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# FOREST VEGETATION CHARACTERISTICS OF THE GARHWAL HIMALAYA

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ABSTRACT

General aspects of vegetation of the Shiwalik ranges and the Garhwal Himalaya between the altitudes : 400-4,200 m together with detailed floristic accounts of the typical forests, are provided. Main types of forests surveyed include moist sal bearing forests, tropical fresh-water swamp forests, tropical dry deciduous forests, Himalayan montane subtropical forests, Himalayan moist temperate forests, sub-alpine forests and alpine forests. Various forest types are illustrated by field photographs. It is noted that there is a general decline in the forest cover and forest degradation is on the increase because of population pressure for more cultivable land and increased tourist flow in the region. Serious efforts at national level are needed to conserve the fast dwindling forest cover.

## INTRODUCTION

Since the time immemorial forests have played an important and vital role in human lives. In India, study of forest types and their composition dates back much earlier to the beginning of Christian era. First scientific work in the direction is "Virkshayurveda" which refers to 14 forest types (cf. Core 1955). In the recent past, Hooker & Thomson (1855) divided the flora of India into 17 botanical provinces. However, Chatterjee (1939) classified Indian forests into 8 botanical subdivisions. In 1936, Champion gave preliminary survey of forest types of India. Later on, Champion & Seth (1968a) divided Indian forests into 16 groups which are further divided into several subgroups. Main work on the silviculture of Indian trees is by Troup (1921) and Champion & Seth (1968b). On the ecology of Indian forests. the compilation by Puri (1960) and Puri *et al.* (1983) are worth mentioning.

In the recent times, the floristic studies of P.N. Mehra and his co-workers (Mehra *et al.* 1971, 1983) on Indian forests were very valuable, yet these were mainly confined to the forests of Simla, Mussoorie, and Nainital in the western and Darjeeling and Assam in the eastern regions, whereas, vast streches of the Garhwal Himalaya have almost remained uninvestigated so far. Therefore, in order to fill in this lacuna, the present studies on the forest compositions in the phytogeographically important Garhwal Himalayan region were undertaken.

These deal mainly with the distribution and floristics of woody taxa. The vegetation sampled pertains to many reserved and/or virgin forests as well as degraded forests coming within an altitudinal range of 325-4, 800 m. Abrupt changes in topography are greatly reflected in the general vegetational patterns of the various forests. Obviously, our studies cover the natural vegetation ranging from the tropical, to subtropical, to temperate and finally to alpine types. About 62% area of the Garhwal Himalaya is covered by forests where even European flora elements are represented

sometimes in fairly large numbers. These forests cover areas of several thousand square kilometers. Therefore, studies in this region provided ample opportunities for surveying the vegetation of the plains as well as the hills. Further, the floristic accounts provided an opportunity to find out the diversity of plant types according to altitudinal variations.

This work as embodied in the present paper was carried out during the months of March-April and June to September in the years 1977-1981. Long distances of several hundred kilometers falling within variable altitudinal ranges were covered year after year on foot in dense forests for on-the-spot study of vegetation.

## GENERAL LOCATION AND CLIMATE

Administratively, the Garhwal Himalayan region includes the districts of Uttarkashi, Chamoli, Tehri-Garhwal, Pauri-Garhwal, and Dehradun of the State of Uttar Pradesh. It lies between 29°26′ — 31°28′ N and 77°49′ — 80°6′ E and the total surveyed area is about 25,000 sq.km. In the south this region starts as the Sub-Shiwalik bhabar (325 m) and extends up to Indo-Tibetan border in the north, with series of snow clad lofty peaks of Yamnotri, Gangotri, Kedarnath, Badrinath, and Valley of Flowers — Hem Kund Sahib sectors. The highest peak in the Garhwal Himalaya is Nandadevi, 7,817 m high. The region is traversed by deep gorges of Bhagirathi, Alaknanda, and the Dhwal Ganga. These merge together to form the Holy Ganges. Shiwaliks of Saharanpur and Doon valley (both in Uttar Pradesh) and the adjoining Nahan Paonta Sahib area (Himachal Pradesh) are also included in the surveys.

Monsoon commences towards the end of June and ceases by the middle of September. During three months of January to March, there is snowfall for 7-8 days of every month at about 2,000 m and above. The months of April and May are marked by occasional hailstorms and thunderstorms. During May and the first half of June *i.e.* before the outbreak of monsoon, on every third or fourth day, there is a small amount of rain (12-25 mm). Average annual rainfall in the region is fairly high *i.e.* Narindra Nagar (318 cm), Rajpur (298 cm), Mussoorie (222 cm), Dehradun (216 cm), Chakrata (189 cm) and Karanprayag (136 cm). Doon valley is the wettest.

The temperature shows usual montane variations. The lower valleys are climatically depressing. These are hot and sultry in summer and hung with mist till noon in the cold weather. During May-June, the maximum temperature reaches up to 43°C but at the ridges it is 34°C. At 1,800-2,100 m, the winter mean temperature is 4.4°C but above 3,000 m and higher up, it is around freezing point.

*Specific Localities* : Forest areas in and around Dehradun (600 m), Mussoorie, 1,850 m (35 km*), Rishikesh, 450 m (43 km), Dakpathar, 600 m (45 km), Paonta Sahib, 500 m (51 km), Kalsi, 800 m (52 km), Narindra Nagar, 1,050 m (59 km), Dhanolti, 2,250 m (59 km), Chakrata, 2,100 m (94 km), Tehri, 525 m (123 km), Kedarnath, 3,500 m (270 km), Yamnotri, 3,200 m (274 km), Gangotri, 3,140 m (301 km), Badrinath, 3,122 m (340 km), Valley of Flowers, 4,200 m (341 km), and Hem Kund Sahib, 4,500 m (342 km) falling within an altitudinal range of 400-4,500 m were surveyed. Map indicates the total area of about 25,000 sq.km which was surveyed during the various botanical tours undertaken in the Garhwal Himalayas and gives the actual routes followed during various collection trips.

## GENERAL ASPECTS OF VEGETATION OF THE SHIWALIK RANGES AND THE GARHWAL HIMALAYA

In the present work, notice has chiefly been taken of the conspicuous and dominating species of the frequently visited forests. Prominent epiphytes, orchids, ferns,

*Indicates distance from Dehradun (See Map).

climbers, and herbaceous elements that lend physiogonomic characteristics to these forests are also included in the account that follows :

(a) *Forest Flora :*

Vast areas of the Shiwalik hills and the Doon valley, between an altitude of 400-1,000 m, support both the dry and the moist tropical deciduous forests. The former are generally confined to the dry areas in the lower Shiwaliks between 400-4,500 m. Near Mohand (400 m) in Saharanpur range forest, the dry sal (*Shorea robusta* Gaertn. f.) forest providing an open and irregular canopy is met with. Here, due to more human influence, the quality of sal timber is poor. It is commonly associated with *Anogeissus latifolia* Wall. *Terminalia tomentosa* Wt. & Arn., *Buchanania lanzan* Spreng., *Mallotus philippinensis* Muell.-Arg., *Emblica officinalis* Gaertn., and *Diospyros cordifolia* Roxb. These Shiwalik ranges also support the dry diciduous mixed forests where forest canopy is light but fairly even, and a large number of small and medium sized tree species grow well. In addition to the species of the dry sal mentioned above, some of the important trees are *Garuga pinnata* Roxb., *Flacourtia indica* Merr., *Sterculia villosa* Roxb., *Grewia elastica* Royle, *G. hainesiana* Hole, *Aegle marmelos* Correa, *Ziziphus jujuba* Linn., *Bauhinia purpurea* Linn., *Ehretia laevis* Roxb., *Cordia vestita* Hook. f. & Th., *Gardenia turgida* Roxb., *Xeromphis spinosa* (Thunb.) Keay, and species of *Diospyros* Linn.

The riverain vegetation of the valley belongs to 'khair-sissoo' type, distributed along the beds of *Chos* or rivers and hill torrents. All these areas are inhabited by *Acacia catechu* Willd. associated with *Dalbergia sissoo* Roxb., *Tamarix dioica* Roxb., *Albizia lebbeck* Benth., and *Cordia dichotoma* Forst. f.

Over the Shiwalik hills and in the Doon valley, extending from 600-1,000 m, the moist sal bearing forests are common. Here, *Shorea robusta** is the dominant species with fairly close and regular canopy. Other important commonly associated trees are of *Terminalia tomentosa, T. bellirica* Roxb., *Anogeissus latifolia, Ehretia laevis, Premna latifolia* Roxb. var. *mucronata* Roxb., *Adina cordifolia* Hook. f., *Emblica officinalis, Xeromphis spinosa, Eugenia jambolana* Lam., *Mallotus philippinensis, Lannea coromandelica* (Houtt.) Merrill, and *Cordia dichotoma* Forst. f. (Fig. 1). At places, where the soil and moisture conditions are not favourable for the proper growth of sal, the moist mixed deciduous forests have established themselves. In these, in addition to the tree element of moist sal, other important trees are *Erythrina suberosa* Roxb., *Hymenodictyon excelsum* Wall., *Salmalia malabarica* (DC.) Sch. & Endl., *Holoptelea integrifolia* Planch., *Mitragyna parvifolia* (Roxb.) Korth., *Holarrhena antidysenterica* Wall., *Elaeodendron glaucum* Pers., *Wrightia tomentosa* Roem. & Sch., *Trema orientalis* Bl., *Ziziphus* spp., and *Oroxylum indicum* Vent.

The shrubby element in these tropical forests is generally constituted by *Adhatoda zeylanica* Medik., *Clerodendrum viscosum* Vent., *Lantana camara* Linn., *Caryopteris odorata* (Don) Robinson, *Murraya koenigii* Spreng., *M. paniculata* Jack., *Ardisia solanacea* Roxb., *Glycosmis pentaphylla* Correa, *Helicteres isora* Linn., *Phlogacanthus thyrsiflorus* Nees, *Maclura cochinchinensis* (Lour.) Cor., *Solanum erianthum* Don, and *Vitex negundo* Linn. Common woody climbers are *Zizyphus oenoplia* Mill., *Millettia auriculata* Baker, *Bauhinia vahlii* Wt. & Arn., *Vallaris solanacea* (Roth.) Kuntze., *Pueraria tuberosa* DC., etc. The two common woody semiparasites of these forests are, *Loranthus longiflorus* Desr. and *L. pulverulentus* Wall. Another parasite, *Cuscuta reflexa* Roxb., is also quite

*Authority name is deleted in subsequent reference to botanical names.

frequently met with. In the moist or wet localities, commonly seen ferns are *Adiantum lunulatum* Burm., *Diplazium esculentum* (Retz.) Sw., *Christella parasitica* (Linn.) Lev., *Tectaria macrodonta* (Fee) C.Chr., *Dryopteris cochleata* (Don) C.Chr., and *Ampelopteris prolifera* (Retz.) Copel. *Adiantum incisum* Forsk. and *Pteris vittata* Linn. are frequently met with on the roadsides on the margins of sal forests. The most common epiphytic ferns of the moist tropical forests are *Lepisorus nudus* (Hook.) Ching and *Pyrrosia flocculosa* (Don) Ching. These grow intermixed with an epiphytic orchid, *Rhynchostylis retusa* Bl., on stems and branches of *Mangifera indica* Linn. and *Eugenia jambolana* which are frequently planted. The herbaceous element is represented by *Alysicarpus vaginalis* DC., *Indigofera hirsuta* Linn., *Cassia mimosifolia* Linn., *Lindernia crustacea* F. Muell., *Leucas cephalotes* Spreng., *Triumfetta rhomboidea* Jacq., *Cyanotis cristata* Sch. f., *Hedyotis pinifolia* Wall., *Sonerila tenera* Royle, *Evolvulus alsinoides* Linn., etc. Common sedges and grasses of these forests are *Cyperus rotundus* Linn., *C. triceps* Endl., *Fimbristylis bisumbellata* Bub., *Ischaemum rugosum* Salisb., *Chrysopogon aciculatus* Trin., *Dichanthium annulatum* Stapf, *Eleusine indica* Gaertn., *Imperata cylindrica* P. Beauv., and *Panicum montanum* Roxb.

