differences in flora. Snow cover is another factor. Little differences occur in the flora of temperate and subalpine regions but alpine areas show individuality in this respect.

In Dicotyledons 57 families and in Monocotyledons 7 families are represented in the subalpine-alpine Kashmir Himalayas (Graminae has not been studied). The families best represented (in maximum number of alpine/subalpine species), respectively, are:

- Compositae (256),
- Cyperaceae (125),
- Papilionaceae (99),
- Cruciferae (90),
- Ranunculaceae (81),
- Rosaceae (74),
- Scrophulariaceae (72),
- Caryophyllaceae (65),
- Labiatae (64),
- Boraginaceae (59),
- Umbelliferae (52),
- Polygonaceae (51),
- Gentianaceae (50).

The following families have single representatives in the area: Capparidaceae, Linaceae, Hippuridaceae, Araliaceae, Adoxaceae, Plumbaginaceae, Polemoniaceae.

Endemism is quite rampant and about 39% taxa are endemic to this area. In each genus endemics are separately discussed. The maximum endemism is shown by the following families:

- Adoxaceae (100%),
- Berberidaceae (64%),
- Fumariaceae (55%),
- Violaceae,
- Umbelliferae (54%),
- Saxifragaceae (53%),
- Compositae, Scrophulariaceae (52%);
- Orchidaceae (43%),
- and Iridaceae (40%).

The genera with the maximum species are the following (the number of the species is followed by the endemics):

- **Taraxacum** 59,51
- **Carex** 53,12
- **Astragalus** 47,25
- **Potentilla** 36,13
- **Gentiana** 31,13
- **Artemisia** 29,5
- **Ranunculus** 23,8
- **Pedicularis** 25,13
- **Nepeta** 25,13
- **Saxifraga** 25,15
**Phytogeographic Analysis**

Ranunculaceae is practically confined to the subalpine/alpine regions. Of the 17 genera 9 are represented by a single species. None of our Aconitum's reach eastern Himalayas. One species occurs in Central Asia and another in Chinese Turkistan, the rest are endemics. In Anemone two species range widely between Europe and Central Asia and one reaches eastern Himalayas but none of our Aquilegia's go beyond Afghanistan, and Callianthemum is restricted to Afghanistan and Kashmir. Clematis ranges from Nepal to Europe. In Delphinium only one reaches Europe the rest lie in Central Asia. Of the single species genera (in our area) the distribution shows restriction to mostly Kashmir-Pakistan or Central Asia excepting in Actaea and Caltha which are Eurasian and circumpolar respectively. Ranunculus is rather widely distributed extending into Europe and Himalayas. Some are circumpolar. Thalictrum javanicum ranges into Peninsular India and Ceylon and T. alpinum is circumpolar.

Berberis (Berberidaceae) is partly alpine and partly temperate but none of our elements go beyond Afghanistan. Podophyllum hexandrum, however, extends into eastern Himalayas as well.

In Papaveraceae, Hypecoum leptocarpum has eastern range.
upto Japan, *Papaver nudicaule* into China, Mongolia and Siberia to Europe. None of our *Corydalis* (Fumariaceae) are common with Europe but some do extend into Caucasus and *C. stricta* is wide in northern hemisphere.

*Capparis spinosa* (Capparidaceae) is widely distributed in the Mediterranean and adjoining regions as well as U.S.S.R. Surprisingly it is absent in Kashmir valley!