In the Doon valley, near Lachiwala (600 m) & Mothronwala (600 m) patches of the tropical freshwater swamp forests are seen. Common trees of these forests are *Ficus glomerata* Roxb., *Trewia nudiflora* Linn., *Eugenia jambolana, Persea gamblei* (King ex Hook. f.) Kosterm, *Phoebe lanceolata* Nees, *Salix tetrasperma* Roxb., and *Shorea robusta* (only at Lachiwala). The most common climbing palm of these area is *Calamus tenuis* Roxb. Other shrubs and climbers are *Ardisia solanacea* Roxb., *Smilax indica* Vitm., *Toddalia aculeata* Pers., and *Scindapsus officinalis* Schott. The herbaceous element is composed of *Ageratum conyzoides* Linn., *Adenostemma lavenia* Kuntze., *Acorus calamus* Linn., *Pouzolzia pentandra* Benn., *Cyperus globosus* All., *C. sanguinolentus* Vahl, and *C. amabilis* Vahl.

The forests between 1,000-1,500 m are sub-tropical in nature. Here the canopy is open and these support a mixture of both the tropical and the temperate species. As one moves from Rajpur (1,000 m) to Mussoorie, there is a narrow zone of sal forest. Here, in addition to *Shorea robusta*, other common species are *Adina cordifolia, Eugenia operculata* Roxb., *E. jambolana, Garuga pinnata, Mallotus philippinensis, Sapium sebiferum* Roxb., and *Flacourtia indica* Merr. The forests up to 1,500 m along bridle path, show an intermixture of many deciduous and a few evergreen species. Here, *Bauhinia retusa* Ham. is the only gregariously growing species. Other important constituent trees are *Eugenia dalbergioides* Benth., *Anogeissus latifolia, Mallotus philippinensis, Sapium insigne* Benth., *Leucomeris spectabilis* Don, *Engelhardtia spicta* Bl., *Erythrina suberosa* Roxb., *Pistacia integerrima* Stew., *Butea monosperma* (Lam.) Taub., *Nyctanthes arbor-tristis* Linn., and *Olea glandulifera* Wall. On dry rocks, *Euphorbia royleana* Boiss. grows very abundantly and conspicuously. At Barkot, Kathnaur and Gangnani, from 1,200-1,800 m the subtropical *Chir* or *chil* pine forests are met with (Fig. 2). The Mussoorie hills are conspicuous by the absence of such forests and only isolated trees of *Pinus roxburghii* Sargent are seen. In the rest of the areas, *chir* pine forms large patches of practically pure strand forests and is restricted to the exposed dry situations such as ridges or the south facing slopes and the well drained areas. The top storey is purely constituted by *Pinus roxburghii*. In the lower storey scattered trees of *Quercus incana* Roxb. and *Lyonia ovalifolia* (Wall.) Drude are met with. Whereas, in moist and shady depressions,

important broad leaved species are *Juglans regia* Linn. var. *kumaonica* C. DC., *Ehretia acuminata* R. Br., *Salix oxycarpa* Anders, *Betula alnoides* Ham., and *Pyrus pashia* Ham. Generally, the forest floor is covered by grass species like *Eulalia mollis* O. Ktze., *Arundinella intricata* Hughes, *Capillipedium parviflorum* Stapf, *Heteropogon contortus* P. Beauv., etc. In certain inner valleys near Barkot and Uttarkashi, *Cedrus deodara* Loud. occurs in association with *Pinus roxburghii*, with latter unusually occupying higher slopes, followed by deodar below. In the Shiwalik ranges near Assarori, *chir* pine descends as low as to 600 m and is found growing scattered with other elements of the Shiwalik sal forest. Sometimes, *Pinus roxburghii* reaches as high as 2,300 m and is found growing scattered with *Quercus incana*. Common shrubs found in the subtropical zone are *Lantana camara*, *Caryopteris odorata* (Don) Robinson, *Carissa spinarum* A. DC., *Berberis asiatica* Roxb., *B. chitria* Lindl., *Prinsepia utilis* Royle, *Woodfordia fruticosa* (L.) Kurz, *Cocculus laurifolius* DC., *Colebrookia oppositifolia* Smith, *Debregeasia hypoleuca* Wedd. and *Adhatoda zeylanica* Medik. *Bauhinia vahlii* Wt. & Arn. and *Milletia auriculata* Baker are the two common woody climbers of the sub-tropical forests, but are not met with in the himalayan *chir* pine forests. Common ferns in this area are *Christella subpubescens* (Bl.) Holtt., *C. dentata* (Forsk.) Brown & Jermy, *Ampelopteris prolifera* (Retz.) Copel., *Dryopteris cochleata* (Don) C. Chr., etc. The herbaceous element in the pine forests is almost absent while in monsoon season there is a good number of herbs in the broad leaved forests. Of these, mention may be made of *Launaea nudicaulis* Less., *Argemone mexicana* Linn., *Rumex nepalensis* Spreng., *Origanum vulgare* Linn., *Blumea aromatica* DC., *Anisomeles indica* Ktze., *Ajuga bracteosa* Wall., *Ageratum conyzoides*, etc. Large tracts of the sub-tropical forests have been destroyed by various biotic factors. Pressure for fodder, fuel, and firewood is immense. Agriculture and inhabitations are also encroaching the forests (Fig. 3). So, the pure pine forests are now left only at steep slopes or in areas where soil is not good for cultivation.

The moist temperate forests are found in whole of the Garhwal Himalayas between 1,500-3,000 m. The subtropical pine forests form its lower limit, while at its upper end, it merges into subalpine forests. The annual rainfall varies from 100-250 cm. Up to 2,000 m, these forests have both the *ban* and the *moru* oak forest. The ban oak (*Quercus incana*) forests, which are near to human settlements, have been adversely affected by indiscriminate felling and lopping for fodder, agricultural land, and fuelwood. Thus in such forest areas, these are reduced to mere oak scrubs or coppices (Fig. 4) which hold mainly stunted, poor boled and ruthlessly cut trees of *Quercus incana*, alongwith a few trees of *Rhododendron arboreum* Sm. and *Lyonia ovalifolia* (Wall.) Drunde. Here, ground is covered with grasses and some bushy and thorny shrubs. Around Mussoorie, Gangnani and Chamba between 1,500-2,100 m, the forests are primarily constituted by *Quercus incana*. Both *Rhododendron arboreum* (Fig. 8) and *Lyonia ovalifolia* are the characteristic species of these forests. In the moist depressions, other important deciduous and evergreen trees are *Aesculus indica* Colebr., *Cornus macrophylla* Wall., *C. capitata* Wall., *Acer oblongum* Wall., *Viburnum cylindricum* Buch.-Ham. ex Don, *V. mullaha* Buch.-Ham. ex Don, *Populus ciliata* Wall., *Pistacia integerrima* Stew., *Daphniphyllum himalayense* Muell.-Arg., *Phoebe lanceolata* Nees, *Litsea elongata* Wall. and *Persea odoratissima* (Nees) Kosterm. At still higher altitude (2,000-2,500 m), ban oak is replaced by moru oak (*Quercus dilatata* Lindl.). In the area of Chakrata, Hanuman Chatti, and between Tehri and Dhanolti,

forests of moru oak are met with. Its common associates are *Q. glauca* Thunb., *Alnus nitida* Endl., *Juglans regia* Linn. var. *kumaonica* D. DC., *Carpinus viminea* Wall., *Aesculus indica, Acer caesium* Wall.,*Betula alnoides* Ham., *Ilex dipyrena* Wall. and a few laurels. The shrubby undergrowth in these oak forests is mainly constituted by *Berberis* spp., *Coriaria nepalensis* Wall., *Daphne papyracea* Wall., *Viburnum cotinifolius* Don, *Wikstroemia canescens* Missm., *Desmodium tiliaefolium* G. Don, *Myrsine africana* Linn., *Prinsepia utilis* Royle, *Lonicera quinquelocularis* Hardwick., *Abelia triflora* R. Br., *Sarcococca pruniformis* Lindl., etc. Common woody climbers are *Rosa moschata* Wall., *Clematis* spp., *Smilax* spp., *Vitis* spp., *Rubus fasciculatus* Duthie and *Hedera nepalensis* K. Koch. The epiphytic growth of lichens and mosses is more in the ban oak than in the moru oak forests. Common ferns in the moist and shaded places are *Athyrium schimperi* Moug. ex Fee, *A. pectinatum* (Wall.) Pers., *Polystichum squarrosum* (D. Don) Fee, *Dryopteris ramosa* (Hope) C. Chr. etc. Whereas *Lepisorus nudus* (Hook.) Ching, *L. excavatus* (Bory) Ching, *Polypodium microrhizoma* Clarke ex Bak. and *Drynaria mollis* Bedd. are the common epiphytic ferns. The herbaceous element, which is more after the rains, is chiefly composed of *Salvia lanata* Roxb., *Craniotome versicolor* Reichb., *Ajuga brachystemon* Maxim., *Primula floribunda* Wall., *Rumex hastatus* Don and species of *Strobilanthes* Bl.

Between 1,700-2,500 m, at certain locations of Mussoorie, Kanasar and Patli Devi, *Cedrus deodara* conspicuously replaces common oak or grows along with it. The canopy of such forests is fairly close. In certain inner cool localities of Barkot and Uttarkashi, deodar also comes at an appreciably lower altitude to form associations with *Pinus roxburghii*, or at places it reaches as high as 3,200 m to form associations with the moist mixed coniferous forests. Normally, it forms a pure crop or may be associated with some scattered trees of ban oak, moru oak, *Rhododendron arboreum* Sm., etc. The shrubby growth is almost similar to that of the oak forests. Epiphytic ferns on *Cedrus deodara* Loud. are *Lepisorus nudus* (Hook.) Ching and *Polypodium microrhizoma* Clarke & Bak.