Cruciferae show an interesting history and of the 44 genera, most are represented by a single species and their distribution is primarily in the neighbouring regions (Iran-east Himalayas) excepting few of which *Torularia humilis* extends beyond Asia into America, and *Capsella, Parrya, and Turritis* are circumpolar. *Allysum* are widely distributed ranging into Europe and to northeast China and Mongolia. *Arabidopsis* reaches Eurasia to east Himalaya-China but in *Arabis* none of our elements reach eastern Himalayas or Europe and are confined upto Afghanistan. *Barbarea* has subcosmopolitan elements and *Braya* is totally nearly circumpolar. *Cardamine* is widely distributed in northern hemisphere (Old World) but *Chorispore* ranges to Siberia. In *Draba*, *D. fladnitzensis* alone extends into Europe, the rest being typically Asian. *Armania* extends into central Himalayas and *Erysimum* into eastern Himalayas, most of our species being common with U.S.S.R. *Isatis* is widely distributed and none of our *Lepidium*’s are true alpines, though amply distributed in Asia. *Megacarpha* is restricted to Kashmir-Ladak. *Sisymbrium* has *S. loesellii* extending into Europe. *Thlaspi arvense* is subcosmopolitan.

*Viola* has rather wide range: *V. betonicifolia* being southeast Asian, *V. biflora* and *V. rupestris* reaching on one hand Europe and on the other America, but most of the rest are restricted
to the neighbouring geographical areas.

Caryophyllaceae has most of its elements with wide ecological tolerance. *Arenaria* is widespread and circumpolar though a few like *A. orbiculata* are restricted and six species are endemic. *Gerastium* is fairly widespread and a few species are circumpolar. The elements in *Dianthus* do not range beyond Central Asia. *Lychnis* is widespread in Europe and mainland of Asia. *Minuartia* has circumpolar and restricted (Iran-Caucasus-Afghanistan) elements. *Silene* has circumpolar-Mediterranean elements and *Stellaria* is rather fairly distributed in temperate-alpines of Old World (excluding Oceania) and ranges into central America! Genera with single species are generally widespread.

*Hyricaria* (Tamaricaceae) has interesting range from east of Europe to Siberia-China; and *Tamarix* elements are close relatives of European species.

*Hypericum* (Hypericaceae) reaches China and occurs in Europe as well as America and *Linum perenne* is a wide boreal temperate of Europe and Central Asia.

In Geraniaceae *Bieberstenia* extends into Iran and *Erodium* has some elements circumpolar and some in widely separated areas such as Ladak and Mongolia. *Geranium* is widespread in Old World. *Oxalis* is circumpolar.

*Dictamus albus* and *Skimmia laureola* (Rutaceae) are interesting, the former being found throughout north hemisphere and the latter confined to west Himalayan range. *Euonymus* is restricted from Afghanistan to western Himalayas; and *Acer* ranges from Iran to China.

Papilionaceae is one of our larger elements, and
Astragalus shows interesting local distribution. It has major affinities with Central Asia. Caragana is restricted to neighbouring regions and Chesneya to Pakistan-Ladak. Desmodiums reach as far as Japan and Hedysarum has circumpolar and restricted (Pakistan-Ladak) elements. Medicago is widespread in Europe and M. orbicularis is now circumpolar. In Hedysarum, H. alpinum is alone circumpolar, the rest are confined to Pakistan-Kashmir. Melilotus reach Europe and one species is circumpolar. Oxytropis is quite extensive extending into Arctic Europe but none to east Himalayas. Thermopsis reaches eastern Himalayas but Trigonella occur in Mediterranean region to Pamir-Alai to central Himalayas. Vicia is widespread in Europe but V. rigidula is restricted to Afghanistan. The genera with single species are restricted to Pakistan-China excluding Lotus corniculatus which is cosmopolitan.

Rosaceae is yet another commoner elements. Some genera are represented by a single species and are widespread in and above temperate Asia. Cotoneasters are common in north temperate of the Old world but the Crataegus does not go beyond Iran nor does it extend eastwards. Geum is widespread. Potentilla is gregarious with 50% endemics and largely Asian (alpine/subalpine range). Rosa is spread from Iran-Caucasus-China and is mainly temperate. In Rubus species are well distributed in the neighbouring areas and R. niveus reaches Java and Filippines. Unlike Potentilla Sibbaldia is less gregarious and extends well into Siberia as well as west China and eastern Himalayas. Sorbaria is well distributed in northern hemisphere but Sorbus does not go beyond Central Asia. In Spiraea three species extend into western China. Crassulaceae is not a large element. Sedum is both
widespread and restricted and *Sempervivella* is definitely restricted.

Saxifragaceae is better represented. *Bergenia* does not extend beyond Afghanistan and Nepal. *Chrysoplenium* is restricted to Pakistan-Kashmir and *Saxifraga* is widespread.

Hydrangaceae, Parnassaceae, Hippuridaceae and Araliaceae are very small elements. *Ribes* does not extend beyond eastern Himalayas and western China. *Deutzia* also occurs in eastern Himalayas and *Philadelphus* is restricted to this area. *Parnassia* is widespread and extends to Japan-America (north and central). *Hippuris* is circumpolar and *Aralia* ranges from Afghanistan to eastern Himalayas.

In Onagraceae, *Circaea* has circumpolar as well as widely distributed elements in Europe to Himalayas. *Epilobium* is boreal with circumpolar range as well as restricted elements.

Many a genus in Umbelliferae is represented by a single species and are restricted to the neighbouring areas excepting for *Sanicula* and *Seelli* which are widespread. *Anthriscus* is common to Europe and Orient and *Bupleurum* ranges from Altai-China-eastern Himalayas. *Chaerophyllum* occurs in Afghanistan-eastern Himalayas; *Ferula* Iran-Central Asia-Afghanistan; *Heracleum* western China-Afghanistan-central Himalayas; *Pimpinella* ranges into Afghanistan and Japan-Taiwan. *Fleuroespernum* from Afghanistan to Central Asia; *Salinum* and *Vacatia* are rather restricted (Afghanistan-Pakistan-eastern Himalayas).


*Valeriana* (Valerianaceae) is one of the few genera which extend into Malaya and Java and links Himalaya with Malaya
archipelago. The species range into Europe as well! *Asperula* does not extend beyond Afghanistan.

Compositae is the second largest element with *Taraxacum*, *Saussurea* and *Artemisia* as the major genera. A number of genera represented by a single species are confined to Asia excepting *Achillea* (circumpolar), *Picris* (Europe), and *Sonchus* (cosmopolitan). *Brachyactis*, *Myriactis*, *Psychrogeton* and *Carpesium* occur in the neighbouring areas; and *Erigeron* is widespread but none reach North America. *Leontopodium* is basically restricted excepting for *L. leontopodium* which reaches Mongolia. *Bidens* has elements reaching North America and *Artemisia* is mainly restricted to the adjoining areas; yet it shows interesting relationships, e.g., a number of species occur in Central Asia or China. *Chrysanthemum* does not extend beyond Afghanistan and *Tanacetum* only occurs in Pamir outside Kashmir-Pakistan. *Waldhemia* is restricted to Central Asia and Asia Minor and *Cremanthodium* ranges to China. *Doronicum* occurs in Pakistan-western Himalayas and *Senecio* extends to China-eastern Himalayas. *Centaurea* occurs from Balkan-southwest and Central Asia to Kashmir and *Cirsium* is circumpolar. *Cousinia* ranges upto Afghanistan and *Jurinea* has a species reaching Pamir. *Tricholepis* does not go beyond Afghanistan. *Crepis* is an interesting element, the species are widespread in parts of Asia. *Lactuca* has species with circumpolar range and some extending upto Afghanistan only. *Scorzonera* is endemic to western Himalayas and *Taraxacum* which in fact is a single species complex (*T. officinale*) is mainly Central Asian. *Tragopogon* is widespread in Europe and *Youngia* extends to southeast Asia as well as to Siberia (!)
Campanulaceae is one of our minor elements. Asyneuma does not range beyond Afghanistan; and Campanula has wider distribution in Europe and northwest Asia, a few elements are restricted. Codonopsis is restricted to Afghanistan Kashmir.