Between an altitude of 1,800-2,750 m in the inner valleys of the Garhwal Himalayas in moist places, depressions, on gentler slopes (Chakrata), and along streams (Gobind Ghat — Gobind Dham, Pandukeshwar-Badrinath, Gauri Kund — Kedarnath), the moist temperate deciduous forests are met with. Here, certain species grow more or less gregariously. Important constituents of these forests are *Aesculus indica, Betula alnoides* (Fig 7), *Populus ciliata* Wall., *Acer* spp., *Celtis australis* Linn., *Juglans regia* var. *kumaonica, Alnus nitida, Corylus colurna* Linn., *Lyonia ovalifolia, Ilex dipyrena, Salix* spp., *Quercus dilatata, Q. incana, Rhus* spp., *Buxus wallichiana* Baill., *Symplocos chinensis* (Lour.) Drunce, and various laurels. Other important components of these forests are *Hypericum cernuum* Roxb., *Buddleja crispa* Benth., *Rhamnus procumbens* Edgew., *Deutzia staminea* Br., *Viburnum* spp., *Salix elegans* Wall., *Elaeagnus umbellata* Thunb., *Euonymus* spp., *Colguhounia coccinea* Wall. and *Excoecaria acerifolia* F. did. Common woody climbers are *Vitis* spp., *Schizandra grandiflora* Hook. f. & Th., *Rubus macilentus* Camb. and *Hedera nepalensis* K. Koch. Woody semiparasite, *Loranthus longiflorus* Desr. is also met with. The herbaceous undergrowth is quite rich and is composed of *Paeonia emodi* Wall., *Impatiens* spp., *Elsholtzia flava* Benth., *Leucas* spp., *Salvia glutinosa* Linn., *Strobilanthes* spp. *Justicia pubigera* Wall., *Rumex hastatus* Don, *Polygonum* spp., etc. Commonly seen ferns are *Athyrium schimperi* Moug. & Fee, *Polystichum squarrosum* (Don) Fee, *Dryopteris sparsa*

(Don) Kuntze, *D. pallida* (Bory) Formins etc. Common epiphytic ferns are *Drynaria mollis* Bedd. and *Polypodium amoenum* Wall. *En route* Gobind Dham at 2,350 m, on the stems of *Lyonia ovalifolia*, an epiphytic orchid *Vanda parviflora* Lindl. grows very profusely and even it covers almost whole of the stem and branches.

At still higher altitudes of 2,400-3,000 m in this region (Deoban and Hannuman Chatti), very beautiful mixed coniferous forests are met with (Fig. 9). Dominating trees are *Abies pindrow** (Royle) Spach and *Picea smithiana* (Wall.) Boiss. At lower altitude, silver fir is also associated with *Cedrus deodara*. Very few other broad leaved species are associated with these forests. Of these, *Quercus semecarpifolia* Sm., *Euonymus lacerus* Ham., *Rhamnus purpurea* Edgew. are at high altitudes, while *Quercus* spp. and *Litsea umbrosa* Nees are met with at low altitudes. Common herbs which come up after the snow melts are *Viola serpens* Wall., *Polygonum* spp., *Fragaria vesca* Linn., *Impatiens* spp., *Geranium* spp., *Ajuga brachystemon* Maxim. and *A. parviflora* Benth. Climbers are very rare, only *Vitis himalayana* Brandis, *Smilax vaginata* Dcne. and *Asparagus filicinus* Ham. are met with. On way to Yamnotri, in a river bed at 2,700 m, *Salix* sp. is found to be growing quite gregariously (Fig. 6). Interestingly, almost all the trees were covered with an epiphyte fern, *Drynaria mollis*.

The mixed coniferous forests merge into the pure *Kharsu* oak forests which extend up to 3,300 m. Such forests are met with at Yamnotri and Deoban areas. With *Quercus semecarpifolia* Sm., other associated trees are *Abies pindrow*, *Picea smithiana* and *Cedrus deodara*. Its broad leaved associates are, *Ilex dipyrena* Wall., *Pyrus lanata* Don, *Quercus dilatata*, *Euonymus lacerus* Ham. *Syringa emodi* Wall. and *Betula utilis* Don. The undergrowth is composed of *Salix elegans* Wall., *Strobilanthes atropurpureus* Nees, etc. After the snow melts, herbaceous elements along with fern species appear on the forest floor.

Above Yamnotri-Gangotri (3,000-3,800 m), the Himalayan birch-fir forests are met with. These are mainly composed of *Abies spectabilis* (Don) Spach and *Betula utilis*. Other very rarely associated broad leaved species are *Rhododendron campanulatum* Don, *Quercus semecarpifolia* and *Sorbus foliolosa* (Wall.) Spach. Commonly met with shrubs are *Cotoneaster acuminata* Lindl., *Ribes* spp., *Lonicera* spp., *Rubus niveus* Wall., *Salix* spp. and *Viburnum nervosum* Don. Herbs appear only for a short duration after the snow melts.

The alpine birch-rhododendron scrub is found above 3,500 m. Here, the ground is covered by a thick layer of humus. Such scrubs have been found *en route* Hem Kund Sahib (4,100 m). *Betula utilis* is dominating with undergrowth of *Rhododendron campanulatum*, *Sorbus foliolosa* (Wall.) Spach, and *Syringa emodi* Wall. The shrubby undergrowth is composed by the species of *Cotoneaster*, *Rhododendron*, *Ribes*, *Polygonum*, *Lonicera* and *Salix*. Towards are Valley of Flowers, which is about 5 km long and 2 km wide, between 3,900-4,200 m, most of the slopes are covered by the above type of scrub. North-eastern and South-western slopes of the valley support beautiful alpine vegetation and grassy slopes, whereas southern aspects of the mountains are dry and do not support any tree vegetation. No where the valley is a flat land. It is often traversed by the water streams. Certain slopes are completely covered by ferns. The herbaceous flowering plants belonging to many genera, of which important ones are *Primula*, *Potentilla*, *Fritillaria*, *Geum*, *Aster*, *Geranium*, *Polygonum*, *Gentiana*, etc. appear for a short period in the months of July and August.

*This is treated as a separate species from *A. spectabilis* (Don) Spach as suggested by Mehra (1971).

(b) *Exotic Flora :*

Due to varied importance of woody plants, many trees and shrubs have been introduced in this region. Most of the plantations have been made around Dehradun, the main reason being the location of Forest Research Institute and various private and government plant nurseries.

Many fruit orchards are scattered throughout the Doon valley, of which the orchards of *Psidium guajava* Linn. and *Litchi chinensis* Sonn. deserve special mention. Other commonly cultivated fruit trees are *Prunus persica* Benth. & Hook. f., *Eriobotrya japonica* Lindl., *Mangifera indica* Linn. and species of *Citrus* Linn. Also a large scale tea [*Camellia sinensis* (Linn.) Kuntze ] plantations have been made. Some of the important ornamental trees of various gardens and parks are *Markhamia platycalyx* Sprange, *Jacaranda mimosifolia* Don, *Millingtonia hortensis* Linn., *Kigelia pinnata* DC., *Saraca indica* Linn., *Cassia fistula* Linn., *Grevillea robusta* A. Cunn, *Magnolia grandiflora* Linn., *Lagerstroemia speciosa* (Linn.) Pers., *Delonix regia* (Boj.) Rafin., etc. Trees which are planted along roadsides in avenues are *Toona ciliata* (Royle) M. J. Roem., *Azadirachta indica* A. Juss., *Terminalia arjuna* Bedd., *Albizia lebbeck* Benth., *Pterygota alata* (Roxb.) R. Br., *Cinnamomum camphora* Linn., etc.

The plantation forests of *sal* are quite common around Rajpur (600-1,200 m). In addition, for experimental purposes large scale plantation of *Pinus roxburghii, Eucalyptus* spp. *Broussonetia papyrifera* (Linn.) Vent., *Tectona grandis* Linn. f., *Aleurites* spp. and many species of bamboo such as *Dendrocalamus giganteus* Munro, *D. strictus* Nees, *Bambusa vulgaris* Sch., etc. have been made in the New Forest Area. Several other exotic trees, which often contribute to the forest wealth, have been grown in the Botanic Gardens and Arboreta of the Forest Research Institute.

Some of the important ornamental shrubs and climbers which have been planted in the New Forest, Doon valley, Mussoorie and other places of this region are : *Lonicera japonica* Thunb., *Petera volubilis* Linn., *Quisqualis indica* Linn., *Jasminum* spp., *Cestrum* spp., *Euphorbia pulcherrima* Willd., *Brunfeslia* spp., *Mussaenda* spp., *Gardenia* spp., *Buddleja madagascariensis* Lam., etc.

At Mussoorie, many species of gymnosperms have been planted: Of these, special mention may be made of *Taxus baccata* Linn., *Pinus wallichiana* Jack., *Ginkgo biloba* Linn., *Cupressus torulosa* Don and *Thuja orientalis* Linn., *Salix babylonica* Linn. is planted on the Mall road at Mussoorie.

Other broad leaved species which are cultivated in the Garhwal Himalayas, particularly around Dhanolti, are mostly for fruits. Of these, important ones are : *Prunus persica* Benth. & Hook. f., *P. armenica* Linn., *P. cerasus* Linn., *P. communis* Hudson., *Pyrus malus* Linn., *P. communis* Linn., *Grewia asiatica* Linn., etc.

## FLORISTICS OF SOME OF THE FREQUENTLY VISITED FORESTS IN THE SHIWALIK RANGES AND THE GARHWAL HIMALAYA

### I. TROPICAL MOIST DECIDUOUS FORESTS

1. **Moist Sal Bearing Forests** : Such forests are distributed over vast areas in plains as well as in the Shiwaliks and outer ranges of the western Himalayas even up to an altitude of 1,000 m. Sal *(Shorea robusta)* is the principal species which forms 60-90% of the top canopy. The top canopy in undisturbed forests is fairly close and regular.

(a) *Moist Shiwalik Sal Forests* These occur in the Shiwalik hills where annual rainfall is above 130 cm. Sal is quite gregarious and the trees are normally 10-17 m in height. It occupies high percentage of the crown space but the quality of timber is rather poor.

*Floristics :*

(i) Jhajra, 600 m (Dehradun) : The top canopy is constituted by *Shorea robusta, Terminalia bellirica, Garuga pinnata, Schleichera trijuga, Adina cordifolia, Terminalia tomentosa, Mitragyna parvifolia, Lannea coromandelica, Anogeissus latifolia, Albizia odoratissima, Cordia dichotoma, Bridelia retusa, Stereospermum suaveolens, Diospyros tomentosa,* etc. The second storey is composed of *Miliusa velutina, Buchanania lanzan, Ehretia laevis, Mallotus philippinensis, Wendlandia exserta, Holarrehena antidysenterica, Casearia tomentosa, Wrightia tomentosa, Trema orientalis, Aegle marmelos, Sterculia villosa, S. pallens, Litsea glutinosa, Premna latifolia* var. *mucronata, Emblica officinalis, Gardenia turgida, Xeromphis spinosa, Butea monosperma* and *Ougeinia dalbergioides.*

Commonly seen shrubs are *Woodfordia fruticosa, Adhatoda zeylanica, Capparis sepiaria, Lantana camara, Murraya koenigii, Helicteres isora* and *Carrisa spinarum.* The woody climbers in this forest are *Bauhinia vahlii, Ziziphus oenoplia, Smilax macro phylla, Abrus precatorius* and *Capparis horrida. Loranthus cordifolius, L. pulverulentus, L. longiflorus* and *Viscum articulatum* are the semiparasitic species of this forest. Common ferns are *Pteris vittata, Adiantum capillus-veneris, A. lunulatum* and *A. incisum. Lepisorus nudus* and *Pyrrosia flocculosa* are the two common epiphytic ferns. Commonly seen herbs and grasses are *Alysicarpus vaginalis, Indigofera hirsuta, Lindernia crustacea, Triumfetta rhomboidea, Erigeron bonariensis, Conyza aegyptiaca, Blumea mollis, Dichanthium annulatum, Chrysopogon aciculatus, Bothriochloa pertusa, Panicum montanum* and *Themeda anathera.*

(ii) Dakpathar (600 m) : Floristics of the sal forest of this region are almost the same as those described with Jhajra. Sal grows gregariously in the top canopy which is fairly close and regular.

(b) *Moist Bhabar-Doon Sal Forests*

This subtype is determined by the soil which is composed of sand, gravel and boulders. Due to the more permeability of the upper soil layers, the level of watertable is quite low. Trees not more than 25 m tall, however, the shrubby undergrowth is dense.

*Floristics :*

(i) Lachiwala (600 m) : In the first storey *Shorea robusta* is abundant. Other occasionally represented trees of this storey are *Lagerstroemia parviflora, Adina cordifolia, Terminalia tomentosa, Albizia odoratissima, Anogeissus latifolia, Terminalia bellirica, T. chebula, Lannea coromandelica, Garuga pinnata, Semecarpus anacardium, Holoptelea integrifolia* and *Eugenia jambolana.* The second storey is composed of *Mallotus philippinensis, Miliusa velutina, Aegle marmelos, Limonia crenulata, Gmelina arborea, Litsea monopetala, Flacourtia indica, Ehretia acuminata* var. *serrata, Trema orientalis, Grewia hainesiana, G. laevigata, Glochidion velutinum, Xeromphis spinosa, X. uliginosa, Holarrhena antidysenterica, Wrightia tomentosa, Sterculia villosa, Emblica officinalis* and *Trewia nudiflora.*

The undergrowth is comprised of *Lantana camara, Glycosmis pentaphylla, Clerodendrum viscosum, Helicteres isora, Murraya paniculata, M. koenigii, Phlogacanthus thyrsiflorus, Desmodium gangeticum, D. parvifolium, Buddleja neemda, Woodfordia fruticosa, , Hamiltonia sauveolens, Pogostemon benghalense, Ardisia solanacea, Carissa spinarum, Solanum erianthum, S. indicum, Flueggea microcarpa* and *Maclura cochinchinensis* (Fig. 1). A large number of climbing shrubs like *Ziziphus oenoplia, Caesalpinia sepiaria, Milletia auriculata, Bauhinia vahlii, Jasminum arborescens* var. *latifolia, Vallaris solanacea, Ichnocarpus frutescens,* etc. are present.

The common epiphytic ferns are *Lepisorus nudus* and *Pyrrosia flocculosa.* Ferns of wet situations are *Adiantum*

*capillus-veneris, Ampelopteris prolifera* and *Asplenium dalhousiae.* Herbaceous species are not many but some important ones are *Nelsonia canescens, Lepidagathis purpuricaulis, Ageratum conyzoides, Ajuga bracteosa, Cyanotis cristata, Hedyotis pinifolia* and *Evolvulus alsinoides.*

(ii) Assarori (600 m) : The sal forest of this range is almost similar to that of Lachiwala. But in the top storey *Eugenia operculata* is also met with. Additional trees of the second storey are *Careya arborea, Glochidion assamicum, Sapium sebiferum,* etc. *Vallaris solanacea* is the extremely common climber of this forest.

2. **Moist Mixed Deciduous Forests** : Such forests are formed by an intermixture of a number of species. Canopy is close, trees are medium to above medium in height. Two storeys are easily recognizable and at favourable sites evergreens are predominant. Climber growth is usually heavy. Herbaceous flora appear only in rainy seasons. Undergrowth is mainly shrubby. Grasses are almost absent. Distribution range is the same as that of the moist sal-bearing forests, but these forests occupy places where soil and moisture conditions are not suitable for the proper growth of sal.

*Floristics :*

(i) Assarori (600 m) : The top storey consists of *Terminalia tomentosa, Ougeinia dalbergioides, Anogeissus latifolia, Adina cordifolia, Albizia odoratissima, Cordia dichotoma, Lannea coromandelica, Erythrina suberosa, Hymenodictyon excelsum, Salmalia malabarica, Holoptelea integrifolia, Mitragyna parvifolia, Ficus cunia, F. glomerata,* etc. Some of the common trees of the lower storey are *Mallotus philippinensis, Premna latifolia* var. *mucronata, Holarrhena antidysenterica, Dalbergia sissoo, Sterculia villosa, Elaeodendron glaucum, Nyctanthes arbor-tristis, Aegle marmelos, Xeromphis spinosa, Wrightia tomentosa, Trema orientalis, Trewia nudiflora, Ehretia laevis, Ziziphus jujuba, Z. xylopyrus,* and *Oroxylum indicum.*

The shrubby undergrowth is constituted by *Adhatoda zeylanica, Clerodendrum viscosum, Lantana camara, Caryopteris odorata, Murraya koenigii, M. paniculata, Casearia tomentosa, Elsholtzia polystachya, Carissa spinarum, Solanum erianthum, Glycosmis pentaphylla,* etc. Common climbers are *Vallaris solanacea, Millettia auriculata, Bauhinia vahlii, Jasminum grandiflorum, Ziziphus oenoplia* and *Dioscorea pentaphylla.* Along water courses at lower altitude *Acacia catechu, Vitex negundo* and *Mimosa himalayana* are abundant. An epiphytic orchid *Rhynchostylis retusa* is quite common. Ferns are the same as those found in the sal forest of this area. The herbaceous flora is composed of *Solanum nigrum, Boerhavia diffusa, Blumea lacera, Vernonia cinerea, Hedyotis pinifolia,* etc.

(ii) Jumna bridge (550 m) : In the top canopy *Anogeissus latifolia* is dominating. Other associates in this storey are *Terminalia tomentosa, T. bellirica, Lannea coromandelica, Holoptelea integrifolia, Ficus cunia, Adina cordifolia, Spondias mangifera,* etc. The second storey is constituted by *Mallotus philippinensis, Bauhinia purpurea, Cassia fistula, Boehmeria rugulosa, Emblica officinalis, Dalbergia sissoo, Sterculia villosa, Kydia calycina, Sapium insigne, Wendlandia exserta, Butea monosperma* and *Ficus palmata.* Near water courses *Acacia catechu* grows in abundance.

Common shrubs are *Murraya koenigii, Adhatoda zeylanica, Lantana camara, Woodfordia fruticosa, Colebrookia oppositifolia,* etc. *Euphorbia royleana* shrubs are a common sight on dry rocks. *Bauhinia vahlii* is the only woody climber of this forest. Common ferns at the moist and wet places are *Diplazium esculentum, Pteris vittata* and *Adiantum incisum.*

(iii) Kalsi (800 m) : Floristics of this area are almost similar to the forests at

Jumna Bridge. But near this place, in seasonal riverlet beds, large scale plantations of *Eucalyptus* ssp. and *Dendrocalamus strictus* have been made to check soil erosion. Such plantations have markedly changed the whole physiogonomy of the low hills.

II. TROPICAL FRESHWATER SWAMP FORESTS

3. **Tropical Hill Valley Swamp Forests** : These are irregular forests with limited number of usually evergreen species. The trees are normally small and much branched and are distributed at continuously wet or atleast moist sites.

*Floristics :*

(i) Mothronwala (600 m) : Common trees are *Bischofia javanica, Ficus glomerata, Trewia nudiflora, Eugenia jambolana, Pittosporum floribundum, Persea gamblei, Phoebe lanceolata, Drypetes roxburghii, Acronychia laurifolia* and *Salix tetrasperma.* The shrubby element is constituted by *Ardisia solanacea, Elaeagnus conferta, Jasminum multiflorum* and *Trachelospermum lucidum. Calamus tenuis* is the most important climbing palm of this forest. Other climbing shrubs are *Scindapsus officinalis, Smilax indica, Toddalia aculeata, Dioscorea bulbifera,* etc.

The herbaceous element is composed of *Ageratum conyzoides, Adenostemma lavenia, Acorus calamus, Pouzolzia pentandra, Floscopa scandens, Cyperus globosus, C. sanguinolentus, C. amabilis* and *Coix lacryma-jobi.*

(ii) At the swampy and marshy localities of Lachiwala (600 m) and Golatappar (600 m) the floristics are almost the same as those of the Mothronwala swamp, except for the difference that in these two areas, some trees of *Shorea robusta* also invade the swampy area.

III. TROPICAL DRY DECIDUOUS FORESTS

4. **Dry Shiwalik Sal Forests** : The soil in such forests is dry, shallow and sandy. It is derived from the Shiwalik sand rock and conglomerates. Regeneration of sal in such forests is very poor, and also these are highly affected by various biotic factors. Trees rarely reach the height of 15 m and are of poor quality. Forest canopy is open and irregular.

*Floristics :*

(i) Paonta Sahib (500 m) : *Shorea robusta* is the dominating species which constitute more than 70% of the upper storey. Other associated trees in the top canopy are *Terminalia tomentosa, Lannea coromandelica, Adina cordifolia, Pterospermum acerifolium, Madhuca indica* and a few scattered trees of *Eugenia jambolana.* The lower storey is formed of *Mallotus philippinensis, Diospyros cordifolia, Ehretia laevis, Flacourtia indica, Emblica officinalis, Casearia tomentosa, Cassia fistula, Xeromphis spinosa,* etc.

The shrubby element is composed of *Carissa spinarum, Murraya koenigii, Clerodendrum viscosum, Woodfordia fruticosa, Adhatoda zeylanica, Ziziphus xylopyrus,* etc. *Combretum decandrum* is a very commonly met with woody climber. The only epiphytic orchid found is *Vanda parviflora.*

(ii) Mohand (400 m) : Commonly met with trees are *Shorea robusta, Anogeissus latifolia, Terminalia tomentosa, Buchanania lanzan, Bauhinia variegata, Mallotus philippinensis, Ficus glomerata, Acacia catechu, A. pseudo-eburnea, Emblica officinalis, Diospyros cordifolia,* and occasionally trees of *Cassia fistula, Ougeinia dalbergioides* and *Grewia oppositifolia* are also found.

Common shrubs are *Woodfordia fruticosa, Lantana camara, Casearia tomentosa, Carissa spinarum* and *Adhatoda zeylanica. Bauhinia vahlii* is a common woody climber of this area. The herbaceous element is scanty. Few commonly met with grasses are *Heteropogon contortus, Eulaliopsis binata, Oplismenus compositus,*

*Panicum psilopodium, Brachiaria ramosa,* etc.

5. **Dry Mixed Deciduous Forests :** These are distributed in dry areas. The canopy is light but fairly even. Trees are with short bole and are of poor quality, not more than 15 m in height. There is an intermixture of a good number of small tree species. The undergrowth includes both deciduous and evergreen shrubs.