Ericaceae is still a smaller representative with Cassiope extending to eastern Himalayas, Gaultheria goes further into China and the Rhododendrons are wholly Himalayan.

Moneses, Monotropa and Pyrola (Monotropaceae) show an interesting distribution. Moneses uniflora reaches Japan, Monotropa hypopitys and Pyrola are circumpolar.

Primulaceae are better represented. Androsace are widespread but do not reach eastern Himalayas. Cortusa reaches Europe, Glaux is widespread from Europe through Asia to North America and is circumpolar (!) Lysimachia is more confined to Himalayas and Primulas are either circumpolar or restricted, many of them are confined to neighbouring areas.

Gentianaceae includes Gentiana which is widespread as well as restricted (none of our species reach eastern Himalayas); Gentianella is endemic to Ladak, and Jaeschkea to Kashmir and Pakistan; Lomatogonium is widely distributed and Swertia does not reach beyond Afghanistan excepting for S. marginata which reaches Siberia.

In Oleaceae Fraxinus reaches Europe and North Africa. Jasminum is widespread from Europe to the Himalayas and Syringa does not extend beyond Afghanistan, same being true to Cynanchum.

Polemonium (Polemoniaceae) is widespread from Atlantic Europe to Siberia-China (it is circumpolar).

In Boraginaceae Actinocarya is restricted to Kashmir, and Arnebia from Iran to Mongolia. Cynoglossum is widespread, Eritrichium is widespread in regions of Alps. Hackelia is common
in northern hemisphere. \textit{Lappula} partially enters Europe; \textit{Lasio-
cavrum} is restricted; \textit{Lindolfia} does not go beyond Iran; \textit{Lithospermum} is widespread in Europe-Afghanistan; \textit{Microula} to Ladak; \textit{Myosotis} is widespread in Europe; \textit{Onosma} from west Him-
alyas to Caucasus; \textit{Pseudomertensia} does not extend beyond Afghanistan \textit{Solenanthus} in neighbouring regions and Iran; \textit{Trigonotis} reaches eastern Himalayas.

\textit{Solanaceae} is little represented. \textit{Atropa acuminta} occurs throughout Eurasia; \textit{Datura stramonium} is cosmopolitan. \textit{Hyoscyamus} are widespread in Europe; \textit{Lycium ruthenicum} occur from eastern Europe to Afghanistan-Turkistan; and \textit{Physochlaina praealta} to Kashmir-Pakistan. \textit{Cuscuta} shows interesting distribution showing elements with Europe as well as Malaysia and Java (!).

In \textit{Scrophulariaceae} \textit{Euphrasia} is totally endemic. \textit{Lasotis} is confined to Kashmir-Pakistan, \textit{Lanceatibetica} from west China to eastern Himalayas, \textit{Leptorhabdos parviflora} from Afghanistan to western Himalayas, \textit{Limosella aquatica} + circumpolar, \textit{Linaria dalmatica} - central Europe (cultivated). \textit{Pedicularis} is a larger genus, nearly half endemic and the rest common to Central Asia, eastern Himalayas and some reach Siberia. \textit{Picrorhiza kurrooa} is endemic to Kashmir-Pakistan, \textit{Scrophularia} does not extend beyond Afghanistan, and \textit{Verbascum thapsus} is restricted to west Himalayas-Afghanistan. \textit{Verbascum} has elements common to China, is circumpolar as well as restricted. \textit{Wulfenia amherstiana} is Himalayan.