*Floristics :*

Shahjahanpur (400 m) : The chief elements are *Terminalia tomentosa, Acacia catechu, Garuga pinnata, Flacourtia indica, Crataeva religiosa, Mallotus philippinensis, Sterculia villosa, Anogeissus latifolia, Grewia elastica, G. hainesiana, Aegle marmelos, Ziziphus jujuba, Butea monosperma, Tamarindus indica, Bauhinia purpurea, Ehretia laevis, Albizia lebbeck, Trema politoria, Cordia dichotoma, C. vestita, Wendlandia exserta, Gardenia turgida, Holarrhena antidysenterica, Xeromphis spinosa, Diospyros cordifolia, D. tomentosa,* etc.

The shrubby undergrowth is composed of *Lantana camara, Helicteres isora, Murraya paniculata, Carissa spinarum, Adhatoda zeylanica, Barleria cristata, Indigofera pulchella, Murraya koenigii,* etc. Woody climbers are *Ziziphus oenoplia, Bauhinia vahlii,* and *Abrus precatorius.* Bamboos *(Dendrocalamus strictus)* are occasionally met with. Important grasses seen in this area are *Heteropogon contortus, Eleusine indica, Imperata cylindrica, Oplismenus compositus,* etc.

6. **Dry Deciduous Khair-sissoo Forests :** The canopy is light but usually complete and attains height up to 20 m. In sissoo forest, *Acacia catechu* forms distinct second storey, but sometimes at certain places it may occur in pure formations. The shrubby undergrowth is rich. These are distributed on new sandy or gravelly alluvial/soils along various riverbeds or water reservoirs. The upper soil is devoid of humus.

*Floristics :*

(i) Paonta Sahib (500 m) : The upper storey is fully composed of *Dalbergia sissoo* *Acacia catechu* does not grow as tall as sissoo, so it forms a distinct second storey. The shrubby undergrowth is very thick and is mainly composed of *Lantana camara, Adhatoda zeylanica, Calotropis procera* and *Vitex negundo.* At certain open places, grass species such as *Saccharum spontaneum, S. munja,* and *Aristida cyanantha* occur in abundance.

(ii) Lachiwala (600 m) : The most dominating species is *Acacia catechu* which forms almost pure patches along riverbed. A little away, it is occasionally intermixed with the trees of *Albizia lebbeck, Tamarix dioica, Spondias mangifera, Cordia dichotoma, Gmelina arborea, Premna latifolia* var. *mucronata* and *Litsea monopetala.*

The shrubby undergrowth is the same as found in Paonta Sahib except *Murraya koenigii* and *Helicteres isora* are also found. Common climber is *Bauhinia vahlii.*

Grasses such as *Saccharum spontaneum* and *S. munja* contribute to the ground cover. The herbaceous flora is represented by *Indigofera linifolia, Rumex hastatus, Heliotropium strigosum, Boerhavia diffusa, Cyperus triceps, Cynodon dactylon,* etc.

### IV. HIMALAYAN MONTANE SUB-TROPICAL FORESTS

**Himalayan Sub-tropical Broad Leaved Forests** : In the Himalayas, these forests occupy a narrow intermediate zone between the montane tropical and montane temperate forests, and fall within an altitudinal range of 1,000—1,500 m. Vegetation shows an intermixture of both the tropical and temperate species. The canopy is generally open and the trees are seldom more than 17 m tall.

(a) *Subtropical Sal Forests :* This subtype occurs in the outer himalayan ranges

where the underlying rock is tertiary sandstone. Sal, which is the dominating species, is of poor quality.

*Floristics :*

(i) Rajpur (1,000 m) : There is a narrow belt of sal forest at Rajpur where *Shorea robusta* is the most dominating species of the upper canopy. Other species of the top storey are *Adina cordifolia, Eugenia operculata, Terminalia bellirica, Eugenia jambolana,* and a few other of *Garuga pinnata, Mangifera indica* and *Ficus bengalensis.*

The common trees of the lower storey are *Mallotus philippinensis, Sapium sebiferum, S. insigne, Miliusa velutina, Grewia oppositifolia, Flacourtia indica, Glochidion velutinum,* etc.

Some of the common shrubs are *Carissa spinarum, Maclura cochinchinensis, Casearia tomentosa, Tabernaemontana coronaria, Mimosa pudica, Ardisia solanacea* and *Crotalaria tetragona.*

Common woody climbers are *Bauhinia vahlii* and *Milletia auriculata.*

The herbaceous element is chiefly composed of *Launaea nudicaulis, Rumex nepalensis, Origanum vulgare* and *Ajuga bracteosa.*

Some of the important ferns are *Dryopteris cochleata, Adiantum venustum, Christella dentata, C. parasitica* and *Ampelopteris prolifera.*

*Vanda parviflora,* an epiphytic orchid, is common on the tree trunks of *Mangifera indica.*

(b) *Sub-tropical Mixed Forests :* The upper limit of such forests coincides with the lower limit of snowfall, that is, upto 1,500 m. These forests occur on fairly steep and well drained slopes. The canopy is open and the trees are 10-17 m in height.

*Floristics :*

(i) Along Rajpur-Mussoorie Bridle Path (1,000-1,500 m) : The only tree species which grows gregariously is *Bauhinia retusa* and is mainly restricted to the southern aspects. Other important constituents are *Ougeinia dalbergioides, Anogeissus latifolia, Terminalia tomentosa, Mallotus philippinensis, Sapium insigne, Leucomeris spectabilis, Boehmeria rugulosa, Albizia lebbeck, Flacourtia indica, Sterculia pallens, Engelhardtia spicata, Erythrina suberosa, Olea glandulifera, Pistacia integerrima, Elaeodendron glaucum, Nyctanthes arbor-tristis, Butea monosperma, Premna barbata* and *Glochidion velutinum.*

The shrubby undergrowth is composed of *Berberis asiatica, B. chitria, Prinsepia utilis, Rhus parviflora, Woodfordia fruticosa, Cocculus laurifolius, Jatropha curcas, Inula cuspidata, Solanum indicum, S. hispidum, Zanthoxylum alatum, Colebrookia oppositifolia* and *Adhatoda zeylanica.* Two important climbers are *Bauhinia vahlii* and *Milletia auriculata. Euphorbia royleana* grows very abundantly on dry rocks.

The herbaceous element is constituted by *Launaea nudicaulis, Argemone mexicana, Rumex nepalensis, Cynoglossum lanceolatum, Anisomeles indica, Ageratum conyzoides, Sida spinosa, Origanum vulgare, Fumaria parviflora,* etc. The important ferns are *Ampelopteris prolifera, Pteris vittata, Adiantum incisum, Diplazium polypodioides* and *Dryopteris marginata, Lepisorus nudus* is an epiphytic fern of this area.

8. **Himalayan Sub-tropical pine Forests :**

(a) *Shiwalik Chir Pine Forests : Pinus roxburghii* forms the upper storey with elements of the tropical mixed deciduous forests. The undergrowth is fairly continuous and composed of xerophytic shrubs.

These are distributed at an altitudinal range of 600-1,000 m on the dry slopes of the Shiwalik conglomerates and sandstone.

*Floristics :*

(i) Assarori (600 m) : At the ridge *Pinus roxburghii* is the dominating species of the top canopy and associated with it are *Shorea*

*robusta* and *Terminalia tomentosa*. The extremely thin lower storey is constituted by *Ougeinia oojeinensis, Anogeissus latifolia, Kydia calycina, Mallotus philippinensis, Sterculia villosa, Grewia oppositifolia, G. hainesiana, Cassia fistula*, etc. The occasional shrubby undergrowth is composed of *Lantana camara, Caryopteris odorata, Carissa spinarum, Murraya koenigii, Glycosmis pentaphylla, Phlogacanthus thyrsiflorus* and *Adhatoda zeylanica*. Very rarely met with climbers on the flowering trees are *Bauhinia vahlii, Milletia auriculata* and *Pueraria tuberosa*. Common ferns at moist places are *Adiantum capillus-veneris, A. lunulatum, Christella parasitica* and *Ampelopteris prolifera*.

(b) *Himalayan Chir Pine Forests* : Typically, *Pinus roxburghii* occurs as a pure crop which usually is not so dense and is marked by the absence of other trees in the top canopy. The shrubby vegetation is rare but the forest floor is sufficiently covered by grasses. Climbers, epiphytes, and bamboos are conspicuous by their absence. In moist situations, as along water courses, broad leaved species are also present. Towards the upper limit *chir* passes insensibly into the ban oak while towards the lower limit there is a corresponding increase in the dry deciduous trees.

These forests are distributed all long the sub-tropical zone of the Western Himalayas from 1,200-1,800 m, at places ascending to 2,300 m on the southern slopes. Summer temperature is high. During winter, snowfall is only for few days.

*Floristics* :

(i) Kathnaur (1,200-1,800 m) : The top storey is purely constituted by *Pinus roxburghii*. In the lower storey there are only a few scattered trees of *Quercus incana* and *Lyonia ovalifolia*. In more shady and moist places, trees of *Juglans regia*, var. *kumaonica, Rhus semialata, R. wallichii, Ehretia acuminata, Salix oxycarpa, Morus serrata, Pyrus pashia, Betula alnoides* and *Ficus palmata* are frequently seen. Sites which are protected from fire, hold a dense undergrowth of shrubs like *Prinsepia utilis, Berberis lycium, Myrsine africana, Sarcococca pruniformis, Debregeasia hypoleuca*, etc.

On the forest floor common grasses species are *Eulalia mollis, Arundinella intricata, Capillipedium parviflorum, Sporobolus indicus* and *Heteropogon contortus*.

(ii) General floristics of *chir* pine forests of Barkot and Gangnani are almost similar to those of Kathnaur (Fig. 2), whereas, at Mussoorie only scattered trees of *Pinus roxburghii* are met with. Pine is restricted to the exposed dry situations such as crest of spurs or south facing slopes and well drained areas. In moist and fire protected places, the shrubby undergrowth and grasses are distinct. In certain inner valleys of the Garhwal Himalayas, near Barkot and Uttarkashi, *Cedrus deodara* has been found growing under *Pinus roxburghii*. Large tracts of the subtropical pine forests in the Garhwal Himalayas near Chamba (Fig. 3) and Gangnani have been adversely affected by various biotic factors such as large scale cutting for timber and pressure for agricultural land due to increasing population. Presently trees of *Pinus roxburghii* are left either at very steep slopes or at the hill tops which are unfit for cultivation.

### V. HIMALAYAN MOIST TEMPERATE FORESTS

These are met with throughout the Himalayas from 1,500 m to 3,300 m with the subtropical pine forests as their lower limit and the subalpine forests as their upper limit. The annual rainfall varies from 100-250 m.

At the lower limit, this region usually supports oak forests which are mainly composed of a single species. With the increase in altitude, oak forests merge into extensively developed coniferous forests, in which the number of dominant species is very small. Depending upon the local

factors, deciduous tree genera like *Acer, Aesculus, Ulmus, Fraxinus, Corylus, Alnus, Betula,* and evergreen laurels are also met with.

9. **Moist Temperate Oak-forests :** These are usually composed of a single species and are generally of low height *i.e.* 10-20 m. Trees of the *ban* oak are generally with poor bole and are widely branched, but those of the *Quercus dilatata,* on favourable soil conditions, are much better developed.

(a) *Ban* Oak *(Quercus incana) Forest :* These occupy the lowest zone of the temperate belt and stretches from 1,500-4,200 m. At cooler places, it even descends as low as 900 m in the *chir* pine zone.

On the southern slopes, *Quercus incana,* forests are open and formed of poor boled low branching trees. Only at favourable sites, the trees are well developed and form a close canopy. Typical associates are *Rhododendron arboreum* and *Lyonia ovalifolia.* At moist sites, oak is associated with various deciduous trees. At places, protected from grazing, shrubs, are quite common. Climbers are rare, but epiphytic mosses, lichens and ferns are quite abundant.

*Floristics :*

(i) Mussoorie (1,850 m) : In the upper canopy, *Quercus incana* is the dominating species and its chief associates, which does not reach the height of the oak, are *Rhododendron arboreum* (Fig. 8) and *Lyonia ovalifolia.* Along water courses and in moist depressions on lime-stone soil, common trees are *Aesculus indica, Cornus macrophylla, Litsea elongata, Persea odoratissima, P. duthiei, Viburnum cylindricum, V. mullaha, Cornus capitata, Carpinus viminea, Meliosma pungens, Phoebe lanceolata, Acer oblongum, Toona serrata, Daphniphyllum himalayense* and *Pistacia integerrima.* The other less common tree species are *Populus ciliata, Salix oxycarpa, Morus serrata, Pyrus pashia,* etc.

At places which are protected from grazing and other biotic factors, the shrubby elements are composed of *Boehmeria platyphylla, Berberis lycium, Leptodermis lanceolata, Coriaria nepalensis, Daphne papyracea, Viburnum cotinifolium, Wikstroemia canescens, Desmodium tiliaefolium, Lonicera quinquelocularis, Prinsepia utilis, Myrsine africana* and *M. semiserrata.* Commonly seen climbers are *Rosa moschata, Clematis montana, C. nepalensis, Vitis obtecta, V. divaricata, Rubus fasciculatus, Hedera nepalensis, Smilax parvifolia, S. aspera,* etc.

Epiphytic vegetation of ferns, lichens, and mosses is quite rich. At shaded and moist places, the common ferns are *Arthromeris wallichiana, Woodwardia radicans, Pteris quadriqurita, Adiantum venustum, Diplazium polypodioides, Asplenium dalhousiae, A. varians* and *Dryopteris pallida.* Common epiphytic ferns are *Lepisorus excavatus, L. kashyapii, Lepisorus clathratus, Phymatopteris oxyloba, Polypodium microrhizoma,* etc. The herbaceous element on rocks and forest floor is composed of *Chirita bifolia, Erigeron alpinus, Geranium ocellatum, Evolvulus alsinoides, Polygonum* ssp., *Lindenbergia indica, Bupleurum lanceolatum, Centella asiatica, Craniotome versicolor, Anisomeles indica* and *Plectranthus coetsa.*

Considerable damage is being done to the *ban* oak forest of Mussoorie due to lopping for fodder and road building activities.

(ii) Gangnani (1,950 m) : *Quercus incana* forms the virgin forests near Gangnani. In the upper storey it is associated with scattered trees of *Alnus nitida* Endl. The elements in the lower storey and shrubs etc. are almost the same as that of Mussoorie.

The woody semiparasite *Loranthus longiflorus* is very common and is infecting almost every third tree in the forest.

(iii) Chamba (1,800 m) : In this forest, of *ban* oak, a few scattered trees of *Pinus*

*roxburghii* are met with. The rest of the elements are same as has been given for Gangnani.

(b) *Moru* Oak *(Quercus dilatata) Forests:* These have relatively restricted range of distribution at 2,000-2,500 m. Found on more deep and moist soil,the trees are thus more luxuriant than *ban* oak. Bole is long and cylindrical. Canopy is evergreen and dense. The second storey is composed of evergreen species. The shrubby undergrowth is quite conspicuous and the epiphytic growth of lichens, mosses and ferns is less as compared to *ban* oak. At higher altitudes, these merge with *Quercus semecarpifolia, Picea smithiana* and *Abies pindrow* forests.

*Floristics :*

(i) Chakrata (2,100 m) : The dominant tree in the top canopy is *Quercus dilatata* (Fig. 10). It is occasionally associated with *O. incana, Alnus nitida, Juglans regia,* var. *kumaonica, Carpinus viminea, Aesculus indica, Persea duthiei, Cedrus deodara,* etc. The second storey is marked by the occasional presence of *Ilex dipyrena, Euonymus pendulus, Persea odoratissima, Betula alnoides, Acer caesium, Rhododendron arboreum, Litsea umbrosa,* etc.

The undergrowth is constituted by *Lonicera quinquelocularis, Desmodium tiliaefolium, Indigofera gerardiana, Daphne papyracea, Abelia triflora, Leycesteria formosa* and *Sarcococca pruniformis.* The herbaceous element is composed of *Salvia lanata, Craniotome versicolor, Leucas lanata, Ajuga brachystemon, Primula floribunda, Arisaema tortuosum, Rumex hastatus, Cynoglossum micranthum* and *Campanula colorata.* Some of the important ferns are *Pteris cretica, P. quadriaurita, Dryopteris pallida, Asplenium dalhousiae, A. ensiforme, Adiantum venustum,* etc. The common epiphytic fern is *Drynaria mollis.*

(ii) At other places, such as Dhanolti and Hanuman Chatti, at a comparable altitude, the *moru* oak forests are quite common. General floristics for these are the same as given for Chakrata.

10. **Oak Scrubs** : These scrub forests are distributed in easily accessible areas or near inhabitations extending from *ban* oak to the *moru* oak type. These scrubs are the result of damage or destruction of *Quercus incana* forests for fuel, fodder, and the shifting cultivation. Only bushy or thorny growth is left out. The ground is covered by various grass species.

*Floristics :*

(i) Mussoorie (1,850 m) : Stunted, unsound and degraded trees of *Quercus incana* are associated with *Rhododendron arboreum, Lyonia ovalifolia* and *Pyrus pashia.* Other bushy shrubs associated with it are *Berberis lycium, B. chitria, Crataegus crenulata, Prinsepia utilis, Wikstroemia canescens, Rhamnus virgata,* etc.

Common grass species are *Cymbopogon distans, Themeda anathera, Capillipedium parviflorum, Chrysopogon* sp., *Dicanthium* sp., etc. (Fig. 4). The herbaceous element which appears after monsoon is composed of *Artemisia parviflora, A. roxburghiana, Salvia lanata, Conyza stricta, Rhynchosia himalensis, Vigna capensis,* etc.

11. **Moist Deodar Forests** : These form almost a pure crop, but at times deodar is associated with *Pinus wallichiana* and *Picea smithiana.* The canopy is fairly complete but not very dense. Trees are with straight and tall boles, average height is 30-40 m. The broad leaved associates are oaks and *Rhododendron arboreum.* The density of shrubs depends on the extent of grazing.

These are largely distributed between 1,700-2,500 m and often merge appreciably lower on cool mountain aspects with *chir* pine and may reach much higher up, even to 3,200 m. Deodar forests avoid outer ranges, where the amount of rainfall

is high. The annual rainfall in areas with these forests is 110-180 cm.

*Floristics :*

(i) Kanasar (2,300 m) : The dominating tree is *Cedrus deodara*. It is associated with a few trees of *Pinus wallichiana, Quercus dilatata* and *Q. incana*. Common shrubs are *Berberis lycium, Viburnum nervosum, Spiraea canescens, Lonicera angustifolia, Abelia triflora, Deutzia staminea*, etc.

(ii) Patli Devi (2,100 m) : The floristics of this area are almost similar to that of Kanasar except for the fact that here *Viburnum nervosum* also met with. The epiphytic ferns on oak are *Drynaria mollis* and *Lepisorus clathratus*.

(iii) Lal Tibba (2,400 m) : *Cedrus deodara* is found in pure formations. Actually, it has been planted on lime stone soil where it is naturalized. Other scattered trees are *Quercus incana* and *Rhododendron arboreum*. Common shrubs are *Viburnum cotinifolium, Wikstroemia canescens* and *Berberis lycium*. Common ferns are *Pteris quadriaurita, Athyrium schimperi, A. pectinatum, Adiantum venustum, Dryopteris chrysocoma, Asplenium varians, Lepisorus excavatus, L. kashyapii, Polypodium microrhizoma, Polystichum squarrosum*, etc.

12. **Moist Temperate Deciduous Forests** : Such forests are constituted by the species often occurring more or less gregariously. The trees are usually much branched but with large girth and 20-30 m tall and the canopy is not so close. Thus there is a definite second storey of trees and large-sized shrubs. On suitable sites, both ferns and herbaceous flora are quite rich. The epiphytic growth of orchids, ferns and mosses is rich. These are distributed between 1,800-2,750 m, in moist places and depressions, generally as strips along streams or on gentler slopes.

*Floristics :*

(i) Gobind Ghat — Gobind Dham (2,000-2,500 m) : The upper canopy is chiefly constituted by *Aesculus indica, Betula alnoides, Populus ciliata, Ulmus wallichiana, Celtis australis, Juglans regia* var. *kumaonica, Alnus nitida, Acer caesium, A. pictum*, etc.

The second storey trees are *Corylus colurna, Lyonia ovalifolia, Ilex dipyrena, Cornus macrophylla, Prunus cornuta, Rhus punjabensis, Euonymus lacerus, Rhododendron arboreum, Morus serrata, Quercus incana, Salix oxycarpa, S. acomphylla, S. wallichiana* and *Taxus baccata*. At about 2,300 m pure strands of *Betula alnoides* (Fig. 7) have been seen.

The shrubby undergrowth is quite rich and is constituted by *Lonicera quinquelocularis, Viburnum cotinifolium, V. nervosum, Berberis chitria, B. edgeworthiana, Colquhounia coccinea, Spiraea sorbifolia, Indigofera gerardiana, Sarcococca pruniformis, Prinsepia utilis, Jasminum humile, Spiraea canescens, Deutzia staminea, Caragana brevispina, Abelia triflora, Salix elegans, Elaeagnus umbellata, Euonymus tingens, Excoecaria acerifolia, Hypericum cernuum*, etc. Common climbers are *Vitis himalayana, V. divaricata, Schizandra grandiflora, Rosa moschata, Hedera nepalensis, Rubus macilentus*, etc. A woody climber semiparasite, *Loranthus longiflorus* attacks a number of tree species.

The herbaceous undergrowth is constituted by *Strobilanthes dalhousianus, S. glutinosa, Justicia pubigera, Plectranthus maddeni, Elsholtzia flava, Salvia glutinosa, Brunella vulgaris, Paeonia emodi, Impatiens* spp., *Aconitum* sp., *Lilium giganteum*, etc. *Vanda parviflora* is a very common epiphytic orchid of this region. Common ferns are *Polystichum squarrosum, Athyrium schimperi, Pteris quadriaurita*, etc. Common epiphytic fern is *Drynaria mollis*.