\textit{Lathraea} and \textit{Orobanche} (Orobanchaceae) are widespread, a few species of the latter are restricted. \textit{Strobilanthes} (Acan-
thaceae) eastern Himalayas to Pakistan; and \textit{Plantago} (Plantaginaceae) is both widespread as well as restricted.
Calamintha (Labiatae) reaches North Africa, *Dracocephalum* is widespread in Europe and north Asia, *Elsbottzia* extends into China and eastern Himalayas as well as Europe and Siberia. Lamiums are circumpolar and some do not extend beyond Afghanistan. *Mentha* is widespread. Nepetas do not extend into Europe and are confined to Asia, mainly in neighbouring regions. *Perovskia* occurs in Ladak, *Phlomis* do not extend beyond Afghanistan, and *Prunella vulgaris* is circumpolar. *Salvia* is restricted to Pakistan-western Himalayas. *Satureia* ranges in Mediterranean and south Europe. *Scutellaria* are restricted from Afghanistan to western Himalayas. *Stachys* is widespread or restricted and *Thymus* is cosmopolitan.

Most of the genera in Chenopodiaceae are represented by a single species and are restricted to our area alone. *Atriplex* is cosmopolitan or widespread, *Chenopodium* is widespread, *Salsola* occurs throughout Europe, same is true of *Kochia*.

In Polygonaceae *Fagopyrum* is widespread, *Rheum* is restricted to Pakistan-Kashmir. Polygonums are mostly circumpolar and some are common to Iran and neighbouring areas. *Rumex* is widespread or restricted.

*Daphne* and *Mykstromia* (Thymeliaceae) occur in west Asia and Europe and *Elaeagnus* and *Hippophae* (Elaeagnaceae) are widespread in Europe and Orient reaching Japan (*E. umbellata*). Euphorbias are restricted excepting *E. stracheyi* which extends into west China and eastern Himalayas.

*Parietaria* and *Urtica* (Urticaceae) include subcosmopolitan elements (*P. debilis*) reaching central America and Australasia, and natives of Himalayas and widespread (*U. dioica*) elements.
However, of Betula and Corylus (Betulaceae) the former is Himalayan and the latter widespread in neighbouring areas and Europe.

In Salicaceae none of the poplars are alpine/subalpine but Salix reaches these altitudes and the elements are common with the adjoining areas.

Of the Monocotyledons (excepting Gramineae) Orchidaceae have nearly all genera represented by a single species each and are widespread in neighbouring areas, some are circumpolar and a few reach eastern Himalayas. In Liliaceae elements are common Central Asia, some are circumpolar and some reach eastern Himalayas. Polygonatum verticillatum is common with North America and Japan but tulips are restricted to Afghanistan-Himalayas. Alliums are mostly Asian and Gagea restricted to Iran-Central Asia. Anisacema flavum (Araceae) reaches North Africa; Juncus and Luzula are interesting: J.articulata is circumpolar, J.punctoric is native to Africa, L.comosetra reaches Australasia and L.spicata reaches North America.

Carex (Cyperaceae) is a large element ranging from Europe to Australasia-North America. A number of species are common with Central Asia as well as eastern Himalayas. Elicocharis is largely widespread and Kobresia ranges in central China and eastern Himalayas. Scirpus is widespread to cosmopolitan.

CONCLUDING REMARKS

The general affinities of the extant flora on basis of species common with the various geographical areas shows that the flora comes very close to Afghanistan, eastern regions of Europe, the eastern Himalayas and Central Asia,
respectively. Considering the species together, the flora leans more heavily towards Afghanistan, Central Asia and equally with eastern Himalayas and Europe. This is quite obvious considering the geological and palaeobotanical history of the area which is discussed at length in the text, in particular reference to the position occupied by Kashmir between Gangamopteris and Glossopteris floral provinces.

Of the "other" areas Japan and Australia may be mentioned: a few families have considerable taxa common with these areas, e.g., Plantaginaceae, Cuscutaceae and Thymeliaceae (Ceylon), Monotropaceae, Onagraceae, Polygonaceae, Elaégnaceae (Japan), and Urticaceae (Australia).

Endemism provides interesting data. Families with maximum endemics are Compositae, Papilionaceae, Scrophulariaceae, Ranunculaceae, Cruciferae. The role of the Himalayas in endemism is significant as is also the extreme cold and intensity of ultraviolet radiations at alpine heights.