(ii) Chakrata (2,100 m) : The trees in the upper storey are *Aesculus indica, Acer caesium, A. villosum, A. oblongum, Quercus dilatata, Betula alnoides, Alnus nepalensis, Quercus incana, Populus ciliata, Juglans regia,* var. *kumaonica, Persea odoratissima, Litsea umbrosa,* etc. The second storey is constituted by *Lyonia ovalifolia, Ilex dipyrena, Cornus macrophylla, C. capitata, Prunus cornuta, Symplocos chinensis, Rhus wallichii, Rhododendron arboreum, Sorbus foliolosa, Viburnum cylindricum, Buxus wallichiana,* etc.

Common shrubs are *Berberis* spp., *Hypericum cernuum, Daphne papyracea, Myrsine africana, M. semiserrata, Jasminum humile, Wikstroemia canescens, Buddleja crispa, Leptodermis lanceolata, Cotoneaster microphylla, Rhamnus procumbens, Desmodium tiliaefolium, Deutzia staminea, Viburnum cotinifolium, Spiraea canescens* etc. Common climbers are *Hedera nepalensis, Vitis* spp. and *Clematis* sp. *Loranthus longiflorus* is the common woody semi-parasite.

The herbaceous flora is almost the same as that of the Gobind Ghat — Gobind Dham area. Here, common ferns are *Pteris cretica, P. quadriaurita, Dryopteris pallida,* etc. *Drynaria mollis* and *Phymatopteris oxyloba* are epiphytic ferns.

(iii) Floristic account for Kedarnath and Badrinath is quite similar to that of Chakrata and Gobind Ghat areas.

13. **Moist Mixed Coniferous Forests** : These are the most attractive forests in the Himalayas and are composed of a varying mixture of coniferous species. Various broad leaved trees may be intermixed with conifers or form pure strips or patches. Average height of the trees varies from 40-50 m. The girth is usually large and the canopy is dense. The epiphytic growth of mosses and lichens is common but the climbers are very few.

These are distributed above deodar forests from 2,400 - 3,000 m. Detailed climatological data about these forests is lacking, but there is a good amount of snowfall in winter.

*Floristics :*

(i) Deoban (2,700 m) : The top canopy is composed of *Abies pindrow, Picea smithiana* and *Cedrus deodara.*

The trees in the second storey are *Quercus semecarpifolia, Euonymus lacerus, Rhamnus purpurea,* etc. At still lower altitudes, scattered trees of *Quercus dilatata, Q. incana* and *Litsea umbrosa* are also met with. Common shrubs are *Lonicera angustifolia, Viburnum cotinifolium, V. mullaha, V. nervosum, Jasminum humile* and *Deutzia corymbosa.*

Commonly seen herbs are *Viola serpens, Polygonum* sp., *Fragaria vesca, Impatiens* sp., *Valariana hardwickii, Geranium wallichiana, Strobilanthes atropurpureus, Galium* sp., *Thymus serphyllum, Ajuga brachystemon* and *A. parviflora.* Among climbers, may be mentioned *Hedera nepalensis, Vitis himalayana, Smilax vaginata* and *Asparagus filicinus.* The epiphytic ferns are *Lepisorus clathratus, Phymatopteris oxyloba* and *Drynaria mollis.* Other common ferns are *Dryopteris pallida, Adiantum venustum, Arthromeris wallichiana, Onychium contiguum, Polystichum squarrosum.* The western aspect of Deoban hill is barren and supports only shrubby growth of *Cotoneaster microphylla.*

General floristics of the mixed coniferous forests of Janaki Chatti (Fig. 5), Gangnani, Yamnotri (Fig. 9), Dhanolti and Hanuman Chatti at comparable altitudes are also similar to Deoban region.

(ii) Yamnotri (3,200 m) : The top storey is mainly composed of *Abies spectabilis, Abies pindrow* and *Picea smithiana.* Other trees of the lower storey are *Quercus semecarpifolia, Q. dilatata* and *Acer caesium.* The shrubby undergrowth is

mainly composed of *Berberis* spp., *Strobilanthes atropurpureus, Rosa sericea,* etc. The herbaceous and the fern vegetation is similar to Deoban.

14. **Upper West Himalayan Temperate Broad Leaved Forests — Kharsu Oak Forests** : *Kharsu (Quercus semecarpifolia)* forms a dense crop which is about 15-20 m high. There is very little admixture of other species. Trees are covered with dark green or brown mosses. The ground flora is composed of deciduous shrubs, ferns, grasses and herbs. In sheltered places, oak is replaced by *Abies* forests. These are distributed between 2,500—3,300 m along the outer and moister southern ranges. There is heavy snow fall in winters. Detailed climatological data are lacking.

*Floristics :*

(i) Near Yamnotri (2,950 m) : In the top canopy *Quercus semecarpifolia* is the most abundant. Other occasionally associated trees are *Abies pindrow, Picea smithiana, Cedrus deodara* and *Taxus baccata.*

The trees of the lower storey are *Ilex dipyrena, Pyrus lanata, Quercus dilatata, Euonymus lacerus, Syringa emodi, Rhamnus purpurea* and *Betula utilis.*

The undergrowth is composed of *Spiraea canescens, S. lindleyana, Salix elegans, Strobilanthes atropurpureus,* etc.

(ii) Deoban (2,700 m) : The main trees are *Quercus semecarpifolia, Picea smithiana, Meliosma dilleniaefolia, Abies pindrow, Cedrus deodara, Quercus dilatata,* etc. The second storey is composed of *Euonymus tingens, E. lacerus, Ilex dipyrena, Viburnum nervosum* and *V. cotinifolium.* Common shrubs are *Rosa macrophylla, Lonicera angustifolia, Jasminum humile, Rubus niveus, Berberis* sp., *Strobilanthes atropurpureus* and *Skimmia laureola.*

Common ferns are *Dryopteris pallida, Pteris cretica, P. quadriaurita* and *Adiantum venustum.*

VI. SUB-ALPINE FORESTS

15. **West Himalayan Birch-fir Forests** : These are irregular forests of *Abies, Betula* and *Rhododendron.* The undergrowth is mainly composed of species of *Rhododendron* and other small shrubs. In certain dry zones even *Quercus semecarpifolia* extends into it. These are distributed in the western Himalayas at 3,000-3,800 m chiefly on the northern slopes. At the upper limits, these merges into dwarf *Rhododendron* shrubs.

*Floristics :*

(i) Above Yamnotri (3,700 m) : The top canopy is mainly of *Abies spectabilis,* while the dominating tree of the second canopy is *Betula utilis* which is occasionally associated with *Quercus semecarpifolia, Rhododendron campanulatum, Sorbus foliolosa,* etc.

The undergrowth is composed of *Cotoneaster acuminata, Ribes* spp., *Lonicera purpurascens, L. alpigena, Rubus niveus, Viburnum nervosum* and *Salix* spp. During summer when snow melts, herbaceous elements appear for a very short duration.

VII. ALPINE SCRUB FORESTS

16. **Birch-Rhododendron Scrub Forests** : These are formed of *Betula utilis* and some species of *Rhododendron.* Birch attains height up to 6 m but the girth is not more than 60 cm. These forests are distributed above 3,500 m throughout the Himalayas. The soil is covered with thick humus layer and is generally wet.

*Floristics :*

(i) *En route* Hem Kund Sahib (4,200 m) : *Betula utilis* is the dominating species which is also associated with *Rhododendron campanulatum, Sorbus foliolosa, Syringa emodi,* etc. The shrubby undergrowth is composed of *Cotoneaster microphylla, Rhododendron lepidotum, R. anthopogon, Ribes glaciale, Polygonum vaccinifolium, Lonicera purpurascens* and *Salix* spp. The herbaceous element in summer months is

composed of species of *Primula,Potentilla, Frittillaria, Geum, Aster, Geranium, Polygonum,* etc. Common ferns are *Osmunda claytoniana* and the species of *Polystichum, Dryopteris, Athyrium, Cheilanthes,* etc.

(ii) Valley of Flowers (3,900-4,200 m) : The general floristics of this region are almost the same as given for Hem Kund Sahib area. Except for the fact that density of ferns and herbaceous elements in this area is very much high as compared to the adjoining localities.

## CONCLUDING REMARKS

Forests in the hills of the Garhwal Himalayas have been seriously affected by various biotic factors. Much damage has been done to the forests near inhabitations. The main reasons being lopping of trees for fodder, indiscriminate chopping of trees for fire, and fuel-wood, heavy grazing and felling of forests to make room for agriculture. Sal forests near Dehradun have been cut down to raise various orchards and for tea plantation. Recent stress on the opening of the Himalayas to tourists and for promoting communication systems for the defence forces, has greatly affected the existing forests because of highly accelerated road building activity. Around Mussoorie (near Jharipani), Rajpur, Sahasradhara, forest vegetation has greatly been destroyed due to repeated blastings for quarrying of lime stone. Other factors responsible for the destruction of forests in this region are the construction of hydroelectric projects and townships connected thereto. This is particularly true near Tehri, where thousands and thousands of acres of forests have been cleared and the landscape imparted a devastating look. Wrong methods adopted for tapping of pine trees for resin are also contributing towards the loss of the subtropical pine forests. Intensive tourist flow to the holy shrines of Yamnotri, Gangotri, Badrinath, Kedarnath and Hem Kund Sahib has put extreme pressure on forests for fuel. In all these places, nothing but forest wood is used for cooking and keeping warm. Opening of Valley of Flowers for grazing has done considerable harm to the herbaceous flora. Badrinath area now presents a look of cold desert. All said and done, there is an urgent need for taking up the forest conservation and regeneration projects. Serious efforts at the national level are needed to conserve the vast dwindling forest cover and to undertake reforestation programmes for checking menacing soil erosion in the region. In a country like India, with steadily rising standard of living, increase in population and brisk industrialisation, we find that our once inexhaustible forests are no longer adequate to meet even our current demands. During the last 3 decades, there is a gradual decrease in area under forest cover in India. Latest unofficial estimates are shocking since according to Chengappa (1982) the area under closed forests has been reduced to merely 10% of land mass. Earlier, Sagreiya (1967) placed it at 23.1% and then reduced to 17.4% (Anonymous 1976). Their output is certainly far far shorter of the projected requirements. To solve the problem of wood shortage, either additional areas of land must be brought under forests at the cost of agriculture and water resources or the productivity of the existing forests must be increased. As it is rather impossible to increase forest area to unlimited extent, so the second approach seems to be more feasible. Thus the improvement of forest trees on scientific lines becomes the necessity of the present times.

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Fig.1. Moist Bhabar Doon Sal Forest *Shorea robusta* dominant with occasional trees of *Eugenia jambolana. Cassia fistula* and *Careya arborea,* undergrowth is constituted by *Lantana camara* and *Murraya koenigii;* Lachiwala (Dehradun)

Fig. 2. Himalayan Chir Pine Forest : *Pinus roxburghii* and scattered trees of *Quercus incana;* Barkot.

Fig. 3. Denudation of Himalayan Chir Pine Forest due to agriculture and inhabitation; Chamba.

Fig. 4. Oak Scrub : *Quercus incana* with undergrowth of grasses, *Wikstroemia canescens* and *Prinsepia utilis;* Mussoorie.

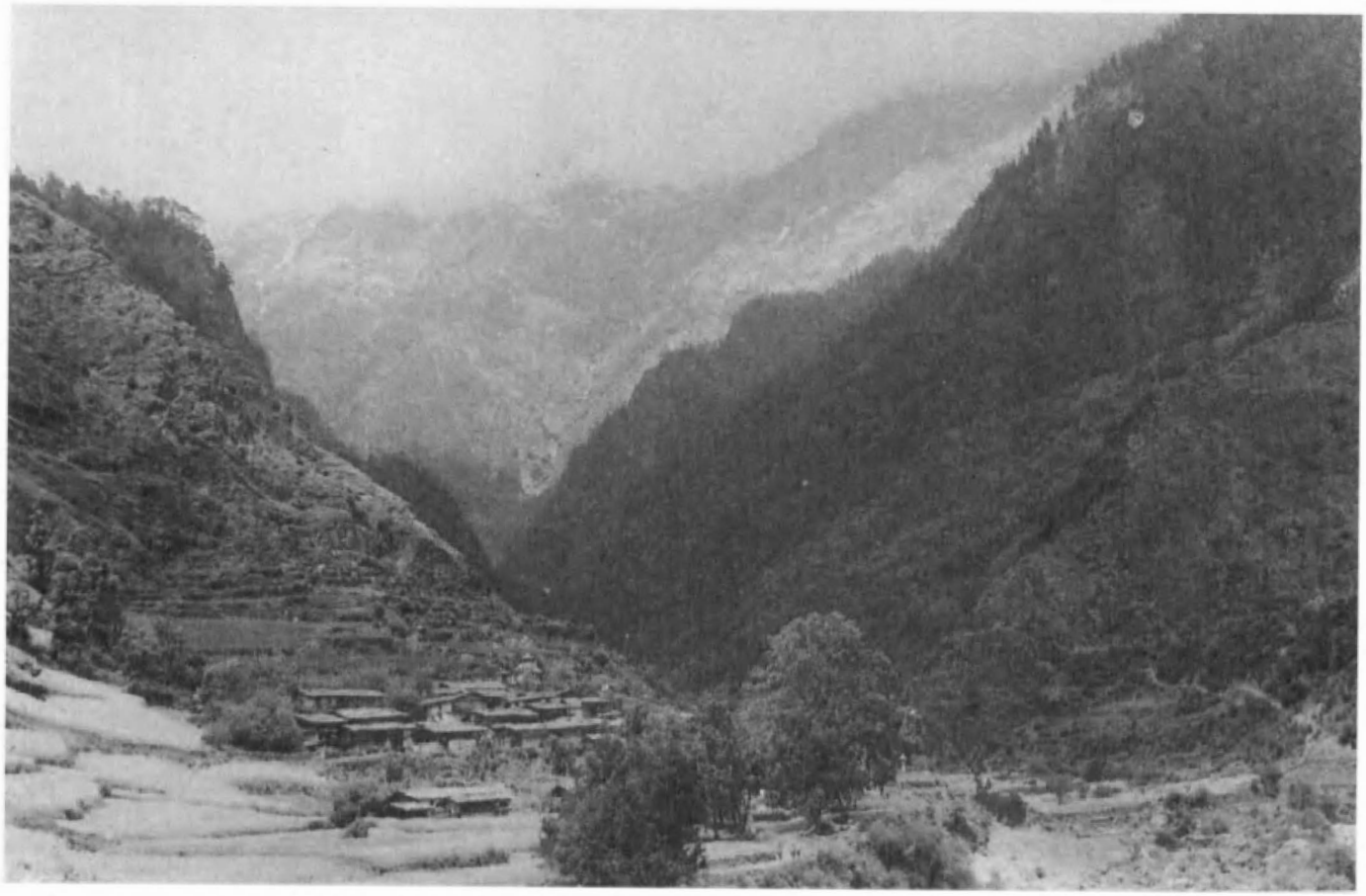


Fig. 5. Moist Mixed Coniferous Forest : *Abies pindrow, Picea smithiana* and *Cedrus deodara* and wheat fields in valley; Janaki Chatti (Uttarkashi).

Fig. 6. *Salix* sp. growing along riverbed, Janaki Chatti (Uttarkashi).

Fig. 7. Moist Temperate Deciduous Forest
An almost pure strand of *Betula alnoides*
Jangalkoti (Gobind Ghat).

Fig. 8. *Rhododendron arboreum* : a part of flowering tree with crimson red flowers in April-June.

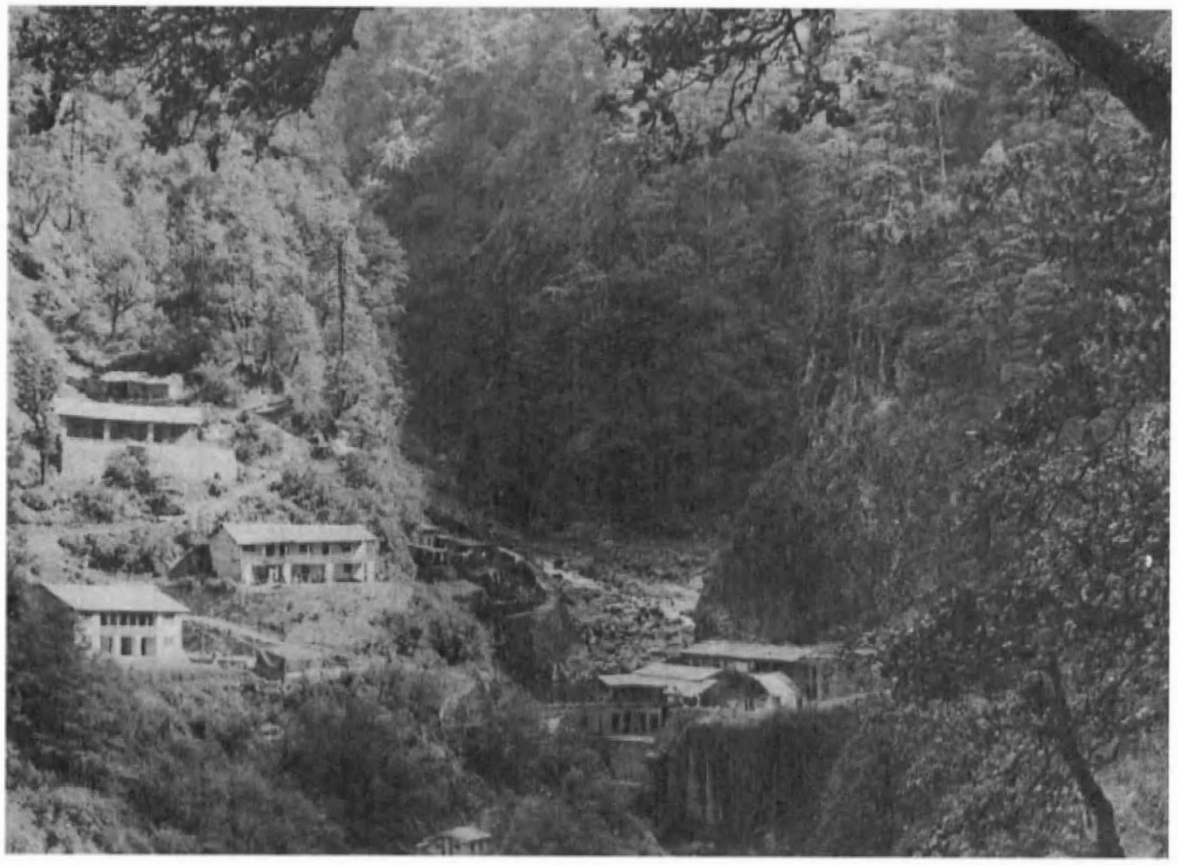
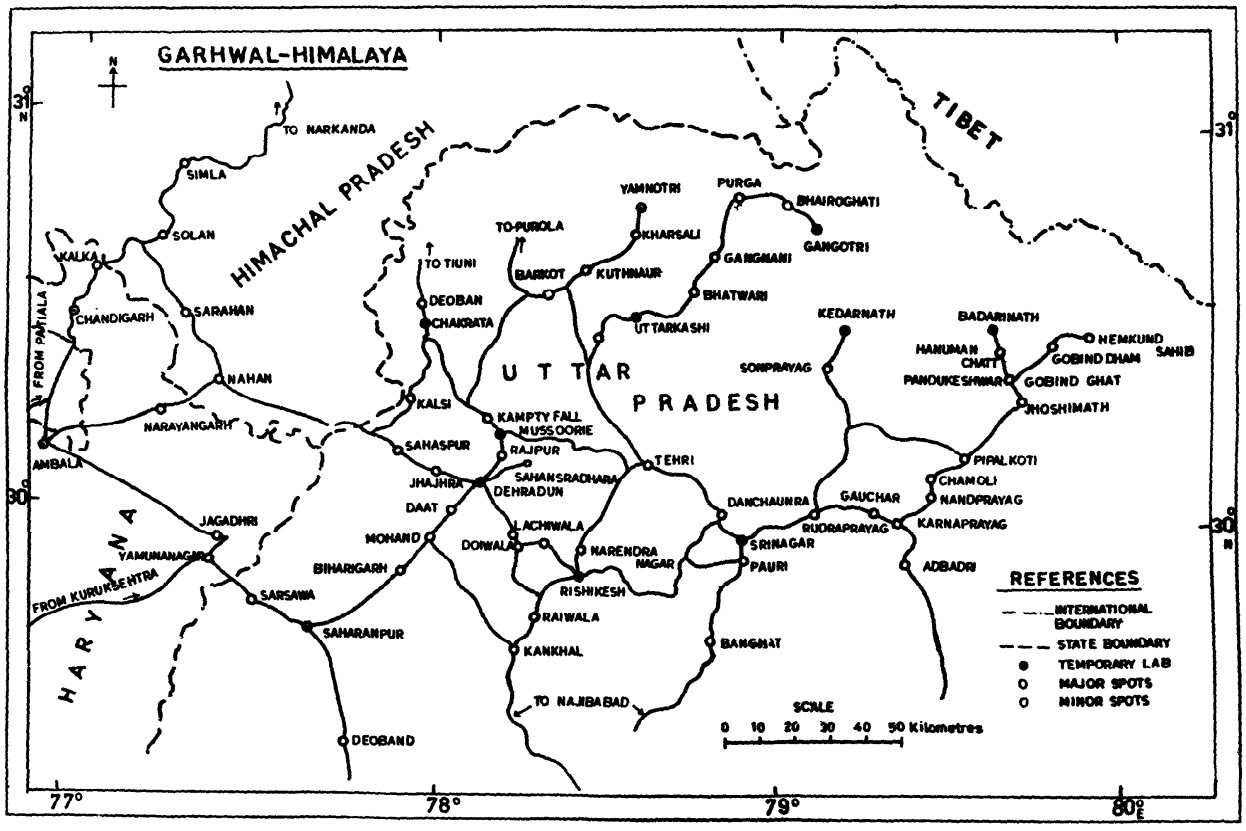


Fig. 9. Moist Mixed Coniferous Forest : *Abies pindrow, Picea smithiana, Quercus semecarpifolia* and *Q. dilatata;* Yamnotri (Uttarkashi).

Fig. 10. A tall tree of *Quercus dilatata;* Dhanolti Road (Mussoorie).




Showing the location of the various areas surveyed in the Garhwal Himalayas.